HAND SEPSIS IN PATIENTS
WITH DIABETES MELLITUS

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( وإذا مرضت فهو يشفين )

صدق الله العظيم

سورة الشعراء آية رقم(80)
Dedication

To

The souls of my parents

Mohammed
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ABBREVIATIONS

+ve  Positive
- ve  Negative
D.M  Diabetes Mellitus
DIP  Distal Interphalangeal
DKA  Diabetic Keto Acidosis
DSF  Diabetic Septic Foot
DVT  Deep Vein Thrombosis
IDDM Insulin Dependent Diabetes Mellitus
PIP  Proximal Interphalangeal
IHD  Ischaemic Heart Disease
L.N  Lymph node
MRSA Methicillin Resistant *Staph. aureus*
KTH  Khartoum Teaching Hospital
M : F Male : Female
NIDDM Non – Insulin Dependent Diabetes Mellitus
No  Number
Pts  Patients
ABSTRACT

This is a prospective analytic hospital based study to identify the clinical presentation, risk factors, causative organisms, management and outcome of hand sepsis in diabetic patients.

75 diabetic patients attending Khartoum Teaching Hospital and Gaber Abu Izz Specialized Center were studied during the period between Sep. 2002 to Sep. 2003. The mean age was $49.4 \pm 12.6$ years and the M : F ratio was 1.1 : 1.0. Hand sepsis was found more common among housewives and employees. Common types of hand sepsis were paronychia in (28.0%), pulp space infection in (28.0%), infection of the other parts of the fingers in (40.0%) and gangrene in (12%) of patients. Peripheral neuropathy in upper extremity occurred in (6.7%) of the patients and most of the patients had good peripheral circulation. 29.3% of patients needed hospital admission, drainage and debridement done in (82.7%) and 17.3% of the patients underwent amputation, 3 patients of them had major upper limb amputation either above or below elbow amputation. 80.0% of the patients had complete healing, 68.0% of them had normal function of the affected part and 12.0% of them had impairment of the function of the affected part. Bacteriological examination showed *Staphylococcus aureus* in 41.3% of cultures and no growth in 25.3% of cultures.

The risk factors for development of hand sepsis in diabetic patients were a history of trauma, poor glycaemic control and housewives job.
We recommended that early good blood glucose control, antimicrobial therapy with adequate drainage and debridement to control the sepsis.
مريض ثانى النمط كان مصاباً بداء السكري عند اليد الخفية. تشخيص المرض في مستوى السكر في الدم، يتطلب الإجراءات الكبيرة والعملية. فضلاً عن ذلك، فإن مراقبة التحكم في النقص، والعملية، والتحكم في الריות، وتشخيص الأمراض، والدم في مستوى السكر، يصبحون مثيراً للقلق. عند ذلك، يلزم التحلي بالصبر، والقدرة على تحمل الواقع، والعمل في تلبية الاحتياجات، والذين يساهمون في الدعم، والحماية، والرعاية.
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1.1. INTRODUCTION

Until the advent of antibiotics, infections of the hand often resulted in severe disabilities, including stiffness, contracture, and amputation. Although such unfortunate results are now less common, they still can and do occur. Improper treatment, as well as delay instituting appropriate therapy, can result in a disastrous outcome\(^{(1)}\).

Diabetes is associated with increased incidence of and morbidity from local and systemic infection\(^{(2)}\). A predisposition to sepsis in a patient with diabetes is a recognized entity with a significant morbidity to the patients\(^{(3)}\). Upper extremity infection in diabetic patients can rapidly lead to tissue destruction, necrosis and sepsis\(^{(2)}\). Clinical studies of upper extremity infections in diabetic patients are relatively few and limited in scope\(^{(2,4)}\). Although not generally recognized as a specific diabetic complication, hand infections nonetheless, result in substantial morbidity or mortality. They are seen most frequently in tropical settings and are commonly associated with mild preceding trauma that may rapidly progress to extensive gangrene of the limb\(^{(5,6,7)}\).
1.2. Historical background:-

Hand ulceration and infection in diabetic patients was first described in United States in 1977\(^6\) and in Africa in 1984 in Nigeria where five (3\%) of 152 consecutive diabetic patients developed hand ulceration and sepsis that were associated with gangrene. In 1991 researchers in Nairobi, Kenya, identified 15 patients with hand ulcer. Although nine of these had ulcers described as neuropathic, the report did not suggest underlying risk factor, possible etiology, or whether the patient had diabetes. During a 6- months period in 1992, 150 patients with hand infections presented to Khartoum teaching hospital. The majority of these patients were manual workers and trauma was the main cause of hand sepsis, and 15 (10\%) patients had diabetes\(^5\).

