A comparative study of tension-free mesh and sutured repair in inguinal, para-umbilical, and incisional herniae

By Saleh Awadh Bin-Tayair

M.B.B.S (University of Aden) 1982

Master in Surgery (University of Baghdad) 1996

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Supervisor

Professor Yahia Al-Tayeb Al-Arabi
FRCS (E.) FRCS (L.) MD (B’ham)

Department of Surgery, University of Khartoum

External supervisor

Professor Hashem Abdull-rahman Mohammed
M.B.ch.B. (Baghdad) F.R.C.S. (Ed.) FRCS (Eng.)

Department of Surgery, University of Hadhramout-Yemen

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بسم الله الرحمن الرحيم

وفوق كل ذي علم عليم

(76)
Dedication

To my family
Acknowledgement

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A.S.A.: American Society of Anaesthetists
A.N.O.V.A.: Analysis of Variance
B.M.I.: Body mass index
C.V.A: Cerebra-vascular accident
C.O.P.D.: Chronic obstructive pulmonary disease
C.I.: Confidence interval
C.A.P.D: Continuous Ambulatory Peritoneal Dialysis.
D.M.: Diabetes mellitus
D.V.T.: Deep vein thrombosis
D0: Day of surgery
D1: First post-operative day
G.A.: General anaesthesia
G.P.R.V.S: Great Prosthesis of Reinforcement of Visceral Sac
H.R.: Hazards ratio
I.S.C.T.H. Ibn Sina Central Teaching Hospital
I.P.S.S. : International Prostate Symptom Score
M.R.I.: Magnetic resonance image
M.I.: Myocardial infarction
N. R. S.: Numerical Rating Scale.
P.I.: Protease inhibitor
P.H.S.: Prolene Hernia System
P.E.: Pulmonary embolism
S.A.: Spinal anaesthesia
S.P.S.S.: Statistical Package of Social Science
T.A.P.P: Trans-abdominal pre-peritoneal repair
T.E.P.: Total extra-peritoneal repair
U.S.: Ultrasonography
U.K.: United Kingdom
U.S.: United States


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ABSTRACT

Objectives:
To compare the outcomes of tension-free mesh and sutured repairs in inguinal, para-umbilical and incisional hernias.

Patients and methods:
This randomized controlled study of 1190 patients with primary inguinal (n=403), para-umbilical (n=372) and incisional (n=415) hernias, has been carried out at Ibn-Sina Central Teaching Hospital, and Al-Amal H., Hadhramout-Yemen., between September 2004 and December 2007. The patients were allocated to either mesh or sutured repairs after matching of risk factors for recurrences. The primary outcome measure was hernia recurrence over a period of 3 years of follow-up.

Results:
There were statistically significant differences in the recurrence rates between mesh and sutured repair groups of inguinal (1.5% versus 10.5%) para-umbilical (2.7% versus 12.9%), and incisional (4.3% versus 27.5%) hernias (p<0.001). The pain score and the analgesic consumption seemed to be significantly greater in the sutured groups (p<0.001). Return to normal activities was significantly shorter in the mesh groups than sutured repair group in inguinal (16.2±4. days versus 20.8±0.9 days) para-umbilical (20.9±5.6 days versus 23.6±10.5 days), and incisional hernias (23.8±6.8 days versus 26.6±13.5 days). The patients who had mesh repairs were significantly more satisfied with the procedure than those who had sutured repairs (p<0.001). The median operating time, hospital stay and the complications were comparable in the two groups, except that chronic pain was more in the sutured groups than in the mesh groups of inguinal (12.4% versus 4%), para-umbilical (14%versus 5.4%), and incisional (13% versus 4.3%) hernia repairs. The differences were statistically significant (p<0.001).

Conclusion:
Tension-free mesh techniques are safe, effective and easy to learn. They result in lower recurrences, lesser post-operative pain, less consumption of analgesia, and quicker rehabilitation. The study confirms superiority of tension-free repair over sutured repair.
الغرض من هذه الدراسة هو مقارنة النتائج بعد عمليات تصليح الفتق الأربي، الجار سري و الجراحي باستخدام الخياطة والشبكة الصناعية.

الدالة: 

لقد أجريت دراسة عشوائية ضبطية على 1190 من المرضى يعانون من فتق أربي (n=403, inguinal) وجارسي (n=372, para-umbilical) في مستشفى إبن سينا التعليمي المركزي ومستشفى الأم. حضرموت - اليمن، في الفترة ما بين سبتمبر 2004 وديسمبر 2007 حيث تم إخضاع المرضى عشوائيا إلى مجموعتين: تصليح الفتق بالشبكة الجراحية والخيوط التقليدية في كل من الفتق الأربي والجار سري والراححي وذلك بعد توزيع عوامل الخطوة الخاصة بتكرار الفتق بالنسايس بين كل مجموعة. معيار النتيجة الأولية كان عودة الفتق على مدى فترة ثلاث سنوات.

وجدت فروقات إحصائية واضحة بالمعادلات التي سجلتها عودة الفتق ما بين مجموعتي التصليح بالشبكة الصناعية ومجموعة التصليح بالخياطة في كل من الفتق الأربي (10.5 مقابل 15.6%, p=0.01) والجارسي (1.2% مقابل 2.7%, p<0.01). في مجموعة تصليح الفتق بالشبكة الصناعية كان متوسط نقاط الألم في المستشفى الإستهلاكية المسمكة للذين أقل (1.010) في كل من الفتق الأربي والجار سري والراححي، و بعد إعادة ممارسة النشاطات الاجتماعية بصورة مبدئية، 20 يوما للفتق الأربي، 23.6 يوما لللفتق الجار سري، و 23.8 يوما مقابل 26.6 يوما لللفتق الجراحي. لا توجد فروق ذات دلالة إحصائية في زمن العملية وعدد الأقاتما في المستشفى بين تصليح الفتق بالشبكة الجراحية والخيوط التقليدية. في كل من الفتق الأربي والجار سري والراححي.

مضاعفات ما بعد العملية كانت مشابهة في كل المجموعتين، ما عدا الألم المزمن كان أكثر في المجموعات المعالجة بالخياطة في كل من الفتق الأربي (2.5% مقابل 4.5%, p=0.01) والجار سري (14% مقابل 5.4%). الفرق بين كل مجموعتين كانت ذات دلالة إحصائية، الدالة p<0.01.

الخلاصة:

تفقيت تصليح الفتق باستخدام الشبكة الاصطناعية تعتبر أمنة من المخاطر، فعالة، وسهلة التعلم. تعطي نسبة إحصائية منخفضة في تكرار الفتق، درجة أقل في الم ما بعد العملية، استهلاكا أقل للأدوية المكسنة، وسرعة تأهيل تدل على تفوق تصليح الفتق بالشبكة الجراحية على تصليحة بالطريقة التقليدية.
Chapter One

Review of the Literature

1.1 History of Hernia

The earliest report of abdominal wall hernias dates back to Hummurabi of Babylon, and the Egyptian pharaohs (1551 BC). During this early era the abdominal wall hernias were treated with trusses or bandage dressings (1). The mummy of Ramses 5th (1151BC), had huge hernia sac in the groin. The mummy of Merneptah had an incision over his inguinal region with one testicle removed (1224 BC) (2). Hippocrates referred to this pathology as “etru rhesis” which means “rupture of the abdominal wall” (1). Since that time, hernia has been an interesting field to many surgeons and followed by evolution of many different techniques for hernia repair that reflect the continuing progress in the understanding of surgical anatomy, patho-physiology, and tissue biology of hernia throughout centuries of surgical practice.

The first evidence of operative repair of hernia dates back to Celsus, in the earlier part of the first century AD. He described an operation for inguinal hernia, through an incision in the neck of the scrotum. The hernia sac was dissected off the spermatic cord and transected at the external inguinal ring with orchidectomy (3). Around 700 A.D., principles of operative hernia repair involved mass ligation and en block excision of the hernial sac, cord and testis distal to the external ring as reported by Paul of Aegina (1). Casper Stromayer in 1559 advised that the testicle need not be removed, and made the first anatomical distinction between direct and indirect hernias (1). The picture became more clear with the description of “Processus Vaginalis” in 1790 by John Hunter, and the definition of the fascia transversalis, and the Cooper’s ligament in 1804 by Sir Astley Cooper (2).

In the middle of the 19th century, that the two major obstacles to the advance of surgery were overcome by means of the discovery of anaesthesia (1842-1846) and the development of asepsis methods by Joseph Lister in England (1867) by carbolic spray, and there was rapid progress in hernia surgery (4). By the beginning of the 20th century, Koch had developed methods of antisepsis, which
were followed by modern dry and wet heat sterilization, and there was rapid progress in inguinal hernia surgery.\textsuperscript{(3)}

1.2 Repairs of inguinal hernias

The three landmarks in the history of inguinal hernia repair were:
1- Tissue repair \textsuperscript{(3-5)}
2- Tension-free mesh repair \textsuperscript{(6)},
3- Laparoscopic hernia repair \textsuperscript{(7)}.

1.2.1 Tissue Repairs

The modern era in the surgical treatment of hernia was ushered in by the work of Marcy (Boston) \textsuperscript{(3)} and Edward Bassini (Italy) (1844-1892) \textsuperscript{(4)} in the late 19\textsuperscript{th} century. Early techniques entailed the use of sutures to close and reinforce the defect.

1.2.1.1 Henry Marcy

He was the first to introduce antiseptic techniques in the repair of hernia. He used high ligation of the sac and tightening of the internal ring by using carbolised catgut to suture the ring on two patients in 1871 \textsuperscript{(3)}. The depressing fact at this time was that the best surgical centers in both Europe and North America were reporting mortality rates of up to 7% in hernia operations. The recurrence rate after one year was 30% to 40%, and almost all hernias had recurred by the end of 4 years. \textsuperscript{(3)}

1.2.1.2 Bassini Repair

Bassini \textsuperscript{(4)}, revolutionized hernia surgery when he described his, radical cure, i.e., a truss would no longer be required (the title of his presentation to the Italian surgical society in Genoa, in 1887). He posted a milestone in the history of not only hernia surgery but of all surgery when he reported a reduction in the recurrence rate from 100% to 10% at a period without antibiotics, primitive anaesthesia and patients presenting with giant size hernias\textsuperscript{(5)}.
Bassini’s repair was conducted in the pre-peritoneal plane and emphasizes both the high legation of the hernia sac and reinforcement of the posterior inguinal canal: after opening of the inguinal canal by splitting the external oblique aponeurosis through the external ring, and excision of the cremaster to expose the spermatic cord, he divided the transversalis fascia from the pubic tubercle to beyond the internal ring. Hernial sacs were dissected and legated under direct vision, flush with the peritoneal cavity.

Using interrupted sutures of silk, Bassini sutured the internal oblique, and transversus abdominis muscles, and the upper leaf of the transversalis fascia in one layer to the lower leaf of the transversalis fascia and the shelving edge of the inguinal ligament. He then placed the cord against that newly constructed wall and closed the external oblique aponeurosis over it, and reformed the external inguinal ring (4).

1.2.1.3 Modified Bassini Repairs
Concerns about bladder fistulae and injury to the external iliac vasculature in the preperitoneal plane and other problems of opening the posterior wall, led other surgeons such as Walfer, Halsted and Halsted 11, Ferguson Andrews Tanner and, McVay Anson, and Shouldice to modify his repair (3).

The modifications avoided the opening of the posterior wall, and leaving the cremaster alone. A suture placed between the transversalis fascia and the inguinal ligament creates tension on the tissues approximated. The results achieved with these modifications were not as good as those of the method originally described by Bassini. The recurrences were primarily in the pubic tubercle area, and were blamed on an inadequate exposure of the preperitoneal space, leading to missed and residual sacs with persistent defects in the transversalis fascial floor of the inguinal canal, or blamed to poor surgical technique, rather than a metabolic or tissue defect that might predispose to recurrent hernia (3).

1.2.1.4 MCvay & Anson (Cooper's ligament) repair:
McVay & Anson (8) further popularized the operation in U.S.A. in 1940 with the addition of a relaxing incision to reduce the increased tension from the repair. However, many surgeons found that it is a more difficult operation, involving much wider dissection, and it was sometimes difficult to approximate the transversus arch to the Cooper’s ligament, it has frequently resulted in a considerable suture-line tension enough to require one or more relaxing incisions, patients complained of a considerable and prolonged post-operative pain, and failure rates became unacceptable. The overall results of hernia repair today are far from satisfactory with recurrence rates varying from 10% to 30% (8).

1.2.1.5 Shouldice Repair
E.Earle Shouldice in 1953 (9), described a modification to the Bassini’s repair, relying on a 4 layer closure through a special continuous suturing technique thereby doubling the fascia transversalis. Recurrence rates of around 0.5% to 1.0% have been reported (20), by the Shouldice Hospital, which were produced by a highly specialized group of surgeons dedicated to the repair of these hernias. In addition, they rejected certain patients such as the obese as well as all incarcerated or strangulated hernias and this may be a factor in their good results. The method is complicated and requires a good deal of dissection. One big drawback of both the ‘‘original,, Bassini’ s and Shouldice repairs is that the surgeon in training may find the method complicated and difficult to master or achieve good results (10).

1.2.1.6 Nyhus Posterior Iliopubic tract technique:
Nyhus described a posterior Iliopubic tract technique. He sutured the arch of the transversus abdominis aponeurosis above to the iliopubic tract below. The recurrence rate has been reported as around 2% (11). The tissue repair of this technique was later changed to tension-free mesh repair as performed by many French surgeons (12).

1.2.1.7 Darn repair:
Darn repairs were first introduced in the early 20th century to reduce wound tension by using either autologous tissue or synthetic suture to bridge the gap
Muscle and fascial flaps were attempted without success (3). In 1918, Handley introduced the first use of silk as a prosthetic darn (darn and stay-lace procedure) followed by Oglivie, who introduced his “silk lattice repair,”; Maingot, in 1940, 1941, and 1979, who advocated floss silk for his darn, and McLeod also reported using silk for the posterior lattice repair (3). However, it was found that heavy prosthetic material increased the risk of wound infection, and the silk suture ultimately lost its strength over time.

Several years later, a nylon darn technique was introduced by Moloney (13) in 1948. His recurrence rate was less than 1%. Abrahamson (1987, 1988) reported a recurrence rate for primary repairs between 0.33% and 0.8% (14). Up to this stage, the procedure constitutes a tissue repair and its strength depends on that of the tissues used.

### 1.2.2 Tension-Free Repairs

The Bassini repair, as well as several variants that have taken on various eponyms over the years, dominated the first half of the 20th century. Almost all of these repairs have sutured closure of the defect, which is under tension, as the edges of the defect are approximated. The problems associated with tension in tissue repair especially with wide defects (pain, prolonged recovery time, recurrence) prompted surgeons in the second half of the century, to seek some form of tension-free repair.

Four developments followed this change: The routine use of prosthetic materials (15) the acceptance of the tension-free concept in some centres in U.S.A. (16). The realization that the preperitoneal space can be used for hernia repair (12) and therapeutic laparoscopy evolved (17).

### 1.2.2.1 The prosthetic materials

The earliest use of prosthetic reinforcement for hernia repair was begun by Phleps in 1894. He used silver wire coils placed in the floor of the inguinal canal, and then approximated the layers of the abdominal wall over the coils, relying on the induced foreign body reaction and fibrosis to reinforce Bassini repair (18).
This concept was expanded by Meyer, and Bartlett in the United States, and McGaven in Britain\textsuperscript{(18)}. They used silver-wire filigree sheets shaped to fit the size and contours of the gap in the tissues and sutured to the borders of the defect. Ball\textsuperscript{(18)} in 1958 used larger silver wire filigree placed in the preperitoneal space. This material eventually fell out of favour because of disintegration, seromata and late infection with sinus discharge. Other materials were tried e.g. tantalum and stainless steel\textsuperscript{(5)}, However, wire patches eroding into the adjacent structures, were difficult to work with, and were too stiff.

Instead, surgeons sought sheets of natural tissues. Flaps of fascia from the thigh, flaps of aponeurosis of the external or internal oblique muscle or of the anterior rectus sheath, sheets of fascia as free grafts from the thigh, fascia lata, or abdominal wall and even sheets of skin, as reported by Mair in 1945 to be sutured to the edges of the posterior wall of the inguinal canal. Since that time, a number of other synthetic materials (non-metalic) including Fortisan fabric, Polyvenyl spong, Knitted weaves of Nylon mesh (1944), and Carbon fibre, have been utilized for hernia repair. None of these materials withstood infection, rejection and recurrence\textsuperscript{(18)}.

A synthetic patch made of polymer (Marlex 50 mesh) was introduced in clinical work (for repair of incisional and inguinal hernias) by Usher in 1958\textsuperscript{(19)}. This material is easily cut to the required shape, is flexible and pleasant to handle, and is practically not destroyed in human tissues. The threads are monofilament, extremely smooth, inert and thus elicit little tissue reaction. Consequently, they are not rejected, even in the presence of infection. Usher and Wallace, described this new material as possessing high tensile strength (50,000-150,000 lbs/m\textsuperscript{2}) and pliability, being impervious to water and resistant to most chemicals, with a softening temperature of 260\textdegree F\textsuperscript{+}, so that sterilization by boiling was no problem, and as an implant it became infiltrated by connective tissue. Collagen tissue can be laid down through the interstices of the weave so that the material is incorporated into healthy new tissue\textsuperscript{(20)}.

Usher placed it anteriorly in the preperitoneal space, thus covering and widely overlapping the inguinal portion of Fruchaud’s myopectineal orifice\textsuperscript{(21)}. Thus
began the era of tension-free hernia repair. There was a recurrence in 10.2% for incisional hernias and 5.9% for inguinal hernias, with complication rates of 15% and 4.3%, respectively. In recent years, sheets of woven monofilament polyamide or knitted monofilament polypropylene have become available\(^{(22, 23)}\).

A further synthetic mesh was crafted from polyethylene terephthalate (polyester) fibers, and introduced in hernia surgery by Wolstenholm in 1956. The properties of polyester used in hernia repair include flexibility, high tensile strength, and high resistance to stretching, furthermore, a sufficient foreign body reaction is induced, resulting in incorporation into the abdominal wall\(^{(24)}\).

A very inert material, expanded polytetrafluoroethylene (e-PTFE), was introduced to hernia surgery by Sheret et al. It has been reported to show incidence of lower rates of adhesion formation than polypropylene\(^{(25)}\).

1.2.2.2 Stoppa Great Prosthesis for Reinforcement of the Visceral Sac (G.P.R.V.S.)

In 1967, Stoppa described an open tension-free posterior preperitoneal mesh repair called the great prosthesis for reinforcement of the visceral sac (GPRVS). He recommended it especially for huge and multiple recurrent hernias in which the tissues have become scarred and weakened and the normal anatomy destroyed. The procedure was performed through a lower midline incision, and a large piece of mesh was placed without suture into the the preperitoneal space. The mesh was of sufficient size to span all of the potential hernia and was held in place by intra-abdominal pressure, an application of Pascal’s principle\(^{(26)}\).

1.2.2.3 Lichtenstein Tension-free mesh hernioplasty:

In the first edition of his book\(^{(27)}\), Lichtenstein described the use of a 3 cm. x 8 cm. plastic mesh patch placed across the inguinal floor for direct and indirect hernias. He recognized that suture line tension was the main cause of failed hernia repairs and that elimination of this problem would largely reduce recurrences. The first edition of his monograph does not present the well-known Lichtenstein “tensionless” repair.
In the second edition of his book in hernia repair (28) published in 1986, Lichtenstein reviewed his total experience with all abdominal hernias, and described a tension-free repair (112,113).

In 1989, Lichtenstein and colleagues (29) reported their use of prosthetic onlay technique, “the tension-free hernioplasty,” in 1000 patients with minimal complications and a zero recurrent rate, after follow up between 1 and 5 years. Unlike surgeons who had reserved prosthetic mesh for difficult cases, Lichtenstein was proposing its routine use for all groin hernias.

He crystallized his procedure to a few simple essentials: outpatient procedure, local anaesthesia, adequate mesh size, and inferiomedial corner to overlap the pubic tubercle, overlap of the mesh lateral to the cord, loose sutures between mesh and tissue and early if not immediate mobilization (29). He pioneered the idea that hernia surgery is a specialty and should be performed by experienced surgeons. It requires the use of mesh to cover the entire inguinal floor (Lichtenstein) (30). A plug and mesh (Gilbert-Rutkow) (31,32) or a Prolene Hernia System (PHS) (33,34) was popularized by Gilbert. The recurrence rate was around 1.5% with a follow-up of more than 10 to 15 years (33), though Fasih et al (35) has quoted a figure of 0.5%.

1.2.2.4 Laparoscopic repair

Ger had advocated laparoscopic repair of hernia in 1990 (47). With the introduction of the modern laparoscopes, two main laparoscopic techniques were developed for hernia repair: the transabdominal preperitoneal (TAPP) (36) and the total extraperitoneal (TEP) (37). The basis of the repair independent of the type of approach is the use of a large piece of mesh to cover the three potential inguinal hernia defects: indirect, direct and femoral (38). The method is costly, technically difficult, and has long learning curve (39). Initial reports suggested that it is associated with less post-operative pain and more rapid return to normal activity, but hospital stay and recurrence rates are no better than with open mesh repair. The possible complications are more serious (40).
1.2.3 Desarda repair

Desarda\(^{(41)}\) in 2001 developed a new technique based on physiological principle that provides dynamic posterior wall for inguinal hernia repair. He placed a strip of external oblique aponeurosis to strengthen the posterior abdominal wall. His prospective cohort study is conducted by the author alone and therefore may be subject to a personal bias.

1.3 Umbilical Hernia Repairs

Umbilical hernias have been documented throughout history since the ancient Egyptians. The first known record of a surgical repair of umbilical hernia was by Celsus in the first century AD \(^{(3)}\). William Cheseldene reported the repair of one in 1740\(^{(42)}\).

The modern method for the surgical management of umbilical hernias dates from 1881 by Lucas Championniore \(^{(3)}\) who reported the longitudinal overlapping of fascial layers. In 1901 William J. Mayo described a series of transverse overlapping fascial operation rather than longitudinal overlapping, using non-absorbable sutures \(^{(43)}\). Repair with simple direct apposition of the fascial defect in a transverse orientation has also been described \(^{(3)}\).

For many years, Mayo repair was established as the procedure of choice for umbilical hernia repair, though some advocated combined suture and Darn repair. Despite the frequency with which these defects were repaired results for this primary tissue repair remain problematic with significant rates of both recurrences and wound complication \(^{(44, 45)}\). However, retrospective studies have shown high recurrence rates amounting to 10-30 % \(^{(46)}\). In Mayo’s original series
it was reported in only 2 out of 75 patients. In the series of Kelly, Pringle, Dubose and Turner, the recurrence rates ranged between 22% and 40%. The lowest figure (7.5%) seems to be the one reported by Gibson and Gasper (47).

With the introduction and acceptance of mesh for inguinal hernias, it has been possible to close defects of any size without tension. Several tension-free techniques have been developed for open para-umbilical hernia repairs including: onlay or sublay mesh patch (48), mesh-plug (42), and Prolene Hernia System techniques (49). Laparoscopic repair using preperitoneal approach also has been advocated (50).

1.4 Incisional Hernia Repairs

Major abdominal surgery developed rapidly during the later part of the last century and with it raised the incidence of incisional hernias (3). For more than 100 years, attempts have been made to develop successful methods of repairing them. Incisional hernias have traditionally been treated by primary closure, including: anatomic layer-by-layer reconstruction, mass layer reconstruction, vertical or transverse overlap of the anterior rectus sheath, Keel operation, and Nuttall’s operation. Almost all of these repairs were tissue repairs, creating tension on the suture line and were followed by a high incidence of complications and recurrence rate (3).

Implants of foreign material were used to bridge gaps of incisional hernias, before the use of natural tissues. Meyer, Bartlett in 1903, and Mc Gavin in 1909 advocated the use of silver-wire filigree. Koontz and Throckmorton, each in 1948, used tantalum gauze (18). Sheets of stainless steel and tantalum also were used. These metals, fragmented within a short time, and the hernia recurred in many patients. Furthermore, the fragments of metal caused skin sinuses and even perforation of the bowel (18). As well as in inguinal hernia repairs, fascia lata grafts used in the form of strips or sheets have been reported also for incisional hernia repairs. The use of skin in sheets or strips also has been advocated. These
tissues tended to be absorbed and were associated with a high recurrence rate, and high complications such as sinus formation, dermoid cyst, and even malignant change (18).

The modern era of prosthetic hernia repair began in 1958 when Usher reported his experience with polyamide mesh (51). Later, braided polyester mesh, polypropylene, and expanded polytetrafluoroethylene (ePTFE) were introduced. These three materials have revolutionized the repair of incisional hernia (3). The use of sheets of nonabsorbable synthetic mesh prosthesis placed across the defect, have eliminated the un-necessary tension and decreased the high recurrence rate historically associated with sutured repair. Many variations of mesh repair have been described with respect to positioning of the graft on the abdominal wall including onlay, sublay, preperitoneal and intraperitoneal onlay mesh repair (52,53) even laparoscopic approach.

1.5 Specific types of abdominal hernias

1.5.1 Inguinal Hernias

1.5.1.1 Definition:
An inguinal hernia is defined as a protrusion of peritoneal sac through a weakness or defect in the posterior wall of the inguinal canal (54).

1.5.1.2 Incidence:
Inguinal hernias are a common surgical problem, and account for approximately 75% of all external hernias (55). The exact prevalence is not known, but the accepted estimated incidence is 3% to 4% of the male population (56). It varies between 5% and 8% in patients 25 to 40 years of age, and ≥ 45% of males at 75 years of age and older (3). After an initial peak in the infant, inguinal hernias become more prevalent with advanced age. In the same way, the complications of hernias (incarceration, obstruction and strangulation) are found more commonly
at the extremes of age. Men are affected more common than women with a ratio of 12:1\(^{(57)}\).

Indirect inguinal hernias constitute about 65% of inguinal hernias. They are most common in the young, and their frequency decreases with age. Males are twenty times more affected than females. Fifty five percent are right-sided, due to later descent of right testis and a higher incidence of failure of closure of the processus vaginalis, and 12% are bilateral. If both sides are explored in an infant presenting with one hernia, the incidence of a patent processus vaginalis on the other side is 60 % \(^{(54, 55)}\).

Direct hernias, are common in elderly men particularly in asthenic with poor lower abdominal musculature, but extremely uncommon in women. In adult males, 35% of inguinal hernias are direct, 12 % of patients will have a contralateral hernia in addition, and there is a four-fold increased risk of future development of contralateral hernia if one is not present at the original presentation. \(^{(54,55)}\)

1.5.1.3 Aetiology of inguinal hernias

It is assumed that the cause of primary inguinal hernia is probably multifactorial with one or more factors applying in any particular case and largely unaffected by human behaviour. The factors involved are:

(1) **Patent processus vaginalis**

The development of the processus vaginalis, its migration into the scrotum, and its final obliteration are linked to the descend of the testis from the abdominal cavity into the scrotum. The presence of a patent processus vaginalis does not necessarily indicate that an indirect inguinal hernia is present, nor does it mean that one will necessarily develop in the future. Surana \(^{(57,58)}\) found, at adult autopsy (postmortem) examination, that 20 % to 30% of adults have a patent processus vaginalis, yet they did not have a hernia during life. Therefore,
additional factors must be present to produce an indirect inguinal hernia when a patent processus vaginalis is present.

(2) Shutter mechanisms

Extremely high intra-abdominal pressures are generated when an individual coughs, strains or lifts heavy weight, but the abdominal wall usually maintains its integrity in the majority of individuals in spite of preformed weak areas, notably the transversalis fascia and the internal ring. The accepted explanation for this is the physiologic shutter mechanism, which is activated when the abdominal muscles contract and cause increase in intra-abdominal pressure when performing these functions.

As the external oblique muscle contracts, it becomes tense and presses on the weak posterior wall of the inguinal canal and so reinforces it and also tends to pull the inguinal ligament upward. At the same time, the muscular arch passing over the cord also sharply contracts, and as its fibers shorten, the arch is straightened out and comes to lie on, or close to, the raised inguinal ligament and so protects the weak posterior wall of the canal. As this shutter comes down, it passes in front of the internal ring and so counteracts the pressure on the ring from inside the abdomen.

The very act of contraction of abdominal muscles in coughing or straining tends to blow out the internal ring and the fascia automatically and at the same moment brings into play mechanisms that resist this damage.

(3) Raised intra-abdominal pressure:

Recent work suggests that the conditions that raises intra-abdominal pressure do not cause groin hernias on their own but there may be additional facilitating factors acting on the basic aetiology to bring a hernia on.

When the intra-abdominal pressure is actively raised, as in coughing, straining or lifting, the physiological shutter mechanisms are automatically activated and, together with the transversalis fascia, are usually sufficiently efficient to resist the increased pressure, and a hernia does not appear; however, when the intra-
abdominal pressure rises passively and the abdominal muscles are relaxed, these mechanisms are not activated, so that the fascia transversalis is left on its own to withstand the increased intra-abdominal pressure. If a patent processus vaginalis is present, or if the fascia transversalis becomes attenuated by prolonged pressure, and stretching, it gives way and an indirect or direct hernia appears.

In elder men, in whom the aging process and stresses of life have weakened the abdominal muscles, the shutter mechanism, and the fascia transversalis, only a moderate effort seems to be sufficient to suddenly produce a groin hernia, indirect through a pre-existing patent processus vaginalis or direct through a tear or rupture of the transversalis fascia or the bulging, direct hernia may simply stretch and balloon out the attenuated fascia transversalis in front of it (59). A decrease in oxytalan fibres and an increase in the amorphous substance of the elastic fibres as a function of age may be responsible for alteration in the resistance of the transversalis fascia and high incidence of groin hernias in elder men (61).

(4) The integrity of the transversalis fascia:

The mechanisms responsible for the weakening of the muscles and fascias of the abdominal wall include:

:a – State of collagen fibers:

The ability of the fascia transversalis to withstand the physiologic and pathologic elevations in the intra-abdominal pressure is dependent on the state of the collagen fibres that make up its tissues and give it strength. Collagen is an active, live tissue maintained by a constant balanced state of production and absorption. The factors that interfere with normal production of collagen or cause its increased destruction or the production of abnormal collagen include certain congenital connective tissue disorder such as Marfan’s, Ehlers-Danlos, and Hurler–Hunter syndromes, and certain mesenchymal metabolic defects
causing a deficiency of collagen and structural abnormalities of the collagen fibres, predisposing to groin hernia \(^{(59)}\).

**b- Cigarette smoking:**

Read has investigated the normal and abnormal metabolism of collagen and its relationship to the causation of hernia, especially in smokers \(^{(62)}\). He found a free unbound and active protease and elastase compounds in the serum of smokers, apparently discharged by the increased number of circulating white blood cells in the blood and lungs of smokers. These circulating unopposed enzymes upset the protease anti-protease system in the blood and bring about destruction of elastin and collagen of the rectus sheath and fascia transversalis and so cause their attenuation and predispose to herniation in cigarette smokers. It is found that the level of circulating serum elastolytic and proteolytic substances is higher in the blood of patients with hernias than in controls. It is also high in those with direct compared with indirect hernias, and is still higher in those with bilateral direct inguinal hernias \(^{(62)}\).

**c- Stress and systemic illnesses**

Stress and systemic illnesses increasing the level of circulating proteases and elastases, but not related to smoking, and causing a disturbed protease anti-protease balance and destruction of tissues leading to hernia formation. These conditions lead to an enhanced leukocyte response and discharge of proteases and oxidants from the leukocytes, with a rise of elastase in the blood leading to a relative decrease in anti-protease activity \(^{(101,102)}\). These mechanisms may be partially responsible for attenuation of the fascia transversalis in non-smokers, in a fashion similar to smokers \(^{(62)}\).

**General factors:**

The ability of the abdominal wall in the groin to withstand the forces of herniation may be reduced by the weakening of the muscles and fascia with advancing age; lack of physical exercise; adiposity; multiple pregnancies and loss of weight as may occur after illness, operation, or prolonged bed rest. Certain cosmetic operative incisions, such as very low and unduly long transverse abdominal incisions for gynaecological or urological procedures or cosmetic appendectomy incisions, may be followed by the appearance of a groin hernia caused by cutting into the aponeurotic arch of the lower fibres of the internal
oblique and transversus abdominis muscle and or cutting across the motor or sensory nerves of the groin, causing atrophy of the muscles (59).

