OSTEOARTHRITIS OF THE KNEE IN KHARTOUM TEACHING HOSPITAL

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A Descriptive Prospective hospital-based Study conducted at Orthopaedic Outpatient Department, Khartoum Teaching Hospital
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بسم الله الرحمن الرحيم

(قل لربِّي زدني علماً)

حيم
DEDICATION

TO MY PARENTS

FOR PROVIDING ME WITH THE GREATEST GIFT ANYONE COULD EVER ASK FOR .....
Acknowledgement

I would like to offer Dr Abdelrahim my deepest gratitude for the guidance he offered to me and the patience he had with me in completing this work.

I would also like to acknowledge the support provided to me by Mr. Hisham and Ms. Randa and all the help they provided.

Finally I would like to thank all those at Khartoum Teaching Hospital who made my work possible, from all the fellow colleagues through the outpatient staff and through to the patients themselves without whom none of this would be possible and to whom I wish that any benefit is to come out of this and other studies it will be for them.
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## Abbreviations

<table>
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<tr>
<td>OA</td>
<td>Osteoarthritis</td>
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<tr>
<td>AC</td>
<td>Articular Cartilage</td>
</tr>
<tr>
<td>RA</td>
<td>Rheumatoid Arthritis</td>
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<tr>
<td>BMI</td>
<td>Body Mass Index</td>
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<tr>
<td>ECM</td>
<td>Extracellular Matrix</td>
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<tr>
<td>MMP</td>
<td>Metalloprotease</td>
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<tr>
<td>NO</td>
<td>Nitric Oxide</td>
</tr>
<tr>
<td>HRT</td>
<td>Hormone Replacement Therapy</td>
</tr>
<tr>
<td>ACR</td>
<td>American College of Rheumatology</td>
</tr>
<tr>
<td>TKR</td>
<td>Total Knee Replacement</td>
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<tr>
<td>NSAID</td>
<td>Non Steroidal Anti Inflammatory Drug</td>
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<td>NHANES</td>
<td>National Health And Nutritional Examination Survey</td>
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Abstract

Patients and Methods: This is a descriptive prospective study conducted in the orthopaedic outpatient department of Khartoum Teaching Hospital during the period from 1\textsuperscript{st} July 2002 and 30\textsuperscript{th} June 2003. 100 consecutive patients aged 40 and above and diagnosed as having osteoarthritis of the knee by either clinical or radiological methods were selected and interviewed, examined and their X-rays viewed and graded according to the Kellgren Lawrence Scale. The data was entered into a questionnaire.

Results: there were 69 females and 31 males aged between 40 and 84. The mean age of the men (65.5 years /SD 9.72) was higher than that of women (57.9 years /SD 10.58)and the mean Body Mass Index was lower than that for women but both these were statistically insignificant. The right knee was affected in more than half the patients (52) with one fifth (20 patients) having bilateral affection. 11 patients have been symptomatic for more than five years. The commonest signs were knee tenderness (65%) and crepitations (62%) while 48 had knee varus deformity. 22 patients had a Kellgren Lawrence radiological grade less than II

Conclusion: OA knee is a common disorder with sex age and weight the most important risk factors. Patients suffer disability at home with toilet usage and prayer causing the most problems. Patients can be symptomatic without having positive radiological signs of OA.
ماخص الطرحوة

قد تمت دراسة مستقلة و العلمية أجريت في القسم العلمي في المدرسة الأولى. ليلة من يوليو 2002 وحتى الاثنين من يوليو 2002 تم فحص عدد مرضى تجاوز عمرهم 30 سنة. تم تشخيص المرضى بالقضية (أبحاث علمية) بطريقة كيميائية أو بصور الأشعة. تم معاينة المرضى والمريضية و مراجعة صور الأشعة و تم تقدير تلك

يتم تشخيص المفاصل الصدرية ب sistem كلاً من لودر لودر. ينتمي متوسط اعجازهم من الأربعة وحتى الثلاثين. والثاني عند المرضى 96 من الإناث و 13 من الذكور. يتراوح

نسبة مجموع 58٪. ينخفض معيار 57٪. متوسط اعمار الإناث 9.7 سنة بانحراف معياري 65.5 اعمار الذكور.

البندع للذكور كان ادنى من ذاتها للإناث ولكن الفرق لم يكن هام إحصائياً من و 02 شكو من الركبة تم 11 مريضاً شكو من أعراض يلياً تعقدنا تم ولد و عرضنا 52

التحسن لأكثر من خمسة سنوات. أكثر العلامات المرتبة كانت الإبل الذكر الرئيسي 36 حالة. و مفاصل 26 حالة. و 84 من المرضى كانوا يعانون من انحراف الركبة إلى الداخل. 22 من المرضي

كانت تقييم صور الأشعة لديهم أقل من 2

اختبار

المفاصل المعتاد أو مفصل الركبة في مفصل الركبة من الهولوس المعدة. ولها الورق والوزن لدى المرضى، و هي يعانون كثيراً و يسبب لهم عجز بالأخير. في الاستماع ض ضر الحساس. فيها بعض الحالات قد تكون هنالك علامات ظاهرة في صور الأشعة دون أن يشكو المري

او العكس.
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Chapter 1

Introduction & Literature Review
1.1 Introduction

Osteoarthritis is a disease of joints. It is the commonest joint disorder worldwide and is a major cause of disability especially among the elderly. It is so common in fact that it has been said that if all people live long enough they will suffer from it someplace in their bodies.

The American College of Rheumatology has defined it as "a heterogeneous group of conditions that lead to joint symptoms and signs which are associated with defective integrity of articular cartilage in addition to related changes in the underlying bone and joint margins" (1). The name Osteoarthritis (OA) contains the suffix –itis which suggest an inflammatory disorder but this is untrue as it is mainly a degenerative condition with inflammation playing but a minor role. This confusion with the nomenclature and the disease process itself has given rise to several different names for the disorder including Osteoarthritis Osteoarthrosis, Hypertrophic Arthritis, Degenerative Arthritis and Degenerative Joint Disease (2).

It is classified into two main groups. The commonest by far is Primary OA which occurs without any prior joint condition and is also been called Idiopathic OA it affects the elderly population and its incidence increases with age as well as affecting a wide range of joints affecting multiple sites at the same time. It affects both small and large joints with the interphalangeal joints of the hand
and the joints of the cervical and lumbar spine commonly affected. The commonest large joints affected are the knee and the hip joints in that order (1,3).

Secondary OA is much less common and as its name implies usually the joint affected has had some form of insult or injury. Both local and systemic factors affect it, local such as trauma, malalignment, infection or haemorrhage and systemic factors such as inflammatory, immunologic or metabolic disorders. The age of onset also differs as those affected may be much younger as this is determined by the prior joint abnormality (2).

OA is a disease of the elderly and middle-aged. Its prevalence varies with age group involved affecting up to forty percent of those in the fifth decade and rising to afflict up to seventy five percent of those beyond seventy years of age (4). It is important to note that most of these figures come from radiological surveys but at least half of those with radiological signs are asymptomatic (5). Most of these studies were conducted in the United States of America and Western Europe but studies from other parts of the world also show a similar degree of affection making it a global disease (3).

It affects both sexes but females seem to be affected at a slightly younger age with a sharp rise in incidence around the menopause. Females also have a
slightly different pattern of joint affection suffering from generalized OA as well as more hand and knee OA than males who are affected with more hip OA (4). Other factors which affect the incidence of OA include Family history and Genetic Background (6), smoking joint usage (7) and in the weight bearing joints especially the persons bodyweight (8).

The diagnosis of OA depends on both clinical and radiological findings although clinical findings alone may suffice. The symptoms are joint pain in a patient above fifty years of age associated with joint stiffness either on waking up or after a period of inactivity as well as joint crepitus (1). This period of inactivity should not last for longer than half an hour as a longer period of morning stiffness would suggest Rheumatoid Arthritis (1,9). If the patients are from younger age group additional radiological evidence is required. The radiological hallmark of OA is new bone growth commonly at the margins of joints which are the osteophytes. Other radiological changes found in OA are narrowing of the joint space, subchondral sclerosis and subchondral cyst formation (2). Late changes which can occur are bony swelling due to the osteophytes, deformities due to both bone and cartilage loss and capsular and muscle contraction as well as muscle wasting. Inflammation which is uncommon can occur late in the disease process in the form of synovitis.
Primary OA requires some factors to develop. Of these increased mechanical stress is quite common and can occur in both weight bearing and non weight bearing joints. In manual labourers OA of the hands is fairly common and obese or overweight individuals have a higher rate of incidence of knee OA. Participation in sports also increases the risk of developing OA of the knees and hips and particularly with long duration high frequency weight bearing exercise such as running (8). People with a strong family history are highly susceptible as studies have shown the presence of genetic factor involved in the development of the disorder especially generalized OA (6,10). Patient suffering from Osteoporosis have lower rates of OA and conversely people with a high Bone Mineral Density have higher rates of OA. This could be attributed to the fact that in the latter case the stronger subchondral bone predisposes to the development of OA (8,11) and the softer more deformable bone in the former case does not.

OA is a leading cause of disability especially among the elderly with up to eighty percent of its sufferers having some limitation of movement and almost a quarter of sufferers unable to perform daily life activities (12). There is a huge loss of working hours and the cost of treatment is high; the United States of America alone spent 82.4 billion dollars on OA in 1995 (12). This huge cost falls both on the healthcare system and on the individuals themselves and it is expected to rise due to the aging population. As life expectancies increase the impact of the disease increases and for this reason among others the WHO and the UN have
declared this decade, the first of the new millennium as The Bone and Joint Decade (12). Research into all aspects of bone and joint disorders will be sponsored with a view to prevention and reducing the costs and suffering to the affected individuals.

The knee joint is the commonest large joint affected by primary OA. It affects the elderly population and all races are affected though there is a higher incidence in Negroid races (8,13). The reverse is seen in hip OA which affects Europeans more. Diagnosis is by both clinical and radiological evidence as almost half of those with radiological changes are symptomless. Radiological surveys show higher figures than studies that include clinical evidence and when both were combined prevalence rates were even lower. OA of the knee has a slight female preponderance as well as affecting the overweight (5,8,13,14).

As yet there is no cure for OA with treatments aiming at reducing the symptoms and the disability it causes. The only viable treatment is joint replacement especially for late cases.