1.3. Diabetes mellitus

1.3.1 Definition:

Diabetes mellitus is a syndrome characterized by chronic hyperglycaemia that is due to relative insulin deficiency, resistance or both\(^8\).

The diabetes is either primary (idiopathic) or secondary diabetes in which there is pancreatic destruction, insulin antagonism (steroid therapy) or
other causes of glucose intolerance (thyrotoxicosis, pregnancy, thiazide diuretics and advanced liver disease)\(^8\).

### 1.3.2 Types of D.M:

There are two clinical types of patients:

1. **Insulin dependent diabetes mellitus (IDDM type I):** It occurs in thin and young. It often presents acutely with severe systemic diseases, malaise, fatigue, weight loss, polyuria, polydipsia, infections and sometimes pre coma and coma\(^8\).

2. **Non-insulin-dependent diabetes mellitus (NIDDM type II):** It occurs in the over weight and elderly. It is often asymptomatic and detected by routine urine testing\(^10\).

### 1.3.3. Clinical presentation of diabetes mellitus\(^8\):

Acute and sub acute presentations often overlap.

#### 1.3.3.1. Acute presentation:

Young people may present with brief 2-4 weeks history and report the classic triad of symptoms:

- Polyuria: due to osmotic diuresis that results when blood glucose levels exceed the renal threshold.

- Thirst: due to resulting loss of fluids and electrolytes.
- Weight loss: due to fluid depletion and the breakdown of fats and muscles secondary to insulin deficiency.

Ketoacidosis may be the presenting feature if these early symptoms are not recognized and treated\(^8\).

**1.3.3.2. Sub acute presentation\(^8\):**

The clinical onset may be over several months, particularly in older patients. Thirst, polyuria and weight loss are usual feature, but medical attention is sought for such symptoms as lack of energy, visual blurring or pruritus vulvae or balanitis that is due to Candida infection.

**1.3.3.3. Complications as the presenting feature\(^8,9,10\):**

These include:

1. Staphylococcal skin infections.
2. Retinopathy noted during a visit to optician.
3. A polyneuropathy; peripheral sensorimotor neuropathy is the main manifestation of neurological damage in diabetes, while autonomic neuropathy, a devasting complication, is also present in large number of patients with long-term diabetes\(^11\).
4. Impotence.
5. Arterial disease, resulting in myocardial infarction or peripheral gangrene.
1.3.3.4. **A symptomatic D.M.** (8):

Glucosuria or raised blood glucose may be detected on routine examination in individuals who have no symptoms of ill-health.

1.3.4. **Investigation of diabetes** (8,10,12):

1- In symptomatic patients, a single elevated blood glucose more than or equal 11.1 m mol\L, measured by a reliable methods, indicates diabetes.

2- In a symptomatic or mild symptomatic patients the diagnosis is made on:
   
i- At least one, preferably two, fasting blood glucose level above 6.7 m mol\L (120 mg\dl) – the equivalent venous plasma level is 7.8 m mol\L (140 mg\dl); OR
   
ii- At least one, preferably two, random values above 10.0mmol\L (180 mg\dl) in venous whole blood, or 11.1m mol\L (200mg\dl)in venous plasma.

3- A glucose tolerance test should be reserved for true border line cases.

4- Glucosuria is measured by using sensitive glucose-specific dipstick methods. Glucosuria is not diagnostic for the diabetes but indicates the need for further investigations.
Other routine investigations include screening of urine for proteinuria, a full blood count, urea and electrolytes, liver biochemistry and a fasting blood sample for cholesterol and triglycerides.

1.3.5. Management of D.M. (8):

Most diabetics are best managed in diabetes clinics where there is close liaison between expert physician, special experienced nursing staff, ophthalmologist, dietician and chiropodist.

1.3.5.1. N.I.D.D.M (10):

Reduction of dietary calorie intake to roughly 1000-1600 calories with weight loss may be sufficient to reduce blood glucose level towards normal and to abolish symptoms. If not, give oral hypoglycemic agents, start with a sulphonylurea (e.g. glibenclamide 5-20 mg). The biguanide metformin (500-850 mg/d) may later be added. In the elderly diet alone is usually sufficient.

1.3.5.2. I.D.D.M (10):

The object of therapy is to prevent hyperglycaemic and Hypoglycaemic state. Good control decreases the incidence of intercurrent infection, coma, and possibly decreases ocular and neurological disability.