1.5.1.4 Anatomic classification of inguinal hernias

Inguinal hernias are divided according to the location of the actual hernia defect to the inferior epigastric vessels into indirect and direct inguinal hernias.

(1) Indirect inguinal hernia
It is a protrusion of the peritoneal sac down the inguinal canal, on the outer (lateral and anterior) side of the spermatic cord, from the deep ring, and may extend beyond the external ring to the scrotum or the labium majus, it is then described as inguino-scrotal or inguino-labial hernias (54,55).

It develops lateral to the inferior epigastric vessels, and represents a congenital persistent processus vaginalis which becomes patent during child-hood or adult life until weakening of the surrounding transversalis fascia as a result of degeneration at the neck of the sac, or because of increased abdominal pressure (54).

(2) Direct inguinal hernia
It is a protrusion of the peritoneal sac directly forwards through a defect or weakness in the posterior wall of the stretched inguinal canal, medial to the inferior epigastric vessels and behind the spermatic cord. In the majority, the whole of the transversalis fascia may be defective, resulting in a diffuse bulge (54,55).

A direct inguinal hernia is always acquired. The patient often has poor lower abdominal musculature. The sac is often smaller than the hernial mass, would indicate; the protruding mass is consisting mainly of extraperitoneal fat. Occasionally the medial half of the sac of a direct hernia is composed of the urinary bladder. The predisposing factors are smoking and occupations that involve straining and heavy lifting. Damage to the ilioinguinal nerve (from previous appendicectomy) is an other cause, due to resulting weakness of the conjoined tendon (54).
1.5.1.5 Diagnosis

- Clinical examination
  Most early inguinal hernias can be diagnosed by appropriate history and careful physical examination. Except for pain or a dull dragging sensation in the groin, the common reducible inguinal hernia usually does not cause significant symptoms (54).

- Sonography
  It may be useful in diagnosing inguinal hernias in patients who report symptoms but do not have a palpable defect, and in differentiating an incarcerated hernia from a pathologic lymph node, hydrocele, lipoma, saphena varix, femoral aneurysm, and ectopic testis (54).

- CT/MRI
  In the extremely rare patient with inguinal pain but no physical or sonographic evidence of inguinal herniation, computed tomographic scanning or magnetic resonance image can be used to evaluate the pelvis for the presence of small hernia particularly uncommon types such as spegilian, obturator or paraduodenal hernia (56,63).

1.5.1.6 Complications of inguinal hernias

1) Irreducibility:
   It occurs when the contents of the sac can not return completely into the abdomen, without evidence of other complications, usually due to adhesions between the sac and its contents or over-crowding within the sac. It occurs in 2 to 18 percent of patients; the incidence rises to 30 percent or more in the first 8 weeks of life. This poses two dangers; intestinal strangulation with gangrene, and gonadal infarction. The risk of gonadal infarction secondary to irreducibility appears to be much higher (30%) in infants less than 12 weeks when compared with older children (3).

2) Obstruction:
Is an irreducible hernia containing intestine, which is obstructed from within, or from without, but, there is no interference with the blood supply of the bowel (55). The obstructed hernia may lead to strangulation and gangrene of the obstructed segment if it is not released promptly. The mortality of obstructed hernia is high in patients with co-existing cardio-pulmonary disease, whereas morbidity is influenced by the viability of the contents of the hernial sac. In turn, this is directly related to the duration of irreducibility or incarceration or delay in presentation (64).

(3) Strangulation:
It is a state where the blood supply of hernia contents is seriously impaired. Bowel gangrene occurs as early as 5-6 hours after the onset of the first symptoms if the strangulation is not released immediately (63). Estimates of the risks of strangulation vary enormously. Galleggos (65), reported that the probability of inguinal hernia strangulation was 2.8 % at three months, 4.5 % after 2 years and 8.6 % after 5 years; (an estimated annual strangulation risk of 1.7 %).

(4) Inflamed hernia;
It can occur when the contents of the sac become inflamed e.g. acute appendicitis or acute salpingitis, or in the terminal stage of strangulated hernia (54, 55, 63).

1.5.1.7 Mortality:
The mortality may occur mainly from the complications of hernia (usually strangulation or incarceration). The mortality rate is much higher following emergency surgery than after elective surgery. The largest series of strangulated hernia was described by Frankau in 1931 (66). He studied 1487 strangulated abdominal hernia from a number of hospitals in Britain and Ireland. The mortality rate from strangulation was 12.6 % for inguinal hernia.

1.5.1.8 Risk
Most can be managed easily, but if neglected, they cause serious medical, social, psychological and economic problems (55). Indirect inguinal hernia is more likely to strangulate than a direct one, because the deep ring is narrow and has a relatively fixed margin. On the contrary, the vast majority of direct inguinal
hernias are spontaneously reducible when the patient lies down and rarely strangulate, because of the direct path and wide neck of the sac(3).

1.5.1.9 Current Surgical Options

Surgical repair is the treatment of choice in all hernias to alleviate symptoms and to prevent the significant complications of hernias, such as incarceration or strangulation. Three options have been described:

(1) Tissur repairs

Tissue repairs such as Modified Bassini (55), McVay (3), and Shouldice (3), close the defect with suture resulted in unacceptably high recurrence rate, with the exception of Shouldice repair which uses meticulous dissection to obtain a low recurrence rate.

(2) Open tension-free repairs

The two most common prosthetic repairs are the Lichtenstein onlay patch (36) and the "plug and patch" repair as described by Gilbert (30) popularized by Rutkow and Robbins (31). Other authors advocated the use of posterior preperitoneal tension-free repairs, including Nyhus (11), Rives and Stoppa (12). The original operation as described by Nyhus (11), repairs the hernia primarily with suture, but more recent modifications incorporate a mesh patch posterior to the floor of the inguinal canal (26).

(3) Laparoscopic repairs

The standard laparoscopic technique for inguinal hernia repair is based entirely on the preperitoneal hernia repair. Three different techniques exist for laparoscopic repair of groin hernias: transabdominal preperitoneal repair (TAPP) (65), total extraperitoneal approach (TEP) (37), and intraperitoneal onlay mesh technique (IPOM). The later is less commonly used now (67).

1.5.2 Para-umbilical Hernia

1.5.2.1 Definition
Umbilical hernia in adults is more accurately described as para-umbilical hernia (P.U.H.). It is a protrusion of the peritoneal sac through a weak area in the linea Alba just above or sometimes below the umbilicus, not through the original umbilical cicatrix with no possibility of spontaneous cure (68).

1.5.2.2 Incidence

Para-umbilical hernias are relatively common (69). The incidence is un-known, but various studies reported an incidence of umbilical hernias varying between 10% and 14% (68-70) of all hernias. It occurs more frequently in middle age, usually between the ages of 35 and 50. Women are affected five times more than men. It is more common in people of African origin (3,55).

1.5.2.3 Aetiology

The cause of para-umbilical hernia is unknown, but is probably multi-factorial with raised intra-abdominal pressure acting gradually on the weakened and stretched scar tissue closing the umbilical ring. There may be a possible relationship with the presence of an umbilical hernia in childhood. It is said that 10% of adults with umbilical hernias, have a history of umbilical hernia in childhood (71,44). The common predisposing factors associated with an increased intra-abdominal pressure include obesity, repeated pregnancies, persistent or repetitive abdominal distention in bowel obstruction, flabbiness of the abdominal muscles, and gross ascites owing to liver cirrosis, congestive cardiac failure, nephrosis, peritoneal dialysis, and long duration of malignant disease (72).

1.5.2.4 Clinical features

Most para-umbilical hernias are symptomatic. The main presenting feature is a bulge located anterior or adjacent to the umbilicus which tends to enlarge
progressively over the time with no spontaneous closure. Adult patient with small umbilical hernia often complain of quite severe pain in the umbilical region, especially when coughing or straining. Larger hernias are usually painless but uncomfortable, because of their weight dragging on the abdomin (57).

Gastro-intestinal symptoms are common, probably due to traction between the hernial contents and the stomach or the transverse colon. When the hernial sac contains bowel, often transient attacks of intestinal colic due to partial intestinal obstruction are common. The skin over the hernia is stretched and often very thin and, may even be ulcerated by pressure necrosis. In long standing cases with large hernias, intertrigo in the inferior fold between the hernia and the abdominal wall is common, especially in obese women, since the combination of moisture, warmth, and friction causes large areas of ulceration, and weeping dermatitis with accumulation of decomposing and foul smelling discharge (3,69).

1.5.2.5 Risk of para-umbilical hernias

The real danger of paraumbilical hernia is the risk of the commonly occurring obstruction and strangulation of the hernial contents, usually due to the narrow neck of the sac, the contents tend to become adherent to the sac and to each other, and the sac is often multilocular (55). This is a serious situation with high morbidity and mortality, especially in elderly, obese females with hypertension, heart disease, and diabetes.

1.5.2.6 Treatment

Elective surgical repair is the treatment of choice in nearly all patients once detected. (69,73). Various surgical options have been described: sutured repairs (Mayo repair (72), open mesh repairs (mesh patch (48), mesh plug (42), and prolene hernia techniques (49)) and laparoscopic repair (50). (videsupra).

1.5.3 Incisional (Post-operative ventral wall) Hernias
1.5.3.1 Definition

Incisional hernia is defined as a protrusion of peritoneal sac containing abdominal contents through the site of pre-existing abdominal wall weakness, produced by previous surgery or trauma, and occurs at points other than the inguinal, femoral or umbilical openings. It is the result of a failure of fascial tissues to heal and close following laparotomy \(^{(54)}\).

1.5.3.2 Incidence

Incisional hernias are frequent complications of abdominal surgical procedures. The exact incidence has not been well defined, but with varied reported incidence ranging from 2% to 20% of patients who had undergone laparotomy \(^{(74-76)}\). In the best centres, the incidence of incisional hernia has been at least 10%, as shown by long-term follow up studies \(^{(77)}\). Where less emphasis is placed in the niceties of abdominal wall closure, the incidence is much higher. Earlier short term studies have the erroneous impression that most (64%) post-operative hernias appear within the first year after the operation, and that 80% appear within the first 2 years \(^{(3)}\).

1.5.3.3 Aetiological factors:

Multiple factors, singly or in various combinations, may cause failure of the wound to heal satisfactory and may lead to the development of incisional hernias \(^{(60)}\).

1.5.3.3.1 Early incisional hernias

(I) Non-anatomic incisions:

Non-anatomic incision represents a vertical para-rectal incision (Battle’s) along the outside of the lateral border of the rectus sheath, which destroys the nerve and vascular supply to the tissues medial to the incision causing them to atrophy. The more lateral the incision, the greater the damage \(^{(78)}\).
A prospective trial, performed by Ellis and co-workers did not demonstrate any significant difference in the rate of hernia formation in patients undergoing midline, standard para-median or transverse incisions \(^{(79)}\).

For vertical midline incision, incisional hernia rates of between 5% and 15% are reported in prospective trials with similar results for the conventional medial para-median incisions \(^{(80)}\). In contrast, the lateral para-median incision has been consistently shown to achieve hernia rates of less than 1% and no wound dehiscence, although it is time-consuming to perform \(^{(81)}\). There have been 3 randomized controlled trials published comparing the lateral para-median incision to the midline incision \(^{(78,80,81)}\). All of these demonstrate the superiority of the lateral para-median incision.

**(2) Inappropriate suture material:**

Reliable trials have shown that wounds closed with non-absorbable material are followed by a far lower incidence of post-operative hernias than wounds closed with absorbable material. Thus, the absorbable sutures such as catgut, should not be used for closure of laparotomy wounds. Biologic sutures such as silk, cotton, and Lenin disintegrate after 2 months, and also should not be used. Furthermore, these sutures, especially silk, perpetuate wound infection and sinuses \(^{(3)}\).

In a meta-analysis by Hodgson et al., the main finding of which, was the incidence of incisional hernias was reduced by 32% when a non-absorbable material such as prolene was used regardless of the incision type \(^{(75)}\). This finding was in agreement with a previous meta analysis by Weiland et al., where the authors concluded that continuous closure with a non-absorbable suture should be used to close most abdominal wounds \(^{(82)}\).

**(3) Inappropriate abdominal wound closure:**

An appropriate surgical technique achieves satisfactory fascial closure and maintains the extrinsic strength of the wound until it develops its own intrinsic strength. Factors related to the abdominal wound closure include:
**Transverse versus vertical closure:**

Weiland et al., reported that, transverse closure is associated with low risk of incisional hernia than vertical closure. The fascial fibres of the anterior abdominal wall lie in a transverse orientation, therefore, vertical closure of the wound; place the suture material between the fibres. Contraction of the abdominal wall would cause laterally-directed tension on the suture and might cause the suture material to cut through by separation of the transversely oriented fibers. In contrast, a transverse closure places the suture material around fascial fibres which are apposed and the suture material would be under minimal laterally-directed tension. (82)

**Mass versus layered closure**

Layered closures are followed by greater incidence of post-operative hernias than are wounds closed by the single-layer of mass closure technique. This may be owing to the fact that many more sutures are used, which are closely placed, and because insufficient size bites of each thin layer are taken. The advantages of mass closure of abdominal incisions have found a support in a clinical study by Santora et al., in which, a reduction in the rate of wound dehiscence from 3.8 percent to 0.8 percent was reported on changing the technique of wound closure from layered closure to mass closure with nylon or dexon (83).

**Continuous versus interrupted;**

In comparisons of the tension created by those two suturing techniques, the tension is different at each suture; this may lead to fascial necrosis if tied too tightly or poor approximation if tied loosely. The continuous technique disperses the suture tension along the length of the wound. (76) In their meta analysis of abdominal fascial closure, Hodgson et al looked at six trials comparing those 2 closure types and found continuous closure to be superior over all (75).
(4) **Tension:**

The lateral pull of the abdominal wall muscles against the suture, which tends to pull them in the opposite direction, creates an area of pressure necrosis where the suture meets the tissue. This pressure necrosis is a primary cause of wound dehiscence (76).

(5) **Sepsis:**

It is the second major cause of early wound failure, and is a contributing factor in more than 50% of incisional hernias that develop in year one after operation (3). It may range from frank acute cellulitis, with fascitis and necrosis of the tissues on each side of the incision, to low-grade chronic sepsis around sutures such as braided or twisted silk. The later case is very difficult to overcome, since the infecting organisms lurk in the spaces between the fibers of the suture thread and constantly reinfect the tissues. The infection causes inflammation and oedema of the tissues, which become soft and weakened, so that the sutures tear the tissues and pull out under the strain of the intra-abdominal pressure (3).

In a study of 1129, abdominal procedures, Bucknall and Colleagues (84), reported that the index operation had been complicated by a post-operative wound infection in 48% of the patients who subsequently developed an incisional hernia.

(6) **Prophylactic antibiotic**

Houck and Colleagues (85), suggested that the rate of wound infection after the repair of an incisional hernia, was significantly greater than that seen in inguinal hernia repair. This suggests the presence of occult infection in the incisional hernia wounds. Furthermore, a prior wound infection in the incision was associated with significantly higher rates of infection after the subsequent repair. For these reasons a number of authors have advocated the routine use of antibiotics in patients undergoing ventral hernia repair (86). Others recommended them only for patients at risk of infection (patients with immunodeficiency, concomitant ileus, prolonged operative treatment, etc) (87).
(7) Laparoscopic surgery:

The recent advances in laparoscopic surgery may have potential implications in forming incisional hernias. Laparoscopic gynaecological, biliary, adrenal, renal and endoscopic-assisted colorectal surgery may improve patient morbidity, but an increased number of studies reported a small but significant rise in the incidence of incisional hernias \((63)\).

(8) Drainage tubes:

Drainage tubes brought out through the operative wound are a potent cause of post-operative hernias \((88)\). Since the tissue planes along the tract of the drain are not sutured, an open and weak passage is present through all layers of the wound through which a hernia may develop. Furthermore, after the first 24 hours there is a rapid rise in the wound infection rate, since the drain allows 2-way traffic for secretions going out and organisms going into the abdominal cavity. Also, the irritation caused by the drain causes oedema or softening and tearing of the tissues and cutting out of the sutures.

(9) Type of operation;

Certain types of operations have a tendency to be followed by incisional hernia. These include; laparotomy for generalized or localized peritonitis in patients with perforated peptic ulcer, appendicitis, diverticulitis, and acute pancreatitis. Also included are operations for intra-abdominal malignant disease (visceral cancer), chronic inflammatory bowel disease, and re-operation through the original wound, especially within the first six months after the initial procedure. The main cause of the failure is not in the operation itself, but the wound becomes infected \((89)\).

(10) Obesity;
Obesity especially morbid obesity is associated with a high percentage of incisional hernias, as well as recurrences following repair of these hernias. This was confirmed by Ellis H. group who found that obesity was associated with a three-fold increase in herniation and recurrence (79). Obese patients frequently have increased intra-abdominal pressure, and a high incidence of seroma and haematoma.

Read and Manninen confirmed that obesity plays a major role in the production of these seromas and recurrence following their repair (90). Cutting through large masses of fat and the increased retraction needed may raise the infection rate in these patients and lead to recurrence. Tissue infiltrated with fat does not hold the sutures well, especially since the excess intra and extra-abdominal accumulations of many kilograms of fat may add enormous tension on the sutures and lead to ischaemia, causing the tissues to tear under the strain and to bring about a defect in the abdominal wall. Furthermore, obese patients tend to develop post-operative complications such as paralytic ileus, atelectasis, and pneumonia and deep vein thrombosis that may increase the incidence of incisional hernia (3).

(11) General condition of the patient;

The patient-specific factors implicated in the aetiology of incisional hernia are; old age (age over 70 years), generalized wasting, anaemia, malnutrition, Crohn’s disease, hypoproteinaemia (especially hypoalbuminaemia e.g. serum alb. < 3.5g/dl), avitaminosis (especially vitamin C depletion), jaundice, chronic renal failure and uraemia, chronic liver disease (liver cirrhosis and failure), ascites, cachexia and malignancy, diabetes mellitus, sleep apnea, prolonged steroid therapy, immuno-suppressive therapy (previous operation and cytotoxic drugs), and alcoholism (3).

All these factors affect the healing process. Chronic obstructive air-way disease (COAD) causing straining on the suture line. There is no significant difference between sexes in the incidence of incisional hernias (men 55%, women 45%). These certain types of patients tend to develop post-operative complications and to display evidence of poor healing of the wound (91).
(12) Post-operative complications;

Inadequate postoperative analgesia and vomiting that caused increase intra-abdominal pressure, prolonged post-operative paralytic ileus, intestinal obstruction with abdominal distension (which places enormous vertical tension on the wound by increasing its length and raising the lateral pull on the sutures by increased girth of the abdomen), chest complications such as chronic obstructive lung disease, pulmonary collapse, bronchopneumonia, emphysema, and asthma, all are risk factors for the development of incisional hernias (3).

(13) Post-operative wound dehiscence and burst abdomen:

Post-operative wound dehiscence or burst abdomen whether covered by skin or with frank evisceration, is often followed by post-operative hernia whether sutured or treated by the open method. All the conditions mentioned previously are also causal factors in burst abdomen (91).

1.5.3.3.2 Late incisional hernias:

(1) Tissue failure

The incidence is not related to the method used for closing the original incision and is presumably the result of the failure of the collagen in the scar. The aging and weakening of the tissues associated with raised intra-abdominal pressure as a result of chronic cough, constipation, and prostatism, are cited as the factors responsible for alterations in the resistance in the transversalis fascia and abdominal wall scar tissue (100). Rodrigues has recently shown a decrease in oxytalan fibres, and increase in the amorphous substance of the elastic fibres as a function of age (61).

(2) Collagen Abnormalities

Abnormal collagen production and maintenance have been shown to be associated with development of primary and recurrent incisional hernias in certain patients. There is a deficiency of collagen and abnormalities in its physico-chemical structure, manifesting in reduced hydroxyprolene production and in changes in the diameter of collagen fibres Read observed that the rectus
sheath in patients with direct inguinal hernias was lighter for a given area than that of normal controls. He postulated that inguinal hernia is part of a widespread connective tissue disorders associated with emphysema and smoking\textsuperscript{(134)}, and in 1981, together with his associate, Cannon, he called his syndrome “metastatic emphysema”\textsuperscript{(135)}. These collagen mechanisms may play a part in the development of late post-operative hernias\textsuperscript{(93)}.

1.5.3.4 Diagnosis of incisional hernia:

Incisional hernias are typically apparent on history and physical examination\textsuperscript{(3,65)}. There are great variations in the degree of herniation. The patients may complain of a bulge in the operation scar, which steadily increases in size, and more and more of its contents become irreducible\textsuperscript{(76)}. It is detected either visually or by direct palpation, and becomes more apparent by manoeuvres that increase the intra-abdominal pressure such as coughing, lifting the head or legs against resistance, or assuming the erect posture\textsuperscript{(76)}.

The patients often suffer from a heavy, sickening, dragging pain sensation or discomfort, aggravated by coughing and straining. Occasionally, patients with large hernias experience difficulty in bending, discomfort, even persistent abdominal pain, or intermittent intestinal obstruction\textsuperscript{(3)}.

In large dependent hernias, areas of skin may undergo pressure ischemic necrosis and may ulcerate. Intertrigo may develop, usually in the deep crease between the hernia and the abdominal wall, where the skin may become moist, infected and odorous. Sometimes, the skin overlying the hernia is so thin and atrophic that normal peristalsis can be seen in the underlying intestine. However, most patients with small, uncomplicated incisional hernias which are broad necked, will be asymptomatic and do not need treatment, or have only minor or intermittent complaints\textsuperscript{(76)}.

In certain doubtful cases, ultrasonography, C.T. or both\textsuperscript{(94,95)} are the best ways to visualize intra-abdominal contents within the sac and to distinguish hernia defects from other abdominal wall processes that may present as mass lesions or be the source of pain syndrome.
1.5.3.5 Risk

Though many are asymptomatic, approximately one-third of incisional hernias are associated with pain, incarceration and/ or strangulation\(^{(3)}\).

1.5.3.6 Treatment of incisional hernias

The treatment of incisional hernia is surgical repair\(^{(96)}\). Three general classes of operative repair have emerged in the modern era. These techniques include:

1. **Primary sutured repairs**: (page 10).

2. **Open mesh repairs**: many variations and combinations of mesh repair have been described\(^{(3)}\), including:
   
   (a) **Onlay mesh repair**: a large piece of mesh, cut to the shape of the defect, but larger, may be sutured as an onlay graft superficial to the fascia.
   
   (b) **Rives-Stoppa technique** of placing the sheet of prosthetic mesh in the plane between the posterior rectus sheeth and the rectus muscle.
   
   (c) **Preperitoneal graft repair**: the mesh is situated between the peritoneum and the abdominal wall.
   
   (d) **Underlay mesh graft repair**: a large piece of mesh cut to the shape of the defect but larger, may be sutured in place deep to the peritoneum. This is the less commonly used\(^{(5)}\).

3. **Laparoscopic repair**: in this technique, the defect is repaired poseriorly and no dissection within the scarred layer of anterior fascia is required. (videsupra page 8).
1.6 Complications of Hernia Repair Techniques

Hernia repair whether sutured, open mesh, or laparoscopic is safe, but like all operations, it may be associated with general or local complications \(^{97,98}\).

1.6.1 The general complications

The general complications include: pulmonary atelectasis, pneumonia, deep vein thrombosis, pulmonary embolism, thrombophlibitis and urinary retention \(^{97,98}\). Most can be avoided by good pre-operative preparations and by early and active ambulation post-operatively.

Urinary retention after hernia repair has a reported incidence of 1.3% to 5.8% \(^{154}\). It is acutely precipitated after surgery in elderly patients, especially if symptoms of prostatism are present. These patients are best catheterized prior to surgery and catheter removed the next morning \(^{3,97}\).

1.6.2 The Local complications

1.6.2.1 Haemorrhage & Haematoma;

Subcutaneous haematoma or severe ecchymosis can result from the careless ties or cautery to the superficial vessels (i.e. external pudendal, circumflex iliac, and superficial epigastric). On deeper plane, during resection of the cremaster, careless ligature of the external spermatic artery can result in a tense haematoma and ecchymoses that extend to the scrotum. Laceration of inferior epigastric vessels (1 artery, 2 veins) at the medial edge of the deep inguinal ring may occur during division of the transversalis fascia, particularly during recurrent surgery when they may be well encased in scar tissue.

Within the space of Bogros, a venous circulation is present, and can be the source of brisk bleeding (i.e. iliopubic vein, rectusial vein, rectusioepigastric vein); less commonly an iliopubic artery is present. Bleeding results from the inadvertent
penetration of these vessels with a needle (open technique) or vigorous scissors and forceps dissection (99). The presence of aberrant obturator artery, originating from the inferior epigstric artery, can be the source of bleeding when blind sutures are inserted into the cooper’s ligament without splitting the transversalis fascia or when the lacunar ligament is incised from below the inguinal ligament during release of an incarcerated femoral hernia (98).

Injuries to the femoral vein may be caused by suture of the anterior wall of the vein during incision of the shelving edge of Poupart’s ligament in the repair or by compression of the femoral vein by a suture that is placed too laterally on the cooper’s ligament. These situations have complicated the cooper’s ligament repair too frequently (0.35%-1.6 %) (99,100). The more serious is injury to the femoral artery during reconstruction of the posterior inguinal wall near the deep ring, a site where the iliofemoral artery is situated 1cm to 1.5cm deep to the transversalis fascia (98). This injury may lead to early vascular impairment and its subsequent complications of thrombosis, embolization, and gangrene. Delayed complications are seen as stenosis, false aneurysm, and arteriovenous fistula (101).

Flat sheets of prosthetic materials are rarely associated with vascular erosion and thrombosis. With reference to plugs, only one case has been associated with iliac artery erosion and thrombosis (102). Vascular injuries from laparoscopic herniorraphy have been to the deep inferior epigastric and spermatic vessels, external iliac, deep circumflex iliac, obturator vessels and aorta (103).

1.6.2.2 Urinary bladder injury

Trauma to the urinary bladder may occur with the open or laparoscopic techniques. The risk of bladder injury was reported as 12% during the open hernia repairs (104), and characterized by haematuria, sepsis, urinary leakage and fistula formation (105). The possible aetiopathogenic factors for these complications are adhesion of the bladder wall to the perivesical fat, or slide into direct, large indirect hernia, which may be opened inadvertently when dissecting the sac of these hernias. Chronically distended bladder, enlarged prostate, pericystitis and
weakness of the abdominal wall \(^{(106)}\) are other possible risk factors. Laparoscopic surgery is associated with laceration of the urinary bladder with an incidence of 1.5 \% to 5 \%\(^{(107)}\).

1.6.2.3 Bowel injuries

A small bowel may be injured if caught in the transfixion suture when the sac is legated. Inadvertent laceration or opening of large bowel (caecum and sigmoid) may occur when they form part of the wall of a sliding hernia. On freeing of an incarcerated or strangulated segment of bowel, the sites of strangulation, may develop ring induced necrosis or perforation of bowel\(^{(98)}\).

Laparoscopic herniorrhaphies have complications, which vary with the technique, and range from 0.06 \%-0.2\%. These complications include; laceration of large or small bowel; trocar site herniation with a Richter type of hernia; adhesion of viscus to mesh with resulting ileus; obstruction; adhesion formation; erosion; and transmigration (oesophagus, duodenum, small bowel, large bowel, and bladder) \(^{(106,107)}\).

1.6.2.4 Nerve injury (post-herniorrhaphy neuralgia)

The main nerves that are injured during open groin hernia repairs are the iliohypogastric, ilio-inguinal, genital branch of the genitofemoral nerve, and the lateral femorocutaneous nerves during laparoscopic repair. The iliohypogastric nerve is often transected when the upper leaf of the external oblique aponeurosis is elevated. The ilioinguinal may be torn when the cord is mobilized, and the genital branch of the genito-femoral nerve is most likely to be injured during stripping of the cremastic muscle fibers. The lateral femorocutaneous nervies are injured during the laparoscopic tacking of the mesh to the anterior abdominal wall. These injuries may cause varying degrees of anaesthesia or paraesthesia in the region of the sensory distribution of the nerves, which pass after some weeks, or months. In 90\% of the cases, the ilioinguinal, and iliohypogastric nerves, were carefully preserved\(^{(108)}\).
Sometimes nerve injury is due to entrapment of a portion of the nerve in the mesh or suture line which causes severe burning pain on movement. This usually passes off spontaneously but occasionally may require an injection for nerve block or even exploration to release the entrapped nerve. These so called post-herniorrhaphy neuralgias (3). It has been claimed that pain syndromes improve when ligation and workmen’s compensation claims are settled (109). An estimated 15% to 20% of patients who undergo repair experience some degree of post-operative neuralgia, paraesthesias, or hypoaeshtesia for up to 6 months after their surgery (104). In an other study, chronic pain was seen in 5 % (61).

1.6.2.5 Testicular complications

The two complications concerning the testicle are ischemic orchitis with swelling, and testicular atrophy. They are the result of interference with the blood supply and probably the lymphatic drainage of the testis. They are rarely the result of tearing and ligation of the testicular artery, but may be the result of tying off the veins in the spermatic cord, when the cremastric muscle is resected, and when the distal part of the sac has been dissected unnecessarily. Another cause of testicular swelling or atrophy may be congestion owing to closing the internal ring too snugly around the cord. The swelling may take some weeks to subside and occasionally leads to testicular atrophy over several months (3).

The incidence of testicular atrophy following open pure tissue repair at the Shouldice hospital, between the year 1986 and 1993, was 0.036 % following primary inguinal hernia repair and 0.46% following recurrent inguinal hernia rep (111). Khalid found a 2.7% rate of testicular atrophy in patients years after hernia repair (112). In children and young adults testicular damage may lead to reduced fertility. It has been reported that 6.69 % of patients with infertility had had inguinal hernioplasty with or without subsequent atrophy of the testis and semen quality was reduced markedly owing to ischaemic orchitis or immunologic reactions (112).

1.6.2.6 Vas deferens injuries
Trauma to the vas deference can be either transaction or obstruction that usually occurs through open repairs, particularly recurrent herniorrhaphies (113). Transection is an unusual accident, can occur with all techniques. Obstruction can result from damage to vas deferens especially in children, by undue pressure, traction, kinking and especially by squeezing between the ends of the dissecting forceps. This trauma may lead to damage to the wall and mucosa of the vas with consequent fibrosis and obstruction (114). The incidence is about 0.04% (115). The most worrisome sequelae of vas deferens obstruction or transection are formation of anti-sperm antibodies in the serum, leading to infertility. Matsuda points out that in his series; the incidence of unilateral vas deferens obstruction was 26.7 % for sub-fertile patients with history of inguinal hernia repair during childhood (116).

1.6.2.7 Wound infection

Infection represents a major complication for all types of surgery, and a potent cause of recurrent hernias. It is estimated that in specialized hernia practice, the incidence of postoperative wound infection is a round 1 % or less. In general hospitals, the incidence may be as high as 5 %. These figures may not reflect the true incidence of wound infection, since they are published by the surgical unit, who do the operation, and several recent surveys, show that 50% -75% of the true incidence of hernia wound infection occur after the patients have left the hospital, and are unknown to the surgeons, so that the overall incidence may be four times that usually reported (3).

Patients who undergo mesh herniorrhaphy are at less risk of postoperative wound infection. It is often difficult to determine whether the mesh itself is infected or if just the skin or soft tissue anterior to the layer of mesh is infected. If mesh repair becomes infected, it can be treated with aggressive use of antibiotics after the incision is opened and drained expeditiously (117).

However, Houck J.P. et al found that repair of incisional hernia has a significantly higher infection rate than other clean operations, ten times that for inguinal herniorrhaphy and especially so if the original incision was infected. The
high rate of infection is significantly reduced if preoperative antibiotics are used (118).

1.6.2.8 Seroma

Seromas are common complications after open and laparoscopic herniorrhaphy. The size of the collection relates to the amount of dissection done between tissue planes, and the amount of dead space remaining in the wound. Seromata may form following herniorrhaphy but with greater frequency following mesh repairs due to tissue trauma, remaining dead space following excessive tissue dissection, and foreign body reaction (111). In the groin, seromas are seldom significant or clinically notable, in contradistinction to para-umbilical and incisional hernias, however, with the introduction of various prostheses, the incidence of seroma ranges from 0 % to 17.6 % after open repair and between 5% and 25% after laparoscopic herniorrhaphy (118).