OA Knee is a common problem in orthopaedic clinics where patients come complaining mainly of the pain and stiffness. As yet there has been no local study into the disease and no common policy on how the patients should be
managed. There is also no established unit especially designed to meet their needs. Surgical options are limited and it is only recently that joint replacement has been offered locally. Patients needed to travel abroad to perform this procedure which for some could be their best chance to lead a somewhat normal pain-free active life. The purpose of this study is to shed some light on these patients and the disability they suffer.
1.2 Literature Review

1.2.1 Anatomy

The knee joint is the largest joint in the human body. It forms the junction of the thigh and leg and is therefore between the femur and tibia. It is a complex synovial joint of the hinge type. It is composed of three separate functional compartments, two large medial and lateral compartments and a smaller anterior compartment. The medial and lateral compartments are between the femoral and tibial articular surfaces and the anterior one is between the anterior part of the femur and the patella. This arrangement is the developmental arrangement where the three compartments are divided by fibrous septae.

The Articular surfaces of the femur are the condyles and are two corresponding to the tibial plateau, which is divided into two parts by a median eminence. This configuration corresponds to the more primitive mammalian arrangement in which the knee joint is divided into two separate joints. The femoral condyles are convex in shape curving more posteriorly with medial condyle more so. They are divided centrally by the inter condylar groove or notch which deepens as it curves posteriorly. This corresponds to the median tibial eminence. They are completely covered by articular cartilage. The tibial plateaus are almost completely flat being only slightly hollow centrally and curving downwards slightly posteriorly. The lateral tibial articular surface or condyle as it has been
referred to is circular while the medial condyle is oval having its antero-posterior diameter as the longer (15).

As such the joint structure has little inherent stability with the joint surfaces almost completely incongruent. The stability is imparted upon the joint by the muscles, the capsule and the intra and extra-articular supporting structures.

The muscles acting on any joint play a major stabilizing role on that joint. The knee joint is not different on the contrary it requires even more stability due its shape and position. The muscles acting on it provide it with great stability while performing their specific functions. Anteriorly the knee is supported by the strong knee extensor the quadriceps femoris, which is one of the strongest muscles in the body. Posteriorly the knee is supported by a large group of muscles these are the hamstrings from above and the gastrocnemius from below. On either side there is not much support for the joint but the two heads of the gastrocnemius rise to be attached to the femoral condyles, the medial head is attached posteriorly and the lateral head is attached to the lateral side of the lateral condyle thus adding a slight contribution to lateral stability. Other muscles aiding stability across the knee joint are the tensor facia latae and the iliotibial band on the lateral side.
The capsule of the knee joint in itself is not strong but it receives reinforcing fibres from the extra-articular ligaments and tendons. Anteriorly lies the patellar tendon centrally, with reinforcements from both medial and lateral sides by the patellar retinacula from the vastus medialis and vastus lateralis muscles respectively. Medially the capsule is reinforced by the medial collateral ligament and laterally by the corresponding lateral collateral ligament. Posteriorly the reinforcement comes from the oblique and arcuate popliteal ligaments.

The intra-articular elements involved in joint stability are the menisci and the cruciate ligaments. The two menisci, medial and lateral, lie peripherally on the surface of the tibial plateaus. They are semicircular in shape and triangular in cross-section. The marginal border is wider as the base of the triangle and is somewhat fixed to the edge of the plateau with the medial meniscus also being attached to the medial collateral ligament. The lateral meniscus is much less fixed being separated from the lateral collateral ligament by the tendon of the popliteus muscle. The menisci are tapered towards their apex in the centre where their inner margin is relatively free. The lower surface is flattened to rest on the tibial plateaus whereas their upper surface is concave to fit the femoral condyles.

The menisci of the knee joint have varying functions vital for proper knee joint functioning. They distribute forces throughout underlying articular cartilage, thus
minimizing point contact; menisci bear 40 to 50% of the total load transmitted across joint in extension and 85% of the compressive load transmitted through the menisci at 90 deg of flexion; They also account for up to sixty percent of the weight bearing surface of the joint (16). They have a minor role in the distribution of the synovial fluid and nutrition of the joint. Other important functions of the menisci include shock absorption due to the circumferential arrangement of its collagen fibres which reduce point contact (16) as well as added stability to the joint by their attachment to capsular ligaments.

Despite the menisci deepening the surface of the tibial articulation this cannot prevent gliding of the femur on the tibia. This is achieved mainly by the cruciate ligaments, which are a pair of strong bands running between the two bones and strongly attaching to them. They are named according to their attachment on the tibial surface, in the inter-condylar area. The anterior cruciate ligament arises from the anterior part of the inter-condylar area and rises superiorly and curves posteriorly and laterally to be attached on the medial surface of the lateral femoral condyle. Its main function is to prevent hyperextension of the knee as well as preventing the posterior gliding of the femur on the tibia. The posterior cruciate ligament arises behind its fellow and curves anteriorly and medially as it ascends to be inserted into the lateral surface of the medial femoral condyle. Its main function is to prevent the anterior gliding of the femur on the tibia. The anterior cruciate ligament is taught in flexion whereas the posterior cruciate
ligament is taught in extension. The two ligaments reciprocate each other and thus provide the stability required for the knee to perform its function adequately (15).

The anterior compartment of the knee joint is the patello-femoral joint between the anterior surface of the condyles and the posterior surface of the patella. The patella is a sesamoid bone in the tendon of the quadriceps femoris and is an essential part of the extensor mechanism of the knee joint.

In its position in the middle of the lower limb the knee is involved in all upright activities in the human. Its tibio-femoral component is a major weight bearing joint and its surface is therefore needed to withstand a large static force. It is understandable therefore that the functional axis of the lower limb must pass through its center. The arrangement of the skeleton is such that the longitudinal axes of the shafts of the femur and tibia do not align exactly, there is a small angle between the two. The femur is attached to the axial skeleton at the hip joint slightly away from the centre due to fact of the presence of the pelvis. It therefore has to descend medially to meet the tibia, which are upright. Thus a slight valgus angle is made between the two bones. This angle is on average seven degrees (17). The functional axis of the lower limb therefore does not pass along the femur but from the head of the femur directly down to meet the femur again in the mid point between the two condyles at the knee joint. The bones at
the joint surface are not exactly flat but are tilted slightly. The medial part of the femur is slightly lower than the lateral and there is a corresponding tilt in the tibial plateau. This slight tilt is about three degrees (18). This arrangement causes the medial compartment to bear a larger proportion of the body weight than the lateral.

The knee joint is not a simple hinge joint but it possesses a complex range of motion other than simple flexion and extension. There is also a slight rotational element near the end of extension as the knee is straightened. This rotation involves the femur medially rotating on the tibia to thus lock it in the fixed fully extended position. It is facilitated by the shape of the medial tibial plateau and is known as the ‘screw home’. The reverse of this movement occurs as the knee is flexed with the femur laterally rotating to unlock the knee. This active range of rotation involves the politeus muscle in part and ranges between twenty and thirty degrees. This locking of the knee joint is needed for its role in static function of the limb. The knee also allows some passive rotation, both medially and laterally of about sixty degrees as well a small passive range of abduction and abduction. All these passive movements can only occur when the knee is in flexion and thus free.

The main motion of the knee joint is flexion and extension and it is this range along with the associated muscles that allows the knee to play a major role in
propulsion and thus movement of individuals. This range varies according to the position of the hip and other forces governing the knee. The normal range with the hip extended is about one hundred and twenty degrees. A further twenty degrees can be added with the hip flexed and a further twenty when a passive component is added such as kneeling or squatting using the body weight to increase the range. The knee can also hyper extend slightly but only about five or ten degrees (18).

The alignment of the knee joint with slight valgus angulation and the medial condyle of the femur being slightly lower than the lateral determines that a larger portion of the force acting through the knee joint goes through the medial compartment of the knee joint. As the alignment of the knee joint is shifted either towards a varus angulation or a valgus angulation the line of force is also shifted causing redistribution either medially or laterally respectively. There is some individual variation in the alignment as certain populations may normally have slight valgus or varus knees. The differences in alignment may predispose to the development of degenerative changes earlier than expected by the age of the individual alone (17).
1.2.2 ARTICULAR CARTILAGE

Joints require a highly specialized surface to allow for the performance of their functions. In synovial joints this surface is the Articular Cartilage (AC) which provides a wear resistant low frictional lubricated surface for easy movement over a similar surface but also able to absorb large forces of compression and shear generated by gravity and muscular power (19). It is a hyaline cartilage covering the articulating ends of the long bones and its thickness is variable being on average two to four millimeters but can be as much a seven millimeters in young active adults (19,20). This variation in thickness depends on the ability of the AC to adapt to the stresses as seen in individuals of greater mass who have thicker layer of cartilage to resist the greater load on it. The thickness also depends on the joint-loading being thickest at the knee joint and thickest at incongruent joints to distribute the forces on it more evenly (21).

The AC is composed of a ground substance, the Extra Cellular Matrix (ECM), and a cellular component, the Chondrocytes. The matrix is mainly water with structural macromolecules which are either collagenous or non-collagenous (22).

Chondrocytes comprise about one percent of the weight and volume of the AC. They are small spherical or slightly flattened cells lying in lacunae in the cartilage (20,22,23) where they may be single cells or less commonly small clusters of
cells. They are stable cells unable to divide after epiphyseal closure (23) but they are responsible for the continuous synthesis and maintenance of the ECM. They are equipped with endoplasmic reticulum and golgi apparatus for both the production of matrix macromolecules as well as cilia which may play a role in the detection of changes in the matrix components (24). The maintenance of the ECM requires of the cell these abilities to degrade and reform the matrix components as well as the ability to detect mechanical changes and reform the macromolecular framework (24).

AC is not a vascular tissue but despite this the chondrocytes have a high metabolic rate similar to vascularised cells. They receive their nutrition mainly from the synovial fluid as it is forced into the AC as each compression of the joint occurs (22). If there were normal vessels flowing through it they would be occluded by these compressions, also the presence of blood vessels would alter the mechanical properties of the cartilage. There are two other minor sources supplying the AC; in the deeper layers of the cartilage adjacent to bone a few blood vessels supply it up to a level known as the tidemark and at the edge of the joint capsular vessels supply the cartilage rim there (19). The double diffusion barrier of the synovium and AC creates an environment lacking in oxygen which forces the chondrocytes to respire mainly anaerobically (24). This barrier also plays a protective role as it prevents certain molecules from entering the AC both due to their size and their electrical charge (24). Immobilization or
dislocation of the joint will stop compression of the joint and therefore leads to degeneration of cartilage due to lack of the pump system of supply.

The chondrocytes are regulated by several growth factors produced either in an autocrine or a paracrine manner. These have the ability to produce both anabolic and catabolic effect and thus altering the amount and rate of matrix component production and breakdown and thus play an important role in disease process (22,24).