The new patient is instructed about diet, insulin therapy, injection technique, urine testing and home blood glucose monitoring. Most are
started on empirical twice-daily insulin injection combining short and medium acting preparation (e.g. 12-20 units b.d depending on the blood glucose). Hyperglycemia remains the major complication of the insulin therapy.

1.4. LITERATURE REVIEW

The hand infection in diabetic patients

1.4.1 Epidemiology:

Although not generally recognized as a specific diabetic complication, hand infections nonetheless result in substantial morbidity and mortality\(^{(5)}\):
In Nigeria in 1984 3% of 152 consecutive diabetic patients developed hand ulceration and sepsis\(^{(5)}\).

In 1992, 150 patients with hand infection presented to Khartoum teaching hospital; 10% of them had diabetes\(^{(13)}\).

Hand infections are seen most frequently in Africa and tropical settings\(^{(5,6)}\).

1.4.1.1. **Sex**\(^{(5,14)}\):

Females were affected more than males.

1.4.1.2. **Age**\(^{(2,6,13,14,15)}\):

Hand sepsis in diabetics commonly occurred between 40-60 years of age but it can affect any age group.

1.4.1.3. **Occupation**\(^{(13)}\):

The majority of patients were manual workers.

1.4.1.4. **Environment**\(^{(5)}\):

There is no discernible seasonal variation in the incidence of hand sepsis among the diabetic population.

1.4.1.5. **Morbidity and mortality**\(^{(5,15)}\):
The morbidity rate was high among Libyan patients, whereas the mortality rate was high among the Tanzanian patients (16%). Prolonged hospital stays were common among diabetic patients with hand sepsis.

1.4.2. Risk factors:

Various risk factors for diabetic hand sepsis have been postulated. These include insect bites or history of hand trauma, type 2 diabetes, female sex, poor glycaemic control, diabetics who were renal transplant recipient, low socioeconomic status or late presentation to hospital\(^5,16,17,18\). Lack of preventive care and difficulty in gaining easy access to medical help may be two of the factors responsible for patients presenting at late stages of limb infections\(^5\). An increased rate of amputation is associated with deep infections below the subcutaneous tissue, renal failure, and infections with gram-negative anaerobic, or polymicrobial cultures. An increased rate of repeat surgery and prolonged hospitalization are associated with deep infection and polymicrobial infections\(^2\).

Hand neuropathy may occasionally lead to anaesthetic injuries in certain manual occupations\(^19\).

1.4.3. Anatomy of the spaces of the hand:
Normally, the fascial spaces of the palm are potential spaces filled with loose connective tissue. Their boundaries are important clinically, since they may limit the spread of infection in the hand.

The triangle-shaped palmar aponeurosis fans out from the lower border of the flexor retinaculum. From its medial border a fibrous septum passes backward and is attached to the anterior border of the fifth metacarpal bone (Fig. 1-1) Medial to this septum is a fascial compartment containing the three hypothenar muscles; this compartment is unimportant clinically. From the lateral border of the palmar aponeurosis, a second fibrous septum passes obliquely backward to the anterior border of the third metacarpal bone (Fig. 1-1). Usually, the septum passes between the long flexor tendons of the index and middle fingers. This second septum divides the palm up into the thenar space, which lies lateral to the septum (and must not be confused with the fascial compartment containing the thenar muscle), and the midpalmar space, which lies medial to the septum (Fig. 1-1)\(^{(20)}\).

1.4.3.1. The thenar space:

Contains the first lumbrical muscle and lies posterior to the long flexor tendons to the index finger and in front of the adductor pollicis muscle (Fig 1-1)\(^{(20)}\).
1.4.3.2. The mid palmar space:

Contains the second, third and forth lumbrical muscles and lies posterior to the long flexor tendons to the middle, ring and little fingers. It lies in front of the interossei and the third, forth and fifth meta carpal bones (Fig. 1-1)(19).

Proximally, the thinar and midpalmar spaces are closed off from the forearm by the walls of the carpal tunnel. Distally, the two spaces are continuous with the appropriate lumbrical canals (Fig. 1-1)(20).

1.4.3.3. The lumbrical canals:

Is a potential space surrounding the tendon of each lumbrical muscle and is normally filled with connective tissue. Proximally, it is continuous with one of the palmar spaces(20).