1.6.2.9 Hydrocele

The incidence of hydroceles complicating inguinal hernia repair has been reported to be 0.7 % (3). Although the aetiology is unknown it has been associated with overzealous skeletonization of the spermatic cord and tissue dissection from the sac at the internal ring. The common mechanism may be a severance of the lymphatic drainage and, the condition may develop as a result of closing the distal section of a large indirect inguinal hernia (98).

1.6.2.10 Pubic osteitis

This may be the result of suture through the periosteum during sutured inguinal herniorrhaphy or due to the generous use of staples into the ligament of cooper (and underlying pubic ramus and tubercle) with tension-free repair (98).

1.6.2.11 Post-herniorrhaphy para-vesical suture granuloma

Several publications have recently reported the finding of a palpable mass close to the urinary bladder, caused by foreign body reaction to surgery used in the
repair of an inguinal hernia. The mass may be found some months after hernia operation or even up to 11 years as in one reported case (98). Lynch reported 11 cases (119).

1.7 Recurrence of hernia after various repair techniques

1.7.1 Incidence

Recurrence remains the most common complication in hernia surgery, and is still too frequent in the large published series (120). Whatever the surgical technique used, its incidence is often inaccurately recorded because of inadequate follow-up in terms of methodology used, its duration or proportion of patients followed up. The incidence after primary repair of groin hernia varies from 0.2 % in specialized centres (121), to 30 % in general surveys (59). Most reported studies also showed high recurrence rate following umbilical (44,46), and incisional hernias (122) (videsupra). The longer and more complete the follow up, the higher the rates of recurrence (59).

Most recurrences appear within 2 or 3 years after the primary repair. This is the early group of recurrences (mechanical) which is secondary to deep infection, undue tension on the repair, or tissue ischaemia. All of these etiologies raise the concern for technical complications on the part of surgeon, either in the handling of the tissue or the placement of mesh or suture (3).

Late recurrences (metabolic) develop three years after the initial surgery, but may appear many years later. The incidence of hernia recurrence tapers off after the first 5 years, but sometimes recurrences appear as long as 30 years later, and constitute the smaller group. It is due to tissue failure as a result of further disorders of collagen production, maintenance and absorption which affect the integrity of the transversalis fascia (62,63). Aging of tissues, weakening of the muscles and loss of body vigor are advanced as the reasons for the late recurrences. The basic mechanisms are not known, but it is assumed that for
unknown reasons there is a break down in the metabolic system responsible for the balanced integrity of the collagen \(^{(61,62)}\).

In the Netherlands, approximately 26,000 hernia operations are performed per year. The methods of repair were: Bassini 64\%, Shouldice 27\%, open mesh 1\% and laparoscopic 1\%. In 1989 the recurrence rate for primary inguinal hernia was 10\% and for recurrent hernia 20\%\(^{(123)}\). Each year in the United States, there are almost 750,000 groin hernia repairs, of these between 50,000 and 100,000 are recurrent inguinal hernias \(^{(124)}\). In Sweden approximately 20,000 hernia operations are performed each year. Between January 1992 and December 1996, Nillson and Colleagues prospectively audited 12542 groin hernias in 21 Swedish hospitals. The cumulative incidence of recurrence was 1\% in one year, 3.5\% in two years, and 4.4\% in three years \(^{(125)}\).

In a retrospective single-centre cohort study \(^{(126)}\), comparing mesh and sutured repairs of incisional hernias. Only 5\% patients with mesh repair developed recurrence, compared with 18\% patients with suture repair, \(p=0.02\) by Log rank test. In a multivariate Cox regression, the recurrence rate was 4-fold higher after sutured repair than after mesh repair \((p=0.02)\).

A review of the literature on the results of herniorrhaphies reveals that for inguinal hernia repairs, recurrences following Bassini repair were 2.9\% to 25\%, Shouldice 0.2\% to 2.7\%, McVay 1.5\% to 15.5\%, and Nyhus 3.2\% to 21\% \(^{(127)}\).

1.7.2 Risk factors of hernia recurrence

Multiple causes and promoting factors are responsible for the development of hernia recurrence. Some of these risks are under the control of the surgeon at the initial operation, while many others are patient-specific or related to postoperative period.

1.7.2.1 Pre-operative factors
Age

It has been suggested that the recurrence rate is actually lower following repair of primary inguinal and incisional hernias in older age groups than in younger patients (98). With others, age was a risk factor of hernia recurrence. They rectified that increasing incidence of hernia with advanced age is attributable to decrease in collagen contents of transversalis fascia and rectus sheath, secondary to either greater destruction or decreased formation (128). This altered collagen metabolism gives a strong and biochemical evidence that permanent replacement of the canal floor by synthetic material and creating a new internal ring as well as a new shutter mechanism, will eliminate the suture line tension and afford permanent protection against future metabolic deficiencies (128). Prematurity in infants, does increase the recurrence rate after repair of an inguinal hernia by herniotomy (59). However, the surgeon who repairs the hernia is more important than the age of the patient.

Occupation and strenuous exercise

The incidence of hernia is the same in sedentary workers as in heavy manual labourers, indicating that strenuous physical activity alone does not cause hernias. However, it does bring about a rise in the intra-abdominal pressure and so may cause an existing small and unnoticed hernia to expand and become more obvious. It may also be the factor bringing on a hernia in those already predisposed to herniation by other more basic causes (59).

Chronic constipation

Constipation is an important factor in the causation of increased intra-abdominal pressure. In a study by Gecim et al. (129), 109 recurrent hernias were repaired and followed for 7 to 92 months. Forty five percent recurred with the chronic constipation being statistically significant, (p< 0.05), while in an other publication by Hesselink V.J. et al., (130) who evaluated the risk factors in incisional hernia recurrence, it is demonstrated that chronic constipation was not a significant risk factor (p= 0.7).
General condition

The state of health of the patient may have a negative influence on the success of hernia repair by influencing wound healing and collagen production. These conditions include; malnutrition, hypoproteinaemia, vitamin deficiencies, jaundice, prolonged infection, chronic debilitating disease, malignant disease, diabetes mellitus, and long term steroid therapy \(^{(59)}\). Decreased wound healing associated with steroid is commonly incriminated as a cause of recurrence \(^{(59)}\).

Obesity

Obesity does not seem to be a factor in recurrence after repair of primary or recurrent inguinal hernias. In fact it has been found that obesity has even a certain protective influence on inguinal hernia development \(^{(56)}\). No definite relationship has been demonstrated between body weight and recurrence, and marked overweight patients are not at increased risk for recurrent inguinal hernia. Others have found that a slightly larger proportion of patients with recurrent inguinal hernia were near/below ideal body weight. So, markedly under weight patients are probably at a greater risk for recurrent hernias \(^{(60)}\). The situation is quite the opposite when dealing with incisional or umbilical hernias where overweight plays a major role in the production of hernia recurrences \(^{(3)}\).

Smoking

Smoking is an important factor for recurrence of hernias, presumably due to an abnormal connective tissue metabolism in smokers. A higher percentage of smokers than non-smokers develop hernias and recurrence after repair, due to interference with the production and maintenance of collagen, causing a reduction in the amount of collagen and abnormal collagen fibrils. The systemic protease/ antiprotease imbalance in cigarette smokers leads to fascial degeneration, interference with normal wound healing, and increased recurrence rate \(^{(62,131,132)}\).
Chronic cough:

Chronic cough denotes history of cough more than three weeks at any period before or after appearance of primary hernia. Many surgeons believe that chronic cough, chronic bronchitis, and respiratory insufficiency are important factors in recurrence of hernias, but little evidence for this is available. Abramson J. H. and colleagues (133) showed that there were no significant independent evidences that chronic cough was associated with development of hernia or recurrence.

Ascites

Increased intra-abdominal hydrostatic pressure in the form of ascites is a potent aetiological factor in the development of hernia and by the same mechanism is responsible for a high rate of recurrence after repair of these hernias in children with ventriculo-peritoneal shunts for hydrocephalus or those in continuous ambulatory peritoneal dialysis (C.A.P.D.) (134).

Recurrent inguinal and umbilical hernias are extremely common in cirrhotic patients with ascites. Control of the ascites is a major determinant of the success of the repair, where medical control of the ascites has failed, a peritoneo-venous shunt and herniorrhaphy should be done separately or concomitantly to avoid almost a certain recurrence of the repaired hernia (3,59). The mechanism by which primary and recurrent inguinal hernia develops in patients with ascites appears to be the opening of a latent processus vaginalis by the increased intra-abdominal hydrostatic pressure (3). Malignant ascites posses a similar problem (59).

Prostatism

Prostatism denotes history of frequency, urgency or hesitancy on micturation indicates a prostatic problem usually benign prostatic hypertrophy (56). It has
been reported that prostatic hypertrophy itself is of no significance in the
development of a hernia or its recurrence after repair. Both conditions are
common in middle aged and elderly men but have no causal relationship\(^{(60)}\).

### 1.7.2.2 Operative factors

Experience of the surgeon;

The success of hernia surgery depends almost entirely on the skill, knowledge,
understanding, and experience of the surgeon. The best results are achieved in
specialized units by dedicated surgeons who confine their practice to hernia
surgery. However, all experienced herniologists obtain equally good results with
respect to recurrence rate, whatever the preferred repair. On the other hand,
even the best method can be blotted by an inexperienced and/or ignorant
surgeon\(^{(129,130)}\).

Most failed herniorraphies, especially the early recurrences, are the result of
failure on the part of the surgeon. Recurrence rates decrease as surgeon’s
experience with the procedure increase\(^{(95)}\). He/she must do careful anatomic
dissection, be gentle at retraction to avoid tissue damage, and control
haemostasis and infection. Specialization could lower the recurrence rate for
primary repairs to 0.1%\(^{(135)}\).

Suture line tension

The approximation of tissues, under tension is a cardinal factor, in the failure of
a hernia repair. Tissue repaired under tension will tend to pull apart even if
sutures or mesh have been affixed to them. The tissue pulling on the suture
creates an area of ischemic pressure necrosis, at the point where the suture meets
the tissues. This process of ischaemic pressure necrosis will progress until there
is no longer any tension, which usually occurs when the tissue have returned to
the previous unsutured position and the hernia will recur through the resultant
gap\(^{(59)}\).

A second mechanism is the cutting out of the sutures from the tissues when the
suture tension becomes greater than the strength or the holding capacity of the
tissues. This depends on several factors but in normal healthy tissues, it mainly depends on the distance of the sutures passing through the tissues from the cut edge and the angle that the suture makes with the line of the fibres of the tissues, as well as the type of the tissues. The greater the mass of tissue, enclosed in, the more the suture is at right angles to the fibres and the more aponeurotic the tissue, the less likely is the suture to cut out. The role of excessive tissue tension in promotion of hernia recurrence is the basic rationale behind the modern, tension-free repairs of Lichtenstein \(^{30}\), the sutureless technique of Gelbert \(^{31}\), and the mesh-plug hernioplasty of Rutkow \(^{32}\).

Type of repair

Much heated controversy is generated over what is the best operation for hernia repair. It was answered as probably the method that the operating surgeon knows well and does best. Recently it has been suggested that successful surgical repair of a hernia depends on a tension-free closure of the hernia defect to attain the lowest possible recurrence rate. The conventional sutured repairs such as Bassini technique and variation of it, Mayo repair, and fascial approximation, have a high chance of recurrence and long period of postoperative pain and rehabilitation.

Furthermore, failure to construct the defect causes some hernias to recur over the years because of factors beyond the control of surgeons, such as aging scar tissue and disturbed collagen metabolism \(^{59}\). Therefore reherniation can be prevented by placement of an adequately wide sheet of mesh that can provide sufficient mesh/tissue interface beyond the border of the defect or the weakness \(^{136}\), as shown in the modern techniques of repair such as mesh-patch, mesh-plug and patch, and bilayer repairs.

In the mesh repair, other technical errors may play a role in the development of recurrent hernia, these include: insufficient dissection and exposure of musculo-
aponeurotic edge, peripheral mesh detachment, prosthesis dehiscence, failure of knots, and suture cutting through edge of mesh \(^{(137)}\).

The suture material

The process of healing of hernia repair takes approximately one year. It involves the production of collagen and its maturation and remodelling so that the fibres lie in parallel bundles according to the lines of stress. Topical tissue is mainly formed of collagen, which tends to heel slowly \(^{(138)}\).

The polypropylene sutures maintain their strength and are practically indestructible in human tissues. They are strong, smooth, and inert and excite very little tissue reaction. Because of these properties, they do not cause a foreign body reaction in infected wounds. Even when exposed in a purulent wound, they become covered by healthy granulation tissue and do not interfere with healing \(^{(3)}\).

In 1970 Lichtenstein et al noted that any suture material that loses most of its strength within two weeks should never be used to close supportive structures \(^{(139)}\).

Suturing technique

The mass suture technique has a great advantage in the prevention of recurrent hernia than suturing anatomic layer, because small sutures enclose only a small amount of tissue close to the edge of the sutured layer, often within the area of the normal collagenolysis of a cut wound, and easily cut out. Each small, tightly tied suture causes a triangular area of ischaemia and necrosis of the tissues it encircles, together with an area on each side of the suture. When these sutures are placed close to each other, their ischaemic areas overlap and cause a strip of necrosis along the sutured edges, which separate from the rest of the tissues, together with the suture, so that the opposed and sutured structures separate and cause the hernia to recur \(^{(3)}\).
A continuous suturing technique causes distribution of tension along the entire length of the approximated tissues. With interrupted techniques, tension is focused on each individual stitch so that dehiscence begins at the stitch where the tension exceeds the suture holding capacity of the tissue\(^{(3)}\).

**Size of hernia**

The size of the hernia defect is proportional to the risk of hernia recurrence. The larger the hernia, the greater the incidence of recurrence\(^{(3)}\). Large hernias recur twice as often as small ones, because of overstretching with attenuation and destruction of tissues normally used for repair of the hernia by longstanding pressure. These tissues are correspondingly weaker when repaired with suture or mesh. The large defect is more difficult to close by any method. Hernias <4cm wide had a recurrence rate of 25% while those >4 cm recurred in 41 %\(^{(5)}\). The repair often involves a wide and difficult dissection, with tissue damage, haematomas, and infection, all conducive to recurrence\(^{(3)}\).

**Anaesthesia**

The type of anaesthesia does not influence the recurrence rate, whether it is local, spinal, or general\(^{(59)}\). Although the tendency today is to repair using local anaesthesia in an ambulatory situation, there is no relation between complications or post-operative recovery and the type of primary anaesthesia\(^{(140)}\).

**Skin preparation**

Many methods are used for pre-operative skin preparation with or without shaving. In obese patients with large hernias, chronic moist and infected dermatitis is often present in the deep folds around the hernia. Efforts should be made to clear up these areas before the operation with povidon iodine to reduce
the bacterial population of the skin, especially when the use of prosthetic mesh is planned for the repair (60).

Repeated repair

The incidence of recurrence increases with repeated repair of hernias because of compounding technical difficulties caused by the repeated tissue destruction and scarring. The defect grows larger with each attempt at repair and the tissues become progressively stiff and unyielding. An attempt to approximate the almost solid edges of the defect under tension only leads to further tissue necrosis and recurrence. This situation calls for a prosthetic mesh repair without any attempt to suture together the edge of the defect (59).

Emergency Repairs:

An emergency operation for strangulated or incarcerated hernia may increase the risk of postoperative recurrence. It is likely that the strangulated hernia, with its inherent inflammation, tissue ischemia, and fascial edema, provides an environment in which the hernia repair is placed either at increased tension or through unhealthy tissue (60).

The incision

The incision for herniorrraphy should be adequately long to expose the anatomical elements involved. Poor exposure leads to inadequate repair and recurrences. Raising skin flaps is not necessary, because it creates large raw surfaces that bleed and ooze serum. After the operation, collections of serum and blood tend to become infected. The infection may spread to the rest of the repair and lead to recurrence (59).

The cremaster muscle:
Many surgeons prefer that cremaster muscle be completely divided and excised to expose the entire posterior wall of the canal and margins of the internal ring. Prolapsed preperitoneal fat is best excised but can also be returned through the internal ring into the abdominal cavity. Failure to excise the cremaster is associated with a higher recurrence rate. At the Shouldice Hospital, excision of the cremaster muscle is stressed, because a bulky cord interferes with the repair and also with reconstruction of the external oblique aponeurosis (60).

Missed hernia

Failure to recognize or repair the original hernia as in the case of a missed or overlooked sac may be the cause of a recurrent hernia. When an obvious direct hernia is found at operation, failure to explore the cord for the presence of an indirect hernia as well, or at least for the presence of the patent processus, will lead to the development of an indirect recurrence. Other often overlooked causes are one or more small herniations of extraperitoneal fat through the transversalis fascia or even higher up through the conjoined tendon (3).

The hernial sac

In indirect inguinal hernia repair, inadequate dissection of the sac and or leaving a stump of the upper end protruding below the internal ring leaves a diverticulum on the peritoneum and leads to early recurrence of the hernia. High ligation and excision of the sac does not influence the recurrence rate, it may be a cause of increased post-operative pain; however, high dissection of the sac well up into the retro-peritoneum and the freeing of the sac from the edges of the internal ring are important for the prevention of recurrence of the hernia as it allows good exposure of the ring to facilitate the repair. Longer sacs may be transacted and the freed upper stump inverted into the abdominal cavity without suture or ligation (59).

Medial recurrence
The medial, direct, recurrent hernia at the angle between the rectus sheath and the inguinal ligament occurs when the buttress has not been constructed sufficiently medially into the pubic tubercle and beyond. It may also occur when the medial angle is closed under tension by the sutures between the rectus sheath and inguinal ligament \(^{(59)}\).

**1.7.2.3 Post-operative factors**

Infection:

Infection, particularly the deep one, is one of the most common serious complications that lead to break down of hernia repairs. It has been estimated that approximately 50\% of recurrent hernias, are the result of infection. One third or more of infected hernia repairs result in recurrent hernias.\(^{(59)}\) Recurrences were 4 times greater in infected than non-infected repairs in the Shouldice Hospital series. Berliner reported that 4 out of 10 infected wounds in his series developed recurrences \(^{(141)}\).

The mechanisms by which infected wounds break down are not entirely clear. Frank cellulitis with fascitis and wide tissue necrosis, leads to complete break down of repair. In less severe reactions, where absorbable and non absorbable biological sutures such as silk have been used, the break down products of the inflammatory process may hasten the disintegration of the sutures before the wound is strong enough to hold together on its own, so that the wound unsupported by the sutures will fall a part \(^{(3)}\).

The inflammation and oedema lead to softening and weakening of the tissue, rendering it unable to hold the suture against the strains to which the wound is subjected, so that the tissues will tear and allow the suture to cut out \(^{(64)}\).

Haematoma

Post-operative haematoma may be a cause of recurrence when it is large and becomes infected. This is especially true in the anticoagulated patient, and
usually following large hernia in which the repair often involves a wide and difficult dissection, with tissue damage, haematomas, and infection all conducive to recurrence. A large volume of hematoma may serve as a nidus for infection deep in the hernia wound and may risk secondary infection of the prosthetic mesh (3).

Seroma

In patients having ventral, or inguinal hernia repairs, serum forms in the dead space remaining from a wide dissection during the open hernia repair, or when fluid fills the distal remnant of the distal sac, or as a result of the porous property of the mesh in patients of laparoscopic surgery. It may be a contributing factor of hernia recurrence when the collection is large and becomes infected (142).

Bowel ileus

Post-operative prolonged bowel ileus may be a factor of hernia recurrence when it occurs immediately, particularly, during the first week after surgical repair. Prolonged post-operative paralytic ileus with abdominal distension leads to enormous vertical tension on the wound by increasing its length and raises the lateral pull on the sutures by increased girth of the abdomen (3).

Chronic post-operative pain

Chronic post-operative pain or chronic residual neuralgia is a pain persisting beyond the normal tissue healing period, assumed to be three months (143). It is usually developed as a product of tension producing suture repair. Rutkow M. et al. did not correlate the pain with preservation or sacrifice of the nerves, nor they operate on any individual with compressed ilio-inguinal or genitofemoral neuralgia. Usually these patients report complete dimension of the symptoms following several months.
It is found that patients, who developed post-operative pain, are associated with increased number of hernia recurrence as a result of tissue approximation under tension. The tensionless repair of Lichtenstein (3) is based on the absence of tension, and consequently is associated with low incidence of neuralgia or hernia recurrence.

Early mobilization and return to work

Early mobilization, and return to normal physical activities and hard work in the immediate post-operative period does not cause recurrences. On the contrary, persons with sedentary occupations suffer double the number of recurrences as those performing heavy manual labor. Time back to work is mainly dependent on socio-economic factors, including the patients' motivation, the type of work he or she does, his social class and type of insurance carried. The post-operative convalescence time does not influence the recurrence rate (26).

1.8 Justification

Abdominal wall hernias are among the most common of all surgical problems in the world that affect all ages and sexes, with an incidence in the general population estimated to be 1.5% (144). Hernia is a leading cause of work loss, and disability and is sometimes lethal. In addition, patients suffering from hernias will alter their life styles so as not to exacerbate their symptoms which in turn
impair the ability to maintain a productive life. So, hernia is a big socio-economic problem\(^{(144)}\).

Any hernia can worsen over a time and can cause serious morbidity, such as incarceration (6% - 15% of cases)\(^{(90,145)}\) and strangulation (2%)\(^{(145)}\), that emergency surgical treatment is required in the form of hernia repair\(^{(54)}\). Mortality from hernia may occur in the majority from its complications (usually strangulation or incarceration), and to a lesser extent from the complications of surgical therapy. The mortality rate is much higher, following emergency surgery than after elective surgery. It varies between 3.1% and 12.6% from strangulation, gangrenous intestine, infection and perforation\(^{(64,146)}\).

The operation rates varying between countries from around 100 to 300 per 100,000 populations per year\(^{(147)}\). In the United Kingdom, approximately 80,000 inguinal hernias are repaired each year in National Health Service Hospitals\(^{(148)}\), and in Italy the number is about 150,000 per year\(^{(149)}\). In the United States approximately 750,000 inguinal, 166,000 umbilical, and 100,000 incisional hernias are repaired surgically each year\(^{(150-152)}\).

Numerous methods have been described for the repair of defects in the abdominal wall. Tissue repairs are associated with undue tension in the suture line, which leads to unacceptably high rates of recurrence\(^{(153)}\). Depending on the technique employed, most reported rates in the literature showed the recurrence rates after primary sutured repairs of hernia ranged from 0.2% to 33% for inguinal hernias\(^{(154-156)}\), between 10% and 30% for para-umbilical hernias\(^{(44,46)}\), and from 12% to 54% for incisional hernias\(^{(74,122,157,158)}\). In addition, abdominal hernia repair may become rise to serious complications such as chronic pain, entero-cutaneous fistula and bowel obstruction rather than improvement of the patient's situation\(^{(159)}\).

Successful surgical repair of hernia depends on a tension-free closure of the defect to attain the lowest possible recurrence rate and significantly less pain and discomfort in the post-operative period\(^{(160)}\). Modern techniques helped in the improvement of this recurrence rate by placement of mesh over or below the
hernia defect and eliminated the undesired tension that have been produced by sutured repairs\(^{(161,162)}\). The improvements in hernia recurrence rate have occurred mostly in centres specializing in hernia surgery to less than 1%\(^{(163,164)}\). In contrast, recurrence rates for general surgeons remain significantly higher. This has important socioeconomic implications.

Surgical repairs of inguinal, para-umbilical, and incisional hernias with sutures and with mesh by open\(^{(165)}\) and laparoscopic\(^{(166)}\) approaches have been reported, but most studies were either retrospective, or case series lacking a control group\(^{(167-172)}\) in which risk factors for hernia recurrence have been inadequately described and unevenly distributed. Of the small number of controlled studies, most have been limited by too small a sample size\(^{(173-175)}\) or short term follow-up. The economical cost structure of sutured technique makes it even today a common form of hernia repair in most parts of the developing world, \(^{(176)}\).

Overall, in Yemen, Sudan, and probably in North Africa and Arab states, sutured repairs are still the standard methods practiced by 68.2%, 73.4% and 54.6% of surgeons for inguinal, para-umbilical and incisional hernias respectively. Mesh repair is restricted for selected cases such as large or recurrent hernias. Many surgeons are afraid of the complications of an infected mesh graft that may dictate removal of the graft, and others are sticking to the technique they know and believe it is the best for their patients\(^{(177)}\).

In view of the previous circumstances, paucity of local data, and the apprehension of using polypropylene mesh for hernioplasty in hospitals with theatres where all kinds (clean, contaminated, and dirty) of cases are carried out, the need was felt to encourage and train young surgeons to be familiar with the tension-free herniorrhaphy, and to design a prospective randomized, controlled study, to clinically evaluate the outcome of mesh, and sutured repairs in primary hernia surgery, in the hands of general surgeons.

1.9 Objectives
1.9.1 General objective:

To evaluate the safety and outcomes of open tension-free mesh repairs in comparison with sutured techniques for the surgical treatment of inguinal (study 1), para-umbilical (study 11) and incisional (study 111) hernias in an open study where variables that constitute risk factors are stratified and controlled.

1.9.2 Specific objectives:-

(1) To estimate the recurrence rates in the tension-free mesh and sutured repairs of inguinal, para-umbilical, and incisional hernias.

(2) To establish the association between the type of repair, experience of the surgeon and hernia recurrence.

(3) To determine the potential risk factors for the development of hernia recurrence in the two treatment groups of hernias.

(4) To analyse the results in terms of operative time, technical difficulty, length of hospital stay, patient’s comfort, post-operative analgesia required, time of return to normal activities and satisfaction with the procedure in the two treatment groups.

(5) To identify the early and late post-operative complications that may take place after mesh and sutured repairs, and their role in the development of hernia recurrence.
Chapter Two

Patients and methods

2.1 Study design

The study was designed as prospective, randomized, controlled (interventional) study. This design was chosen for the following reasons: (a) well-designed and conducted study is the most reliable way to evaluate the safety and efficacy of new treatments in a controlled situation, (b) randomized study is an efficient and affordable method to obtain a wide range of information, helpful when implementing new techniques, and to assess the practical aspects of using a new treatment in clinical practice, (c) It includes a randomization: a process used for allocating treatment to two or more groups of subjects by chance. This allows the treatment groups to be balanced for known and unknown variables that may influence the disease process and response to treatment. It was an open (unblinded) interventional study where both the investigator and the patient know which treatment has been assigned; this is indispensable, since the study was carried out on surgical procedures.

2.2 Sample size

The original sample size was 1321 patients with inguinal (n=454), para-umbilical (n=421), and incisional (n=446) hernias. The successful sample size eligible for follow-up was 1190. By using data from previous studies, the sample size was estimated to provide 80% power at the two sided 0.05% significance level to detect a reduction of at least 50% in the recurrence rate with the new surgical repair, by using the following formula:

\[
n = \frac{[Z(\alpha/2) \sqrt{2P(1-P)} + Z(\beta) \sqrt{P_1(1-P_1)+P_2(1-P_2)}]^2}{(P_1-P_2)^2}
\]

- \( n \) = sample size.
- \( P_1 \) = the expected event rate (first probability).
- \( P_2 \) = the expected proportional risk reduction with new treatment (second probability).
- Alpha error sets at 0.05 (\( \alpha \)), this gives a significance threshold level of 5%.
- Beta error sets at 0.2 (\( \beta \)) this gives at least 80% power to detect the expected risk reduction.
• $Z (\alpha / 2)$ and $z(\beta)$ are constants from the standard normal distribution depending on the values of $\alpha$ and $\beta$. $Z (\alpha/2) = 1.96$, $Z (\beta) = 0.842$.

2.3 Study setting

This clinical sample was composed of patients attending the surgical outpatient clinics of Ibn Sina Central Teaching Hospital, and Al-Amal Specialized Hospital. These hospitals receive referrals from a wide catchment area mainly from Hadhramout, Shabowa, and Al-mahra provinces. The patients referred to these clinics are of mixed socio-economic status.

2.4 Study Subjects

One thousand and two hundred fifty one adult patients diagnosed with primary inguinal ($n=403$), para-umbilical ($n=372$), and incisional ($n=408$) hernias, were randomly allocated to either sutured repair or mesh repair between September 2004 and May 2005, over a period of two to three years follow-up.

2.4.1 Inclusion criteria:

Patients were eligible for enrolment in the study if they meet the following criteria:

Any patient of 18 years of age or older, who presented with a clinical diagnosis of primary inguinal, para-umbilical or incisional hernias, fit to receive spinal or general anaesthesia, and gave an informed consent for participation in the study. If a patient has bilateral inguinal hernias, both hernias can be treated simultaneously, and one selected as the study hernia.

2.4.2 Exclusions:

The exclusion criteria were; patient was classified as American Society of Anesthesia (A.S.A.) score 1V (having severe systemic disease that is a constant threat to life) or score V (a moribund patient unlikely to survive 24 hours without operation), or has contraindications to general or spinal anaesthesia, patient refused to give informed consent, presence of bowel obstruction, strangulation, peritonitis or perforation, presence of severe local or systemic infection, previous hernia repair, morbid obesity.
(Vide infra), and patients in whom hernia repair was part of another intra-abdominal procedure.

2.4.3 Ethical approval
The study protocol was approved by the Ethical and research Committee of the Faculty of Medicine, University of Hadhramout. Furthermore, the study protocol has been studied and approved by the Research Committee of the Faculty of Medicine. University of Khartoum in fulfillment of requirement of MD by research. The study was explained to the patient in details, who gave an informed consent.

2.4.4 Base line information:
A research physician specially allocated to the study visited the patients before operations. The patients were interviewed, and base line data gathered and entered in a special sheet (appendix 1). A standard history was obtained, and a clinical examination checked fitness and established a diagnosis. The patient-related factors of sex, age, occupation, complete address, build; chronic Cough, constipation, urinary problems, systemic disease, glucocorticoid therapy, smoking status, and abdominal surgical history were recorded.

According to the National Institutes of health definitions, obesity was measured by body mass index (B.M.I.) \(^{(179)}\) which is defined as a measure of weight in kg. divided by the square of the height in meters. The BMI is distributed into one of the following categories: under-weight with BMI < 18.5, normal B.M.I. is 18.5-24.9, overweight is 25-29.9 B.M.I and obesity which is defined as a BMI of 30 or more. Furthermore, obesity is mild: is the range of B.M.I. 30-34.9, Moderate: is within B.M.I. level of 35-39.9, Severe obesity: is B.M.I. more than 40.

Factors related to the hernia were also recorded such as; type, location, symptoms and size of hernia, presence of swelling at the site of operation and duration, original operation, and type of incision.

2.5 Study intervention
2.5.1 The participating surgeons:
The surgeons involved in the study were those normally working with the surgical units of the participating hospitals and enrolled patients in the study. Before starting the study, a meeting was conducted in the presence of the managers of the hospitals, with all of the participating surgeons, anaesthesiologists, research physicians, and nurse coordinators to ensure that they are thoroughly familiar with the protocol. During this meeting they agreed on standardization of herniorrhaphy technique and reached a consensus on all aspects of post-operative management of patients including post-operative instructions, follow-up schedule, and definition of recurrence and complications. The surgeons were classified according to years of experience into three levels; level 1; up to 4 years of experience, level 11; from 5 to 12 years, and level 111 >12 years.

2.5.2 Preparation for surgery:
The patients were admitted one day before operation, or the morning of operation during which they have already completed the standard routine preoperative studies to measure complete blood count (CBC), blood chemistry, chest radiograph, electrocardiogram, as well as urinalysis, and the surgeon may require additional studies depending on the cardio-pulmonary condition of the patient. Every patient was assessed by the anaesthesiologist before the operation, and has been given a medical report regarding fitness for operation.

Smokers were asked to stop smoking, if possible, several weeks before. Diabetic patients were controlled initially, and were asked to continue their normal regimen. For patients taking aspirin and warfarin, the surgeons chose to follow the recommendations published in the New England Journal of Medicine (180). Patients taking warfarin were instructed to stop their warfarin for four doses preoperatively, and a blood sample was taken the morning of surgery to ensure normalization of the International Normalized Ratio to less than or equal to 1.5. Patients were advised to continue taking aspirin, because there is no evidence to support an increased risk of complications in patients on aspirin when undergoing hernia repair (181). All patients were advised to achieve bowel preparation with bowel cathartics. Shaving was performed immediately before the operation.
2.5.3 Allocation to treatment groups:

After reviewing and signing the informed consent at the anaesthetic office, the patients were randomly allocated to either mesh repair or sutured repair after matching of risk factors of hernia recurrence. Randomization was carried out by use of pre-prepared treatment allocated lists generated from random number tables.