The ECM is composed mainly of water which comprises between sixty and eighty percent of its weight and the matrix macromolecules (20,22,24). In the water are dissolved some gases and metabolites and also a large number of cations to balance the negatively charged proteoglycans. Some of this water can move freely into and out of the matrix which enhances the mechanical properties of the cartilage (24). The high concentration of ions dissolved in this matrix tissue fluid give the ECM a very high osmotic potential which draws water into the matrix which is important functionally.

The main matrix structural macromolecules are the collagens which comprise sixty percent of the dry weight of the matrix (20,24). The fibres form an interlocking meshwork which provides the ECM with its strength, form and resilience. The major collagen is type II with over ninety percent of this type and
minor contributions from types III, V, VI IX, X and XI (24,25). Type X is found mainly in mature cartilage in the deepest layer at the bone-cartilage interface and is possibly involved in calcification (24). The alignment of the fibres is defined by the function required of them; in the superficial layers the forces are mainly shearing forces and therefore the fibres are arranged tangentially and slightly offset but in the deeper layers the fibres are required to resist compression forces so they are arranged radially and perpendicular to the surface (22,24).

The collagen is arranged in four layers in the matrix. Each layer serves its purpose and its fibres are arranged in such a way as to achieve that purpose. The first and outer layer is the superficial or tangential zone also known as the lamina splendens (2022,24). Here there is a high water content to increase its tensile strength and the fibres are arranged parallel to the surface to resist the shear forces at the joint surface. It also acts as a barrier to large molecules such as immunoglobulins and since it is the first layer to be broken down in the development of OA its loss may lead to the entry of such molecules into the AC and influence the disease process (20).

The second layer is the transitional layer and here fibres are arranged obliquely to the surface becoming perpendicular deeper into the layer. It is a small layer involved in the transmission of forces to the deeper layers. The next layer is the
largest of all the zones of the AC, it is the deep radial layer where the fibres and
the chondrocytes are arranged in pillars or struts that resist and absorb the
compressive and distractive forces on the cartilage (22).

The deepest layer is known as the calcified layer and is involved in anchoring the
AC to the underlying bone. It contains a greater proportion of collagen type X
and is identified by possessing a line known as the tidemark (20,24). The matrix
deeper to this line is calcified and is supplied directly by subchondral blood
vessels (19) and this line is only breached by these vessels in disease states such
as OA (26).

The non collagenous portion of the matrix are mainly the proteoglycans and
some glycoproteins. It is the proteoglycans that supply the matrix with its
compressibility and elasticity (22,24,25). They are composed of a protein core
onto which are attached a large number of Glycosaminoglycan chains which are
non-branching negatively-charged polysaccharide chains of repeating
disaccharides containing amino acids (24). The major and functionally most
important of these is Aggrecan (25) which comprises about ninety percent of all
proteoglycans and fills in most of the interfibrillar space of the matrix. They form
large aggregates with other molecules such as hyaluronic acid and minor
proteins, which help stabilize the proteoglycans position within the matrix. The
negative charge attracts water molecules to the aggregates and also helps
maintain the position of all aggregates within the matrix relative to each other (24). The role of both water molecules and the negative charge is seen when a compressive force acts on the AC. When the cartilage is compressed the water molecules are forced out of these aggregates and out of the matrix itself and the aggregates are forced closer together and the matrix becomes more compact. Once this force is released the negative charges repel the aggregates to restore their former positions and attract the water molecules back in again and thus restore the matrix to its former or resting state (22).

The small remaining part of the matrix is made up of some non-collagenous proteins and glycoproteins. These are poorly understood but seem to play a role in cell matrix interactions and matrix breakdown. Some molecules are also being considered as possible marker for matrix breakdown in disease states such as OA (24,25)

The AC is adapted to its functions and is able to resist considerable forces applied on it but if these forces exceed a certain level damage can occur. Excessive forces can be seen in cases of malalignment of the joint, limb length discrepancy and intra-articular fracture. The load at any surface is the product of the force and the area onto which it is applied and joints have some adaptations to resist these forces and reduce their effect. Firstly muscles around the joint actively contract to dampen the forces as well as the passive stretching of both
muscles and ligaments, which dissipates the force throughout them. The joints themselves are at the ends of the bones which are somewhat flared having a larger cross-sectional area than the shaft of the bone which bears the brunt of any damage during repeated or even single severe trauma. Finally the shape of the knee joint allows for a greater area of joint surface to come into contact with increasing load (21,22). This achieves a greater area of contact with a greater load and this larger area reduces the force on the cartilage.

The ECM is constantly being broken-down and reformed by the chondrocytes. The chondrocytes produce several enzymes which facilitate the turnover and breakdown of the matrix components. The most significant group is a large family of enzymes known as the Matrix Metalloproteases (MMP) (22,25,27).

These are a large family of at least eighteen enzymes divided into five structurally related subgroups (27). The first group are the Collagenases which include tissue collagenase (MMP-1), neutrophil collagenase (MMP-8) and collagenase 3 (MMP-13). The second group are the gelatinases which includes gelatinases A and B (MMP-2 &MMP-9). The third group are the stromelysins which includes stromelysin 1 (MMP-3) and stromelysin 2 (MMP-10). The last two groups are the membrane-type metalloproteases and the other metalloproteases the most important members of which are stromelysin 3(MMP-11), matrilysin (MMP-7), metalloelastase (MMP-12) and enamelysin (MMP-20) (22,27)
The action of these enzymes is held rigidly in check by their specific inhibitors the Tissue Inhibitors of Metalloproteases (TIMP-1, TIMP-2, TIMP-3 and TIMP-4). The balance between them determines the activity of the enzymes and their levels in synovial fluid can be used as a measure of their actions (27).

AC on the outside looks like a fairly permanent tissue but internally it is undergoing continuous turnover. The rate of turnover of its component molecules is fairly slow. Collagen turnover is much slower than the other macromolecules ranging from a few months to several years whereas that of the proteoglycans ranges between eight and six hundred days (22).

The overall rate of matrix turnover is not constant but is influenced by certain factors. The chondrocytes which are responsible for the breakdown and reformation of all matrix macromolecules also are responsible for the production of cytokines which alter the rate of turnover. Of these Interleukin 1 (IL-1) is the most important catabolic cytokine (24,26). When present it increases the rate of breakdown of both collagens and proteoglycans, it stops the transcription of proteoglycans and thus their production and it increases the expression of MMPs in the chondrocytes (28). The role of IL-1 is potentiated by Nitric Oxide(NO) which stimulates MMP proenzyme formation and its conversion to active forms and reduces the rate of matrix macromolecule synthesis. Tumour Necrosis
Factor-β has a similar though less potent effect to NO (26). Counteracting this are the anabolic cytokines Transforming Growth Factor-β and Insulin Like Growth Factor which stimulate the synthesis of matrix components and cell proliferation (24). These cytokines are secreted into the ECM in a response to a variety of stimuli and they bind and stimulate cells either in an autocrine or paracrine manner (24). The mechanism responsible for turnover of the matrix is poorly understood. The anabolic response possibly follows mechanical stimulation of the cell due to joint loading whereas the catabolic response is much more complex following a cascade involving several cytokines (24).

The matrix also plays a role as a signal transducer relaying to the chondrocytes signals from the mechanical loading of the articular surface. The chondrocytes then alter the composition of the matrix according to the load. Experimental studies have shown that a reduction in proteoglycans concentration occurs following a reduction in joint loading and that the composition is restored to normal once joint loading is restored (24).

Degeneration and loss of the normal structure and function of articular cartilage is an integral part of Osteoarthritis. This gradual loss progresses in three stages.

Initially there is fibrillation of the surface of the articular cartilage and small clefts appear which extend down to the transitional zone. This is accompanied by
disturbance of the matrix macromolecular framework and an increase in water content of the matrix, reduction in concentration and aggregation of the proteoglycans, especially aggrecan, and a shortening in the length of the glycosaminoglycan chains. These changes allow for an increase in the permeability and the softening of the matrix predisposing it to further damage (2).

The chondrocytes detect this damage and respond in an attempt at repair. There is both an anabolic and a catabolic side to this response. The catabolic response results in the release and activation of the MMPs leading to breakdown of the collagen types IX & XI cross links which destabilizes the collagen framework. This allows the matrix to expand with water further softening the matrix. These effects are mediated by NO through interleukin-1 (26).

The MMPs also degrade damaged and intact matrix components and may lead to previously trapped anabolic mediators such as transforming growth factor-β and insulin like growth factor which promote matrix macromolecule synthesis and chondrocyte proliferation. This anabolic response may eventually lead to the restoration of the damaged tissue (2). If there is failure to stabilize the tissue the anabolic response weakens there is progressive loss of the AC. The chondrocytic response decreases and there is an increase in cell death and apoptosis (29).
These changes at the molecular level are also accompanied by other gross changes. The superficial clefts deepen and widen leading to large ulcerations of the cartilage. There is an associated proliferation of blood vessels from the deep calcified zone of cartilage which breach the tidemark. The progressive damage and loss of the cartilage eventually results in completely exposed bone which articulates with a similar surface. The underlying bone also undergoes changes in response to the altered mechanical properties of the damaged cartilage. The bone thickens especially just beneath the cartilage by laying down of new bone in the trabeculae. Associated with this is formation of cysts just beneath this thickened surface. These are usually filled with fibrous, cartilaginous or myxoid tissue. There is also an attempt at regeneration and new cartilage and bone form osteophytes especially at the margins of the joint. The bony and cartilaginous changes also lead to a change in the shape of the joint and this leads to deformity and instability (2,26).

This final picture of a bony surface denuded of cartilage articulating with a similar surface is the end stage of the process (2).

**1.2.3 RISK FACTORS**

Primary OA of the knee requires no predisposing conditions for it to develop but the presence of certain factors increases the risk of its development. These
factors include advancing age, female sex, increased weight high bone mineral density and racial and genetic factors as well.

**Age:** OA is a disease of the elderly and affection of the knee is no exception. The prevalence rates are highest among that age group with up to one third of the adult population above fifty five years of age have radiographic evidence. The studies in the United Kingdom also show the prevalence rates of knee pain in the elderly, above fifty years of age, vary between twenty one and thirty percent while studies in the United states of America and Holland showing slightly lower results (5). When both radiological and clinical features were combined the prevalence rates were below twenty percent.