2.5.4 Anaesthesia:

General or spinal anaesthesia has been chosen as the methods of choice, depending on the site of hernia, and patient’s condition as assessed by surgeon and anaesthesiologist. All patients received I/V single dose of prophylactic ceftriaxone 1 gram pre-operatively at the induction of anaesthesia.

2.5.5 Surgical techniques

2.5.5.1 Operative techniques for inguinal hernias:

In the patients assigned to undergo repair with mesh, Lichtenstein method was performed as described by Amid: Through a 5-6 cm. oblique inguinal incision, the external oblique aponeurosis was opened. The spermatic cord was freed from the inguinal floor and the pubic bone area. For indirect inguinal hernias, the cremastric sheath was incised longitudinally. The sac was then dissected from the cord beyond its neck and inverted into the pre-peritoneal space. Very large indirect sac was divided at the midpoint of the inguinal canal. The proximal end was closed and inverted into the pre-peritoneal space. The distal end was left behind. Large direct sac was inverted with absorbable suture to make a floor for the mesh placement.

The plane between the external oblique aponeurosis and conjoint tendon was opened up as widely as possible. A polypropylene mesh L.W. version (Prolene ®; DynaMesh, Germany), measuring 8x16cm, trimmed to fit this space. The first anchoring suture of the mesh fixes the inferio-medial corner of the mesh to a point for approximately 2cm. medial to the pubic tubercle. The lateral edge of the mesh was sutured to the inguinal ligament using loose, continuous, 2/o prolene suture. A slit was made on the lateral end of the mesh for 3-5 cm. creating two tails – 2/3 above, 1/3 below to accommodate the cord. The two tails
were sutured to the inguinal ligament lateral to the internal ring with one or two interrupted sutures to ensure snug fit around the cord, leaving 5 cm. of mesh lateral to the internal ring. Three or four sutures were used to fix the mesh superiorly. Care was taken to keep the mesh slightly relaxed, to compensate for increased intra-abdominal pressure when the patient stands up from the recumbent position, and to compensate for the future shrinkage of the mesh. Having checked for haemostasis and safeguarded the ilio-hypogastric nerve, the cord is placed over the mesh.

In the patients assigned to undergo inguinal sutured repair, Modified Bassini repair (55); after herniotomy, the repair includes a technique of narrowing the deep internal ring by 2 or 3 interrupted sutures, followed by reinforcement of the posterior wall of the inguinal canal by approximation, without, or with a minimum of tension, the tendinous aponeurotic arch of the internal oblique to the under surface of the inguinal ligament and to the pubic tubercle, using number one polypropylene (prolene®) continuous suture. The cord was placed over the constructed posterior wall. In both techniques, the external oblique aponeurosis was closed anterior to the cord, using continuous number one, Vicryl suture. The skin closed with a continuous 3/0 subcuticular Vicryl.

2.5.5.2 Operative techniques for para-umbilical hernias
A transverse incision was made either supra-umbilically or infra-umbilically, depending on the location of the para-umbilical hernia. The hernia sac was dissected from the surrounding tissue until the hernial ring was identified circumferentially and opened. The contents of the sac were reduced into the peritoneal cavity then the peritoneum was closed and reduced to avoid any contact of the mesh with the contents of the peritoneal cavity. In the patients assigned to mesh repair, an onlay mesh repair (3) was performed: a prolene mesh patch was prepared and overlaid onto the defect with about 4 cm of the mesh over the sheath from the edge of the defect, and fixed with 2-0 prolene suture.

In the patients assigned to sutured surgery, Mayo repair was selected (43): the defect was closed transversely by overlapping the upper flap of the abdominal fascia over the lower flap by using two rows of prolene sutures. The first raw of
staggered interrupted full thickness, and the second raw with continuous polypropylene suture for complete closer of the defect. A closed suction drain was placed subcutaneously in all cases of both groups and removed when the drainage was less than 50ml /24hours. The incision was closed with a subcuticular suture.

2.5.5.3 Operative techniques for Incisional hernias
The previous scar was excised, and the hernial sac was completely dissected to the edge of the defect and opened for separation of adhesions of intra-abdominal structures to the scar or to the abdominal wall and excision of the scar at the neck of hernia. The peritoneal sac was closed with absorbable material and reduced to the abdominal cavity forming a bed below the hernial ring to receive the mesh.

In the mesh repair, the rectus sheath or external oblique aponeurosis was clearly exposed around the circumference of the defect. A polypropylene mesh was tailored to the defect so that at least 4 cm of the mesh overlapped beyond the edges of the fascia, and the mesh was implanted and sutured peripherally as superficial onlay with a continuous 2-0 prolene suture. Subsequently a second line of suture was inserted from the edge of the defect to the mesh using the same suture material, thus guaranteeing secure fixing of the mesh.

In the patients assigned to undergo repair with sutures, the two edges of the fascia were approximated in the midline, usually with a continuous polypropylene suture (Prolene® no. 1), with tissue bites and intervals of approximately 1cm. Meticulous haemostasis was assured and closed suction drain was inserted in all patients in the two groups. Dead space was closed using 3-0 plain catgut suture. Excess skin was excised allowing primary skin closure, and the skin closed with sub-cuticular vicryl. The suction drain was removed when the daily drainage was observed to be less than 50 ml.

2.5.6 Post-operative instructions:
The patients were advised to mobilize as soon as possible without restriction concerning activities unless the activities caused severe pain. All patients were
allowed to leave the hospital when they had passed urine normally, and were able to walk except those who have developed complications or those with general disability and need further follow-up. They were encouraged to resume their normal activities after surgery when they were able to do so.

2.6 Outcome measures

The primary outcome measure of the study was hernia recurrence. The secondary outcome measures include: operative time, technical difficulty, length of post-operative stay, intra-operative and post-operative complications, pain score, analgesia required, time of return to usual social activities, and patient’s satisfaction to surgery.

2.7 Data collection and follow-up

2.7.1 Operative data
Intra-operative data were completed by a research physician, on a standardized form (Appendix 11). Information was collected about the type of technique, diameter of defect, anaesthetic and operative complications, technical difficulties, and operative time; defined as the time from the incision to the placement of the last suture. Operations which lasted 70 minutes or more were considered prolonged and indicative of technical difficulty (182).

2.7.2 Post-operative hospital stay data
Post-operatively, the hospital stay data of each patient were evaluated by the attending surgeon. Pain score was recorded during the day of surgery (D0), the 1st, 7th, 14th, 30th post-operative day. The level of pain was indicated by asking the patients to rate the intensity of their pain by using the 0 to 5 Numeric Rating Scale (NRS) on which 0 equals no pain while 5 represents the worst possible pain (Appendix V). Narcotic and non-narcotic analgesics were administered as necessary for severe and moderate pain, and the frequency and duration recorded, afterwards analgesia was provided as oral non-steroidal anti-inflammatory drugs (diclofenac).

All potential complications such as urinary retention, haematoma, seroma, and wound infection were assessed and recorded in preformed sheets (Appendix 111).
Antibiotics were not prescribed post-operatively as routine. They are prescribed only in the presence of pus in the wound and a positive blood culture.

2.7.3 Follow-up data

The operated patients were requested to return to the surgical outpatient clinic, at one week, two weeks, one month, three months, and yearly for three years after surgery for standardized history taking and clinical assessment by the attending surgeon only for the first two weeks. Afterwards the patients were followed-up by an independent resident in surgery who recorded variables and data at each visit by physical examination. Post-operative complications after hospital discharge such as chronic wound infection, chronic pain, and chronic constipation and hernia recurrences were also assessed and documented (Appendix V1).

The persisting or chronic pain was defined as pain or discomfort at the site of surgery that interferes with the normal daily activities at three months after surgery. It was evaluated by asking the patient to evaluate their site pain as none, mild, moderate, and severe. The patients had a recurrent hernia if a bulge or protrusion exacerbated by a cough impulse was clinically manifested in the operation area (183) or any fascial defect was palpable during physical examination, or detected by ultrasonography, or during a second operation and was located within 7 cm. of the site of the hernia repair. U/S examination was performed only when physical examination was not conclusive.

At three months after surgery, the patients were asked about the date on which they resumed normal daily activities, by asking them, when they had returned to normal activities. Patient’s level of satisfaction, was assessed at three months after repair, by asking how satisfied they were with their treatment and whether they would recommend this operation to a friend or relative. Patients were considered satisfied according to the definition used by Reitter et al. (184) if they had no complaints regarding their operation or operative results. All deaths were assessed in terms of immediate cause and the relation of the death to the hernia operation.

2.8 Data analysis
All data were collected and analyzed using SPSS 13.0 for windows program (SPSS Inc., Chicago, IL). Analyses of the differences between continuous, normally distributed data are expressed as means ± s.d., and were performed by using t-test. Other continuous data were expressed as medians. Percentages were compared with the use of Chi-square test. The cumulative percentages of patients with recurrence over time were calculated with use of Kaplan-Meier curves and compared with log-rank test. Pain score for the two groups of repair at different intervals and operative time by surgeon experience were compared with the use of an analysis of variance (ANOVA) for repeated measurements. Multivariate analyses of various factors of hernia recurrence were performed with Cox regression analysis.
3.1 Entry of patients
A total of 1321 consecutively referred adult patients presenting with clinically diagnosed inguinal, para-umbilical and incisional hernias were screened for suitability, between September 2004 and May 2005 at Ibn Sina Central Teaching Hospital (I.S.C.T.H.) and Al-Amal Specialized Hospital (A.H.), Mukalla, Hadhramout-Yemen. One thousand hundred ninety patients were successfully screened for follow-up after surgery, representing 90.1% of those seen. The remaining 9.9% (n=131) were excluded because of the following reasons: seventy (5.3%) patients did not meet the criteria for entry during screening phase. Of them; 46 were below the study age criterion (<18 years) and considered unrepresentative of the age group range, 4 had severe urinary tract infection, 4 suffering from severe obesity, and 16 had previous repair.

Following randomization, 26 (7 in inguinal, 7 in para-umbilical, and 12 in incisional hernias) refused to participate in the study, and 15 (8 in inguinal, 3 in para-umbilical, and 4 in incisional hernias) were considered to be poor candidates for surgery (American Society of Anaesthesia class IV).

During surgery, one was found to have a femoral hernia at the time of surgery in inguinal hernias, 8 (3 in inguinal, 2 in para-umbilical, and 3 in incisional hernias) hernia repairs were part of another surgery, 3 had damaged mesh (in para-umbilical hernias).

After surgery, 8 (6 in inguinal, and 2 in para-umbilical hernias) refused annual follow-up and opted out. However, 1190 patients (with primary inguinal [n=403], para-umbilical [n=372] and incisional [n=415] hernia repairs) were eligible for follow-up and analysis (Fig. 1, 1.1, 2.1, 3.1).

3.2 Follow-up and response rate
The mean duration of follow-up was 32.5 months (range 12-36 months) in the mesh groups, and it was 30.0 months (range 12-36 months) in the sutured groups of inguinal, para-umbilical and incisional hernia repairs. The cumulative response rate in the study population was 96.2%. In inguinal hernia repairs the response rate was 92.8% (91.5% for the sutured group and 94.1% for the mesh repair group) (Figure 1.2). In para-umbilical hernia repairs it was 97 % (96.7% for the sutured group and 97.3% for the mesh repair group) (Figure 2.2), and in incisional hernia repairs it was 98.3% (97.6% for the sutured group and 99% for the mesh group) (Fig. 3.2 ).

The number of non-respondents (lost) in inguinal hernia repairs was 29, 7.2% (17 in the sutured group and 12 in the mesh group), of these, 3 patients died (2 in the sutured and 1 in the mesh groups) and 26 patients were lost during follow-up for the following reasons; two moved abroad, 5 changed their local address, and 19 did not keep their appointment for various reasons such as work, or long distance.

In para-umbilical hernia repairs the non-respondents were 11, 3 % (6 in the sutured group and 5 in the mesh group) for the following reasons; one moved abroad, 2 changed their local address, and 8 did not attend their appointment. There were no deaths.

In incisional hernia repairs 7 patients (1.7%) were lost (5 in sutured group and 2 in mesh group) for the following reasons; 2 patients died (one in each group), 3 did not attend their appointment for unknown reasons, and 2 patients were transferred to another region. The censored patients were included in the analysis until their follow-up data were censored at the time of follow-up.

All the deaths in the study were not related to surgical repair. The causes were C.V.A. in 3 old patients occurred at 10, 16 and 17 months after surgery, and myocardial infarction in 2 patients at 15 and 18 months after surgery.

3.3 Patients' characteristics
The demographic characteristics of patients and hernias were similar as was the proportion of patients in each group of repair having the prognostic factors of hernia recurrence. (Tables 1.1, 2.1, 3.1).

3.3.1 Age and sex

The majority of participants in inguinal hernias were males (n=366, 90.8%), while in the para-umbilical and incisional hernias, the majority were females (86.3%, and 85.8% respectively). The mean age was 49.9± 15.6 years (range 18 – 90 years) in inguinal, 41.94± 10.492 years (range 25 – 72 years) in para-umbilical and 48.1 ± 13.6 years (range 20 – 90 years) in incisional hernias (Tables 1.1, 2.1, 3.1).

The distribution of inguinal, para-umbilical and incisional hernias among age groups is shown in figures 1.3, 2.3, and 3.3. The highest rate of incidence of inguinal hernias (41.75%) was in patients between 40 and 59 years, while in para-umbilical hernias the highest rate (67.5%) was in patients between 30 and 49 years, and in incisional hernias (53%), it was in patients between 40 and 59 years of age.

3.3.2 Symptomatology

The main presenting complaint in patients with inguinal hernias was a swelling in the groin region (98.5%) for inguinal hernias (Table 1.1), a swelling in or around the area of umbilicus (95.2%) for para-umbilical hernias (Table 2.1), or a swelling in the vicinity of the previous operation scar (94.7%) for incisional hernias (Table 3.1). The other main presenting symptoms were pain (28.5%, 58.1% and 43.8%) and irreducibility (8.7%, 7.0%, and 10.7%) in inguinal, para-umbilical and incisional hernias respectively. (Tables 1.1, 2.1, 3.1).

3.3.3 Strain factors

Strain factors of each hernia are shown in tables (1.1, 2.1, and 3.1). In inguinal hernias, 37.7% of the participants had hard jobs (Figure 1.4), 9.5 % were obese with the majority of patients (60.5%) had normal body mass index (Figure 1.5), and more than half are smokers (57.7%), of these 29.5% were heavy smokers (Figure 1.6).
In para-umbilical hernias, heavy jobs constitute only 23.4% (Figure 2.4). About 2/3rd of the participants (66.6%) had mild to moderate obesity (Figure 2.5), with a mean BMI 32.1± 4.8 (Table 2.1), and smoking was only in 11.55 %, (Figure .2.6).

In incisional hernias, only 11.1 % had manual active jobs (Figure 3.4), and two thirds of the participants were obese (26% mild obesity and 42.7% moderate) (Figure 3.5). Smoking participants constitute only 8.2% (Figure 3.6).

3.3.4 Index operation

An index operation is the previous surgery which resulted in an incisional hernia. The mean hernia-free interval (the period between surgery and hernia appearance) was similar in both group (Table 3.1). Gynaecological operations accounted for 71.1% of the incisional hernias. Of these caesarean section constitutes 53.3% (Table 3.2).

3.4 Intra-operative findings

3.4.1 Anaesthesia

Spinal anaesthesia was the method of choice for inguinal hernia repairs. It was given to 97% (n= 391) of the patients (Table 1.2).In para-umbilical and incisional hernia repairs, general anaesthesia was the main anaesthetic approach. It was given to 83.6 % and 62.2% of patients respectively (2.2, .3.3). However, the results showed that the types of anaesthetic procedures were similarly distributed between the two groups of surgery.

3.4.2 Surgeons and surgical operations

The 14 surgeons in the two hospitals performed 403 surgical repairs for inguinal (65.4% at I.S.C.T.H., 34.6% at Al-Amal hospital), 372 of para-umbilical, (72.6% at I.C.C.T.H., and 27.4% at Al-Amal Hospital), and 415 incisional hernias (62.2. % at I.C.C.T.H., and 157, 37.8% at Al-Amal Hospital), distributed among the levels of surgeons. There was no major imbalance in the proportions of mesh and non-mesh
procedures performed by the three levels of surgeons, nor between the two groups of surgery.

3.4.3 Types of inguinal hernias found at operation

The type of hernia that was found at operation and the proportions of patients with each type were comparable. The most common type was indirect inguinal hernia (51.9 %). (Table 1.2).

3.4.4 Size of hernia defect

The size of hernia defect measured as a mean diameter of defects in the sutured group of inguinal hernias was $3.7 \pm 0.7$ cm. compared with $3.8 \pm 0.7$ cm. in the mesh surgery group. The corresponding diameters in the sutured and mesh surgery groups of para-umbilical hernia repairs were $3.73 \pm 1.2$ cm. versus $3.6 \pm 1.1$ cm and of incisional hernia repairs., were $7.09 \pm 3.5$ cm. versus $7.70 \pm 3.80$ cm. respectively (Tables 1.2, 2.2, 3.3 ). However, the mean diameters of defects in the two groups were similar, $p=0.9, 0.2$, and 0.9 respectively.

Figure 2.7 shows that the majority (76.3% in the sutured, and 75.3% in the mesh groups) of patients with para-umbilical hernias, were having a defect diameter of 3-5 cm., while in incisional hernias, 54.9 % of the patients (54.1% in the sutured group, and 55.8% in the mesh group) were having defect diameters ranging from 5 to 10 cm. (Fig. 3.7).

3.4.5- Operative time and technical difficulty

The operative time was analysed in two ways: with respect to the method of repair, and the surgeon involved. With respect to the method of repair: in inguinal hernia repairs, the median duration of operation was 42 minutes (35-80 minutes), in the mesh-surgery group compared with 40 minutes (30-70 minutes) in the sutured-repair group while the corresponding number in the para-umbilical hernia repairs was 50
In incisional hernia repairs, the median duration of operation was 62 minutes (range 38 – 100 minutes) for the mesh surgery group, compared with 60 minutes (range 32 – 90 minutes) for the sutured group. Although mesh repairs took longer time than sutured repairs, the difference in the median time between the two groups of inguinal, para-umbilical and incisional hernia repairs did not achieve statistical significant, \( P = 0.1, 0.07, \) and 0.09 respectively (Tables 1.2, 2.2, 3.3).

In inguinal hernia repairs, 6 (3%) of the sutured group and 8 (4%) of the mesh group operations lasted more than 70 minutes, and were considered prolonged, while in para-umbilical hernia repairs, 7 (3.5%) of the sutured group and 9 (4.5%) of the mesh group operations were considered prolonged. The same was 12 (5.8%) in the sutured group and 14 (6.7%) in the mesh group of incisional hernia operations (Tables 1.2, 2.2, 3.3).

It is not surprising, that the more senior surgeons achieved faster operative time when compared with the junior surgeons. In inguinal hernia repairs, the senior surgeons (level 111) achieved a median time of 39 minutes (range 30 – 65 minutes); this was significantly shorter time than the junior surgeons (level 1) who achieved a median time of 59 minutes (range 41 – 80 minutes), \( P <0.001, \) and than the intermediate surgeons (L 11) who achieved a median time of 48 minutes (range 36 – 70 minutes), \( p = 0.001 \) (Figure 1.7).

In para-umbilical hernia repairs, the high experienced surgeons (L 111) achieved a median time of 44 minutes (range 32–61 minutes); this was significantly shorter than the intermediate experienced surgeons (L 11) who achieved a median of 49 minutes (range 40–67 minutes), and than the young surgeons (L 1) who had a median of 60 minutes (range: 46 – 76), with a statistically significant differences between L 1 and L 11 (\( p= 0.01 \)), and L 1 and L 111 (\( p<0.001 \)) (Figure 2.8).

In incisional hernia repairs, level 111 surgeons achieved a median time of 52 minutes (range 32 – 79 minutes), this was significantly shorter than the level 1 surgeons who achieved a median of 69 minutes (range 50 – 102), \( P<0.001, \) and than L 11 surgeons who achieved a median time of 59 minutes (range: 40–85), \( P=0.001, \) (Figure 3.8).
However, at all grades of surgeon experience, there were statistically significant differences in the median operative time between the three levels of surgeons, in inguinal, para-umbilical and incisional hernia repairs. The longer the experience of a surgeon, the shorter is the operative time achieved.

### 3.4.6 Intra-operative complications

In the inguinal hernia repairs, the intra-operative complications were not life threatening, and were comparable in both groups of repair with no statistically significant difference, \( P > 0.05 \) in all comparisons (Table 1.11). In the sutured repair group, one patient had a minor perforation of the urinary bladder which was closed in two layers followed by an insertion of Foley's catheter, which was removed seven days after the operation. No patients in either group sustained bowel injury.

There were no intra-operative complications detected in the two treatment groups of para-umbilical and incisional hernia repairs, except in one patient of the sutured group of incisional hernia repairs with previous intestinal obstruction; a loop of small bowel was inadvertently ruptured during release, because it was adherent to the anterior abdominal wall. The tear was simply closed with overlying omentum (Table 3.12). The same patient later developed severe subcutaneous infection (vide infra).

### 3.4.7 Drain insertion

Suction drain was not used in inguinal hernia repairs, but it was inserted into all operations of incisional and para-umbilical hernias. In the majority of para-umbilical hernia repairs (65%), the drains were inserted for 48 hours (66% in the mesh group versus 64% in the sutured group). The mean duration of drain insertion was 51.10±14.43 hours in the mesh group comparable with 48.90±14.20 hours in the sutured group. The difference in the mean duration was not statistically significant, \( p = 0.14 \) (Table 2.2).

In more than half of the incisional hernia repairs (56% in the sutured group and 54.8% in the mesh group), drains were inserted for 48 hours, (Figure 3.9). The mean duration
of insertion of drain was 59.8 ± 16.2 hours (59.3 ± 15.9 hours for the sutured group, and 60.2 ± 16.5 for mesh group (p=0.6), (Table 3.3).

3.5 Recurrences

3.5.1 Recurrence rate
The recurrence rate, was 1.5 % (n=3) in patients who underwent mesh repair, compared with 10.5% (n=21), in those who underwent sutured repair of inguinal hernias. The apparent difference in the rates of recurrence between the two groups was statistically significant, p<0.001 by log-rank test (Figure 1.8).

In para-umbilical hernia repairs, the rate of recurrence was 2.7% (n=5) in the mesh repair group, and 12.9 % (n=24) in the sutured repair, p< 0.001 ( Figure 2.10), while in incisional hernia repairs, it was 4.3% for mesh repair group, compared with 27.6% for sutured repair ( Figure 3.10). The apparent difference in the recurrence rates between the two groups of incisional hernia repairs were statistically significant (P < 0.001). However, the mesh repair groups had lower recurrence rates than the sutured groups following inguinal, para-umbilical, and incisional hernia repairs, with statistically significant differences, p< 0.001. Furthermore, rates of recurrence were statistically significant when analyzed in the first year, second year, and third year of the study (Tables 1.3, 2.3, 3.4).

3.5.2 Recurrences by levels of surgeons
In an analysis of recurrences with regard to the surgeon experience, the inguinal hernia repairs showed that with level 1 surgeons, the recurrence rate was 6.5 % (n=13) in the sutured surgery group, compared with 1% (n=2) in the mesh-repair group, while with L_{111} it was 1.5% (n=3) only in the sutured group, and no recurrences in the mesh group (Figure 1.9). Furthermore, with Level_{11}, the recurrence rate was 2.5% (n=5) in the sutured group and 0.5% (n=1) in the mesh group (Fig. 1.9). The difference in the rate of recurrence was statistically significant between $L_1$ and $L_{111}$.
In the para-umbilical hernia repairs, with L_1 surgeons, the recurrence rate was 6.45\% (n=12) in the sutured group, compared with 1.6\% (n=3) in the mesh group, while with L_{11}, it was 3.76\% (n=7) in the sutured group and 0.54\% (1.0\%) in the mesh group. Level _111 surgeons showed 2.69\% (n=5) in the sutured group compared with 0.54\% (n=1) in the mesh group. The apparent difference in hernia recurrence was statistically significant between L_1 and L_{111} (p=0.009), and between L_1 and L_{11} (p=0.02), but not between L_{11} and L_{111} (p=0.8), (Table 2.4).

Similarly in incisional hernia repairs, with level_1 surgeons, the recurrence rate was 15.94\% (n=33) in the sutured group compared with 2.8\% (n=6) in the mesh group, while with level_{111} surgeons, the recurrence rate was 4.34\% (n=9) in the sutured group and 0.5\% (n=1) in the mesh group. The difference was statistically significant, p>0.001. Furthermore, with level_{11} surgeons the recurrence rate was 7.31\% (n=15) in the sutured group versus 1\% (n=2) in the mesh group (Fig. 3.11). The difference between L_1 and L_{11} was statistically significant, p=0.001, but not between L_{11} and L_{111}, p=0.8 (Table 3.5). This indicates that the recurrence rate was high in the hands of young surgeons, and tends to fall with increased years of experience of the surgeon.

### 3.5.3 Analysis of prognostic factors of hernia recurrence

Univariate analysis of predictors for hernia recurrence identified multiple significant risk factors. In inguinal hernia repairs, the patient’s specific factors include: diabetes mellitus, prostatism, chronic cough, and smoking (Table 1.5). The significant operative risk factors include: sutured repair, junior surgeon, and direct hernia (Table 1.6), while the significant post-operative risk factors include: wound infection, haematoma, and postoperative chronic pain (Table 1.7).

The multivariate analysis of these factors by using Cox-regression is shown in table 1.8. In this analysis: sutured repair (p=0.001), young surgeon (0.001), wound infection (p=0.01), chronic cough (p=0.04), and prostatism (p=0.03) were all identified as independent predictors for inguinal hernia recurrence.
In the para-umbilical hernia repairs, the significant pre-operative factors include: obesity, constipation, chronic bronchial asthma, chronic cough, and diabetes mellitus (Table 2.5), while the significant operative factors were sutured repair, and young surgeon (Table 2.6). The post-operative factors were: wound infection, seroma, and chronic pain (Table 2.7). The results of a multivariate Cox-regression analysis however, of these factors identified sutured repair (p=0.001), wound infection (p=0.001, junior surgeon (p=0.002), chronic cough (p=0.004), and obesity (p=0.02), were all identified as independent predictors for para-umbilical hernia recurrence (Table 2.8). The difference in rates of recurrence between the suture group and mesh repair group was not affected by the age, and size of hernia.

In incisional hernia repairs, the results of univariate analysis showed obesity, diabetes mellitus, and chronic cough as pre-operative significant factors of hernia recurrence (Table 3.6). The operative significant factors were: sutured repair, young surgeon, and diameter of defect (Table 3.7). The post-operative factors include: wound infection, seroma and chronic pain (Table 3.8). Multivariate analysis, of these factors identified sutured repair (p=0.001) wound infection (p=0.005), young surgeon (p=0.007), diameter of hernia defect (0.01), and obesity (p=0.003), as independent risk factors for incisional hernia recurrence (Table 3.9).

3.5.4 Recurrences after mesh repair

The possible explanations for recurrences after mesh repairs were the use of a small size mesh with insufficient overlap beyond the pubic tubercle or the edge of defect (3 in inguinal, 3 in para-umbilical and 6 patients in incisional hernia repairs), improper fixation of mesh (1 in para-umbilical and 2 in incisional hernia repairs), infection of a large haematoma (1 in para-umbilical hernia repairs) and infection of a large seroma (1 patient in incisional hernia repairs).

3.6 Post-operative pain score

The early post-operative pain from the day of surgery (D0) up to one month was assessed at regular intervals by using Numerical Rating Score (NRS). On the day of surgery (day 0) of inguinal hernias, the mean pain score was $3.7 \pm 0.9$ in the sutured
group compared with 3.2 ± 1.4 in the mesh surgery group. This difference was statically significant (P= 0.004). The pain score in the first post-operative day (D1), showed a steady and significant improvement in both groups, with less pain particularly in the group that had mesh repairs (3.1 versus 2.5). The apparent difference was statistically significant (p < 0.001).

At the first and 2nd post-operative week assessment, there was much less pain felt after mesh repair than after sutured repair with mean pain scores of 2.6 ± 0.7 versus 1.9 ± 0.7 and 2.1 versus 1.4 respectively (p < .001 at both comparisons). At one month follow-up the pain score remained low in the mesh group than in the sutured group (1.1± 0.2 versus 0.4± 0.1, p<0.001) (Figure 1.10). At this time most patients described pain as mild to moderate in both groups. Similarly in para-umbilical and incisional hernias, a much decrease in the mean pain score has been shown more after mesh repair than after sutured repair (Figures 2.12, and 3.12).

### 3.7 Analgesic use

The percentages of patients consuming parenteral analgesic drugs for pain were 93.5%, 84.5% and 93.7% in the sutured-repair groups, compared with 65.8%, 50.6%, and 65 4% in the mesh-surgery groups of inguinal, para-umbilical, and incisional hernia repairs respectively (Tables 1.9, 2.9, and 3.10) The differences in the consumption between the two groups of repairs were statistically significant (P < 0.001).

Pethidine (50 mg. injection) was used by 51.2%, 38%, and 74.9%of patients in the sutured groups compared with 20.3%, 12.4%, and 48.1% of patients in the mesh-surgery groups of inguinal, para-umbilical and incisional hernia repairs respectively. The differences were statistically significant (P<0.001), (Tables 1.9, 2.9, and 3.10). The mean consumption of parentral analgesics in the sutured groups (0.9 ± 0.5 inj., 0.98± 0.42 inj., 1.1 ± 0.7 inj) was higher than in the mesh surgery- groups (0.5 ± 0.3 inj., 0.48± 0.201 inj., and 0.7 ± 0.6 inj ) in inguinal, para-umbilical and incisional hernia repairs respectively (p=0.001).
Similarly, both groups used oral analgesics in the form of Voltaren (Diclofenac Na 50 mg) orally from the next day of surgery. The proportions of patients requiring oral analgesic drugs for the post-operative pain in inguinal hernia repairs was 68.6% in the sutured group, compared with 36.6% in the mesh group (Fig. 1.11), while in para-umbilical hernia repairs it was 69.5% for the sutured group versus 33.3% for the mesh group (Fig. 2.12). In incisional hernia repairs, it was 63.8% in the sutured group versus 38% in the mesh group (Figure 3.13).

The duration of patients' analgesic consumption in weeks are demonstrated in figures 1.11, 2.13, and 3.13. The mean duration of oral analgesic use was 1.18± 0.09 weeks for the sutured group compared with 0.5± 0.2 week for the mesh group of inguinal hernia repairs (p <0.001), 1.2 ±0.9 versus 0.56± .018 weeks in para-umbilical hernia repairs (p <0.001), and 1.6 ± 0.7 versus 0.9 ± 0.5 weeks in the sutured and mesh groups of incisional hernia repairs respectively (p <0.001).

These results showed that the patients, who underwent sutured repair, needed more parenteral and oral analgesics than those who underwent mesh repair in inguinal, para-umbilical, and incisional hernias, with a significant benefit to the group that had mesh repair (P < 0.001).

3.8 Length of hospital stay

The mean length of hospital stay was 1.9 ± 0.80 (range 1-5 days) for the mesh surgery group compared with 2.09 ± 0.78 days (range 1-5) for the sutured-surgery group in inguinal hernia repair (Table1.10), while it was 2.13 ± 1.01 days (range 1-6 days) for the mesh-surgery group and 2.31± 0.94 days (range 1-7 days) for the sutured group in para-umbilical hernia repairs (Table 2.10), and in incisional hernia repair, the hospital stay was 2.83 ± 1.1 days (2-7 days) for the mesh group compared with 1.58 days for the sutured surgery group (Table 3.11). Although the patients in the sutured groups stayed longer than those in the mesh groups, the differences did not achieve statistical significance, p=0.09, 0.8, and 0.09 in inguinal, para-umbilical, and incisional herniorrhaphies respectively.
3.9 Return to normal activities

The time to return to normal activities was significantly shorter in the mesh-repair group (16.2 ± 8.3 days) than in the sutured-repair group (20.8 ± 8.3 days) of inguinal herniorrhaphies. The difference was statistically significant, p = 0.001 (Table 1.10).

In para-umbilical hernia repairs, the mean time to return to normal activities was 20.9 ± 16.94 days in the mesh group and 23.6 ± 15.29 days in the sutured group, with a statistically significant difference, p = 0.009 (Table 2.10), while in incisional hernia repairs, it was 23.8 ± 10.2 days in the mesh group and 26.6 ± 13.5 days in the sutured group. The difference was statistically significant, p < 0.001 (Table 3.11). However, the sutured groups in inguinal, para-umbilical and incisional hernia repairs, showed delayed return to social activities than mesh groups.

3.10 Patient’s satisfaction

At three month-visit, all patients were asked to take into account all possible positive and negative effects of inguinal, para-umbilical and incisional hernia repairs and state whether they were satisfied with the surgical procedure or not.

The patients who had mesh repairs were significantly more satisfied with the results of their surgery (94.5%, 94.1% and 85.1%) than patients who had sutured repairs (60.7%, 59.1% and 49.9%) in inguinal, para-umbilical and incisional hernia repairs respectively, The difference between each two groups was statistically significant, p < 0.001 at all comparisons. (Figures 1.12, 2.14, 3.14).

When the dissatisfied patients asked why they were dissatisfied?, the patients in the sutured groups assumed that they had suffered a recurrence, tension pain and discomfort, while patients in the mesh repair assumed that they had suffered seroma.

3.11 Post-operative complications
Among the early post-operative complications; urinary retention, haematoma, seroma, wound infection, hydrocele, local numbness and scrotal oedema were comparable in the two groups of inguinal hernia repairs (Table1.11). The difference did not achieve statistical significant (p>0.05). Urinary retention developed in 14 patients (7.0 %) after the sutured repair, compared with 12 (5.9 %) after mesh repair, that required catheterization after operation, but only five patients ( 3 in the sutured group and 2 in the mesh group) required an indwelling catheter, that relatively prolonged their hospital stay, probably due to prostatic problems superimposed by the action of spinal anaesthesia. There was no association between the method of repair and complaints about voiding.

Haematoma; including subcutaneous and scrotal, developed in 5 patients (three in the sutured-surgery group and two in the mesh surgery group), 3 of them were scrotal haematomas. Haematomas resolved spontaneously in 2 patients, but in the remaining 3 patients, haematomas were severe and required return to operation theatre for drainage.

Wound infection occurred in 5 patients (2.5 %) of the sutured group and in 6 patients (3%) of the mesh repair group. Almost all infections were subcutaneous with the exception of one severe scrotal infection as a consequence of scrotal haematoma in the sutured group. Infections were treated by open drainage and antibiotic. None of meshes required removal.

Late post-operative complications of the sutured and mesh repair groups in inguinal hernia repairs, were comparable, except that, chronic post-operative pain in the groin and scrotum was occurred in 12.4% of patients in the sutured group, compared with 4 % of patients in the mesh-surgery group. The difference was statistically significant (p < 0.001), (Table 1.11). The severity of chronic pain in the sutured repair group was regarded mild in 15 (7.5%), moderate in 8 (4.0%), and severe in 2 (1.0%). In the mesh-repair group, the chronic pain was mild in 6 (3.0%) patients and moderate in only two patients (1%). Persistent numbness beyond three months, as a result of nerve paresis ( either genito-femoral or ilio-inguinal nerve paresis or both) occurred in 5 patients (2.5%) of the sutured group and 6 patients (3%) of the mesh group, almost, all symptoms of pain and numbness disappeared by the end of the first-year
of follow-up. However, chronic wound infection, chronic constipation, intestinal obstruction and numbness, were in the two groups of repair.

Similarly, the early and late post-operative complications were comparable in two groups of para-umbilical hernia repairs. The only significant difference was in the chronic pain which was occurred in 26 patients (14%) of the sutured repair compared with 10 patients (5.4%) in the mesh group, p< 0.001. (Table 2.11).

Following incisional herniorrhaphy; the early complications were comparable in the two groups (Table 3.13). Seroma formation was relatively high in the two groups. It developed in 17 patients (8.2%) of the sutured group, and in 20 patients (9.6%) of the mesh group, particularly in obese patients who underwent excessive dissection of the subcutaneous tissue plane. More than half of seromas in the 2 groups were mild (n= 21) and resolved spontaneously. The remaining ranged between moderate and severe seromas which were managed by repeated needle aspiration, except only one big seroma which became infected in the mesh-repair group and was controlled by open drainage, but the mesh implant did not require removal. Non-fatal pulmonary embolism developed in one patient of the sutured group on the day of surgery. The same patient developed deep vein thrombosis of the left lower limb, three days later. This was a 65 years old female with moderate obesity.

The late post-operative complications were similar in the two groups of repair, except that chronic post-operative pain was significantly greater in the sutured group than in the mesh group occurred (13.0% versus 4.35%), (Table 3.12). The apparent difference was statistically significant (p< 0.001).
**Table 1.1** Descriptive data for the characteristics of patients with inguinal hernias according to allocated method of repair

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Type of repair</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sutured (n = 201)</td>
<td>Mesh (n = 202)</td>
<td></td>
</tr>
<tr>
<td>Sex – n. (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>182 (90.5%)</td>
<td>184 (91.1%)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>19 (9.50%)</td>
<td>18 (8.90%)</td>
<td></td>
</tr>
<tr>
<td>F:M</td>
<td>1:9.5</td>
<td>1:10.2</td>
<td></td>
</tr>
<tr>
<td>Age – (yrs.) mean±sd.</td>
<td>50.3 ± 15.6</td>
<td>49.5 ± 15.5</td>
<td></td>
</tr>
<tr>
<td>BMI mean±sd.</td>
<td>24.0 ± 8.4</td>
<td>23.5 ± 4.8</td>
<td></td>
</tr>
<tr>
<td>Clinical presentation: n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative swelling</td>
<td>196 (97.5%)</td>
<td>201 (99.5%)</td>
<td></td>
</tr>
<tr>
<td>Mean duration of hernia</td>
<td>47.9 ± 43.1 months</td>
<td>54.2 ± 37.9 months</td>
<td></td>
</tr>
<tr>
<td>Mean external diameter</td>
<td>6.28 ± 1.75 cm</td>
<td>6.41 ± 2.11 cm</td>
<td></td>
</tr>
<tr>
<td>Preoperative pain</td>
<td>55 (27.4%)</td>
<td>60 (29.7%)</td>
<td></td>
</tr>
<tr>
<td>Irreducibility</td>
<td>16 (8.0%)</td>
<td>19 (9.4%)</td>
<td></td>
</tr>
<tr>
<td>Preoperative type of hernia</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Direct</td>
<td>96 (47.8%)</td>
<td>94 (46.5%)</td>
<td></td>
</tr>
<tr>
<td>Indirect</td>
<td>105 (52.2%)</td>
<td>108 (53.5%)</td>
<td></td>
</tr>
<tr>
<td>Side of hernia:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>129 (64.2%)</td>
<td>132 (63.4%)</td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>60 (29.8%)</td>
<td>57 (28.2%)</td>
<td></td>
</tr>
<tr>
<td>Bilateral</td>
<td>12 (6.0%)</td>
<td>13 (6.4%)</td>
<td></td>
</tr>
<tr>
<td>Pre-operative risk factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic constipation</td>
<td>27 (13.4%)</td>
<td>29 (14.4%)</td>
<td></td>
</tr>
<tr>
<td>Chronic cough</td>
<td>27 (13.4%)</td>
<td>30 (14.9%)</td>
<td></td>
</tr>
<tr>
<td>Prostatism</td>
<td>22 (10.9%)</td>
<td>22 (10.9%)</td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>18 (8.9%)</td>
<td>16 (7.9%)</td>
<td></td>
</tr>
<tr>
<td>Bronchial asthma</td>
<td>13 (6.5%)</td>
<td>13 (6.5%)</td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td>116 (57.7%)</td>
<td>110 (54.5%)</td>
<td></td>
</tr>
<tr>
<td>Steroid use</td>
<td>11 (5.5%)</td>
<td>13 (6.4%)</td>
<td></td>
</tr>
<tr>
<td>Heavy manual activity</td>
<td>73 (36.3%)</td>
<td>79 (39.1%)</td>
<td></td>
</tr>
<tr>
<td>Under weight</td>
<td>25 (12.4%)</td>
<td>27 (13.4%)</td>
<td></td>
</tr>
<tr>
<td>Obesity</td>
<td>19 (9.5%)</td>
<td>21 (10.4%)</td>
<td></td>
</tr>
<tr>
<td>Urethral stricture</td>
<td>1 (0.5%)</td>
<td>2 (1.0%)</td>
<td></td>
</tr>
</tbody>
</table>

Plus – minus values are means ± standard deviation. Values in parentheses are Percentages. BMI: denotes Body Mass Index; was calculated as the weight in kilograms divided by the square of height in meters
Table 2.1  Descriptive data for the characteristics of patients with para-umbilical hernias according to allocated method of repair

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Type of repair</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sutured (n = 186)</td>
<td>Mesh (n = 186)</td>
<td></td>
</tr>
<tr>
<td>Sex – n. (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>26 (14.0%)</td>
<td>25 (13.4%)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>160 (86.0%)</td>
<td>161 (86.6%)</td>
<td></td>
</tr>
<tr>
<td>F:M</td>
<td>1:6.2</td>
<td>1:6.4</td>
<td></td>
</tr>
<tr>
<td>Age – (yrs.) mean± sd.</td>
<td>41.8 ± 10.6</td>
<td>42.01 ± 10.4</td>
<td></td>
</tr>
<tr>
<td>BMI mean± sd</td>
<td>31.9 ± 4.7</td>
<td>32.3 ± 4.9</td>
<td></td>
</tr>
<tr>
<td>Clinical presentation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative swelling</td>
<td>179 (96.2%)</td>
<td>175 (94.1%)</td>
<td></td>
</tr>
<tr>
<td>Mean external diameter</td>
<td>6.8 ± 1.3 cm.</td>
<td>6.5 ± 1.4 cm.</td>
<td></td>
</tr>
<tr>
<td>Duration of hernia</td>
<td>48.2 ± 43.5 months</td>
<td>49.1 ± 37.6 months</td>
<td></td>
</tr>
<tr>
<td>Preoperative pain</td>
<td>148 (79.6%)</td>
<td>150 (80.7%)</td>
<td></td>
</tr>
<tr>
<td>Irreducibility</td>
<td>12 (6.5%)</td>
<td>14 (7.5%)</td>
<td></td>
</tr>
</tbody>
</table>

| Coexisting disease            |                |          |          |
| Chronic Constipation          | 23 (12.5%)     | 22 (11.8%) |
| Chronic Cough                | 26 (14.0%)     | 25 (13.4%) |
| Diabetes mellitus            | 18 (9.7 %)     | 17 (9.1 %) |
| Bronchial asthma             | 14 (7.5 %)     | 15 (8.1 %) |
| Smoking                      | 12 (6.5 %)     | 14 (7.5 %) |
| Steroid                      | 33 (17.7%)     | 34 (18.3%) |
| Obesity                      | 123 (66.2%)    | 125 (67.2%) |
| Heavy work                   | 44 (23.7%)     | 43 (23.1%) |

Plus - minus values are means ± standard deviation. Values in parentheses are Percentages. BMI: Denotes Body Mass Index; was calculated as the weight in kilograms divided by the square of height in meters.
**Table 3.1** Descriptive data for the characteristics of patients with incisional hernias according to allocated method of repair

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Sutured repair (n=207)</th>
<th>Mesh repair (n=208)</th>
<th>Total (415)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex – n. (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>29 (14.0%)</td>
<td>30 (14.4%)</td>
<td>59 (14.2%)</td>
</tr>
<tr>
<td>Female</td>
<td>178 (86.0%)</td>
<td>178 (85.6%)</td>
<td>356 (85.8%)</td>
</tr>
<tr>
<td><strong>Age – (yrs.)</strong></td>
<td>47.7 ± 13.6 (range 20-90)</td>
<td>48.5 ± 13.5 (range 23-85)</td>
<td>48.1 ± 13.5 (range 20-90)</td>
</tr>
<tr>
<td><strong>B.M.I.</strong>*</td>
<td>32.5 ± 6.6</td>
<td>31.8 ± 6.8</td>
<td>32.1 ± 6.7</td>
</tr>
<tr>
<td><strong>Clinical presentation:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Preoperative swelling</td>
<td>196 (94.7%)</td>
<td>197 (94.7%)</td>
<td>393 (94.7%)</td>
</tr>
<tr>
<td>- Duration of hernia in months</td>
<td>20.6 ± 19.1</td>
<td>24.3 ± 23.1</td>
<td>22.5 ± 19.3</td>
</tr>
<tr>
<td>- External hernia diameter</td>
<td>8.2 ± 4.8 cm.</td>
<td>7.98 ± 3.8 cm.</td>
<td>8.1 ± 4.3 cm.</td>
</tr>
<tr>
<td>- Irreducibility of hernia</td>
<td>17 (8.2%)</td>
<td>20 (9.6%)</td>
<td>37 (8.9%)</td>
</tr>
<tr>
<td>- Preoperative pain</td>
<td>82 (39.6%)</td>
<td>85 (41.4%)</td>
<td>167 (40.2%)</td>
</tr>
<tr>
<td>- Hernia-free interval</td>
<td>23.4 ± 18.9 months</td>
<td>23.6 ± 22.4 months</td>
<td>23.5 ± 19.3</td>
</tr>
<tr>
<td><strong>Strain factors and comorbidities:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic Constipation</td>
<td>40 (19.3%)</td>
<td>42 (20.2%)</td>
<td>82 (19.8%)</td>
</tr>
<tr>
<td>Chronic Cough</td>
<td>35 (16.9%)</td>
<td>34 (16.3%)</td>
<td>69 (16.6%)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>27 (13.1%)</td>
<td>26 (12.5%)</td>
<td>53 (12.8%)</td>
</tr>
<tr>
<td>Bronchial asthma</td>
<td>18 (8.70%)</td>
<td>18 (8.7%)</td>
<td>36 (8.7%)</td>
</tr>
<tr>
<td>Smoking</td>
<td>17 (8.20%)</td>
<td>19 (9.1 %)</td>
<td>36 (8.7 %)</td>
</tr>
<tr>
<td>Steroid</td>
<td>12 (26.1%)</td>
<td>14 (31.8%)</td>
<td>26 (28.9%)</td>
</tr>
<tr>
<td>Malnutrition</td>
<td>15 (7.20%)</td>
<td>18 (8.7 %)</td>
<td>33 (8.0 %)</td>
</tr>
<tr>
<td>Prostatism</td>
<td>01 (0.5 %)</td>
<td>02 (1.0 %)</td>
<td>03 (0.7 %)</td>
</tr>
<tr>
<td>Obesity</td>
<td>141 (68.1%)</td>
<td>145 (69.2%)</td>
<td>285 (68.7%)</td>
</tr>
<tr>
<td>Heavy effort</td>
<td>22 (10.6%)</td>
<td>24 (11.5%)</td>
<td>46 (11.1%)</td>
</tr>
</tbody>
</table>

Plus-minus values are means ± standard deviation
Values in parentheses are percentages of patients
* B.M.I. : Body Mass Index
Table 3.2  Types of index operations in the sutured and mesh groups of incisional hernia repair

<table>
<thead>
<tr>
<th>Type of repair</th>
<th>Type of index operation</th>
<th>Sutured</th>
<th>Mesh</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(53.6%)</td>
<td>(52.9%)</td>
<td>(53.3%)</td>
</tr>
<tr>
<td>L.S.C.S.</td>
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<td>111</td>
<td>110</td>
<td>221</td>
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<tr>
<td>appendicectomy</td>
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<td>5</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>cholecystectomy</td>
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<td>13</td>
<td>23</td>
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<tr>
<td>hysterectomy</td>
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<td>32</td>
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<tr>
<td>cholecystectomy</td>
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<td>7</td>
<td>12</td>
</tr>
<tr>
<td>nephrectomy</td>
<td></td>
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<td>Intestinal obstruction</td>
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<tr>
<td>laparotomy for peritonitis</td>
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<td>13</td>
<td>25</td>
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<tr>
<td>ovarian cyst excision</td>
<td></td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>myomectomy</td>
<td></td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>pylolihthyomy</td>
<td></td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>207</td>
<td>208</td>
<td>415</td>
</tr>
</tbody>
</table>

The mean hernia-free interval was 23.5 months (23.4 ± 198.9 months in the sutured group and 23.6 ± 22.4 in the mesh group).
Table 1.2 Operative findings in patients with inguinal hernias according to allocated method of repair

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Type of repair</th>
<th>P* value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sutured (n = 201)</td>
<td>Mesh (n = 202)</td>
</tr>
<tr>
<td>A) Anaesthesia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spinal</td>
<td>193 (96.0%)</td>
<td>198 (98.0%)</td>
</tr>
<tr>
<td>General</td>
<td>2 (1.0 %)</td>
<td>0 (0.0 %)</td>
</tr>
<tr>
<td>Complemented</td>
<td>6 (3.0 %)</td>
<td>4 (2.0 %)</td>
</tr>
<tr>
<td>Surgeon experience level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L 1</td>
<td>64 (31.8%)</td>
<td>65 (32.2%)</td>
</tr>
<tr>
<td>L 11</td>
<td>68 (33.8%)</td>
<td>70 (34.7%)</td>
</tr>
<tr>
<td>L 111</td>
<td>69 (34.3%)</td>
<td>67 (33.1%)</td>
</tr>
<tr>
<td>Types of hernia at operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect</td>
<td>104 (51.7%)</td>
<td>105 (52.0%)</td>
</tr>
<tr>
<td>Direct</td>
<td>77 (38.3%)</td>
<td>74 (36.6%)</td>
</tr>
<tr>
<td>Combined</td>
<td>20 (10.0%)</td>
<td>23 (11.4%)</td>
</tr>
<tr>
<td>Per-operative diameter of defect (mean)</td>
<td>3.7 ± 0.6 cm.</td>
<td>3.8 ± 0.7 cm.</td>
</tr>
<tr>
<td>Median operative time (min.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prolonged repair</td>
<td>40 min. (30-70)</td>
<td>42 min. (35-80)</td>
</tr>
<tr>
<td></td>
<td>6 (3.0%)</td>
<td>8 (4.0%)</td>
</tr>
</tbody>
</table>

Plus - minus values are means ± standard deviation. Values in parentheses are percentages of patients. P is significant if it is < 0.05. Prolonged operative time is >70 minutes.
Table 2.2  Operative findings in patients with para-umbilical hernias according to allocated method of repair

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Type of repair</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sutured (n = 186)</td>
<td>Mesh (n = 186)</td>
</tr>
<tr>
<td>Anaesthesia:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>153 (82.3%)</td>
<td>158 (84.9%)</td>
</tr>
<tr>
<td>Spinal</td>
<td>33 (17.7%)</td>
<td>28 (15.1%)</td>
</tr>
<tr>
<td>Surgeon experience level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L 1</td>
<td>63 (33.9%)</td>
<td>63 (33.9%)</td>
</tr>
<tr>
<td>L 11</td>
<td>60 (32.3%)</td>
<td>63 (33.8%)</td>
</tr>
<tr>
<td>L 1 11</td>
<td>63 (33.8%)</td>
<td>60 (32.3%)</td>
</tr>
<tr>
<td>Type of incision of repair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transverse Supra-umbilical</td>
<td>46 (24.7%)</td>
<td>42 (22.6%)</td>
</tr>
<tr>
<td>Transverse Infra-umbilical</td>
<td>107 (57.5%)</td>
<td>109 (58.6%)</td>
</tr>
<tr>
<td>Elliptical</td>
<td>33 (17.8%)</td>
<td>35 (18.8%)</td>
</tr>
<tr>
<td>Per-operative diameter of defect</td>
<td>3.7 ±1.2</td>
<td>3.6 ±1.1</td>
</tr>
<tr>
<td>Operative time in minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prolonged repair</td>
<td>48 min. (34-76)</td>
<td>50 min. (32-75)</td>
</tr>
<tr>
<td></td>
<td>7 (3.8%)</td>
<td>9 (4.8%)</td>
</tr>
<tr>
<td>Drain insertion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of drain insertion</td>
<td>186 (100%)</td>
<td>186 (100%)</td>
</tr>
<tr>
<td>(in hours)</td>
<td>51.0 ±14.4</td>
<td>48 ±14.2</td>
</tr>
</tbody>
</table>
Plus - minus values are means ± standard deviation. Values in parentheses are percentages of patients. p is significant if it is < 0.05. Prolonged operative time is >70 minutes

**Table 3.3** Operative findings of patients with incisional hernias according to allocated method of repair

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Type of repair</th>
<th></th>
<th></th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sutured (n = 207)</td>
<td>Mesh (n = 208)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Anaesthesia:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>128 (61.8%)</td>
<td>130 (62.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spinal</td>
<td>79 (38.2%)</td>
<td>78 (37.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Surgeon experience level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L 1</td>
<td>65 (31.4%)</td>
<td>67 (32.2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L 11</td>
<td>74 (35.7%)</td>
<td>73 (35.1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L 111</td>
<td>68 (32.9%)</td>
<td>68 (32.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Incision of repair</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical elliptical</td>
<td>179 (86.4%)</td>
<td>177 (85.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-costal</td>
<td>10 (4.8 %)</td>
<td>13 (6.3 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pfanensteil</td>
<td>8 (3.9 %)</td>
<td>6 (2.9 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lumber</td>
<td>6 (3.0 %)</td>
<td>7 (3.7 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extended grid iron</td>
<td>4 (1.9% )</td>
<td>5 (2.4 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Per-operative diameter of defect (mean in cm.)</strong></td>
<td>7.09 ± 3.59</td>
<td>7.70 ± 3.80</td>
<td>0.91</td>
<td></td>
</tr>
<tr>
<td>Operative time in minutes</td>
<td>60 min. (32-90)</td>
<td>62min. (38-100)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------</td>
<td>-----------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prolonged repair</td>
<td>12 (5.8 %)</td>
<td>14 (6.6 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drain insertion</td>
<td>207 (100%)</td>
<td>208 (208%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of drain insertion (in hours)</td>
<td>59.3 ± 15.9</td>
<td>60.2 ± 16.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Plus - minus values are means ± standard deviation. Values in parentheses are percentages of patients. p is significant if it is < 0.05. Prolonged operative time is >70 minutes

**Table 1.3** Rates of recurrences in the two treatment group of inguinal herniorrhaphy according to the period of follow-up

<table>
<thead>
<tr>
<th>Time of follow-up</th>
<th>No. of patients</th>
<th>No. of recurrences</th>
<th>Recurrence rate</th>
<th><em>O.R. <em>(95% C.I.)</em></em></th>
<th>**p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st year-follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sutured repair</td>
<td>197</td>
<td>8</td>
<td>4.1%</td>
<td>2.1 (1.9-2.3)</td>
<td>0.004</td>
</tr>
<tr>
<td>Mesh repair</td>
<td>200</td>
<td>0</td>
<td>0.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd year-follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sutured repair</td>
<td>183</td>
<td>7</td>
<td>3.8 %</td>
<td>3.6(2.3-12.6)</td>
<td>0.02</td>
</tr>
<tr>
<td>Mesh repair</td>
<td>195</td>
<td>2</td>
<td>1.03%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd year-follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sutured repair</td>
<td>169</td>
<td>6</td>
<td>3.6%</td>
<td>7.2(2.4-27.5)</td>
<td>0.001</td>
</tr>
<tr>
<td>Mesh repair</td>
<td>188</td>
<td>1</td>
<td>0.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-year cumulative rate of recurrence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sutured repair</td>
<td>201</td>
<td>21</td>
<td>10.5%</td>
<td>7.0 (2-28)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Mesh repair</td>
<td>202</td>
<td>3</td>
<td>1.5%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* O.R.: odds ratio
* 95% C.I. Denotes 95 percent confidence interval
** P value < 0.05 is significant
Table 2.3 Rates of recurrences in the two treatment groups of para-umbilical surgery according to the period of follow-up

<table>
<thead>
<tr>
<th>Time of follow-up</th>
<th>No. of patients</th>
<th>No. of recurrences</th>
<th>Recurrence rate</th>
<th>O.R.* *(95% C.I.)</th>
<th>**p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st year-follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sutured repair</td>
<td>186</td>
<td>7</td>
<td>3.8 %</td>
<td>2.1(1.8-2.2)</td>
<td>0.03</td>
</tr>
<tr>
<td>Mesh repair</td>
<td>186</td>
<td>0</td>
<td>0.0 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd year-follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sutured repair</td>
<td>177</td>
<td>9</td>
<td>5.1 %</td>
<td>2.7(1.2-11.4)</td>
<td>0.02</td>
</tr>
<tr>
<td>Mesh repair</td>
<td>185</td>
<td>3</td>
<td>1.6 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd year-follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sutured repair</td>
<td>177</td>
<td>8</td>
<td>4.5 %</td>
<td>4.7(1.2-11.4)</td>
<td>0.002</td>
</tr>
<tr>
<td>Mesh repair</td>
<td>185</td>
<td>2</td>
<td>1.1 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-year cumulative rate of recurrence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sutured repair</td>
<td>186</td>
<td>24</td>
<td>12.9 %</td>
<td>4.9(2-14.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mesh repair</td>
<td>186</td>
<td>5</td>
<td>2.7 %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* O.R. : odds ratio
* 95% C.I. Denotes 95 percent confidence interval
** P value < 0.05 is significant
Table 3.4 Rates of recurrence in the two treatment groups of incisional Hernias according to the period of follow-up

<table>
<thead>
<tr>
<th>Time of follow-up</th>
<th>No of patients</th>
<th>No of recurrences</th>
<th>Recurrence rate</th>
<th>O.R.* (95% CI**)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st year follow-up</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sutured repair</td>
<td>207</td>
<td>13</td>
<td>6.3%</td>
<td>3.3 (1.3-16.4)</td>
<td>0.01</td>
</tr>
<tr>
<td>Mesh repair</td>
<td>208</td>
<td>3</td>
<td>1.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2nd year follow-up</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sutured repair</td>
<td>191</td>
<td>24</td>
<td>12.6%</td>
<td>7.2(2.7-14.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mesh repair</td>
<td>204</td>
<td>4</td>
<td>2.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3rd year follow-up</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sutured repair</td>
<td>165</td>
<td>20</td>
<td>12.1%</td>
<td>13.5(4.2-18.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mesh repair</td>
<td>199</td>
<td>2</td>
<td>1.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3-year cumulative rate of recurrence</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sutured repair</td>
<td>207</td>
<td>57</td>
<td>27.5%</td>
<td>7.6(4.2-18.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mesh repair</td>
<td>208</td>
<td>9</td>
<td>4.3%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

O.R.*: Odds ratio
95%CI **: 95 percent confidence interval
Table 1.4 Comparisons of hernia recurrence rate against surgeon levels in inguinal herniorrhaphy

<table>
<thead>
<tr>
<th>Surgeon level (a)</th>
<th>Type of repair</th>
<th>Total</th>
<th>Surgeon level (b)</th>
<th>P* value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>suture</td>
<td>mesh</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>L 1</strong></td>
<td>13 (6.5 %)</td>
<td>2 (1.0%)</td>
<td>15 (3.7%)</td>
<td>L 11</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L 11</td>
</tr>
<tr>
<td><strong>L 11</strong></td>
<td>5 (2.5 %)</td>
<td>1 (0.5%)</td>
<td>6 (1.5 %)</td>
<td>L 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L 11</td>
</tr>
<tr>
<td><strong>L 111</strong></td>
<td>3 (1.5 %)</td>
<td>0 (0.0%)</td>
<td>3 (0.7 %)</td>
<td>L 11</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L 11</td>
</tr>
</tbody>
</table>

Values in parenthesis are percentage. Percent refers to the recurrence rate by the surgeon in the accounted group of repair.
* p values are significant
Table 2.4 Comparisons of hernia recurrence rate against surgeon levels in para-umbilical herniorrhaphy

<table>
<thead>
<tr>
<th>Surgeon level (a)</th>
<th>Type of repair</th>
<th>Total</th>
<th>Surgeon level (b)</th>
<th>P* value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>suture</td>
<td>mesh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L 1</td>
<td>12 (6.45%)</td>
<td>3 (1.61%)</td>
<td>15 (4.0%)</td>
<td>L 11</td>
</tr>
<tr>
<td></td>
<td>L 111</td>
<td></td>
<td></td>
<td>0.009*</td>
</tr>
<tr>
<td>L 11</td>
<td>7 (3.76%)</td>
<td>1 (0.54%)</td>
<td>8 (2.2%)</td>
<td>L 1</td>
</tr>
<tr>
<td></td>
<td>L 111</td>
<td></td>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td>L 111</td>
<td>5 (2.69%)</td>
<td>1 (0.54%)</td>
<td>6(1.6%)</td>
<td>L 1</td>
</tr>
<tr>
<td></td>
<td>L 111</td>
<td></td>
<td></td>
<td>-0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>24 (12.9%)</td>
<td>5 (2.7%)</td>
<td>29 (7.8%)</td>
<td></td>
</tr>
</tbody>
</table>

Values in parenthesis are percentage. Percent refers to the recurrence by the surgeon in the accounted group of repair.
* p values are significant.
Table 3.5 Comparisons of hernia recurrence rate against surgeon levels in incisional herniorrhaphy

<table>
<thead>
<tr>
<th>Surgeon level (a)</th>
<th>Type of repair</th>
<th>Total</th>
<th>Surgeon level (b)</th>
<th>P* value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>suture</td>
<td>mesh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L 1</td>
<td>33 (15.94%)</td>
<td>6 (2.8%)</td>
<td>39 (9.4%)</td>
<td>L 11</td>
</tr>
<tr>
<td></td>
<td>L 11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15 (7.31%)</td>
<td>2 (1.0%)</td>
<td>17 (4.10%)</td>
<td>L 111</td>
</tr>
<tr>
<td></td>
<td>L 111</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9 (4.34%)</td>
<td>1 (0.5%)</td>
<td>10 (2.40%)</td>
<td>L 11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>57 (27.5%)</strong></td>
<td><strong>9 (4.3%)</strong></td>
<td><strong>66 (15.9%)</strong></td>
<td></td>
</tr>
</tbody>
</table>

Values in parenthesis are percentage. Percent refers to recurrence rate developed by the surgeon in the accounted group of repair.

* p values are significant
Table 1.5  Univariate Analysis of Pre-operative factors of inguinal hernia recurrence

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>patients (n=374)</th>
<th>Recurrence (n=24)</th>
<th>Rate of recurrence</th>
<th>RR**(95% CI*)</th>
<th>P value of RR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 – 65 ys*</td>
<td>309</td>
<td>19</td>
<td>6.7%</td>
<td>1 BaseLine</td>
<td></td>
</tr>
<tr>
<td>&gt; 65 ys</td>
<td>65</td>
<td>5</td>
<td>7.7%</td>
<td>1.2 (0.7-6)</td>
<td>0.308</td>
</tr>
<tr>
<td><strong>Underweight</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>322</td>
<td>19</td>
<td>5.9 %</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>52</td>
<td>5</td>
<td>9.6 %</td>
<td>1.6 (0.4 –5.2)</td>
<td>0.9</td>
</tr>
<tr>
<td><strong>Prostatism</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>330</td>
<td>16</td>
<td>4.85%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>44</td>
<td>8</td>
<td>18.2 %</td>
<td>3.8 (2.1-9.7)</td>
<td>0.008</td>
</tr>
<tr>
<td><strong>Constipation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>318</td>
<td>19</td>
<td>6.0 %</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>56</td>
<td>5</td>
<td>8.9 %</td>
<td>1.4 (0.8 –5.8)</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>Br. asthma</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>348</td>
<td>21</td>
<td>6.1 %</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>26</td>
<td>3</td>
<td>11.5 %</td>
<td>1.9 (0.9 –10.3)</td>
<td>0.055</td>
</tr>
<tr>
<td><strong>Chronic cough</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>317</td>
<td>15</td>
<td>4.7%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>57</td>
<td>9</td>
<td>15.8 %</td>
<td>3.4 (4.3 –20.)</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>Steroid therapy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>350</td>
<td>22</td>
<td>6.3%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>24</td>
<td>2</td>
<td>8.3%</td>
<td>1.3 (0.6 –3.9)</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Diabetes mellitus</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>340</td>
<td>19</td>
<td>5.9%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>34</td>
<td>5</td>
<td>14.7%</td>
<td>2.6 (1.7-15.8)</td>
<td>0.004</td>
</tr>
<tr>
<td>Smoking</td>
<td>patients</td>
<td>Recurrence</td>
<td>Rate of recurrence</td>
<td>RR**(95% CI)*</td>
<td>p value of RR</td>
</tr>
<tr>
<td>---------</td>
<td>----------</td>
<td>------------</td>
<td>-------------------</td>
<td>---------------</td>
<td>--------------</td>
</tr>
<tr>
<td>No*</td>
<td>165</td>
<td>6</td>
<td>3.6%</td>
<td>1</td>
<td>0.02</td>
</tr>
<tr>
<td>yes</td>
<td>209</td>
<td>18</td>
<td>8.6%</td>
<td>2.4 (1.4 - 6.3)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Occupation</th>
<th>patients</th>
<th>Recurrence</th>
<th>Rate of recurrence</th>
<th>RR**(95% CI)*</th>
<th>p value of RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>light job*</td>
<td>232</td>
<td>14</td>
<td>6.3%</td>
<td>1</td>
<td>0.209</td>
</tr>
<tr>
<td>Heavy job</td>
<td>152</td>
<td>10</td>
<td>6.6%</td>
<td>1.0 (0.6 - 3.5)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

R.R**: denotes Relative risk, 95% CI*: 95 percent confidence interval. *The patients in this category served as the reference group.