A major American study, NHANES (12), showed an increasing prevalence and incidence rate as the age of individuals involved increased in ten year increments. The study also showed a difference in the incidence and prevalence rates between men and women, with women having higher rates for both. The Chingford study (31) also recorded the increased incidence in the adult population. Its study population was post menopausal women aged between forty five and sixty nine years age and had an annual incidence of about three percent.
The increase in both incidence and prevalence with age is a likely consequence of changes that occur with age as the chondrocytes become less responsive to growth factors that stimulate repair. The ligaments around the joint become lax making the joint more prone to injury and there is loss of their shock absorbing capability. Finally the tidemark of calcified cartilage duplicates itself and migrates towards the surface leaving a narrower rim of uncalcified cartilage to resist the compression forces (8).

Sex: females tend to suffer more from OA of the knee. In most studies the number of female sufferers far exceeds that of male sufferers (13,14,30) especially after the fifth decade, a reflection of the effect of female sex hormones on the AC (8).

NHANES studied the prevalence of OA on a large cohort and it showed a greater prevalence of OA knee in women than in men across all age groups except between 35 and 44 years of age where the prevalence was almost the same (13). Not only is the prevalence greater among women but the recorded incidence rates have also been greater. The Framingham OA study is a United States population based cohort study in which a large group of people were selected from the community and followed up with examination and investigations every two years to record signs of heart disease and OA knee among others. It recorded an 18% incidence for women between examinations.
18 and 22 whereas that for men was only 11% (14). The study also suggested that the annual incidence rates were about 2% for new radiographic disease, 1% for symptomatic disease and 4% for disease progression for women. The rates for men were approximately half of that. The Chingford study recorded an annual rate of 3% for new disease among middle aged women (31).

This difference in both prevalence and incidence rates between men and women is age related being evident after the fifth decade (8,30). Before that the incidence of OA is low with similar rates for both sexes (13,30) or if there is any there might be a slight male preponderance (8).

The difference in both prevalence and incidence rates between men and women is a reflection of the effect of female sex hormones on the chondrocyte. They have been known to alter and modify chondrocyte function and their withdrawal at menopause accelerates the degeneration of the AC (4,8). Additional proof of this comes from the fact that Hormone Replacement Therapy (HRT) has a definite protective effect against the development of knee OA (32).

**Weight:** it is well known that increased body weight and in particular obesity increases the risk of developing OA of the knee. The knee is a weight bearing joint and the greater the load on it the greater the chance of it degenerating
over time. The anatomy of the joint confers that the majority of the weight is borne by the medial compartment and that is the part greatly affected by OA.

Obesity and increased body weight are known predisposing factors for OA of the knee and have been reported by most studies (4,8,13,14,30,33). Obesity is defined as having a Body Mass Index (BMI) above 30 and was used by NHANES to stratify patients according to weight groups (13). The study concluded that there was a strong link between OA of the knee and the three highest groups especially the obese group. It also found that obesity was a more of a factor in women than in men. Other studies also showed that increased body weight was associated with OA more in women than in men (8). Obesity was also linked with both asymptomatic radiological disease as well as being the greatest predictor of disease progression among sufferers (33).

Not only are obesity and increased body weight factors for the development of OA but weight reduction has been associated with a reduced risk of OA of the knee (13).

The increase in body weight seen in most sufferers of OA knee could also be a reflection of the effect of the disease on the patient. The pain and restriction of movement that they endure leads them to lead a less active and sedentary
lifestyle and therefore predispose them to the observed increase in body weight and BMI (8).

**Bone Mineral Density:** OA patients have an increased bone mineral density especially of the weight bearing joints including the knee. This can be explained by the fact that since the underlying bone is stronger therefore more force is imparted upon the AC and the chance of its damage and progression to OA is greater (34). Osteoporosis sufferers have softer, more resilient bone which has the ability to deform under pressure and therefore draws the force away from the AC. They are less likely to suffer from OA.

NHANES found the bone mineral density of African American women to be greater than her counterparts of Caucasian descent and suggested this to explain the increased prevalence of OA knee among African American women. The study also suggested that the increased bone mineral density could be due to the increased body weight of those individuals (13).

**Increased activity and Joint injury:** Increased joint activity has been considered as a possible risk for factor for developing OA and with the knee joint weight bearing sports activity was found to be a culprit. A British study (36) concluded that long term intense sports were associated with a two to three fold increase in the risk of developing OA of both the knee and the hip in women.
Sports are also indirectly linked to OA by the injuries it may cause. The risk of developing OA following meniscectomy for meniscal injury is fourteen times higher than normal (37). The risk following knee injury and both cruciate ligament and meniscal injury is also higher.

**Other Factors:** many other factors have been linked to the development of OA knee both local and systemic.

NHANES suggested that both lower socioeconomic class and lower education were factors for its development but once BMI was considered these were disposed of (13). Smoking was also considered by several studies (8,13) and was found to have a protective effect against the development of OA. Diabetes Mellitus increases the risk of developing OA knee but this has been found to be independent of the associated increase in body weight.

Local factors come into play in the development of Secondary OA and of these malalignment and joint injury have the most prominent roles (5). Weight is also considered to be a local factor as it induces a varus malalignment which increases the forces on the medial compartment by increasing the portion of weight acting medially as the varus tilt increases (35). Valgus inclined knees
have less of a problem because as the weight increases the varus tilt the weight is distributed more evenly over the surface of the joint.

Joint immobilization has also been considered as a local predisposing factor. As mentioned previously joint immobilization affects the nutrition of the AC and leads to reduction in proteoglycan and collagen biosynthesis (2). A study conducted by the Department of Biomedical Engineering at Duke University, Durham USA, showed both reduction of both compression and shear moduli and an increase in MMP-1 and MMP-3 concentration in the tibial plateau of immobilized canine hind limbs (38). It concluded that joint immobilization possibly leads to both reduction in cartilage mechanical function and a possible link to enzymatic degradation.

Another study showed that quadriceps muscle wasting could also be a risk factor in middle aged women (39). Quadriceps wasting is a known complication and clinical sign of OA knee due to disuse but the weakness of the muscle is seen in asymptomatic patients and could therefore have an aetiological role.
1.2.4 CLINICAL PICTURE

Patients suffering from OA knee are usually elderly mostly female and probably overweight. The main complaints are knee pain, stiffness, swelling and associated loss of range of movement. Joint deformity is a late feature (40).

Patients present to the orthopaedic and rheumatology clinics as well as primary healthcare facilities complaining of pain in one or both knees. This is usually the first symptom of the disease. Initially the pain is mild and intermittent and occurs primarily during walking especially when some degree of force is required as in climbing stairs and running. As disease progresses the attacks of pain become more frequent and severe with less time between attacks and lasting for longer duration. The pain ultimately becomes so severe during these attacks that it occurs at rest and even wakes them from sleep (40,41).

Early on in the disease stiffness is not very significant but there is some limitation of movement in activities requiring an extreme range of movement, especially flexion. These movements are accompanied pain at first and later on become very difficult to perform. The stiffness then becomes periodic and especially following periods of inactivity such as sitting in a chair for some time and more commonly when rising from sleep. The duration of this stiffness though is usually
brief lasting no more than a few minutes after which movements become free (1,41).

Reduction in the active range of movement which occurs is due to one or two reasons. Initially pain is the main cause as patients tend to restrict their own movements to avoid the pain. Later there is actual physical impairment in the range due to both capsular stiffening and marginal osteophytes which block the extremes of joint motion (2).

A varying degree of muscle wasting especially affecting the Quadriceps femoris due to disuse (39) as the patient will reduce all active knee movements due mainly to pain but also to a lesser degree to the reduction in range.

As disease progresses functional impairment increases due to the pain joint stiffness and later deformity. Patients depend more and more on their partner, the people around them and walking aids to move about and perform simple activities. In the late stages patients have constant pain with stiff and deformed joints sometimes becoming almost crippled requiring even a wheel chair to move about.

Disease progression is not absolute and is determined by several factors of which weight and age are the most significant (33). The majority of patients are
affected by the disorder for many years and are able to cope with it very well whereas a small minority can rapidly become crippled.

1.2.5 DIAGNOSIS

Diagnosis depends both on the clinical picture and the radiological findings. Most epidemiological studies into OA knee use radiology for the diagnosis but it has been noted that almost half the patients with radiological changes have no clinical symptoms and studies now differentiate between symptomatic and asymptomatic disease (1).

Examination of the patient will reveal several signs which point to the diagnosis of OA knee.

Inspection may show any signs of previous injury or surgical intervention as well as scars and deformities all of which could be local predisposing factors. Joint deformity could indicate both an old injury or congenital or childhood problem or the sign of longstanding disease. The commonest joint malalignment occurring with longstanding disease is a varus deformity due to increased damage to the medial compartment of the joint (42). Inspection will also reveal quadriceps muscle wasting.
Palpation of the joint and especially the joint line will reveal tenderness which is usually medial as this is the side commonly affected as well as patellofemoral tenderness. Wasting of the quadriceps may also be noted. Feeling the joint while it is moving will show crepitations from both the tibifemoral and patellofemoral surfaces. Warmth due to inflammation of the joint and synovial thickening and joint effusion are uncommon findings. In later stages of disease bony swelling at the joint margins due to the osteophytes and deformation of the subchondral bone becomes more prominent (40,43).

Movement of the joint will show the limitation in flexion and extension as well as reveal the extent of muscle wasting by testing for muscle power. Laxity of the joint ligaments and joint instability may also be revealed (44). These can be both a sign of late disease and may also predate the disease and be a factor for both disease incidence and progression. Other sign which may be demonstrated include loss of proprioception which could be a factor in the sense of giving way which is experienced by some patients (45).

Radiological investigations are important for confirmation of diagnosis of OA knee. After the clinical examination patients undergo radiological examination of their knees, usually both tibio-femoral and patello-femoral views are requested and the X-rays thus obtained are viewed. The radiological hallmark of OA is the osteophytes (2) clearly visible in the X-rays of sufferers. Another change visible
in OA is Joint Space Narrowing (JSN) which is a result of the loss of AC thickness as it becomes eroded. This is seen at the part of the joint affected and is therefore more often seen in the medial compartment of the knee joint and to a lesser extent in the patello-femoral joint. Late changes seen in more advanced cases include thickening of the sub-chondral bone (sub-chondral sclerosis) which is due to proliferation of bone attempting to resist the increased forces on it and sub-chondral cyst formation (46). The cause is unknown but suggestions are that the bone under increased pressure becomes ischaemic and infarcts with resorption of bone and some element of myxoid degeneration.

A radiological scheme for the diagnosis and classification of OA knee was adopted by Kellgren and Lawrence in 1957 and is still in use today. It is composed of five grades from zero to IV with increase in changes in that order. OA of the knee is classed grade II or higher according to this scale (1,46).