Table 1.6) Univariate Analysis of operative factors of inguinal hernia recurrence
**Table 1.7** Univariate Analysis of post-operative factors of inguinal hernia recurrence

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Patients (n=374)</th>
<th>Recurrence (n=24)</th>
<th>Rate of recurrence</th>
<th>RR**(95% CI)*</th>
<th>P value of RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound infection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>363</td>
<td>19</td>
<td>5.2%</td>
<td>1.0</td>
<td>Baseline</td>
</tr>
<tr>
<td>yes</td>
<td>11</td>
<td>5</td>
<td>45.4%</td>
<td>9.1</td>
<td>(2.9–18.9)</td>
</tr>
<tr>
<td>Wound haematoma</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>369</td>
<td>23</td>
<td>6.2%</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>5</td>
<td>1</td>
<td>20.0%</td>
<td>3.3</td>
<td>(0.9–17.5)</td>
</tr>
<tr>
<td>Wound seroma</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>366</td>
<td>23</td>
<td>6.3%</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>8</td>
<td>1</td>
<td>12.5%</td>
<td>1.9</td>
<td>(0.6 – 3.1)</td>
</tr>
<tr>
<td>Chronic pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>341</td>
<td>16</td>
<td>4.7%</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>33</td>
<td>8</td>
<td>22.2%</td>
<td>4.4</td>
<td>(2.2 –10.2)</td>
</tr>
<tr>
<td>Return to work:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>early(up to 18 days)*</td>
<td>175</td>
<td>11</td>
<td>6.2%</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>&gt;2 weeks</td>
<td>199</td>
<td>13</td>
<td>6.5%</td>
<td>1.1</td>
<td>(0.4 - 10.9 )</td>
</tr>
</tbody>
</table>

RR**: denotes Relative risk, 95% CI*: 95 percent confidence interval. *The patients in this category served as the reference group.
**Table 1.8:** Results of multivariate analysis of factors that affect recurrence following inguinal hernia repairs

<table>
<thead>
<tr>
<th>Variables</th>
<th>P value</th>
<th>HR**</th>
<th>95% CI* of HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sutured repair</td>
<td>0.001</td>
<td>7.32</td>
<td>2.63 – 16.24</td>
</tr>
<tr>
<td>Junior surgeon</td>
<td>0.001</td>
<td>4.4</td>
<td>3.15 – 5.18</td>
</tr>
<tr>
<td>Wound infection</td>
<td>0.01</td>
<td>3.11</td>
<td>2.9 – 24.7</td>
</tr>
<tr>
<td>Prostatism</td>
<td>0.03</td>
<td>2.5</td>
<td>1.12 – 9.53</td>
</tr>
<tr>
<td>Chronic cough</td>
<td>0.04</td>
<td>2.7</td>
<td>1.23 – 19.12</td>
</tr>
</tbody>
</table>

HR**: denotes Hazard ratio.  95% CI*: 95 percent confidence interval. Multivariate analysis was performed by Cox- regression test.
Table 2.5 Univariate Analysis of Pre-operative factors of para-umbilical hernia recurrence

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>patients (n=361)</th>
<th>Recurrence (n=29)</th>
<th>3-year cumulative rate of recurrence</th>
<th>RR** (95% CI*)</th>
<th>p value of RR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong>:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 – 60 ys*</td>
<td>348</td>
<td>28</td>
<td>8.1 %</td>
<td>1.0 Baseline</td>
<td>0.9</td>
</tr>
<tr>
<td>&gt; 60 ys</td>
<td>13</td>
<td>1</td>
<td>7.7 %</td>
<td>0.96 (0.1-1.4 )</td>
<td></td>
</tr>
<tr>
<td><strong>Obesity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-obese*</td>
<td>113</td>
<td>3</td>
<td>2.7 %</td>
<td>1.0</td>
<td>0.001</td>
</tr>
<tr>
<td>Obesity</td>
<td>248</td>
<td>26</td>
<td>10.5 %</td>
<td>3.5 (1.3 – 13.6)</td>
<td></td>
</tr>
<tr>
<td><strong>Constipation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>316</td>
<td>21</td>
<td>6.6 %</td>
<td>1.0</td>
<td>0.01</td>
</tr>
<tr>
<td>yes</td>
<td>45</td>
<td>8</td>
<td>17.8 %</td>
<td>2.5 (1.3 – 5.7)</td>
<td></td>
</tr>
<tr>
<td><strong>Bronchial asthma</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>332</td>
<td>21</td>
<td>6.3 %</td>
<td>1.0</td>
<td>0.001</td>
</tr>
<tr>
<td>yes</td>
<td>29</td>
<td>8</td>
<td>27.6 %</td>
<td>4.6 (2.9-17.4)</td>
<td></td>
</tr>
<tr>
<td><strong>Chronic cough</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>310</td>
<td>14</td>
<td>4.5 %</td>
<td>1.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>yes</td>
<td>51</td>
<td>15</td>
<td>29.4 %</td>
<td>5.9 (3.3 – 22.7)</td>
<td></td>
</tr>
<tr>
<td><strong>Steroid therapy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>294</td>
<td>21</td>
<td>7.1 %</td>
<td>1.0</td>
<td>0.09</td>
</tr>
<tr>
<td>yes</td>
<td>67</td>
<td>8</td>
<td>11.9 %</td>
<td>1.3 (0.8 – 7.4)</td>
<td></td>
</tr>
<tr>
<td>Risk factor</td>
<td>patients (n=361)</td>
<td>Recurrence (n=29)</td>
<td>rate of recurrence</td>
<td>RR** (95% CI*)</td>
<td>P value of RR</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------</td>
<td>-------------------</td>
<td>-------------------</td>
<td>----------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Type of repair</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mesh*</td>
<td>180</td>
<td>5</td>
<td>2.8 %</td>
<td>1.0 Baseline</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>sutured</td>
<td>181</td>
<td>24</td>
<td>13.3 %</td>
<td>4.4 (1.9-12.2)</td>
<td></td>
</tr>
<tr>
<td>Size of hernia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>diameter 1-6cm*</td>
<td>277</td>
<td>20</td>
<td>7.2 %</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>diameter &gt;6cm*</td>
<td>84</td>
<td>9</td>
<td>10.7 %</td>
<td>1.5 (0.7 - 3.1)</td>
<td>0.32</td>
</tr>
<tr>
<td>Diameter of defect</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 - 3 cm.</td>
<td>165</td>
<td>11</td>
<td>6.7 %</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>&gt; 3 cm</td>
<td>196</td>
<td>18</td>
<td>9.2 %</td>
<td>1.3 (0.8 – 1.9)</td>
<td>0.1</td>
</tr>
<tr>
<td>Duration of op.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>up 70 minutes</td>
<td>328</td>
<td>26</td>
<td>7.9%</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>&gt;70 minutes</td>
<td>33</td>
<td>3</td>
<td>9.1%</td>
<td>1.1 (0.5 – 1.6)</td>
<td>0.9</td>
</tr>
<tr>
<td>Surgeon experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>111*</td>
<td>120</td>
<td>5.0 %</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

R.R**: denotes relative risk, 95% CI*: 95 percent confidence interval. *The patients in this category served as the reference group.
Table 2.7  Univariate Analysis of post-operative factors of para-umbilical hernia recurrence

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>patients (n=361)</th>
<th>Recurrence (n=29)</th>
<th>rate of recurrence</th>
<th>RR** (95% CI*)</th>
<th>P value of RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound infection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>344</td>
<td>21</td>
<td>6.1%</td>
<td>1.0</td>
<td>5.8 (2.7–11.9) &lt; 0.001</td>
</tr>
<tr>
<td>yes</td>
<td>17</td>
<td>8</td>
<td>47.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wound haematoma</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>358</td>
<td>28</td>
<td>7.8%</td>
<td>1.0</td>
<td>4.2 (0.8–21.9) 0.1.0</td>
</tr>
<tr>
<td>yes</td>
<td>3</td>
<td>1</td>
<td>33.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wound seroma</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>329</td>
<td>23</td>
<td>7.1%</td>
<td>1.0</td>
<td>2.7 (1.2–6.3) 0.015</td>
</tr>
<tr>
<td>yes</td>
<td>32</td>
<td>6</td>
<td>18.8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>325</td>
<td>17</td>
<td>5.2%</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

RR**: denotes Relative risk, 95% CI*: 95 percent confidence interval. *The patients in this category served as the reference group.
Table 2.8  Results of multivariate analysis of factors that affect recurrence following para-umbilical hernia repairs

<table>
<thead>
<tr>
<th>Variables</th>
<th>P value</th>
<th>HR **</th>
<th>95% CI* of HR **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sutured repair</td>
<td>0.001</td>
<td>4.8</td>
<td>3.5 – 21.16</td>
</tr>
<tr>
<td>Junior surgeon</td>
<td>0.002</td>
<td>3.5</td>
<td>1.9 – 5.3</td>
</tr>
<tr>
<td>Wound infection</td>
<td>0.001</td>
<td>4.3</td>
<td>2.7-11.9</td>
</tr>
<tr>
<td>Obesity</td>
<td>0.02</td>
<td>2.6</td>
<td>1.3 – 13.6</td>
</tr>
<tr>
<td>Chronic cough</td>
<td>0.004</td>
<td>5.9</td>
<td>3.3 – 22.7</td>
</tr>
</tbody>
</table>

RR**: denotes Relative risk, 95% CI*: 95 percent confidence interval. *The patients in this category served as the reference group.
HR**: denotes hazards ratio.  95% CI*: 95 percent confidence interval.  
Multivariate analysis was performed by Cox- regression test.

Table 3.6 Univariate Analysis of Preoperative Factors of Incisional Hernia Repair

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>patients (n=208)</th>
<th>Recurrence (n=66)</th>
<th>rate of recurrence</th>
<th>RR**(95% CI*)</th>
<th>P value of RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes mellitus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>355</td>
<td>53</td>
<td>14.9 %</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>53</td>
<td>13</td>
<td>24.4 %</td>
<td>4.5 (3.2 – 6.9)</td>
<td>0.01</td>
</tr>
<tr>
<td>Constipation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>327</td>
<td>49</td>
<td>15.0 %</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>81</td>
<td>17</td>
<td>20.9 %</td>
<td>1.4 (0.7 – 4.0)</td>
<td>0.1</td>
</tr>
<tr>
<td>Chronic cough</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>341</td>
<td>54</td>
<td>15.8 %</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>67</td>
<td>12</td>
<td>17.9 %</td>
<td>1.2 (0.08 – 6.3)</td>
<td>0.2</td>
</tr>
<tr>
<td>Bronchial asthma</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>373</td>
<td>59</td>
<td>15.8 %</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>35</td>
<td>07</td>
<td>20.0 %</td>
<td>1.3 (0.91-4.23)</td>
<td>0.1</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>light work*</td>
<td>305</td>
<td>46</td>
<td>15.1 %</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Heavy work</td>
<td>103</td>
<td>20</td>
<td>19.4%</td>
<td>1.7 (0.9 – 4.8)</td>
<td>0.09</td>
</tr>
<tr>
<td>Risk factor</td>
<td>patients (n=208)</td>
<td>Recurrence (n=66)</td>
<td>rate of recurrence</td>
<td>RR** (95% CI*)</td>
<td>P value of RR</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------</td>
<td>-------------------</td>
<td>--------------------</td>
<td>-----------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Type of repair</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mesh*</td>
<td>206</td>
<td>9</td>
<td>4.4%</td>
<td>1.0</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Suture</td>
<td>202</td>
<td>57</td>
<td>28.2%</td>
<td>9.4 (3.8 – 12.8)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Diameter of defect</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 5 cm*</td>
<td>123</td>
<td>13</td>
<td>10.6%</td>
<td>1.0</td>
<td>0.001</td>
</tr>
<tr>
<td>5-10 cm</td>
<td>224</td>
<td>32</td>
<td>14.3%</td>
<td>1.4 (1.2 – 6.1)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

RR** denotes Relative risk, 95% CI*: 95 percent confidence interval. *The patients in this category served as the reference group.

Table 3.7 Univariate Analysis of operative risk factors of Incisional hernia repair
<table>
<thead>
<tr>
<th>Risk factor</th>
<th>patients (n=208)</th>
<th>Recurrence (n=66)</th>
<th>rate of recurrence</th>
<th>RR** (95% CI*)</th>
<th>P value of RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound infection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>392</td>
<td>57</td>
<td>14.5%</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>16</td>
<td>9</td>
<td>56.3%</td>
<td>3.9 (2.3 – 8.5)</td>
<td>0.001</td>
</tr>
<tr>
<td>Wound haematoma</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>403</td>
<td>65</td>
<td>16.1%</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>5</td>
<td>1</td>
<td>20.0%</td>
<td>1.3 (0.8 – 8.1)</td>
<td>0.10</td>
</tr>
</tbody>
</table>

RR**: denotes Relative risk, 95% CI*: 95 percent confidence interval. *The patients in this category served as the reference group.

Table 3.8 Univariate Analysis of post-operative factors of Incisional hernia repair
### Table 3.9 Results of multivariate analysis of factors that affect recurrence following incisional hernia repairs

<table>
<thead>
<tr>
<th>Variables</th>
<th>P value</th>
<th>HR**</th>
<th>95% CI* of HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound seroma</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>386</td>
<td>58</td>
<td>15.0 %</td>
</tr>
<tr>
<td>yes</td>
<td>22</td>
<td>8</td>
<td>36.4 %</td>
</tr>
<tr>
<td>Duration of drain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 3 days*</td>
<td>361</td>
<td>55</td>
<td>15.5 %</td>
</tr>
<tr>
<td>&gt; 3 days</td>
<td>47</td>
<td>11</td>
<td>23.4 %</td>
</tr>
<tr>
<td>Chronic pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No*</td>
<td>372</td>
<td>50</td>
<td>13.4 %</td>
</tr>
<tr>
<td>yes</td>
<td>36</td>
<td>16</td>
<td>44.4 %</td>
</tr>
<tr>
<td>Return to work:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>up to 3 weeks*</td>
<td>181</td>
<td>27</td>
<td>14.9 %</td>
</tr>
<tr>
<td>&gt;3 weeks</td>
<td>227</td>
<td>37</td>
<td>17.2 %</td>
</tr>
</tbody>
</table>

RR**: denotes Relative risk, 95% CI*: 95 percent confidence interval. *The patients in this category served as the reference group.
<table>
<thead>
<tr>
<th>Types of Repair</th>
<th>HR</th>
<th>95% CI</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sutured repair</td>
<td>0.001</td>
<td>6.69</td>
<td>3.83–12.03</td>
</tr>
<tr>
<td>Junior surgeon</td>
<td>0.007</td>
<td>4.3</td>
<td>2.2–8.7</td>
</tr>
<tr>
<td>Wound infection</td>
<td>0.005</td>
<td>3.9</td>
<td>2.3–8.5</td>
</tr>
<tr>
<td>Obesity</td>
<td>0.003</td>
<td>4.8</td>
<td>3.24–8.2</td>
</tr>
</tbody>
</table>

Size of defect

<table>
<thead>
<tr>
<th>Size of Defect</th>
<th>HR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5 cm*</td>
<td>0.04</td>
<td>1</td>
</tr>
<tr>
<td>5-10 cm</td>
<td>0.01</td>
<td>3.3</td>
</tr>
<tr>
<td>&gt; 10 cm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HR**: denotes hazards ratio. 95% CI*: 95 percent confidence interval.
Multivariate analysis was performed by Cox-regression test.

Table 1.9 Types and frequency of Parenteral analgesics used by sutured and mesh repairs of inguinal hernia
<table>
<thead>
<tr>
<th>Type of analgesia</th>
<th>Type of repair</th>
<th>suture</th>
<th>mesh</th>
<th>P* value</th>
</tr>
</thead>
<tbody>
<tr>
<td>narcotics (pethidine)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>suture</td>
<td>103</td>
<td>41</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>mesh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Single dose</td>
<td>73</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Double dose</td>
<td>30</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>non-narcotics (Diclophenac)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>suture</td>
<td>85</td>
<td>92</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>mesh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Single dose</td>
<td>47</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Double dose</td>
<td>38</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Total analgesics consumed</td>
<td></td>
<td>188</td>
<td>133</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Values in parenthesis are percentages of patients

Mean consumption: 0.9 vs. 0.5 inj., p < 0.001

Table 2.9 Types and frequency of Parenteral analgesics used by the two groups of para-umbilical repair
<table>
<thead>
<tr>
<th>Variable</th>
<th>Type of repair</th>
<th>p value</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sutured (n=186)</td>
<td>Mesh (n=186)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pethidine (50mg)</td>
<td>71 (38.0%)</td>
<td>23 (12.4%)</td>
<td>&lt; 0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single dose</td>
<td>48 (25.6%)</td>
<td>17 (9.2%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double dose</td>
<td>23 (12.4%)</td>
<td>6 (3.2%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diclophenac (75mg)</td>
<td>87 (46.5%)</td>
<td>71 (38.2%)</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single dose</td>
<td>52 (27.7%)</td>
<td>50 (26.8%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double dose</td>
<td>35 (18.8%)</td>
<td>21 (11.3%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total analgesics</td>
<td>157 (84.5%)</td>
<td>94 (50.6%)</td>
<td>&lt; 0.001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values in parenthesis are percentages of patients
Mean consumption: 0.98 vs. 0.48 inj., p < 0.001

**Table 3.10** Types and frequency of Parenteral analgesics used by the two groups of incisional hernia repairs
<table>
<thead>
<tr>
<th>Variable</th>
<th>Sutured (n=186)</th>
<th>Mesh (n=186)</th>
<th>P* value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pethidine (50mg)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single dose</td>
<td>155 (74.9%)</td>
<td>100 (48.1%)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Double dose</td>
<td>103 (49.8%)</td>
<td>81 (38.9%)</td>
<td></td>
</tr>
<tr>
<td><strong>Diclophenac (75mg)</strong></td>
<td></td>
<td></td>
<td>0.06</td>
</tr>
<tr>
<td>Single dose</td>
<td>39 (18.8%)</td>
<td>36 (17.3%)</td>
<td></td>
</tr>
<tr>
<td>Double dose</td>
<td>26 (12.5%)</td>
<td>31 (15.0%)</td>
<td></td>
</tr>
<tr>
<td><strong>Total analgesics</strong></td>
<td>194 (93.7%)</td>
<td>136 (65.4%)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Values in parenthesis are percentages of patients.
Mean consumption: 1.1 vs. 0.6 inj., p< 0.001

Table 1.10 Postoperative hospital stay and convalescence in the two treatment
groups of inguinal hernias

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type of repair</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sutured Repair (n=201)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mesh Repair (n=202)</td>
<td></td>
</tr>
<tr>
<td>Postoperative hospital stay (days)</td>
<td>2.09± 0.78</td>
<td>0.09</td>
</tr>
<tr>
<td>Time to resumption of normal activity (in days)</td>
<td>20.8± 8.3 (18-42days)</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>16.2± 5.1 (14-36days)</td>
<td></td>
</tr>
</tbody>
</table>

*Parentheses are mean ± standard deviation*
Table 2.10  Postoperative hospital stay and convalescence in the two treatment groups of para-umbilical hernias

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type of repair</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sutured Repair (n=186)</td>
<td>Mesh Repair (n=186)</td>
</tr>
<tr>
<td>Postoperative hospital stay (days)</td>
<td>2.31±1.94</td>
<td>2.13±1.01</td>
</tr>
<tr>
<td>Time to resumption of normal activity (in days)</td>
<td>23.6 ±15.29</td>
<td>20.9± 16.935</td>
</tr>
</tbody>
</table>

Parentheses are mean ± standard deviation
Table 3.11 Post-operative hospital stay and convalescence in the two treatment groups of incisional hernias

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sutured repair (n=207)</th>
<th>Mesh repair (n=208)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-operative hospital stay</td>
<td>3.07± 1.58 days</td>
<td>2.83± 1.07 days</td>
<td>0.09</td>
</tr>
<tr>
<td>Time of resumption of normal activities (in days)</td>
<td>26.6 ± 13.05 days</td>
<td>23.8± 6.8 days</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Values are mean ± standard deviation

Table 1.11 Intra-operative and post-operative complications in the two treatment groups of inguinal hernia repairs

<table>
<thead>
<tr>
<th>Complication</th>
<th>Type of repair</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraperitoneal</td>
<td>Sutured (n=201)</td>
<td>Mesh (n=202)</td>
</tr>
</tbody>
</table>

131
<table>
<thead>
<tr>
<th>Condition</th>
<th>Group 1 (Patient)</th>
<th>Group 2 (Patient)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nerve injury</td>
<td>4 (2.0%)</td>
<td>6 (3.0%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Epigastric artery injury</td>
<td>1 (0.5%)</td>
<td>1 (0.5%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Vas injury</td>
<td>1 (0.5%)</td>
<td>0 (0.0%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Minor bladder injury</td>
<td>1 (0.5%)</td>
<td>0 (0.0%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Early postoperative</td>
<td>37 (18.4%)</td>
<td>40 (19.8%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Urinary retention</td>
<td>14 (7%)</td>
<td>12 (5.9%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Haematoma</td>
<td>3 (1.5%)</td>
<td>2 (1.0%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Seroma</td>
<td>1 (0.5%)</td>
<td>2 (1.0%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Wound infection</td>
<td>5 (2.5%)</td>
<td>6 (3.0%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Local numbness</td>
<td>8 (4.0%)</td>
<td>10 (5.0%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Scrotal oedema</td>
<td>4 (2.0%)</td>
<td>5 (2.5%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Hydrocele</td>
<td>2 (1.0%)</td>
<td>3 (1.5%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Late postoperative</td>
<td>34 (16.9%)</td>
<td>18 (8.9%)</td>
<td></td>
</tr>
<tr>
<td>Testicular atrophy</td>
<td>1 (0.5%)</td>
<td>0 (0.0%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Chronic infection</td>
<td>1 (0.5%)</td>
<td>2 (1.0%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Chronic groin pain</td>
<td>25 (12.4%)</td>
<td>8 (4.0%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Chronic constipation</td>
<td>1 (0.5%)</td>
<td>2 (1.0%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Persistent numbness</td>
<td>5 (2.5%)</td>
<td>6 (3.0%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Intestinal obstruction</td>
<td>1 (0.5%)</td>
<td>0 (0.0%)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Total</td>
<td>78 (38.8%)</td>
<td>65 (32.2%)</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

Values in parenthesis are percentages of patients. P < 0.05 is significant

Table 2.11 Early and Late post-operative complications in the two treatment groups of para-umbilical hernia repairs
<table>
<thead>
<tr>
<th>Complications</th>
<th>Type of repair</th>
<th></th>
<th></th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sutured (n=186)</td>
<td>Mesh (n=186)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Early complications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary retention</td>
<td>31 (16.7%)</td>
<td>33 (17.7%)</td>
<td></td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Wound haematoma</td>
<td>2 (1.1%)</td>
<td>1 (0.5%)</td>
<td></td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Wound seroma</td>
<td>15 (8.1%)</td>
<td>18 (9.7%)</td>
<td></td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Wound infection</td>
<td>8 (4.3%)</td>
<td>9 (4.8%)</td>
<td></td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Local numbness</td>
<td>2 (1.1%)</td>
<td>3 (1.6%)</td>
<td></td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>Ileus</td>
<td>1 (0.5%)</td>
<td>1 (0.5%)</td>
<td></td>
<td>&gt;0.05</td>
</tr>
<tr>
<td><strong>Late complications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic infection</td>
<td>2 (1.1%)</td>
<td>3 (1.6%)</td>
<td></td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>Chronic local pain</td>
<td>26 (14.0%)</td>
<td>10 (5.4%)</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Chronic constipation</td>
<td>3 (1.6%)</td>
<td>5 (2.7%)</td>
<td></td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>Intestinal obstruction</td>
<td>1 (0.5%)</td>
<td>0 (0.5%)</td>
<td></td>
<td>&gt;0.05</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>63 (33.8%)</td>
<td>51 (27.4%)</td>
<td></td>
<td>0.07</td>
</tr>
</tbody>
</table>

Values in parenthesis are percentages
P < 0.05 is significant
### Table 3.12  Early and late post-operative complications in the two treatment groups of incisional hernias

<table>
<thead>
<tr>
<th>Complications</th>
<th>Type of repair</th>
<th></th>
<th></th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Sutured (207)</strong></td>
<td><strong>Mesh (208)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intra-operative complications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bowel injury</td>
<td>1 (0.5 %)</td>
<td>0 (0.0 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Early post-operative complications</strong></td>
<td>39 (18.8%)</td>
<td>40 (19.2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary retention</td>
<td>3 (1.5 %)</td>
<td>2 (1.0 %)</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>1 (0.5 %)</td>
<td>0 (0.0 %)</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>D.V.T</td>
<td>1 (0.5 %)</td>
<td>0 (0.0 %)</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>Local numbness</td>
<td>4 (2.0 %)</td>
<td>5 (2.4 %)</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>Haematoma</td>
<td>3 (1.5 %)</td>
<td>2 (1.0 %)</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>Seroma</td>
<td>17 (8.2 %)</td>
<td>20 (9.6 %)</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>Wound infection</td>
<td>8 (4.0 %)</td>
<td>10 (4.8 %)</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>Ileus</td>
<td>2 (1.0 %)</td>
<td>1 (0.5 %)</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td><strong>Late postoperative complications:</strong></td>
<td>38 (18.4%)</td>
<td>17 (8.1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic infection</td>
<td>3 (1.5%)</td>
<td>4 (1.9%)</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>Chronic pain</td>
<td>27 (13.0%)</td>
<td>9 (4.3%)</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Constipation</td>
<td>7 (3.4 %)</td>
<td>4 (1.9%)</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td>Intestinal obstruction</td>
<td>1 (0.5 %)</td>
<td>0 (0.0%)</td>
<td>&gt;0.05</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>78 (37.7%)</td>
<td>57 (27.4%)</td>
<td>&gt;0.05</td>
<td></td>
</tr>
</tbody>
</table>

D.V.T: deep vein thrombosis
**Figure 1:** Flow chart of patients screened for participation in inguinal, umbilical, and incisional hernia repairs
**Figure 1.1**: Flow Chart of Patients screened for participation in inguinal hernia repairs

- 454 screened for participation
  - 26 excluded
  - 428 eligible for randomization

- 214 assigned to suture repair
  - 3 refused participation
  - 6 poor surgery
- 205 completed intervention
  - 1 femoral hernia
  - 2 with other surgery
  - 1 refused FU
- 201 eligible for follow-up
  - 2 died
  - 15 lost
  - 21 recurrences
- 184 Response rate (91.5%)

- 214 assigned to mesh repair
  - 4 refused participation
  - 2 poor surgery
- 208 completed intervention
  - 1 hernia repair with other surgery
  - 5 refused F.U
- 202 eligible for follow-up
- 190 Response rate (94.1%)

Cumulative response rate 92.8% (n=374)
Figure 2.1: Flow Chart of Patients screened for participation in para-umbilical hernia repairs

- 421 screened
- 32 excluded
- 389 eligible for randomization

194 assigned to suture repair
- 5 not undergo surgery
- 3 refused participation
- 2 poor surgery

189 completed intervention
- 2 other surgery
- 1 refused follow-up

186 eligible for follow-up
- 6 losses
- 24 recurrences

180 attended F.-U. (96.7%)

195 assigned to mesh repair
- 5 not undergo surgery
- 4 refused participation
- 1 poor surgery

190 completed intervention
- 3 damaged mesh
- 1 refused follow-up

186 eligible for follow-up

- 5 losses
- 5 recurrence

181 attended F-U (97.3%)

Cumulative response rate 97% (n=361)
Figure 3.1: Flow Chart of Patients screened for participation in incisional hernia repairs

- 446 screened
- 12 excluded
- 434 eligible for randomization

217 assigned to suture repair
- 9 did not undergo surgery
- 6 not participate
- 3 poor surgery
- 1 hernia repair associated with other surgery
- 1 died
- 4 lost
- Recurrences 57
- 202 attended follow-up (97.6%)

217 assigned to mesh repair
- 7 not undergo surgery
- 6 not participate
- 1 poor surgery
- 2 hernia repair associated with other surgery
- 1 died
- 1 lost
- Recurrences 9
- 206 attended follow-up (99%)

208 completed intervention
210 completed intervention

208 eligible for follow-up
208 eligible for follow-up

Cumulative response rate

408 (98.3%)
Figure 1.2: Cumulative response rate of follow-up of patients following inguinal herniorraphy
Figure 2.2 Cumulative response rate of follow-up of patients following para-umbilical herniorraphy
Figure 3.2 Cumulative response rate of follow-up of patients following incisional herniorraphy
Figure 1.3: Age distribution among the two treatment groups of inguinal hernias
Figure 2.3: Age distribution among the two treatment groups of para-umbilical hernias.
Figure 3.3: Age distribution among the two treatment groups of incisional hernias
Figure 1.4: Levels of effort in the two treatment groups of inguinal hernias
Figure 2.4: Levels of effort in the two treatment groups of para-umbilical hernias.
Figure 3.4: Levels of effort in the two treatment groups of incisional hernias
Figure 1.5: Build of patients in the two treatment groups of inguinal hernias
Figure 2.5: Build of patients in the two treatment groups of para-umbilical hernias
Figure 3.5: Build of patients in the two treatment groups of incisional hernias
Figure 1.6: Smoking in the two treatment groups of inguinal hernias
Figure 2.6: Smoking in the two treatment groups of para-umbilical hernias
Figure 3.6: Smoking in the two treatment groups of incisional hernias
Figure 2.7: Mean diameter of defects in the two groups of para-umbilical hernias
Figure 3.7: Diameter of defects in the two groups of incisional hernias
Fig. 1.7  Box Plots of duration of operation according to the level of surgeon in the sutured and mesh surgery groups of inguinal hernias
Fig. 2.8 Box Plots of duration of operation according to the level of surgeon experience in the sutured and mesh surgery groups of para-umbilical hernias.
Fig. 3.8  Box Plots of duration of operation according to the level of surgeon in the sutured and mesh surgery groups of incisional hernias
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Figure 3.9 Duration of drain insertion in the sutured and mesh repair groups of incisional hernias
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Figure 2.10: Kaplan-Meier Curves for non-recurrence of hernia after repair of primary para-umbilical hernias according to whether the patient was assigned to sutured repair (n=186) or mesh repair (n=186). The p value for the difference in the rates of recurrence between the two groups was <0.001 by log rank test.
Survival Functions

Figure 3.10: Kaplan-Meier Curves for non-recurrence of hernia after repair of primary inguinal hernias according to whether the patient was assigned to sutured repair (n=207) or mesh repair (n=208). The p value for the difference in the rates of recurrence between the two groups was < 0.001 by log rank test.
Figure 1.9: Relative hernia recurrence of each level (surgeon experience) in the sutured and mesh repairs of inguinal hernias
Figure 2.11: Relative hernia recurrence of each level (surgeon experience) in the sutured and mesh repairs of para-umbilical hernias
Figure 3.11: Relative hernia recurrence of each level (surgeon experience) in the sutured and mesh repairs of incisional hernias.
Figure 1.10  Pain score in patients with inguinal hernias repaired with either suture or mesh.

- Mean (± s.d.) pain score on D0 (day of surgery), D1 (1st post-operative day), D7 (7th Post-operative day), D14 (14th post-operative day) and D30 (30th post-operative day).
Figure 2.12 Pain score in patients with para-umbilical hernias repaired with either suture or mesh

- Mean (± s.d.) pain score on D0 (day of surgery), D1 (1st. post-operative day), D7 (7th. Post-operative day), D14 (14th. post-operative day) and D30 (30th. post-operative day).
Figure 3.12  Pain score in patients with incisional hernias repaired with either suture or mesh.

- Mean (± s.d.) pain score on D0 (day of surgery), D1 (1st post-operative day), D7 (7th Post-operative day), D14 (14th post-operative day) and D30 (30th post-operative day)
Figure 1.11: Percentage of patients using oral analgesic plotted against time (weeks) in the two groups of inguinal hernia repair.
Figure 2.13: Percentage of patients using oral analgesic plotted against time (weeks) in the two groups of para-umbilical hernia repair. * 100% refers to all patients in the group of repair.
Figure 3.13: Percentage of patients using oral analgesic plotted against time (weeks) in the two groups of incisional hernia repair. *100% refers to all patients in the group of repair.
Figure 1.12: Patients' satisfaction in the mesh and sutured groups of inguinal herniorraphy.

*Vertical axis: represents patients as a percent of all patients in the repaired group.
Figure 2.14: Patients' satisfaction in the mesh and sutured groups of inguinal herniorraphy.
*Vertical axis: represents patients as a percent of all patients in the repaired group.
Figure 3.14: Patients' satisfaction in the mesh and sutured groups of Incisional herniorraphy.

*Vertical axis: represents patients as a percent of all patients in the repaired group.
Chapter Four

Discussion

4.1 Over view

Abdominal wall hernia is a common clinical problem treated by the general surgeon worldwide. There is a local defect which has to be closed technically, either by sutures (46,153) or, in modern times, with meshes (149,166,168).

Although, many techniques have been described for the repair of the primary abdominal wall hernias, recurrences and complications remained a vexing problem which is frustrating surgeons of all experience and skill. With the use of mesh material in the repair of abdominal hernias, defects of any size can be closed without the pulling and tension which are produced by the sutured surgery, and this may help in reducing the rate of recurrence and intensity of postoperative pain and consequently promote early return to social activities (185-187).

Despite the high recurrence rates associated with sutured technique, it is still one of the most often preferred surgical options of hernia repair in hospitals all over the developing world (157,176).

In Yemen, Sudan, and probably North Africa and Arab States, sutured repairs are still the standard methods practiced by 68.2%, 73.4%, and 54.8% of surgeons in inguinal, para-umbilical and incisional herniorraphies respectively. Mesh materials are restricted for large and recurrent hernias (177).

Multiple studies have been performed comparing tissue repairs against mesh repairs (44, 46,122,154,166,171,173,188). A systemic review by the European Union’s Hernia Trialists Collaboration, reported a three-fold reduction in recurrence rates from 4.4% to 1.5% with the use of mesh compared with sutured techniques of inguinal hernias (169). In a prospective randomized controlled study by Prior et al. (188) comparing mesh (Lichtenstein) repair with sutured (Modified Bassini) repair of inguinal hernias on short-term follow-up, there was no significant difference between the two procedures with regard to post-operative complications, but there was significantly less pain in
the mesh group. Arroyo et al (44) in their series also reported superiority of mesh repair over sutured repair of para-umbilical hernias in terms of hernia recurrence rate (1% versus 11%).

Luijendijk et al (122) reported 43% recurrence rate in the sutured repair and 22% in the mesh repair of incisional hernias. Friis et al. performed a prospective randomized study comparing the mesh (Lichtenstein) repair to tissue repair (Cooper’s ligament). They found that the recurrence rate was reduced by 1/3 of that following tension-free mesh herniorrhaphies (167). Aytac et al. in Turkey performed a retrospective study comparing the Lichtenstein repair to the Shouldice repair for treatment of primary inguinal hernia. He also showed the superiority of Lichtenstein repair (168).

Though many of the previous authors have reported favourable results with mesh repair over sutured repair, most of these studies were either retrospective with unreliable data, and lacked stratification of variables that are considered be risk factors for hernia recurrence, or had a small sample size and short-term follow-up.

The current study reported the results of a prospective, randomized, controlled study in which mesh repairs were compared with sutured repairs of inguinal, para-umbilical, and incisional hernias with regard to recurrence (The primary outcome), operative time, technical difficulty, postoperative hospital stay, patients comfort, complications, and rehabilitation, in the hands of general surgeons.

The study provided evidence that mesh repairs of inguinal, para-umbilical and incisional hernias are superior to sutured repairs. They had fewer recurrences, lesser intensity of abdominal pain, faster return to normal activities, more patient satisfaction with the results of the operations, and no more complications than sutured repairs.

### 4.2 Characteristics of the patients

In the current study, males constituted the majority (90.8%) in inguinal hernia repairs while females predominated in para-umbilical and incisional hernia repairs (86.3% and 85.8% respectively); this is similar to previous studies (189,190). The mean age of participants in this study was 49.9 years, 41.9 years, and 48.1 years in inguinal, para-
umbilical and incisional hernias respectively. These are similar to findings in other studies (44,191).

Spinal and general anaesthesia were selected as the methods of choice in this study, depending on the location of hernia. They allow the surgeon greater freedom to manoeuvre within the operative field since the anaesthetized region is larger than in local anaesthesia. Though these modes of anaesthesia carry their own infrequent systemic risks, they had no effect on the rate of recurrence or local complications (192). Local anaesthesia was not used, because it may be associated with considerable pain during repair particularly of large hernias, and was not accepted by almost all the study population, and it was not preferred by the participating surgeons.

4.3 Follow-up

Assessment by physical examination during follow-up is indispensable for obtaining reliable data on rates of recurrence and post-operative complications, but follow-up by questionnaire, telephone or a mail is relatively unreliable (193). Virtually all patients in this study were assessed by physical examination at regular intervals, that was performed by the attending surgeon for the first two weeks. This gave the patients confidence to continue with follow-up for any post-operative complication occurring. Beyond the second week of surgery up to three years, the assessment is continued by assessors who were not present at operation. The assessors paid visits sometimes to the patients who were unable to come to the hospital for follow-up.

Although many studies (194,195) have recognized the importance of the physical examination after hernia repair, the percentages of patients examined during follow-up were usually lower than in the present study in which, the response rates of follow-up were 92.8%, 97% and 98.3% in inguinal, para-umbilical and incisional hernia repairs respectively.
4.4 Recurrences

4.4.1 Recurrence rate

Hernia recurrence is a burden on the patient and relatives, and may represent a challenge for the operating surgeon. It contributes to increasing health care costs, and its prevention will offer advantages \(^{(56)}\). Hernia repair without prosthetic mesh, is associated with unsatisfactory recurrence rates varying between 0.2% and 33% of inguinal \(^{(154,155)}\), 10% and 30% of para-umbilical \(^{(196-199)}\), and 12% and 54% of incisional hernia repairs \(^{(74,122,157,158)}\). However, because most studies have only provided short-term follow-up, recurrence rates may even be higher, as has been reported in the recent long-term follow-up (10 years) of a randomized trial \(^{(196)}\). The high rates well explain the importance of the problem, considering that hernia repair is a common problem around the world.

Langer and Christiansen \(^{(200)}\) compared their results using primary repair with historical data using a mesh and suggested that the use of mesh gave a better repair with less recurrence. Loh et al. \(^{(201)}\) in their literature review suggested that the better results with mesh were simply a manifestation of inadequate length of follow-up. Liakakos et al \(^{(189)}\) carried out a prospective comparison of primary closure against the use of mesh and showed that the recurrence rate was less with mesh at a mean of 7.6 years of follow-up. Their patients were not, however, randomized.

The results of the current study showed that patients with inguinal, para-umbilical and incisional hernia repairs have fewer recurrences after mesh repairs (1.5%, 2.7% and 4.3% respectively) than after the commonly practiced sutured repairs (10.5%, 12.9% and 27.5%). The differences in the rates of recurrence between the two groups were statistically significant. These results confirming the superiority of mesh repairs over the sutured repairs in terms of recurrence. This is in accordance with that suggested in previous trials comparing the same techniques \(^{(167,168,170,202)}\).

In the present study, the 1.5% recurrence rate in mesh repair of inguinal hernias was lower than that reported by Liem et al. series \(^{(182)}\) who showed 6% recurrence rate, and was comparable to that of Alam S. N. et al. \(^{(2)}\) (1.2%), Choudy et al. \(^{(203)}\) (1.2%), and
Farooq & Rehman (204) (1.5%). Other authors like Butters et al. (205) and Sakorafas et al. (206) with large series showed a recurrence rate of less than 1%

In para-umbilical hernia repairs of the present study, there was a surprisingly low recurrence rate after mesh repair (2.7%) than after sutured repair (12.9%) with statistically significant difference between the two treatment groups (p<0.001), supporting the findings in the series published by Arroyo et al. (44), Sanjay et al. (199), and Polat et al. (187), in which mesh repair seemed to decrease the incidence of recurrence significantly after para-umbilical hernia repair. Furthermore, Arroyo et al. (44) in their published randomized controlled trial on para-umbilical hernia repair, reported that even for small para-umbilical hernias, mesh repair results in significantly few recurrences than sutured repair. In contrast, Halm et al. (198) did not confirm these results, and Asolati et al. (207) had a surprisingly low recurrence rate (7.7% after sutured repair, and 3% after the mesh repair) similar to the rates published by Bowely and kingsnorth (46) but with no significant difference between sutured repair and mesh repair, supporting the findings of Halm et al. (198).

Similarly in incisional hernia repairs of this study, the three-year cumulative rate of recurrence was 4.3% in the mesh repair group and 26.6% in the sutured surgery group. The difference in recurrence rate between the two groups would appear to be clinically significant and can therefore be expected to increase over time. However, the overall recurrence rate of 27.5% in the sutured repair was similar to that predicted in Luijendijk previous work (208), but unexpectedly low in comparison with other studies (122,209,210) which reported up to 43% rates of recurrences.

In the mesh group of incisional hernia repairs of this study, the 4.3% recurrence rate is lower than reported by Luijendijk et al. (122), and is higher than those reported by Hamilton Le et al. (211), who reported a 2% recurrence rate after mesh repair of incisional hernias. Long-term (10-years) results of Burger et al. (74) showed a recurrence rate of 63% for sutured repair and 32% for mesh repair (P < 0.001).

In the present study, the junior surgeons were initially supervised directly and asked to follow the standard described techniques. Although not directly recorded, the general impression was that the learning curve was short and efficiency was rapidly attained.
Chan et al. \textsuperscript{(212)} in their study described similar findings, that trainee surgeons acquired the skills easily.

Early recurrences in hernia surgery may be caused by technical errors and most of these occur within the first two or three years \textsuperscript{(206)}. Previous studies have shown that up to 50\% of recurrences occurred within the first year after repair and 70-75\% at the second year \textsuperscript{(122,213)}. Hesselink et al. studied a group of primary incisional hernias for a mean follow-up 34.9 months. The recurrence rate was 36\%: of these 45.5\% had recurrences in the first year, 64\% in the second year, and 78\% of all recurrences within three years. Therefore, a follow-up evaluation of at least three years is recommended \textsuperscript{(130)}. One could argue, therefore, that the 3-year follow-up in this study is enough to detect the difference in hernia recurrence.

\subsection*{4.4.2 Risk factors of hernia recurrence}

Based on experience and literature review, variables considered to be potential risk factors or predictors of subsequent recurrence in elective inguinal, para-umbilical and incisional hernia repairs have been clearly identified and studied \textsuperscript{(158,207)}. There are numerous prognostic factors; including those present pre-operatively, operatively and postoperatively which have an effect on outcome of hernia surgery. The findings in previous reports have varied; these may be due to differences in patient populations, surgical techniques, methodologies, definitions and the choice of variables studied. These disparities demonstrate that such data from the literature can not necessarily identify risk factors at an individual institution where local data may be more accurately defined as local risk factors. A better understanding of recurrence mechanisms is warranted.

In Luijendijk et al. study \textsuperscript{(122)} the independent risk factors of incisional hernia recurrence were sutured repair, wound infection, prostatism (in men) and previous operation of abdominal aortic aneurysm. However, in the present study, no patient had abdominal aortic aneurysm surgery. In another midline literature review \textsuperscript{(214)}, the results revealed that only five factors that include obesity, technique of surgery, size of hernia, and infection, are predictors for hernia recurrence. Both these reports were similar findings predicted in the current study.
In the present study, the association between each single factor and the occurrence of hernia recurrence has been examined initially with univariate analysis. Each factor has been looked at separately. The results demonstrated multiple risk factors significantly associated with the development of hernia recurrence. Multivariate analysis, of the univariate significant potential variables identified sutured repair, young surgeon, wound infection, as independent predictors for inguinal, para-umbilical, and incisional hernia recurrence.

### 4.4.2.1 Technique of repair

Operative characteristics associated with the development of hernia recurrence have been a major focus of this surgical research. The attempt to approximate the conjoined tendon to the inguinal ligament as done in sutured inguinal hernia repair (e.g. Bassini modifications), and the stitching together or overlapping the edges of the defect in para-umbilical and incisional hernias (e.g. Mayo and fascial approximation repair) are causes of unavoidable tension at the suture line, and subsequent hernia recurrence (29).

In the present study, the high recurrence that has been produced by sutured repairs has been reduced to a minimum by adopting tension-free techniques with polypropylene mesh material. Polypropylene mesh can be quickly fused by the fibroblastic reaction, setting up a scaffolding that in turn induces the synthesis of collagen, and allows the formation, in a very short time, of a new resistant wall which withstands the rising abdominal pressure extended by the abdominal content once the patient strains (215). So defects of any size can be closed easily without tension.

However, in this study, the multivariate Cox-regression analysis sets up sutured repair as an independent risk factor for recurrence in all inguinal, para-umbilical and incisional hernia repairs. In contrast to the sutured repair, mesh repair was found to be as a protective factor against hernia recurrence. This is in accordance with other studies (188,190).

### 4.4.2.2 Surgical experience

Surgeon experience is the most important factor for hernia recurrence. Specialist institutions of hernia repair such as that of Shouldice and Lichtenstein, reported results
(recurrence rates of <1%, and of 0.1% respectively) better than those of non-specialist centres, since experience with a method leads to better results \((216)\). In the results of this study, more than half of recurrences followed operations done by the junior surgeons for inguinal, para-umbilical, and incisional hernia repairs with statistically significant differences between senior and junior surgeons \((p<0.001)\). This indicates that the recurrence rate tends to fall with the years of surgeon experience. This is in accordance with other studies \((182)\). These findings clearly demonstrated that most failed herniorrhaphies, especially the early recurrences, are the result of failure on the part of the surgeon, and that is why fewer recurrences occurred in hernia specialized centres in which the surgeons were dealing specifically with one procedure, and confined in their practice to hernia repair \((30)\).

### 4.4.2.3 Wound complications

Other factors have been examined. Wound complications (infection, seroma, and haematoma) historically have been associated with an increased recurrence rate \((217)\). It has been estimated that hernia recurrence was 4 times greater in patients with infection than patients with no infection after hernia repair in Shouldice Hospital series \((59)\). These data were supported by the results of the present study, in which the recurrence rate has shown 3-4 fold increase in patients with infection than patients with no infection following inguinal, para-umbilical, and incisional hernia repairs respectively.

Recent studies have documented that some patient’s characteristics are associated with increased risk of infection and consequently increased risk of recurrence, including: diabetes mellitus, smoking, steroid therapy \((217,218)\).

In a randomized controlled trial of open suture versus open mesh incisional hernia repair, wound infection occurred in 3.7% of subjects and was associated with a greater than 80% risk of recurrence \((122)\).

In a retrospective study of retrofascial mesh repair of incisional hernias by Hamilton et al. \((211)\), the post-operative wound infection rate was 9% which was higher than the percentage in the present study, with two patients \((1.3%)\) who required mesh removal.
In a large cohort study of ventral hernia repair subjects from 13 VHA Medical Centre, wound infection rate was 5%. It was also reported that smoking, chronic steroid, prolonged operative time are independent predictors of wound infection. After adjustment for other significant covariates, mesh use was not a significant predictor of wound infection\(^{(218)}\).

Wound haematoma and seroma were often associated with the resultant wound infection but by themselves were not a significant factor.

**4.4.2.4 Prostatism**

Few studies\(^{(108,122)}\) identified prostatism as an independent risk factor for hernia recurrence. This is supported by a similar finding in inguinal hernia repair of the present study. Abrahamson\(^{(133)}\) related that both prostatism and hernia recurrence are common in middle aged and elderly men but has no significant causal relationship.

In patients with para-umbilical and incisional hernia repairs, recurrence was not affected by symptoms of prostatism, might be related to that, the majority of participants were females.

**4.4.2.5 Size of hernia defect**

In the current study, the size of hernia defect is considered among the generally accepted risk factors for developing a recurrent hernia after primary incisional hernia repair. The recurrence rate was 10.6%, in hernias with a defect diameter of less than 5cm, while it was 34.4% in hernias with a defect diameter of more than 10 cm. This difference in the recurrence rate between small and large hernia defects was statistically significant. This is most likely due to the fact that large hernias stretch and attenuate the surrounding fascial planes; these tissues are correspondingly weaker when repaired with suture or mesh\(^{(3)}\).

Similarly, the size of hernia defect was an independent risk factor for incisional hernia recurrence in 2 retrospective studies of “approximating” fascial repair\(^{(130)}\), and “overlapping” repair\(^{(135)}\). It was reported in a series of 302 patients with incisional hernia repair, that incisional herniation less than 4 cm in diameter had a
significantly lower recurrence rate (p-0.01) than hernias of more 4 cm. diameter \(^{(130)}\). This was in accordance with that by Luijendijk \(^{(208)}\) who generally found the same result but in a smaller series of overlapping repair of midline incisional hernias.

The present study, could not establish a relationship between the two factors in inguinal and para-umbilical hernia repairs, because the diameters in most hernias were below 4 cm. This is in consistence with other studies \(^{(207,219)}\).

4.4.2.6 Obesity
Several scientific papers have reported obesity as a significant risk factor for the development of recurrence of primary para-umbilical and incisional hernia repairs, but not of inguinal hernia surgery \(^{(158,199)}\). In para-umbilical hernia repairs, Halm et al. \(^{(198)}\) reported an increased recurrence rate from 5% to 18% with a body mass index greater than 25kg/ m\(^2\), but not for a BMI greater than 30 kg/m\(^2\), and consequently he did not establish a relationship between obesity ( in addition to smoking and wound infection) and recurrence. These factors may be limited by the small patient sample in the recurrence group.

Medina et al. \(^{(220)}\) found that patients undergoing incisional herniorrhaphy with a BMI above 37 (97.5%) were at a six-fold increased risk of surgical wound infection and consequently hernia recurrence, but Asolati et al. \(^{(207)}\) data did not establish a clear relationship between increased BMI and para-umbilical hernia recurrence. In incisional hernia repairs, two publications \(^{(73,158)}\) show a statistically significant association with recurrent hernia repair. There was a positive correlation between severity of obesity and incisional hernia recurrence respectively (BMI <25 kg/ m\(^2\) -13 % recurrence rate, BMI > 25kg/m \(^2\) - 39 % recurrence rate \(^{(90)}\). Similarly, Sugerman showed severe obesity as a risk factor for both incisional and recurrent incisional hernias. However, the outcome of incisional hernia patient were not analyzed independently \(^{(221)}\).

The current study, supported the previous studies, and established a clear relationship between body mass index and para-umbilical and incisional hernia repair recurrences. It was found that patients with obesity (BMI > 30 kg/m\(^2\)) had a 2.6-fold increase in recurrence over normal patients in para-umbilical hernia repairs, and 4.8- fold increase
in incisional hernia recurrences. Finally the comorbidities of obesity lead to increased risk of surgery, including deep vein thrombosis and pulmonary embolus \(^{(222)}\). These two complications were actually demonstrated in a 65 years old obese female patient in the current study.

### 4.4.2.7 Chronic cough

The para-umbilical and inguinal hernia data in this study supported a correlation between chronic cough and recurrence. The significance of such observation might be due to increased numbers of participants with chronic bronchial asthma and persistent asthmatic attacks. Furthermore a large number of patients with inguinal hernias were smokers which are the main cause of chronic cough in these patients, though Abramson and colleagues \(^{(133)}\) showed that there was no significant independent evidence that chronic cough was associated with hernia recurrence.

### 4.4.2.8 Smoking

In the current study, smoking was also a significant factor for inguinal hernia recurrence by univariate analysis but disappeared with multivariate Cox analysis where approximately 29.5 % of the participants were heavy smokers. This is in keeping with other previous studies \(^{(62,131,223)}\). In a clinical study Sorensen; \(^{(132)}\), evaluated the effect of abstinence from smoking on incisional wound infection, the results showed that, in smokers, wound infection rate was 12 % compared with 2 % in never-smokers. The author also proved that abstinence from smoking reduces the incidence of wound infection \(^{(224)}\).

These data suggested that multiple factors may be involved in the recurrence of a hernia directly related to the surgical technique, to the patient characteristic, or post-operative period factors in inguinal, para-umbilical and incisional hernia repairs in the population under study. Early identification of these risk factors and institution of treatment for correction is the key to reduce the rate of hernia recurrence.

### 4.4.3 Causes of recurrences in mesh repair

In most cases of this study, the causes of recurrences in mesh repairs were: use of small size mesh and consequently, either fixation of the mesh under tension or
insufficient overlapping of the pubic tubercle (1.5% in inguinal hernia repair), or beyond the edge of the defect (1% in para-umbilical, and 0.5% in incisional hernia repairs), and inadequate fixation of the mesh that may lead to peripheral mesh detachment. This corresponds well with the finding published by Amid and Lichtenstein (16), who in a series of 5,300 hernia repairs found five recurrences, of which three were direct inguinal hernia recurrences. After modifying the technique slightly and using a wider overlap over the pubic tubercle they claimed to have virtually eliminated recurrences.

4.5 Operative time

This study demonstrated that the median duration of surgery was shorter in the sutured repair groups than in the mesh surgery groups of inguinal, para-umbilical and incisional hernia repairs, but the differences did not achieve a statistical significance. The longer operative time in the mesh repair groups was due to the time consumed in adequate dissection to fit and fix the mesh graft. However, the time became shorter with continuous practice. The length of operation as recorded in this study compares favourably with the results reported by Arroyo et al. (44), Polate et al (187), and Asolati et al (207) in para-umbilical hernia repairs and with other published data in inguinal (38) and incisional hernia repairs (122).

Both procedures were performed faster in the hands of highly experienced surgeons (L11) with a statistically significant advantage over intermediate surgeons (L11) and young surgeons (L1). This gives further support to the fact that a group of surgeons who are interested in a particular procedure will always perform better and faster than those who do not have this special interest, and the difference in levels of experience should be taken into account when comparing the two groups of repair.

In a retrospective single-centre cohort study (126), a total of 384 consecutive patients had a repair of incisional hernias (34 patients with mesh repair, and 305 with sutured repair). Compared to suture repair, mesh repair had prolonged operative time by over 30 minutes, confirming the results of the present study.
However, the duration of operation is a surgeon related variable \(^{(225)}\), that reflects the ease or difficulty of an operation encountered. When the method is easy to learn, a high standard is quickly acquired, and the results of experienced general surgeon will tend to approach those obtained by specialists in hernia.

The length of operation should be kept to a minimum. This is important for the following reasons: (1) The patients, who are on the whole middle-aged or elderly who spend less time on the operating table, will experience less risk of complications, (2) The long duration of operation may be a factor in increasing the susceptibility to wound infection, (3) Shorter operations allow more operations to be carried out in a single operating session, assuming anaesthetic time is taken into consideration.

### 4.6 Post-operative pain score and need of analgesic medication

During mesh repair of inguinal, para-umbilical and incisional hernias, the tissue tension in closing abdominal defects was considerably less \(^{(30)}\) than in techniques in which approximating sutures were used, such as in Bassini and or Modified Bassini \(^{(4,55)}\) Mayo \(^{(43)}\) and fascial approximation \(^{(3)}\) methods. Therefore it would be expected that there would be less pain involved in the mesh repair technique, because of the reduction of tension. This was born out by results of the present study in which the pain score levels were significantly greater in the sutured repair groups, although the difference in pain level diminished with time. This is in accordance with what has been reported by several published studies \(^{(122,130,169,170,188,222)}\).

None of the published studies concentrate on analgesic requirements after herniorrhaphy. In this study, the data showed that the pain experienced by the two groups after operation was indeed different, and correlates well with the type of repair. It was found that there was an increased requirement of narcotic (Pethidine HCL by the sutured repair group. In contrast, the overall narcotic requirement in the mesh group was low. Most patients were managed with non-narcotic analgesics. This is in keeping with the finding of Kux et al. \(^{(226)}\).

In contrast to the present study, Polate et al. \(^{(187)}\) demonstrated slightly lesser pain in the sutured repair group than in the mesh repair group of para-umbilical hernias.
However his study had a very small sample size (n=50 patients) and used a standard polypropylene mesh with interrupted suturing technique. A better abdominal wall compliance (less stiff abdomen) and less chronic pain have been reported following hernia repair using light weight version of polypropylene mesh with continuous suturing technique in the present study, though both types of mesh had high tensile strength and low recurrence rate in the long run (227). This is in accordance with a randomized controlled trial by Schumpelick (213) who noted a tendency toward less pain in patients who received the new mesh material, and Burger (74) who compared suture and mesh repair, found more frequent early abdominal pain in sutured repair patients (p = 0.01), but there was no difference in chronic pain.

Findings in the current study indicated that sutured repair groups were associated with higher levels of post-operative pain and more analgesic drugs required than in the mesh repair groups as well. Undue tension on the abdominal wall accounts for the increased post-operative pain (228), and consequently these patients needed more analgesic medication for pain relieve.

4.7 Return to normal activities and satisfaction

The length of post-operative rehabilitation is of great importance not only economically but also socially (186). A common index for rehabilitation is the time taken to return to work (202). In the current study it was decided to use the return to social activities as an index. All the patients were asked when they returned to normal activities. This was felt to be an acceptable alternative, owing to the fact that the majority of participants in this study were not working.

Most patients are being advised to limit their physical activity for long periods post-operatively to prevent recurrence. Although there is no scientific backing for such advice, but this common and costly practice persists (211). In Britain, when patients returned to full activity within a few weeks, recurrences were not more common, because it was reported that immediate return to full activity as soon as the wound soreness permits (7-10days) has not increased recurrence (229).
In the present study, the majority of participants (72.6%) were under the age of 60 years, thus still active in their respective professions, and early return to work was of paramount importance to them. In patients who were manual workers and daily wage carriers, the ambulation was the immediate concern. The tension-free techniques do facilitate early ambulation and early return of patients to normal activities in this series. These are comparable to other published trials (44,122).

In this study, the patients were motivated to return to normal activities as early as possible, but low education levels, previous habits of long staying after any operation, fear from early recurrence and the possible complication of a new implant, still constitute an obstacle to the policy of early rehabilitation for many patients.

### 4.8 Post-operative complications

There are a number of complications known to arise with some regularity after hernia repair (230). In the context of this study, none of the complications occurred significantly more often in one treatment group than in the other, except for a difference in chronic post-operative pain, possibly due to association of tension that is usually produced by sutured repair. This is similar to the finding reported in other studies (187,231). Persisting pain beyond the normal tissue healing time, assumed to be at three months (chronic residual neuralgia) (231) has been recognized as a long-term complication and disability following inguinal herniorraphy, causing notable effect on quality of life and daily activities (232).

Wantz et al. firmly stated that chronic herniorrhaphy neuralgias are mostly the result of tension-producing technique. The repair, and not the entrapment of a nerve, is the cause of pain (143) confirming that which has been found in the present study. This statement was supported by Kux and colleagues, (226) who compared 107 sutured with 102 Lichtenstein onlay mesh repair and found that the post-operative pain medication required was significantly reduced in the mesh-surgery group. Similar favourable experience was reported from another institution (232). Others have suggested that up to 50% of patients with incisional hernia repairs developed complaints because of a reduced mobility of the abdominal wall (65).
Light weight polypropylene mesh is expected to improve quality of life of all patients, by reducing post-operative pain and complications, by creating less fibrosis reaction (162). This is in accordance with the finding in the present study, in which light weight version of polypropylene mesh was used in the repair with resultant less frequent and less intense pain in the patients having undergone mesh repair than those who underwent sutured repair (4.3% versus 13%). We think that the strategies to reduce the number of patients with chronic pain after mesh herniorrhaphy will include a specific advice that modifies behavioural attitude after surgery and technological improvements in mesh design. This is in accordance to other studies (233,234).

The presence of serous collection is a frequent finding in the immediate post-operative period in patients undergoing para-umbilical and incisional hernia repairs, and less frequent following inguinal herniorrhaphy. It is usually the result of the accumulation of fluid in the potential space created during surgical manipulation and the porous property of the mesh (235). In the present study, seroma was also a problem in both groups of para-umbilical (9.1% in the mesh versus 8.1% in the sutured repair group) and incisional (9.7% versus 8.7%) hernia repairs but the difference between the two groups was not statistically significant. The patients with seromas were evaluated clinically, and occasionally by ultrasound. In most cases it required no treatment unless the patient feels discomfort or the collection persists in which case accumulation, was easily managed by multiple needle aspirations and usually subsided within 2-4 weeks later. Drainage of only one large infected seroma in the mesh group of incisional hernia repair had occurred, with no removal of the mesh, for which antibiotic was prescribed.

The incidence of seroma in the present study was relatively higher than those proposed by Metapurkar et al. (5%) (236) Molloy et al. (4%) (86), Lewis (6%) (210) but its incidence was lower than 14% seroma rate reported after laparoplasty using expanded polytetraflouroethylene (e-PTFE) mesh (237) and a study by Loh et al. who reported 12.7 % of seroma incidence in 79 patients with mesh repair, and 305 with sutured repair. Development of this seroma seems to be related to the large dead spaces resulting from associated dissection.
An often expected complication was post-operative infection (238). In this study, post-operative wound infection in the sutured and mesh repair groups was comparable, and mostly related to operative contamination that responded to drainage with antibiotic treatment. The late infection occurred only in few patients, usually due to persisting fluid collection.

The incidence of post-operative wound infection in this study was comparable with that in a study performed by Aziz et al (3%) (239), and with a large study of the inguinal herniorrhaphy performed annually in the United States, where infection rates were estimated to be between 3% and 4% (234), and it was lower than 12% infection rate that was expressed in Stoppa series (240), and relatively higher than the rate of infection reported by British Hernia Centre (241). The difference in rates of infection might be related to difference in minor breaks in antisepsis and aseptic procedure for the changing load of different operations done by the general surgeon when contrasted by the meticulous technique of a hernia specialist in British Hernia Centre in a closed theatre environment for hernia repair only.

In the present study, mesh was not associated with greater infection than sutured repair. This is in accordance with data from published series that did not support the contention that infection is more common in open mesh repair of hernias as compared with sutured repair (242).

Thrill and Hopkins (243), found 0.54% versus 1.2%, and the pooled Lichtenstein reports (242) support an overall infection rate of 0.03% for patch repair. Leber et al. (244) reported 5.4% of small bowel obstruction, 3.5% of entro-cutaneous fistula, and a 5.9% incidence of mesh to skin fistulas. In the current study none of these fistulas was found. The infection did not lead to the removal of the mesh in this study and most other series (122,137,208) but it was a risk factor for hernia recurrences.

4.9 Data quality control

In this clinical study, it was essential to avoid bias and to control confounding and to undertake accurate replication. These major threats to internal validity of the study
should always be taken into account. Potential sources of bias should be eliminated or minimized through rigorous design considerations and meticulous conduct of a study.