Another radiological change is the alignment change that occurs with loss of cartilage height and bone remodeling which occurs in late and progressive disease. The possible change is either a varus or valgus angulation of the tibia relative to the femur. The commonest is varus angulation which occurs in approximately 90% of osteoarthritic knees (47).
The dependence on radiology for diagnosis results in an excess of asymptomatic individuals being classified as having OA of the knee. The ACR has developed criteria for the diagnosis of Knee OA. There are three groups, either clinical examination and laboratory investigations, clinical examination and radiological assessment, or clinical examination alone. To diagnose OA by clinical and laboratory means the practitioner must have a patient complaining of knee pain and five of the following nine criteria:

- Age above 40 years
- Morning stiffness less than 30 minutes
- Joint crepitus on active motion
- Tenderness of the joint margins
- Bony enlargement
- Lack of palpable synovial warmth
- Erythrocyte sedimentation rate less than 40 millimetres per hour
- Rheumatoid factor titre less than 1 in 40
- Synovial fluid suggestive of OA (clear, viscous white blood cell count less than 2000 per cubic millimeter)

To diagnose OA with clinical examination and X-rays the patient should have knee pain, osteophytes in the X-ray and any one of the following criteria:

- Age above 50 years
- Morning stiffness less than 30 minutes
• Joint crepitus on active motion

The diagnosis of OA by clinical means alone requires the following: knee pain and any 3 of the following six criteria:

• Age above 50 years
• Morning stiffness less than 30 minutes
• Joint crepitus on active motion
• Tenderness of the joint margins
• Bony enlargement
• Lack of palpable synovial warmth

The ACR also concluded after their extensive research that clinical and laboratory investigations are useful for clinical surveys and general practice, clinical laboratory and radiological assessment are useful for clinical trials and is the most often used and the last group by using clinical examination alone is most useful in population surveys (1). They also concluded that these criteria are not perfect and that they are not to replace normal clinical diagnosis but they are most useful in screening patients and diagnosing the majority of those suffering from primary or idiopathic OA.
1.2.6 TREATMENT

OA has no cure. Once degeneration of the AC starts the process can not be reversed but also progression to severe joint attrition and crippling does not occur universally. The rate of progression varies widely from person to person according to a few factors of which body weight is the most significant (33).

With this in mind the aims of treatment of OA of the knee are as follows:

1. educating the patient about their condition
2. alleviating the pain
3. maintaining and optimizing function
4. retarding the progression of the disease (48)

Several treatments have been prescribed for this disorder and written about in the literature. They can be grouped together as follows:

- Alternative and complementary medicine - such as folk medicine, acupuncture, Trans-cutaneous Electronic Nerve Stimulation, diet and supplements.
- Oral Drugs – simple analgesics and Non Steroidal Anti Inflammatory Drugs (NSAIDs).
- Intra articular injections – steroids, hyaluronic acid
• Educational and behavioral change – support, coping strategies, dietary changes, psychological treatments and lifestyle adaptations.
• Exercise programs and physiotherapy
• Surgery – arthroscopy, High Tibial Osteotomy, joint replacement (49).

Treatment is provided by specialized orthopaedic and rheumatological practitioners as well as primary care physicians. Patients may also seek help from traditional healers witches and druids. The American Medical Association concluded in a study that patients treated by Primary care providers were more likely to be prescribed oral NSAIDs and oral steroids (50). NSAIDs are the mainstay of treatment and at least half of all the studies into interventions for OA knee have included them (49). They are the most used drugs due to their easy use and good short term relief of symptoms but their long term benefit is not known and they are not without their complications (51). The main long term effects of NSAIDs are related to the gastro-intestinal tract (GIT). They are well known causes of upper GIT ulceration, perforation and haemorrhage (51,52) and between two to two and a half thousand deaths have been attributable to their use in the United Kingdom (51).
As mentioned patients on NSAIDs only gain benefit from the first few weeks of therapy as studies have shown that there is no long term benefit over placebo (51). When compared to simple analgesics such as paracetamol no significant difference has been observed (50,51).

NSAIDs act by inhibiting cyclo-oxygenase 1 (COX 1) and cyclo-oxygenase 2 (COX 2) and relieving the pain and inflammation caused by the products of COX-2. Inhibition of COX 1 is responsible for the GIT complications and to reduce this a selective COX 2 inhibitor has been developed to lessen these effects. Celecoxib a selective COX 2 inhibitor was the first such NSAID to be developed and in clinical studies it has shown a 40 to 60% reduction in patient withdrawal due to Gastrointestinal symptoms signifying improved tolerance over standard drugs and a 40 to 75% reduction in the rate of serious upper GIT complications (52).

NSAIDs can also be given in combination with analgesics such as paracetamol (48) and with other NSAIDs. COX 2 inhibitors have been given with aspirin and even this combination has a reduced rate of complications (52).

The ACR has published guidelines for the management of OA of the knee. It outlined that initial management should be non pharmacological and as the symptoms progress or there is no response then drugs should be introduced gradually (53). It also advocates the use of intra-articular steroid injections but
only in cases with inflammatory signs and joint effusion. No mention is given to other intra-articular drugs. If these measures fail to produce a response then surgery becomes the best option.

Non pharmacologic therapy for OA of the knee can be divided into two main groups, physical therapy and alternative medicines. Physical therapy includes physiotherapy and knee exercises as well as strategies to reduce the impact of the disorder such lifestyle adaptation and weight loss. The proper use of a cane can help relieve the pain incurred while moving about and the wearing of braces can improve function. Active exercises are also associated with pain relief and improve function but they are only valuable in the short term (54,55). Obesity is a well known risk factor (13,14,31,33,35) and weight loss can reduce the risk of OA but it is not known if weight reduction can improve the situation of those already affected. Still weight reduction is advised to most overweight sufferers especially if they are being considered for Total Knee Replacement (53).

Alternative therapeutic means were the only means of treatment before the advent of modern medicine. The different modalities reflect the different cultures and therefore they vary from region to region. The most mentioned of these is Acupuncture and it has been found to be a safe and effective adjunct to modern drugs (56). Herbal medicines have also been studied scientifically and they have shown some promise but further investigation is required (57).
Intra articular steroid injections have been used for a long time in the treatment of OA of the knee (58) despite it not being an inflammatory disorder. It is effective to some degree in relieving the pain and some of the swelling affecting patients but this relief is relatively short lived. Several steroid preparations have been tried and the ones with the longest duration of action were trimicinalone and prednisilone with the former having the longest action (58). The average duration of action of steroids is between two to three weeks but some patients have sustained longer periods of relief from just one or two injections. Repeated injections give rise to complications such as tendon rupture, synovitis and progressive cartilage destruction therefore it has been recommended that it should only be used three to four times a year (53).

More recently Hyaluronic Acid (HA) has been introduced for intra-articular use in the treatment of OA of the knee. HA is a basic glycosaminoglycan forming the side chain of PG molecules in the extracellular matrix of the AC (2) and its injection intra-articularly is an attempt to replace the PGs degraded by the protease enzymes in the first stages of the degenerative process. Injection of HA intra-articularly is associated with pain relief and gradual functional improvement and is at least as effective as oral NSAID (59). it is administered as five weekly intra-articular injections in a viscous formulation and is associated very limited
and minor local complications (59). It is capable of causing a prolonged relief of symptoms for up to 6 months.

When comparing HA to steroid injections little difference has been observed after treatment and follow up for six months although men have a slightly better outcome than women (60). Arthroscopy has shown that both forms of treatment are effective in modifying the synovium of affected knees towards normal appearance (61i).

Other substances have also been investigated for intra-articular administration. Other Glycosaminoglycans have been tried in animal models (62) as well as glucosamine (63) both intra articularly and orally but the have shown little benefit but they are still in the early stages of research and development.

Failure of pharmacologic and non pharmacologic treatment suggests the need for surgical intervention. There are several different surgical procedures and selection of which procedure suits which candidate depends on several factors. These vary from patient dependent factors such as age and severity of the disorder to subjective factors such as patients' expectations and surgeon's capabilities and preferences (64). The possible procedures are:

- Arthroscopic Surgery – including lavage, debridement and chondral shaving
• Osteotomy – realignment of the joint with or without ligament reconstruction
• Arthroplasty

Arthroscopy of the knee is now the commonest orthopaedic surgical procedure performed today (65). It is now being adopted for both the diagnosis and treatment of OA. The earliest lesions of OA of the knee can not be seen radiologically therefore arthroscopy can provide a useful tool for their detection (66). Classification systems have been developed for the staging of knee OA and the most commonly used are those of Collins, Outbridge and the French Society of Arthroscopy (67). These systems classify OA knee according to severity ranging from early softening of cartilage to end stage eburnation of bone (67) but there has been some inter-observer variation depending mainly on the experience of the observer (67,68).

The procedures possible with an arthroscope include joint lavage, debridement of degenerate cartilage and menisci as well as removal of loose bodies from the joint (65,69,70,71). Joint lavage with between 3three to ten litres of warm saline has provided up to 60% relief of symptoms for up to 24 months (69). It probably achieves relief of symptoms by dilution and washing out of inflammatory enzymes and debris (70). Arthroscopic debridement is now being used more and
more for the treatment of OA knee with up to 650 000 procedures done in the United States of America annually (70) but long term benefit has not been achieved. Indeed when comparing long term results to that of a placebo procedure no significant difference has been observed (70).

The increased use of arthroscopy despite it not showing great or significant long term improvement is due to the fact that it is a simple out-patient procedure with predictable results and known post operative course (71). The results of arthroscopic surgery have not been too good and it is associated with higher arthroplasty rates (65).

Chondral shaving and subchondral abrasion either by an open or arthroscopic approach are now being tried for the treatment of degenerate AC. A study on adolescent white rabbits has shown that complete abrasion of the full thickness of the cartilage will lead to healing and regeneration with hyaline like cartilage; whereas partial curettage of only the damaged cartilage will not only fail to heal but the remaining underlying cartilage will degenerate. The healing of full thickness defects is enhanced by post-operative continuous passive motion. These animal models will provide useful information on the potential for regeneration of AC (72).
For any surgical procedure on the knee to be successful it must provide a stable painless knee. It should also be able to provide movement. Joint replacement, Total Knee Arthroplasty (TKR), and Knee Valgus Osteotomy have the ability to provide both and have been used very successfully for the treatment of OA of the knee.

Arthrodesis of the knee has been used in the past for treatment of OA knee especially in young active patients with severe disease. It permits the greatest loads and allows for a very wide range of activities but without any possible range of movement. It was not widely used for OA but more for other conditions such as Tuberculosis of the knee and instability due to osteomyelitis. TKR has provided the stability and the mobility required but in cases with severe infection of a knee prosthesis arthrodesis is still being performed as a salvage procedure (73).

Realignment of the axis of the knee by osteotomy is a well known procedure and it has proven effective especially for unicompartmental OA of the knee (64). It is a simple procedure in which either a wedge is excised or opened in the upper tibia to correct the alignment of the knee joint and divert the weight bearing axis from the affected part of the knee to the unaffected side. The deformity is usually secondary to the loss of cartilage in the affected side and since the
medial side is affected more commonly the deformity is usually a varus deformity (64,74,75).

Not all candidates are suitable for this procedure. The most suitable candidates are usually younger in age and lighter in body weight at the same time they are fairly active individuals with localized unicompartmental disease. This valgus osteotomy will allow a good degree of activity including running and hopping which arthroplasty will not allow (64).

The surgery will also achieve decompression of the subchondral bone and this in itself will cause some degree of pain relief and once the affected side is relieved of its weight bearing the cartilage undergoes some degree of regeneration as observed by arthroscopic studies (64).

The main drawback seen in this procedure is if the angle of correction is not judged probable and you end up with either an over-corrected or an under-corrected deformity. To measure the angle required for correction accurately very good radiographic weight bearing images are taken and the angles measured correctly. With the measurement taken the osteotomy can then be done. The angle of the deformity is not usually very great and most authors report an average of 5 to 14 degrees of correction is sufficient to provide a good result (64,74).
TKR has been successful in providing a decent range of movement and at the same time enough stability and dependability to prevent the knee buckling under his or her weight and also freedom from pain. The history of knee arthroplasty seems to be very long as Egyptian mummies have been found with both their lower femurs and tibial plateaus reshaped. Over the past two centuries surgeons have tried to treat patient with painful knee by interposing substances between the two degenerate joint surfaces. These materials included endogenous flaps of fascia, fat and muscles, xenograft material such as pigs' bladder and finally synthetic materials such as nylon (76).

The idea of a true metallic joint came from a surgeon who attended a patient with a broken Kuntcher nail in 1947. he suggested that if a bearing could be inserted between the two broken ends of the nail then an artificial joint could be produced with the stems running into the medullary cavities of the two bones. The development of artificial joints continued with the realization that these medullary cavities do not align perfectly but that the cavity of the femur lies on average about one to two centimetres behind that of the femur. The first joint to take that into consideration was offset by 1.25 cm (76).
Development over the past fifty years has been rapid both in prosthesis design and in the materials used to produce modern Knees with high reliability and durability.

A very important consideration in the understanding of the knee joint is the point of rotation in the joint. In the hip joint which is a ball and socket joint this point lies at the centre of the head of the femur. Because of the complex nature of the knee joint this point here lies at the point of crossing of the two cruciate ligaments and this varies according to the amount of flexion of the knee. Any knee prosthesis design has to either incorporate this or to replace this feature somehow (77).

There have been several designs used for knee replacement. The earliest designs followed on the success of hip hemi arthroplasty and initially a femoral component was used but it had a problem with loosening and did not significantly reduce pain. A tibial component was then tried and was more stable but it also didn't provide a satisfactory outcome (76).

The first true TKR was a hinge and initially its results were good but it only provided movement in one plane and did not take into account the rolling and gliding that occur between tibia and femur. The next generation of knee designs was somewhat freer and retained the collateral ligaments but the cruciate
ligaments were sacrificed. There were two separate components and they replaced the two joint surfaces. This condylar knee design allowed some freedom of movement (77).

The next logical step in knee design was to adopt a more physiological approach and retain all the knee ligaments and only resurface the joints. These designs had a major drawback which was that the point of contact was only a small area between the spherical femoral condyle and the flat tibial plateau. This resulted in the femoral component wearing through the tibial surface in a very short time (77,78).

To correct for this point loading designers used nature's solution which is to interpose a free fragment similar to the meniscus in the knee joint. This meniscal design allowed for a great degree of mobility as well as a large surface area of contact. It comprised three separate pieces, a tibial plateau component, a femoral condylar part and an interposed free polyethylene slab with a concave upper surface and a flattened lower surface. Both femoral and tibial components are metallic. The free nature of the joint requires intact collateral ligaments and PCL to function. The ACL may be deficient and still get a good outcome but with it intact the results are much better (77,78).
A vital component in any knee prosthesis is the materials used to create them. Initially prostheses used metals but experience in engineering showed that the use of two dissimilar substances created a lower frictional resistance. The development of synthetic polymers for use in artificial joints has led to the development of the Ultra High Molecular weight Polyethylene used in joints today. This material is both biocompatible and has low friction and low wear (79,80).

The surgical procedure itself requires great care to correctly align the components and produce the desired outcome. Special instruments have been developed to aid the surgeon in inserting the prosthesis and not removing too much bone. It is vital that the ligaments are maintained especially in the unconstrained knee designs such as the condylar and meniscal types and excessive bony resection would affect their stability negatively (64).

A modification of TKR is the unicompartmental replacement. This is used to replace the more commonly affected medial compartment especially in elderly obese patients with a sedentary lifestyle and limited disease. It has the benefit over osteotomy in that it is a simpler procedure with less damage or resection of the underlying bone. It is used especially in patients with some contraindications to TKR and can be used bilaterally in the same session (64).
Complications of TKR include general surgical complications as well as specific ones such as aseptic loosening of the components, early failure due to wear of the polyethylene or breakage of the metallic parts. To prevent loosening prostheses are either fixed using polymethyl methacrylate bone cement or are designed with porous coats to encourage ingrowth of bone and good anchorage (80).

Modern experimental research is trying to find ways to repair cartilage lesions by using grafts to replace the lost tissue. A variety of synthetic and biological materials have been tried and a study conducted by the Imperial College, St. Thomas' Hospital and the Institute of Orthopaedics in London used three different materials on mature goats (81). The results showed that all three materials showed some success at six months but within a year had started to degenerate.

A new technique is being developed to repair AC defects. This comprises the introduction of cultured autologous chondrocytes into these defects. These were tried in rabbit models and showed promising results at twelve months. A controlled study was conducted on a canine model with follow up at twelve and eighteen months but it showed that there was no significant difference between cases and controls and that the repair tissue was less at eighteen months. It also
concluded that the procedure itself can damage the AC and initiate a degenerative process (82).

AC as is known has limited capacity to heal but trials of Recombinant Human Bone Morphogenetic Protein-2 have shown that there is some regeneration of excised defects of AC at twenty four weeks with cartilage similar histologically to mature AC. (83). A related factor Osteogenic Protein-1 (Bone Morphogenetic Protein-7) has been used to stimulate proteoglycan synthesis in explants of pig AC. This is an important prerequisite for the repair of the AC (84). These procedures are now past the animal testing phase and have been adopted for human use.

There are many modalities of treatment of OA knee but they can not and usually are not used on each patient. The recommendations of both the ACR (53) and the Standing Committee for International Clinical Studies Including Therapeutic Trials (48) are that there is a need to individualize treatment. Every single patient should be considered separately and treatment should be catered to his or her individual needs (53). Early disease should be treated by patient education weight loss and physical therapy with analgesics and NSAIDs used later. Arthroscopic surgery for unresponsive patients is inconclusive and surgery should be advocated for unresponsive symptomatic with functional impairment (53).
Chapter 2

Patients & Methods
2.1 Objectives

The aim of this study is to describe the presentation of OA knee among our Sudanese patients with respect to certain factors:

- Age of patients
- Sex
- Weight

and to relate the age and weight of patients to sex as there is a reported and well known difference between these in the literature.

To identify any disability encountered by these patients in their daily life activities and any work related disability.

To describe the radiological changes encountered in these patients according to a set scale.
2.2 Patients and Methods

This study was conducted between July 1st 2002 and June 30th 2003.

Patients were selected from those presenting to the Orthopaedic Out-patient department at Khartoum Teaching Hospital complaining of knee pain excluding that due to recent violent trauma. Patients also had to be aged forty or above.

The patients selected were then interviewed and a thorough physical examination were then carried out and then the patients x-rays were viewed. The information thus obtained was entered into a questionnaire.

The first section of the questionnaire was concerned with personal history of the patient. Age and sex, both of which are known risk factors for the development of the condition, were recorded as was the patients' occupation and a small note on the patients' geographic location and origin.

The next section of the questionnaire was concerned with the presenting complaint of the patient, the duration of his/her symptoms and the side affected, whether it was the right knee, the left knee or both. Other knee symptoms asked about were crepitus, stiffness and knee swelling. Stiffness is found in both OA
and Rheumatoid Arthritis (RA) but that for OA is specific in that it occurs on rising from sleep and after any period of inactivity and that it lasts for a few minutes and no longer than half an hour, unlike RA which usually lasts much longer (9).

Symptoms in other joints, hips, neck, hands and back were also enquired about to assess other possible degenerative disease.

The patient was then asked about disability mainly at home and any work absence. Patients were first asked about walking distance which was defined as the longest distance a patient could walk without stopping. This was estimated by the patient but they were also asked about how they arrived to the clinic, by car or public transport, to determine the approximate distance the patient could actually walk. The use of walking aids such as a walking stick or a walking frame was also noted. The patients were also asked about stair climbing and if possible the number of stairs or flights they could walk up.

Two specific daily tasks were inquired about; these were the ability to pray on a prayer mat and the ability to use a traditional squat toilet. These two activities require a pain-free full range of knee flexion and would be impaired by damage to the knee surface. Their duration also hinted at the duration of the patients'
complaint. Other tasks that were inquired about included the ability to get up out of bed unaided or standing from a sitting position.

On enquiry about the patients medical history, two specific conditions were included. Firstly if the patient was Diabetic this could be and aetiological factor as mentioned in some studies (8). Secondly OA of the knee has always been considered as having a familial inheritance and family history was then inquired about (10). Asthma and Peptic Ulcer were asked about to identify possible problems that might occur in relation to treatment with NSAIDs.

An outline of the patients' treatment history was also recorded to understand the course of the disorder and to note what treatment if any the patients have had specifically drugs, physiotherapy and any surgical intervention.

The interview was followed by a clinical examination. The weight was measured using a simple standard bathroom scale and height was measured using a tape measure. From them the Body Mass Index(BMI) was calculated to determine the patients' status. BMI is calculated using the following formula:

$$\text{BMI} = \frac{\text{weight (kilograms)}}{[\text{height (metres)}]^2}$$

The patients were then grouped according to their BMI into one of five groups as follows:
• Underweight: BMI up to twenty
• Ideal Weight: BMI more than twenty up to twenty five
• Overweight: BMI more than twenty five up to thirty
• Obese: BMI more than thirty up to thirty five
• Very Obese: BMI more than thirty five

The patient was then inspected standing with both feet together to note any alignment change at the knee.