*A random error* results in an estimate of effect being equally likely to be above or below the true value. The major component of random error is sampling error. This type of error cannot be eliminated since we can study only a sample of the population, but it can be reduced to an acceptable level (245), because chance effect (random error) diminishes as sample size gets larger. In order to accomplish this goal, a suitable sample size was calculated.

**Selection bias** refers to a distortion in the estimate of the effect as a consequence of the way in which subjects are selected for the study population (246). The commonest source of selection bias could be non-well balancing and non-matching for the possible confounding variables. In order to reduce this kind of bias in this study, it was decided that risk factors should be matched in both groups, and all patients had to be allocated to treatment groups by chance through adopting a simple random sampling technique using tables of random sampling numbers. This allows the treatment groups to be balanced for known and unknown variables that may influence hernia recurrence, and response to treatment. This supposition of balanced groups is fundamental to the statistic assumptions made when analyzing comparative randomized studies.

*Information bias* arises from systematic error in measurement applied to participants. All measurements are potentially subject to error. Error in categorical measures of either the exposure or the disease status is conventionally referred to as misclassification. The effect of the bias depends upon whether the error is differential or non-differential. Where differential misclassification has occurred, bias might operate in either direction, that is, the ‘true’ strength of the association may be over- or underestimated. If misclassification is non-differential, then results will be biased towards the null. This means that the ‘true’ strength of association will be underestimated (247).
The classification of obesity as proposed by National Institute of Health Definition (179), and the Numerical Rating Score for pain have been shown to be valid and reliable for the assessment of obesity status, and pain intensity respectively in patients with herniorrhaphy. International prostatic symptom score (IPSS) had already been validated (248). These measures are simple with a higher rate of completion, particularly in a population the majority of whom has a low educational level (249). These demonstrated that misclassification was not so marked as to be likely to obscure true effects.

Interviewer bias may arise when collecting survey data. Selecting carefully the interviewers, providing a thorough training with ongoing close supervision during the fieldwork and using a highly structured interview to assess the outcome minimizes this potential problem (246). In the present study, the interviewers and assessors were selected, from physicians working in the field of surgery, and trusted by the participants. The mode of introducing the interview, collecting data, and reporting it in a preformed sheet were explained in detail. Training on the theoretical aspects was carried out, and at the end of training, role-play exercises were carried out followed by a field-training session in the clinic (page 55).

Finally, non-response bias: Certain characteristics of the study design may affect the response rate such as: the manner of the initial approach to the participant, the medium for the administration of the research interview and the burden imposed on the participant by the survey (250). Furthermore, Vikan (251) reported that low response rate could be related to less support from local authorities.

The enthusiastic support of the local health authorities from the beginning seemed to have a positive outcome on all stages of this study. A letter from them describing the project and inviting surgeons and patients to participate was very helpful. Recruiting interviewers' surgeons from the hospital workers, who were well known and trusted by the patients, to administer the questionnaires and the interviews also seemed to have encouraged patients and increased the response rate.
All measures in this study were administered in a face-to-face interview as it offers the participant the convenience of being examined at several intervals of their appointment in the surgical outpatient. The questionnaire or postal method could not have been possible because of the high illiteracy rate of participants in the study, and the likelihood that this would result in a very low response rate and selection bias. Telephone interviews may be a valuable alternative to face-to-face interviews since they offer economies in term of time saved travelling to a hospital or participant’s home, and response rates are quite high only in some settings (250) but not as effective as physical examination.

In Yemen, however, substantial proportions of the population do not have a telephone and failure to sample this group would represent a major selection bias against families with lower socio-economic status and lower educational level.

Procedures, which impose a burden on the participant, may reduce the response rate, like paying money for each outpatient clinic attendance for physical examination, excessive laboratory or radiological investigations were avoided since they were not essential in achieving the aims of this study.

**Conclusions**

1. Tension-free repairs using polypropylene mesh (PPM) are safe, effective, easy to learn, and simple to perform.

2. They have lower recurrence rates, lesser post-operative pain, lesser consumption of analgesic medication, faster return to normal activities, higher patient satisfaction rates with the results of the procedures, and no greater complications than sutured repairs.

3. The present study confirmed the superiority of tension-free mesh repairs over the sutured repairs, in the hands of general surgeons.
(4) Sutured repair, junior surgeon, and wound infection, were identified as independent risk factors for inguinal, para-umbilical, and incisional hernia recurrence. Chronic cough was an extra independent risk factor for inguinal and para-umbilical hernia recurrence. Obesity was found to be an extra independent predictor for para-umbilical and incisional hernia recurrence, while prostatism was an extra independent predictor for inguinal hernia recurrence.

(5) The cost associated with the use of a prosthetic mesh is a minor stumbling block, but long-term benefits of this hernia repair and the economic advantages ensuing from the quick return of the individual to full activity, make it the benchmark for all.

**Recommendations**

(1) Developing and implementing a multidisciplinary surgical program with expertise in the care of hernia disease.

(2) Developing a Hernia Institution, with Institutional Review Board or Independent Ethical Committee-approved hernia patient registry to promote outcomes through clinical trials in hernia repairs.
(3) Financial support by the health authorities to make available the different modern prosthetic materials to all hospitals or to all patients for acceptable price.

(4) Encouragement of surgeons to practice tension-free hernioplasties in a routine manner for all abdominal wall hernias, whatever the size, and to abandon sutured repairs, whenever possible.

(5) Continuous education and training courses for the junior surgeons about the newly developed tension-free hernioplasties to make them familial with the procedure.
References


## APPENDIX (1)

### Pre-operative data

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### Pre-operative history

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<th>b- site:</th>
<th>c. duration:</th>
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<th>c. duration:</th>
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<td>3</td>
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<tr>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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| h. Intermittency:      | 0      | 1                   | 2 | 3 | 4 | 5  |
| f. nocturea:           | 0      | 1                   | 2 | 3 | 4 | 5  |

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<td></td>
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<td></td>
<td>(b) site;</td>
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<tr>
<td>25 - Urine: pus cells;</td>
<td>(a) nill</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>26- CXR ;</td>
<td>(a) Normal</td>
</tr>
</tbody>
</table>
Upper fibrosis:
Cavities
Emphysema

27- U/S

1- Abdominal mass size; nq <10cm 10-20 cm

21-30 cm >30 cm

2- Hepat-spleno-megally + ascites; yes nq

APPENDIX (11)

Per-operative data

Serial number

Per-operative findings

28 – Type of anaesthesia S. A G.A S.A.+G.A.

29 – Type of incision

30- type of hernia found at operation: 

31 – Size of defect: for inguinal; < 2cm 2-4 cm > 4 cm
for umbilical; < 3 cm 3-5 cm >5 cm
for incisional; <5 cm 5-10 cm >10 cm

32 – Contents of the sac: bowel omentum fluids u. bladder

Appendix empty

33- Type of repair: M. Bassini Mayo - f. approximation
Intra-operative procedures

35 – Orchidectomy:  a- yes  no  b- reason of orchidectomy …………..

36 – Drain:  a- yes  no  b. duration: …………..

Intra-operative complications:

27 – Cardio-vascular: ……………………..  32. Pulmonary: ……………………..
28 – Anaesthetic: ……………………..  33. Bowel injury: ……………………..
30 - Vas injury: ……………………..
35 - Bladder injury: ……………………..
36 - bleeding: ……………………..
37 - Operative time;  hrs. ………….. min. …………..
38 - Post-operative pain:
   a- Postoperative pain/24 hrs:  yes  no
   b- Postoperative pain score/ 24 hrs:  0  1  2  3  4
5
39- Pain in 1st post-op. day: yes  no
   b- Pain score in 1st postop. day  0  1  2  3  4
5
   c- character of pain; ……………………..
39- Analgesic inj.  a- number / 24hrs: …………..  b- name ……………………..
41- Analgesic inj.  a- number till discharge………..  b- name: ……………………..
42- Oral analgesics:  a- yes  no
   b- name; ……………………..  c- number of tablets….
Immediate post-operative complications

44 - a- yes □ no □

b- Cardio-vascular & pulmonary:-

. non □ P.E. □ pneumonia □ atelectasis □

asthma □ MI □ D.V.T □ cardiac arrest □

45- Urologic: non □ . retention □ haematurea □

46- Wound: a- haematoma: no □ mild □ moderate □ severe □

b- seroma ; non □ mild □ moderate □ severe □

c- infection; non □ mild □ moderate □ severe □

d- method of treatment:............................................................

47- Testicular: a- pain: no □ mild □ moderate □ severe □

b- swelling : no □ mild □ moderate □ severe □

48-Intestinal complications:

non □ obstruction □ strangulation □

illus

49- Bleeding: no □ in the wound □ intra-peritoneal □ retro-periton.

50- Hospital stay: days □ hrs □

APPENDIX ( IV )

Post-operative follow-up

Serial number ..........

Date of visit :

1 week □ 2 weeks □ 1 month □ 3 months □ 1 year □ 2 years □

Post-operative pain

51- Pain: 1- yes □ no □

2- Site; incision □ scrotal □ infrascrotal □ thigh □
3- Score  0  1  2  3  4  5

52- Parasthesia:  a- yes  no  b- site ....................
c- severity ; mild moderate severe

53- Parasthesia : a- yes  no  b- site ....................
c- severity ; mild moderate severe

54- Analgesic & antibiotic requirement

53- Analgesic used;  a- yes  no  b- type..................... 3- no. of tablets/inj......

54- Antibiotic used:  a - yes  no  b- type:.....................

55- Diabetes mellitus; a- yes  no  b- controlled  uncontrolled

56- Liver cirrhosis& ascites;  a. yes  no  b. controlled  uncontrolled

57- Cardio-pulmonary disease;  a- yes  no  b- type....  c- cont.  non

58- Urinary disease ;  a - ye  no  b- type ....  c- con  nd

59- Wound haematoma a- yes  no

. b-severity;  mild moderate Severe

c- method of treatment ................................

60- Wound seroma :  a- yes  no

. b- severity;  mild moderate severe

c- method of treatment;.................................

61- Wound infection:  a - yes  no

b- severity;  mild moderate severe

c- method of treatment : ................................

62- U.T.I. :  a- yes  no

b- non  insign  mild  moderate severe  v.severe

63- Urine retention yes  no

64- Hydrocele :  yes  no

65- Testicular pain;  1- yes  no

2- mild moderate severe

66- Testicular swelling;=
1- yes ☐ no ☐
2- mild ☐ moderate ☐ severe ☐

67- Testicular atrophy; yes ☐ no ☐

68- Hernia recurrence; 1- yes ☐ no ☐ 2- date of noticing………..

69- Femoral hernia; yes ☐ no ☐

70- Bowel: normal ☐ obstruction ☐ strangulation ☐ ileus ☐ constipation

71- a- Fistula- yes ☐ no ☐ b- sinus ; yes ☐ no ☐

72- surgery : a- yes ☐ no ☐ b- type:……………………………

73- Death; a- yes ☐ no ☐ b- date of death;……………………

74- Time of return to social activities;……….weeks (at three months)

75- Patient’s satisfaction : (at three months)

   a- satisfied ☐ dis-satisfied ☐

   b- reason of dis-satisfied; ………………………………………..
When using the NRS for pain, the provider would ask, "on a scale of zero to 5, where zero means no pain and 5 equals the worst possible pain, what is your current pain level?"

KEY:

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-----------</td>
<td>-------------------</td>
<td>---------------------</td>
<td>----------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>none</td>
<td>v. mild</td>
<td>mild</td>
<td>moderate</td>
<td>severe</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>very severe</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(the worst possible pain)</td>
</tr>
</tbody>
</table>

Please fill in your score with the corresponding day.

<table>
<thead>
<tr>
<th>Pain Score</th>
<th>D0</th>
<th>D1</th>
<th>D7</th>
<th>D14</th>
<th>D30</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix (V1)

International prostate symptom score (IPSS)

The test contains 7 questions concerning urinary symptoms. Each question is answered with a score ranged from 0 (none or asymptomatic) to 5 (severe) indicating increasing severity of the particular symptom.

Name: ........................................ Serial number: ................. Date: ........................................

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>Less than 1 time in 5</th>
<th>Less than half the time</th>
<th>About half the time</th>
<th>More than half the time</th>
<th>Almost always</th>
<th>Your score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete emptying</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over the past month, how often have you had a sensation of not emptying your bladder completely after you finish urinating?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over the past month, how often have you had to urinate again less than two hours after you finished urinating?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Intermittency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over the past month, how often have you found you stopped and started again several times when you urinated?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Urgency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over the last month, how difficult have you found it to postpone urination?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Weak stream</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over the past month, how often have you had a weak urinary stream?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Straining</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over the past month, how often have you had to push or strain to begin urination?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>1 time</th>
<th>2 times</th>
<th>3 times</th>
<th>4 times</th>
<th>5 times</th>
<th>Your score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nocturia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over the past month, many times did you most typically get up to urinate from the time you went to bed until the time you got up in the morning?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

**Total IPSS score**

Total score: 0-7 mildly symptomatic; 8-19 moderately symptomatic; 20-35 severely symptomatic
APPENDIX (V11)

Questionnaire on methods of hernia repair

- Your answers to the questionnaire will be treated confidentially.
- It is expected from the surgeon answering the questionnaire to fill available information, and to leave unclear or unavailable data unattempted.
- It is expected that the answers are the surgeon's own figures on working experience not a group opinion.

Speciality of interest: □ general surgery □ urology □ plastic □ paediatric surgery

Surgeon experience in surgery: □ 4 years □ 4-12 years □ >12 years

The standard method of elective primary hernia repair:

For inguinal hernia is: □ Sutured repair (e.g Bassini, Shouldice ) □ Open mesh repair □ Laparoscopic mesh repair □ Sutured repair & occasionally mesh repair
If you are adopting a modified technique please write……………………
Anaesthesia used: Local □ Spinal □ epidural □ general □

For para-umbilical hernia is: □ Sutured repair (e.g. Mayo) □ Open mesh repair □ Laparoscopic mesh repair □ Sutured repair & occasionally mesh repair
If you are adopting a modified technique please write……………………
Anaesthesia used: Local □ Spinal □ epidural □ general □

For incisional hernia is: □ Sutured repair □ Open mesh repair □ Laparoscopic mesh repair □ Sutured repair & occasionally mesh repair
If you are adopting a modified technique please write…………………..
Anaesthesia used: □ Local □ Spinal □ epidural □ general □

Type of mesh used
□ Pure polypropylene (PP) □ e-polytetrafluoroethylene □ Polyvinylidenfluoride + P.P. □ Polyester □ □ □
<table>
<thead>
<tr>
<th>Type of suture used</th>
<th>Polypropylene</th>
<th>nylon</th>
<th>vicryl</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>□ Silk</td>
<td>□ chromic catgut</td>
<td></td>
</tr>
</tbody>
</table>

Antibiotic used:
- □ Prophylactic
- □ single inj.
- □ Two inj.
- □ Three inj.
- □ Treatment duration
- □ No antibiotic used

<table>
<thead>
<tr>
<th>Estimation of recurrence rate of the standard method:</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Published data OR □ Non-published data</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment duration</th>
<th>Inguinal</th>
<th>Para-umbilical</th>
<th>Incisional</th>
</tr>
</thead>
<tbody>
<tr>
<td>sutured repair</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>open mesh repair</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>laparoscopic mesh repair</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
</tbody>
</table>

Post-operative complications of the favorite repair:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Inguinal</th>
<th>Para-umbilical</th>
<th>Incisional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haematoma</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>seroma</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>wound infection</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Mesh infection</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Persistent pain</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Chr.residual neuralgia</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Stitch abscess</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Sinus</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>fistula</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Mesh erosion</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Others</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
</tbody>
</table>

Surgeon attitude towards mesh repair:
- □ Satisfied
- □ Non-satisfied
- □ very satisfied
- □ not practicing

Reasons of dis-satisfaction:
- □ Fear of infection
- □ Rejection
- □ High hernia recurrence
- □ High cost of mesh
- □ Insufficient experience

References:

........................................................................................................................................................................

........................................................................................................................................................................

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APPENDIX (VIII)

What are the standard methods of repair of inguinal, para-umbilical, and incisional hernias in North Africa and Arab States?

Saleh Bin Tayair, Yahia Arabi

Abstract

Background

The standard methods of abdominal hernia repairs in North Africa and Arabic States are not clearly defined. The aim of this study is to know the place of mesh and sutured repairs in these countries.

Method:

A questionnaire on methods of hernia repair was sent to the surgeons in selected countries of North Africa and Arabic States in order to answer questions on the standard methods of inguinal, para-umbilical and incisional hernia repairs, on their own figure on working experience. The surgeons were categorized according to years of experience in surgery into 3 levels: L1 surgeon: < 4 years, L11 surgeons: 4-12 years and L111 surgeons: > 12 years experience in surgery.

Results

A total of 406 surgeons participated in the questionnaire. Level 111, and L11 surgeons constitute 76.6 % of all the participants. Sutured repair is the commonly practiced method for inguinal (68.2 % versus 18.5 %) para-umbilical (73.4 % versus 13.4%) and incisional (54.6 % versus 17.1%) hernias, with trend towards mesh repair in selected cases. The majority of surgeons are satisfied with mesh techniques (63.3%), while 26.4% are not practicing mesh repairs and, 10.3% are not satisfied due to the following reasons: fear of mesh infection and rejection, insufficient experience, and high cost of mesh

Conclusion:
Sutured repairs are still the standard techniques in the repair of inguinal, umbilical and, incisional hernias in most of North Africa and Arabic states, with trend towards mesh repair in selected cases.

Full Text

Background

Abdominal wall hernias are among the most common of all surgical problems today, with a local defect which has to be closed technically, either under tension by sutures \(^{(1,2)}\) or in a modern time with tensionless mesh. \(^{(4)}\) In Africa and Arabic States, the standard methods of abdominal hernias are not clearly defined. The aim of this study is to know the place of mesh and sutured repairs in these countries.

Method:

A questionnaire on methods of hernia repair was sent to surgeons at Yemen, Sudan, Saudi Arabia, Egypt, Bahrain, Jordan, and Quait. The questionnaire contains parameters to answer the following questions: surgeon experience in surgery, the standard methods of inguinal, umbilical and incisional hernia repairs, Anaesthesia adopted in these operations, type of mesh and suture used for repair or fixing the mesh, use of antibiotic, satisfaction with the mesh repair, and reasons of dissatisfaction. The answers were the surgeon’s own figures on working experience. The surgeons were categorized according to years of experience in surgery. \(L_1\) surgeon: < 4 years, \(L_{11}\) surgeons: 4-12 years and \(L_{111}\) surgeons: > 12 years experience.

Results
A total of 406 surgeons participated in the questionnaire. The majority are from Yemen (186, 45.8%), and Sudan (76, 18.7%), (Figure 1). Level L11, and L1 surgeons constitute the majority of all the participants (L11 37.9%, L1 38.7%, and level L1 surgeons 23.4%), (Figure 2).

In Yemen, the commonly practiced method of hernia repair is sutured technique, in inguinal (81.7%), umbilical (82%) and incisional (63.1%) hernias, while mesh repair is practiced by only 6.4% of surgeons for inguinal, 5.5% for umbilical and by 10.6% for incisional hernia treatment with a tendency of other surgeons to practice sutured repair mainly and mesh repair is reserved for difficult or big hernias of inguinal (11.8%), umbilical (12.1%), and incisional (26.3%). Of the mesh repair, laparoscopic technique is performed by only 0.5% in each of inguinal and incisional hernias.

In Sudan, sutured repair is the standard method in inguinal (63.2%), umbilical (76%) and incisional (43.4%) hernias, while mesh repair is the standard by 11.8% of surgeons for inguinal, 13.3% for umbilical and 17.1% for incisional hernias. The surgeons, who are treating hernia with sutured repair or mesh repair in selected cases, constitute 25%, 10.7% and 30.2% for inguinal, umbilical and incisional hernias respectively.

In Egypt, sutured repair is reported by 77.1% of surgeons for inguinal, 73.9% for para-umbilical and 64.4% for incisional hernias, while mesh repair technique is practiced by 23.9%, 17.8% and 20% for inguinal, umbilical, and incisional hernias respectively. Of the mesh repair, laparoscopic technique is performed by 2.2% in each of umbilical and incisional hernia repairs, and 15.6%
of surgeons are practiced sutured repair and mesh repair in selected cases of inguinal hernias.

In Jordan, for inguinal hernias; sutured repairs are reported by 61.8% of surgeon, while mesh repair by 14.7%, and sutured or mesh repairs for selected patients by 23.5%. For umbilical hernias; sutured repair is the surgical treatment by 44.1%, mesh repair by 29.4%, and sutured with mesh repairs in selected patients by 26.5%. For incisional hernias; sutured repair is the standard by 41.2%, mesh repair by 32.3 % and sutured with mesh repair in selected patients by 26.5%. In contrast, in Bahrain, for inguinal hernias; mesh repair is the standard operation by 41.9%, sutured repair by 35.5%, and sutured with mesh repair by 22.6 %, while sutured repairs are common for umbilical (69.3 % versus23.8%) and incisional (41.4 % versus 27.6%) hernias (Table 1).

In Saudi Arabia, mesh (40.7%) and sutured (44.5%) repairs are nearly similarly practiced for only inguinal hernias, while for umbilical and incisional hernias, sutured methods are commonly practiced by 60 % versus 20 % and 56 % versus 12% respectively. Those who are using mesh repair in selected patients constitute 14.8 % for inguinal, 20 % for umbilical and 32 % for incisional hernias. Of the mesh repairs, laparoscopic technique is performed by 4 % in each of the para-umbilical and incisional hernias. Unfortunately, the number of participating surgeons from Quait is too small (4 surgeons, 1%) and is not representative (Table 1).

Of all the participant surgeons (406), sutured repair is the standard method for inguinal (68.2 % versus 18.5 %) para-umbilical ( 73.4 % versus 13.4% ) and
incisional (54.6 % versus 17.1%) hernias (Table 2). For those surgeons who are using mesh surgery repair, polypropylene mesh is the one of choice by more than half (53%), (Figure 3). Nylon suture is the preferred suture by most surgeons (52.2%), while propylene and vicryl are used by 18.0% and 17% of surgeons respectively, (Figure 4).

Antibiotic is prescribed as prophylactic by 10.8% in both types of repair, and by 37% only in the presence of mesh. Of the prophylactic antibiotic, 25.6% of surgeons used a single dose, and 22.2% three doses Treatment antibiotic is prescribed by 30.0% , no antibiotic by 10.3%, and combined prophylactic and treatment antibiotic in the presence of mesh by 9.4. The antibiotic treatment continued for 3 days by 27.9%, five days by 54.9%, and > 5 days by 17.2% , (Figure 5).

With regard to the attitude of surgeon to ward mesh repair, 66.4% of surgeons are satisfied with the mesh techniques and, 33.4% are not satisfied due to the following reasons: fear of infection and rejection (18.2%), insufficient experience (7.7%), high cost of mesh (4.2%), and seroma (2%). In 1.5% no data available (figure 6).

Conclusion:

Sutured repairs are the most commonly practiced methods for inguinal, umbilical and, incisional hernias in Yemen, Sudan, Egypt, and, Jordan with a trend towards mesh repair in selected cases. In Bahrain and Saudia Arabia, mesh repairs are commonly practiced for inguinal hernias only, while sutured repairs are still the common methods for umbilical and incisional hernias.
References


<p>| Table (1) The standard methods of inguinal, para-umbilical, and incisional hernia repairs by countries |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| country                  | Type of hernia | Sutured repair | Open mesh repair | Sutured &amp; mesh repair | total           |
| Yemen                    | Inguinal       | 152 (81.7%)    | 11 (5.9 %)       | 22 (11.8%)       | 186(100%) |
|                         | Umbilical      | 150 (82.0%)    | 10 (5.5 %)       | 22 (12.1%)       | 182(100%) |
|                         | incisional     | 113 (63.1%)    | 18 (10.1%)       | 47 (26.3%)       | 179(100%) |
| Sudan                    | Inguinal       | 48 (63.2%)     | 9 (11.8%)        | 19 (25.0%)       | 76 (100%) |
|                         | Umbilical      | 57 (76.0%)     | 10 (13.3%)       | 8 (10.7%)        | 75 (100%) |
|                         | incisional     | 33 (43.4%)     | 13 (17.1%)       | 30 (39.5%)       | 76 (100%) |</p>
<table>
<thead>
<tr>
<th>Type of Hernia</th>
<th>Sutured</th>
<th>Mesh</th>
<th>Sutured/mesh</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inguinal</td>
<td>277 (68.2%)</td>
<td>75 (18.5%)</td>
<td>54 (13.3%)</td>
<td>406 (100%)</td>
</tr>
<tr>
<td>Para-umbilical</td>
<td>290 (73.4%)</td>
<td>53 (13.4%)</td>
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<td>395 (100%)</td>
</tr>
<tr>
<td>Incisional</td>
<td>214 (54.6%)</td>
<td>67 (17.1%)</td>
<td>111 (28.3%)</td>
<td>392 (100%)</td>
</tr>
</tbody>
</table>

The percentages are calculated from the total number of each method.
Fig. 1 Percentage of participants by country

Fig. 2 Experience of the participating surgeons
Fig. 3 Types of mesh used in hernia repair

e-PTFE: polytetrafluoroethylene. PVDF: polyvinylidene fluoride
NDA: no data available

Fig. 4 Types of sutures used in the repair of inguinal, umbilical, and incisional hernias

NDA: no data available. PP: polypropylene
Fig. 5 Use of antibiotic in hernia repair
NDA: no data available

Fig. 6 Surgeons' attitude towards mesh repair
NDA: no data available
APPENDIX (1X)

A comparison of tension-free and sutured repair of inguinal hernias.
A paper presented at 36th International Conference of Sudan Association of Surgeons. 2008 April 1-3

Introduction.

Inguinal hernia repair is a frequent operation, performed by the general surgeon today (1). Numerous methods have been described for the repair of inguinal hernia defect. Tissue repair: is associated with undue tension, at the suture line, which leads to higher rate of recurrence (2,3), up to 15% in most series, and in others up to 33% (4). Mesh repair, is promising (5), but most studies were retrospective, case series, small sample size, or short follow-up (6-10). Overall, in North Africa & Arabic States sutured repair is still the standard method by 68.2% of surgeons. Mesh repair is restricted for large and recurrent hernias (11).

Table 1 The standard method of repair of inguinal, umbilical and incisional hernias by the total participating surgeons

<table>
<thead>
<tr>
<th>Type of hernia</th>
<th>Sutured</th>
<th>Mesh</th>
<th>Sutured/mesh</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inguinal</td>
<td>277 (68.2%)</td>
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The percentages are calculated from the total number of each method

Aim of the study.

Was to compare the outcome of tension-free repair, and sutured repair, in primary inguinal hernia, in terms of, recurrence.
Patients & methods.

This was a randomized controlled study, carried out on 403 patients having primary inguinal hernias, at two main hospitals in Hadhramout, Yemen, between September 2004 and December 2007. After matching of risk factors of hernia recurrence, the patients were randomly allocated to either Lichtenstein mesh repair (n=202), or Modified Bassini sutured repair (n=201).

Any patient above 18 years, who presented with clinically diagnosed inguinal hernia, fit to receive spinal anaesthesia, and gave informed consent, was included in the study.

Exclusions were: previous hernia repair, American Society of Anaesthesia score 4 or 5, emergency operation, and severe local or systemic infection.

The participating Surgeons were classified into three levels according to the years of experience: Level 1; < 4 years, Level 11; 4-12 years, and Level 111; more than 12 years. The patients were assessed at regular intervals, for a period of 3 years, by physical examination.

Technique:

The trial protocol requires patients having mesh repair and sutured repair. The patients who assigned to mesh repair underwent Modified Lichtenstein technique (n= 202), and those who assigned to sutured repair, underwent Modified Bassini repair (n=201).

Fig. 1 shows Modified Lichtenstein Repair as described by Amid. The method consists of; complete reinforcement of the inguinal canal floor, with a large sheet of Light weight polypropylene mesh, with adequate tissue mesh interface beyond the boundaries of inguinal floor, and creation of a new internal ring made of prosthesis. The mesh was fixed using loose continuous 2/0 prolene suture.
Care was taken to keep the mesh slightly relaxed, to compensate for increased intra-abdominal pressure, and future mesh shrinkage.

Fig. 1  Lichtenstein tension-free repair as described by Amid.
Results:

The demographic characteristics of patients and hernias & the prognostic factors of hernia recurrence were similar. The 3-year cumulative rate of recurrence was 1.5% for the patients in the mesh repair group, and 10.5% for the patients in the sutured surgery group. The difference was statistically significant, p<0.001.

In fig. 3, Kaplan-Meier Curves analysis was used to compare the mesh and sutured groups on their non-recurrence. It plots the percentage of patients without recurrence and the time (in months) after surgery. The curves are expressed as series of horizontal steps with a declining magnitude. Each patient's recurrence is clearly visible as a downward step in the curve. The small vertical marks indicate cases when patient's data has been censored. After a follow-up of 3-years, the patients in the sutured group develop recurrences more quickly than those in the mesh group, establishing the efficacy of mesh repair over sutured repair.
Figure 2: Kaplan-Meier Curves for non-recurrence of hernia after repair of primary inguinal hernias according to whether the patient was assigned to sutured repair (n=201) or mesh repair (n=202). The p value for the difference in the rates of recurrence between the two groups was <0.001 by log rank test.

The results of multivariate analysis, of the prognostic factors of hernia recurrence, identified sutured repair, junior surgeon, wound infection, chronic cough, & prostatism, as independent predictors for inguinal hernia recurrence (Table 2).

Table 2: Multivariate analysis of prognostic factors for recurrence in inguinal hernia repairs

<table>
<thead>
<tr>
<th>Variables</th>
<th>P value</th>
<th>HR**</th>
<th>95% CI of HR</th>
</tr>
</thead>
</table>

251
<table>
<thead>
<tr>
<th></th>
<th>HR**</th>
<th>95% CI</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sutured repair</td>
<td>0.001</td>
<td>7.32</td>
<td>2.63 – 16.24</td>
</tr>
<tr>
<td>Junior surgeon</td>
<td>0.001</td>
<td>4.4</td>
<td>3.15 – 5.18</td>
</tr>
<tr>
<td>Wound infection</td>
<td>0.01</td>
<td>3.11</td>
<td>2.9 – 24.7</td>
</tr>
<tr>
<td>Prostatism</td>
<td>0.03</td>
<td>2.5</td>
<td>1.12 – 9.53</td>
</tr>
<tr>
<td>Chronic cough</td>
<td>0.04</td>
<td>2.7</td>
<td>1.23 – 19.12</td>
</tr>
</tbody>
</table>

HR**: denotes Hazard ratio.  95% CI*: 95 percent confidence interval.
Multivariate analysis was performed by Cox- regression test.

Figure 3: shows the relative hernia recurrence, of each level of surgeons, in the sutured and mesh repairs of inguinal hernias. With Level 1 surgeons, the recurrence rate was 6.5% in the mesh group, and 1% in the sutured group, while with L 111, it was 1.5% in the sutured group and 0.5% in the mesh group. The difference is statistically significant (p < 0.001). Furthermore, L11 developed recurrence of 2.5% in the sutured group, and 0.5% in the mesh group, indicates recurrence rate is high in the young surgeons, and tends to fall with years of experience.

Pain score: after surgical repair, seemed to be significantly greater in the sutured group, than in the mesh group. The difference was statistically significant, (p< 0.001). The time to return to normal activities, was significantly shorter in the mesh group (16.2 ± 8.3 days), as compared to the sutured group (20.8 ± 11.3 days), which was statistically significant, p<0.001.

Overall, the patients who had mesh repair were significantly more satisfied with their procedures (94.5%) compared with those who had sutured repair (60.7%), p<0.001.
Finally, operative time (45. vs. 43.1 min.) hospital stay (1.9 vs. 2.09), and complications: were comparable in both groups, except, chronic post-operative pain was significantly greater in the sutured repair group than the mesh group, (4% vs. 12.4%, p<0.001)

Conclusion
Tension-free mesh repair is safe, effective method, if correctly performed. It has a: lower recurrence rate, lesser post-operative pain, faster rehabilitation. Tension-free mesh repair has shown the superiority over the sutured repair, even in the hands of general surgeons.

Fig. 3  Relative hernia recurrence of each level of surgeon in the sutured and mesh repairs of inguinal hernias

References