With the patient lying down on a couch a more detailed inspection of both knees was undertaken. Here inspection was for any swelling, as well as any scars or deformities. Further examination was to determine if any swelling present was bony soft tissue or fluid, temperature changes and to assess the quadriceps muscle bulk as compared to the unaffected side. The patients' range of movement was observed and any restriction in that noted in either passive or active movement. The knee joint was then tested for any instability or ligamental damage. Quadriceps strength was assessed both by testing the muscle bulk and also the power of the muscle against resistance in comparison to the unaffected side if any.

The patient was then observed walking to notice any gait change or the use of walking aids.
Finally X-rays of the knee joint were examined for evidence of joint space narrowing and osteophytes as evidence of OA and then graded according to the Kellgren Lawrence OA scale. This scale is composed of five grades and assesses joint space narrowing, osteophytes and bone attrition with OA considered as a Grade 2 or higher score. The scale is as follows:

- Grade 0: no changes
- Grade 1: minute osteophyte, doubtful significance
- Grade 2: definite osteophyte, unimpaired joint space
- Grade 3: moderate diminution of joint space
- Grade 4: joint space greatly impaired with sclerosis of subchondral bone (1)
Chapter 4

Results
4.1 RESULTS

Age, sex, weight: 100 patients were included in this study the 69 of them were female (fig 1). The mean age of the 31 males was 65.5 years (range 46 to 80, Standard Deviation 9.5) and that of the females was 58.9 (40 to 84, SD 10). (fig. 2 & 3)

The mean weight was calculated for both men and women and then using the height the BMI was calculated. The mean BMI was much higher for the female patients than the males (tables 1 & 2). When the patients were grouped according to their BMI only 6 patients out of 69 females (8.7%) were considered to have normal weight as opposed to 15 from 31 males (48.3%) (fig. 4 & 5). Despite the differences in means of age, weight and BMI when they were correlated for significance the values were 0.799, 0.198 and 0.303 and were insignificant.

Complaints: (table 3) The presenting complaint was knee pain and the duration of complaint was found to vary widely ranging from 2 weeks to 15 years. 32 patients had complained of it for less than three months whereas 35 patients had been complaining for over a year and 11 of those for more than 5 years. No differences were found between men and women concerning the duration of complaint.
The right knee was affected in more than half, 52 patients had right knee pain and 28 patients had left knee pain. The remaining 20 complained of both knees (fig 6). No patient presented with a history of a fracture or major trauma involving the knee joint that required hospital treatment but 5 patients, 4 female 1 male, reported a minor bump or twist preceding their symptoms and may possibly have made them aware of it.

The next commonest complaint was knee crepitus described by patients as a grating or creaking sensation during active motion and seventy-one patients reported this. It was sometimes accompanied by an audible popping or snapping sound. No patient gave a history of joint locking.

The third most common complaint was joint stiffness and fifty-four patients reported this. It was described as a difficulty in moving the knee sometimes accompanied by pain and was most in the morning on rising from sleep and after any period of inactivity lasting only a few minutes.

Joint swelling was reported by thirty-nine patients and was not a constant feature. It would usually last for a few days only usually during an exacerbation of pain (table 3).
Patients also complained of other parts of their bodies with back pain the commonest associated symptom affecting thirty-three patients, eleven complained of neck pain and ten complained of hand pain and stiffness. Hip pain was the least associated joint symptom being observed in only four patients.

Thirteen patients were diagnosed with Diabetes Mellitus and were on treatment for it.

Family history of a similar condition was not a very common feature with only fourteen patients giving such a history.

Seventeen patients currently resided outside Khartoum but seventy eight were originally from outside Khartoum. No patient from the southern districts of Sudan presented to the outpatient department during the period of the study.

Only eight patients were not seen before by any doctor. All the remaining ninety-two patients were seen before and all had received oral or topical NSAIDs. Seven patients received a course of physiotherapy and three had intra-articular injections administered to them. Of the latter group two improved initially for a few weeks and one had releif from her symptoms for a few days only. One patient had a high tibial osteotomy done six years previously and had remained symptom free for the following three years. One patient had a knee arthrodesis
performed on her other twenty years previously but the indication was unknown to her.

**Disability:** this was gauged according to walking distance, use of walking aids and stair climbing and the performance of some daily activities.

Poor walking ability was considered as unable to complete fifty metres walking distance without stopping for a rest and forty three patients could not complete that. Thirty two patients could walk up to 100 metres and the remaining thirty five were considered as having good walking ability as they could walk longer distances. Of the poor group nineteen could only do a few paces.

Fifteen patients used a form of walking aid to help with their mobility. Twelve used a walking stick from time to time and one lady walked using the wall or with the help of her daughter. Another lady was carried in a chair when her condition flared up and one elderly lady moved about in a wheelchair.

Twenty two patients said that using a staircase was part of their regular schedule and only four of them could use it without any difficulty. The remaining eighteen said that they tried to avoid using them if possible or used the wall and banister or take a few steps at a time. One could not even climb one step without stopping.
Two daily tasks were used to gauge disability these were toilet usage and praying.

Only four patients claimed that their homes were equipped with modern western type toilet seats and that was their daily habit. The remaining ninety six patients all used the traditional squat toilet. Twenty three patients could use this toilet without any problem and of the remaining seventy three, twenty two modified their position by extending one knee to facilitate toilet use and the remaining fifty three used a modified stool or chair.

Eighty patients could not pray normally on a prayer mat because the pain or limitation of knee flexion prevented proper kneeling. They would either remain seated on the mat or use a chair or pray on the edge of a bed. Ten of the men said they could no longer go to the mosque to pray and three would go but use a chair there, the remaining eighteen would go to the mosque normally.

**Occupation:** Fourteen male out of thirty one (45.2%) were currently retired from their jobs. The occupations of the men were as follows:

- Seven truck and bus drivers
- Six farmers (four retired)
- Six soldiers, police or guardsmen (four retired)
• Four retired teachers
• Four had desk jobs (one retired civil servant)
• Three free lance traders
• One retired electrician

Twenty of the men could be considered to be currently or previously employed in heavy work. Three men absented from their work due to their knee problem but for a few days only.

Only thirteen of the sixty nine women (18.8%) were currently employed, four were teachers, five were doing some form of office work and four were cleaning ladies. There were also three other retired teachers. Only four cleaning ladies could be considered as doing any form of heavy labour. Eight of these women had absented from work due to their condition.

**Examination Findings:** The main deformity observed in the patients was a varus deformity seen in forty eight individuals with another forty nine having no visible deformity. Three patients had a valgus knee and they claimed that it was a life long deformity, probably congenital, but they claimed no family history of a similar condition. Four patients had a varus valgus laxity but no patient had detectable ligament damage.
The commonest finding on joint palpation was tenderness at the tibiofemoral joint and on the medial side of that joint seen in sixty five patients. Sixty two patients had crepitations on joint movement and fifty three patients had Quadriceps muscle wasting on the affected side. Patello-femoral tenderness was observed in fifty eight patients.

Restriction in the range of joint motion was seen in the advanced cases and twenty one patients were affected by it. They were affected by various degrees of limitation of joint flexion and some limitation of extension was also observed.

Swelling of the knee joint was seen in a considerable number of patients with bony swelling of the knee the most common cause seen in thirty seven patients. A mild joint effusion was observed in fourteen patients with thirteen patients having detectable synovial thickening. Seven patients had a slightly warm joint possibly due to inflammation. Four patients had a detectable popliteal cyst.

**Radiological Findings:** (table) the X-rays of the patients were viewed and then graded. Seventy seven patients were classified as having OA according to the Kellgren Lawrence Scale (Grade 2 or higher) while the remaining were not. Seven had no OA changes (grade 0) and sixteen were Grade 1.
Figure 1: Sex distribution of patients

n=100
Figure 2: Age Distribution of male patients

n = 31
Figure 3: Age distribution of female patients

n = 69
Figure 4: BMI of all Patients in Study

n=100

Key:
A - Under Weight
B – Normal weight
C – Overweight
D – Obese
E – Very Obese
**Figure 5: Relative BMI of patients, male vs female**

![BMI Graph]

- **A** - Underweight
- **B** – Normal Weight
- **C** – Overweight
- **D** – Obese
- **E** – Very Obese

**n=100**
**Table 1: Male patients statistics**

<table>
<thead>
<tr>
<th></th>
<th>Range</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>46 - 80</td>
<td>65.5</td>
<td>9.72</td>
</tr>
<tr>
<td>Weight (kilograms)</td>
<td>61 - 90</td>
<td>73.9</td>
<td>9.62</td>
</tr>
<tr>
<td>Height (metres)</td>
<td>1.60 – 1.86</td>
<td>1.70</td>
<td>7.08</td>
</tr>
<tr>
<td>BMI</td>
<td>22 – 32</td>
<td>25.7</td>
<td>3.29</td>
</tr>
</tbody>
</table>

\[ n = 31 \]
## Table 2: female patients' statistics

<table>
<thead>
<tr>
<th></th>
<th>Range</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>40 - 84</td>
<td>57.9</td>
<td>10.58</td>
</tr>
<tr>
<td><strong>Weight (kilograms)</strong></td>
<td>55 – 118</td>
<td>80.9</td>
<td>14.77</td>
</tr>
<tr>
<td><strong>Height (metres)</strong></td>
<td>1.50 – 1.70</td>
<td>1.60</td>
<td>4.38</td>
</tr>
<tr>
<td><strong>BMI</strong></td>
<td>23</td>
<td>44</td>
<td>31.3</td>
</tr>
</tbody>
</table>

\( n=69 \)
**Table 3: Knee symptoms**

<table>
<thead>
<tr>
<th>Joint Symptom</th>
<th>Number of patients Affected (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crepitation</td>
<td>71 (71%)</td>
</tr>
<tr>
<td>Stiffness</td>
<td>54 (54%)</td>
</tr>
<tr>
<td>Swelling</td>
<td>39 (39%)</td>
</tr>
</tbody>
</table>

n=100

**Table 4: duration of patients knee pain**

<table>
<thead>
<tr>
<th>Duration of symptoms</th>
<th>No of patients(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 3 months</td>
<td>32(32%)</td>
</tr>
<tr>
<td>3 months to 1 year</td>
<td>33(33%)</td>
</tr>
<tr>
<td>1 year to 5 years</td>
<td>24(24%)</td>
</tr>
<tr>
<td>More than five years</td>
<td>11(11%)</td>
</tr>
</tbody>
</table>

n=100
### Table 5: Associated joint symptoms

<table>
<thead>
<tr>
<th>Other joints affected</th>
<th>Number of patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Back (lumbar spine)</td>
<td>39 (39%)</td>
</tr>
<tr>
<td>Neck (cervical spine)</td>
<td>11 (11%)</td>
</tr>
<tr>
<td>Hand (small joints)</td>
<td>10 (10%)</td>
</tr>
<tr>
<td>Hip</td>
<td>4 (4%)</td>
</tr>
</tbody>
</table>

n=100

### Table 6: walking distance

<table>
<thead>
<tr>
<th>Distance</th>
<th>No of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 50 metres</td>
<td>43(43%)</td>
</tr>
<tr>
<td>50-100 metres</td>
<td>25(25%)</td>
</tr>
<tr>
<td>More than 100 metres</td>
<td>32(32%)</td>
</tr>
</tbody>
</table>

n=100
Figure 6: knee affected

n=100
## Table 7: Knee findings

<table>
<thead>
<tr>
<th>Knee findings</th>
<th>Number affected (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint line tenderness</td>
<td>65 (65%)</td>
</tr>
<tr>
<td>Crepitations</td>
<td>62 (62%)</td>
</tr>
<tr>
<td>Patello-femoral signs</td>
<td>58 (58%)</td>
</tr>
<tr>
<td>Quadriceps wasting</td>
<td>53 (53%)</td>
</tr>
<tr>
<td>Bony Swelling</td>
<td>37 (37%)</td>
</tr>
<tr>
<td>Knee Effusion</td>
<td>14 (14%)</td>
</tr>
<tr>
<td>Synovial Thickening</td>
<td>13 (13%)</td>
</tr>
<tr>
<td>Popliteal Cyst</td>
<td>4 (4%)</td>
</tr>
<tr>
<td>Knee Laxity</td>
<td>4 (4%)</td>
</tr>
</tbody>
</table>
Figure 7: joint deformity

n = 100
### Table 8: Radiological grade

<table>
<thead>
<tr>
<th>Radiological grade</th>
<th>No. of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KL Grade 0</td>
<td>7 (7%)</td>
</tr>
<tr>
<td>KL Grade 1</td>
<td>15 (15%)</td>
</tr>
<tr>
<td>KL Grade 2</td>
<td>17 (17%)</td>
</tr>
<tr>
<td>KL Grade 3</td>
<td>40 (40%)</td>
</tr>
<tr>
<td>KL Grade 4</td>
<td>21 (21%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100 (100%)</strong></td>
</tr>
</tbody>
</table>

**n=100**
Chapter 4

Discussion
5.1 Discussion

This study included only patients presented to the outpatient orthopaedic clinic at Khartoum Teaching Hospital and cannot represent OA knee in the community. Many patients treated by non-specialists such primary care providers and general practitioners as well as being treated at private health care facilities. This is a hospital-based study and it therefore cannot reflect the impact of OA at a community level but it can identify some of the aspects of the disease from those affected by it. The duration of the study was one year but due to the reasons stated above it cannot give an accurate indication of the incidence or prevalence of this condition.

**Sex:** One hundred patients were included in this study and from them it can be seen that OA of the knee is clearly more common in female patients than in male patients. Sixty nine females were affected as opposed to thirty one males with a ratio of >2:1. most studies into OA knee show this female preponderance (2,8,13,14). The Framingham study (14) shows both the incidence and prevalence of OA higher in women with a 1.8 odds ratio for women to develop new disease as well as a 1.6 times greater risk for their disease to progress (30). One of the most likely reasons for this is hormone withdrawal at menopause (8) and it has been shown that Hormone Replacement Therapy can delay or prevent the development of OA (31,32).
A study conducted in Shiraz University, Iran (85) on one hundred patients presenting consecutively with symptomatic osteoarthritis in which ninety-four had symptomatic knee OA and eighty-four were females suggested a possible role for traditional practices in the household. Fifty-nine of the study population were housewives and the authors suggested that the practice of sitting cross-legged and kneeling common among these ladies had a possible aetiological role in the development of the disease.

A population based study conducted among 10734 individuals between the ages of forty-five and sixty-five in Jeddah, Saudi Arabia showed an overall prevalence of knee OA of 1.43 % but was highest in the 55-65 year age group (86). It also concluded that females were more likely to be affected as they comprised almost two thirds of the patients (66.9%), another finding was that OA knee accounted for only 40.1% (86) of all OA patients presenting in that area.

**Age:** The majority (73%) of patients were above fifty years of age with more than half (51%) of the study group sixty years of age or older. All studies into OA state that it is a disease of the elderly and this study has also found similar results. NHANES (12) found that the prevalence of OA increased with age and was higher for women between the ages of forty-five and seventy-four. The increase in the incidence among females after the age of fifty is consistent with
Age relation to OA varied with sex as it was more likely to affect men before fifty years of age after which the incidence and prevalence would be higher in women (8). This study has shown a different pattern to this, as the mean age of men (65.5 years) is higher than the mean age in women (57.9 years).

**Body Weight and BMI:** Weight has an important role in the development of OA knee and overweight individuals are more likely to develop it (8). In this study seventy-nine patients were overweight, obese or very obese according to their BMI. Felson et al (14) not only reported that excess weight was one of the strongest risk factors but that it was one of the most important factors for the progression of knee OA (31).

NHANES (13) found that obese and very obese individuals had a much higher rate of OA knee than even overweight individuals. It also found that underweight individuals did not have a reduced risk of OA when compared to normal weight individuals (13). The effect of weight was much more significant among women, as a history of obesity throughout life conferred a higher risk of OA on women.
but not on men (13). Weight change also affected the risk of OA with a reduction reducing such a risk (8).

In this study the BMI of most of the study group (77%) was in the overweight category or higher with only six women out of sixty nine (8.7%) classified as normal weight normal weight as opposed to almost half the men (15 from 31, 48.3%). Despite the differences in mean weight and BMI they were not statistically significant.

NHANES showed that knee bending demand was associated with a higher rate of OA knee (13). Jobs with high demand on both strength and knee bending included transport operatives, labourers, farmers, janitors and maids whereas jobs with low demand included teachers and office personnel. Forty seven patients, all thirty one men and sixteen of the women, were now or had been in the past employed. Twenty men and four women had work with high demand on their knees (51.1%). The role of occupation on the development of OA could not be determined due to the small number but it possibly may have played a role.

**Disability:** Disability at home was also considered and the two categories were toilet use and prayer.
Concerning toilet use, ninety-six individuals normally use the squat toilet. Twenty-three (24%) could use without any difficulty, twenty two (22.9%) had pain and modified their seating position with use and the remaining fifty one (53.1%) had to convert their toilet type with the use of a chair or stool. The first group could be considered to have good function and the last group poor

Prayer could also be graded into three grades with good being the ability to pray on a mat and only twenty patients were able to do this. The remaining eighty patients were unable.

Since these were daily activities and in the case of prayer several times a day this caused the patients the greatest distress and they had to modify their habits to accommodate this or to bear through the pain. Ten of the men were unable to go to the mosque to pray.

The above two activities depend very much on a normally functioning knee. The knee pain, stiffness seen in fifty-four patients, the quadriceps weakness (fifty three patients) and the actual reduction in range of knee movement all contribute to this reduction in knee function and therefore to the disability suffered by these patients.
Squatting in our community is considered a social habit as well as the more common toilet practice. People tend to sit in low stools or even without such stools in low crouched positions as well as in prayer. As osteoarthritis of the knees causes restriction of flexion as well as pain it can cause sufferers some minor embarrassment especially women who are tend to squat on the floor in certain social events where no proper seating is available. A common such event is when there is a funeral and ladies tend to remain on the floor for a few days in mourning. Inability to squat would mean that the older ladies may not fully participate in this important social event. Men in all events pray in groups and if knee pain and restriction are severe enough the sufferer will be unable to pray on the prayer mat and will use a stool or chair if available or remain kneeled during the prayer.

Squatting on its own is a predisposing factor for development of OA knee (13,85,87). Inability to squat or crouch down can be considered as a marker of disability for both men and women as it may limit their participation in the community.

Another aspect of disability was walking distance and forty-three patients were unable to complete fifty metres without a rest. Carrying a walking stick, if used properly would actually improve their function, was refused by some on the grounds that it made feel and look older than they are. The twelve patients who
used them stated that they depended on it and it helped them greatly. One patient was carried on a chair when her condition flared up and this caused her much discomfort since she needed others to carry her.

All the patients in the study were diagnosed with OA knee according to the ACR criteria (1) by both clinical examination alone or clinical examination and radiological investigation. The finding that twenty-two patients were not radiologically considered to have OA goes to show that some patients are symptomatic without any radiological evidence of OA. The opposite is also true as there are many patients who have been diagnosed with OA knee due to X-ray changes while being asymptomatic. A review of knee pain and OA in older adults showed that 50% of people with radiographic evidence of OA have no pain and 50% of those above fifty five years of age and are complaining of knee pain have no radiographic changes. It concluded that positive X-ray findings are not required to begin treatment especially oral NSAIDs (6).

This radiological scale is useful in community studies to screen for OA and to determine the prevalence of OA in a community. It cannot be used to assess the progression of the disease, as it does not correlate to the clinical picture. In this study 22% had no definite OA features despite their symptoms.
**Treatment:** It can be seen that patients can be asymptomatic for some time before being diagnosed. This may allow for the disease to progress and become more advanced. Advances in treatment especially TKR have allowed such patients who would have become severely disabled to lead a full active life. Only one patient out of the study group has had surgery performed despite eleven having symptoms for more than five years and twenty one having advanced OA according to their radiographic score. Surgical intervention would provide a useful option for such patients.
4.2 Conclusion

From this study we can conclude the following

1. OA of the knee is a disorder more common in women and the elderly. Increased body weight and obesity are important risk factors.

2. The right knee is more commonly affected than the left knee with bilateral affection seen in approximately one fifth of patients.

3. Patients suffer a considerable disability in walking and daily activities mainly toilet use and prayer.

4. Patients can be symptomatic without having radiological changes of OA knee according to the Kellgeren Lawrence scale

5. Treatment of OA is mainly pharmacologic and only one patient from the study has been operated upon.
4.3 Recommendations

From the study the following recommendations have been suggested:

1. That further studies be done at the population level to identify both the incidence and prevalence of OA in the community and to gauge their impact at the community level.

2. To coordinate between orthopaedic specialists and rheumatologists for the treatment of OA patients, and to coordinate between primary health care providers and specialist care to better treat patients.

3. To establish a national centre for OA for which would be equipped with all facilities for the treatment of OA including joint replacement and facilities for physiotherapy and rehabilitation as well as being a centre for ongoing research and training of both doctors and auxiliary staff to further develop the service.
4.4 List of References


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