1.4.3.4. Pulp space of the finger:

The deep fascia of the pulp of each finger fuses with periosteum of the terminal phalanx just distal to the insertion of the long flexor tendons and closes off a fascial compartment known as the pulp space (Fig. 1-1). Each pulp space is subdivided by the presence of numerous septa, which passes from the deep fascia to the periosteum. Through the pulp space, which is filled with fat, runs the terminal branch of the digital artery that supplies the diaphysis of the terminal phalanx.
Thrombosis of the vessels caused by infection of the pulp space, will result in the necrosis of the diaphysis of the bone. The epiphysis of the distal phalanx receives its blood supply proximal to the pulp space\textsuperscript{(20)}.

At each of the skin creases of the fingers, the skin is bound down to the underlying flexor sheath so that the pulp over each phalanx is in a separate compartment cut off from its neighbours. Infection may, however, track from one space to another along the neurovascular digital bundles\textsuperscript{(21)}.

Over the palm of the hand there is very little subcutaneous tissue, the skin adhering to the underlying palmar fascia; in contrast, the skin of the dorsum of the fingers and the hand is loose and fluids can, therefore, readily collect beneath it. Unless this is remembered the marked dorsal edema which may accompany sepsis of the palmar aspect of the finger or hand may result on the primary site of the infection being overlooked\textsuperscript{(21)}.

The fibrous flexor sheaths are lined by synovial membrane, which is reflected around each tendon. The tendons of the second, third and forth fingers have synovial sheaths which are closed off proximally at the metacarpal head, but the synovial sheaths of the thumb and little finger extend proximally into the palm. That of the long flexor tendon of the thumb extend through the palm, deep to the flexor retinaculum to about one inch (2.5 cm) proximal to the wrist and is termed the radial bursa. The synovial
sheaths of the fifth finger continuous as the ulnar bursa; an expanded
synovial sheath which encloses all the fingers tendons in the palm and which
also extend proximally below the flexor retinaculum for one inch (2.5 cm)
above the wrist. In about 50% of cases the radial and ulnar bursa
communicates. These synovial sheaths may become infected either
directory, for example, following the entry of a splinter, or may be
secondarily involved from a neglected pulp space infection. Infection of the
second, third and forth sheaths are confined to the finger concerned, but
sepsis in the first and fifth sheaths may spread proximally into the palm
through the radial and ulnar bursa respectively, and may pass from one bursa
to another via the frequent cross-communication between the two. Since
these both bursae extend proximally beyond the wrist, infection may, on
occasion, spread into the forearm\(^\text{(21)}\).

1.4.3.5. Web spaces:

Three web spaces lie in the distal part of the palm between the
bases of the proximal phalanges of the four fingers. From the skin edge they
may be said to extend proximally as far as the metacarpophalangeal joints.
Between the palmar and dorsal layers of the skin lie the superficial and deep
transverse ligaments of the palm, the digital vessels and nerves, and tendons
of interossei and lumbricals on their way to the extensor expansions. The web is filled in with a packing of loose fibrofatty tissue\textsuperscript{(22)}.

\textbf{1.4.3.5.1. The web of the thumb:}

Lacks both superficial and deep transverse ligaments, a factor contributing to the mobility of the thumb. The transverse head of adductor pollicis and the first dorsal interrosseous muscle lie here and between them emerge the radialis indicis and princeps pollicis arteries. Each hugs its own digit and the central part of the web can be incised without risk to either vessel\textsuperscript{(22)}.

\textbf{1.4.3.2. Arteries of the palm of the hand:}

\textbf{1.4.3.2.1. Ulnar artery:}

The ulnar artery enters the hand anterior to the flexor retinaculum on the lateral side of the ulnar nerve and the pisiform bone. The artery gives off a deep branch and then continues into the palm as the superficial arch\textsuperscript{(20)}.

\textbf{1.4.3.2.1.1. The superficial palmar arch:}

Is a direct continuation of the ulnar artery. On entering the palm it curves laterally behind the palmar aponeurosis and in front of the long flexor tendons. The arch is completed on the lateral side by one of the branches of the radial artery, either the superficial palmar branch, the radialis indicis or
princeps pollicis. The curve of the arch lies across the palm, level with the distal border of the fully extended thumb\(^{(20)}\).
1.4.3.2.2. Digital arteries:

Four digital arteries arise from the convexity of the arch and pass to the fingers. The most medial artery supplies the medial side of the little finger, and the remaining three subdivided into two and supply the contiguous sides of the little, ring, middle and index fingers respectively\(^{(20)}\).

1.4.3.2.1.3. The deep branch of the ulnar artery:

Arises in front of the flexor retinaculum, passes between the abductor digiti minimi and flexor digiti minimi, and joints the radial artery to complete the deep palmar arch\(^{(20)}\).

1.4.3.2.2. Radial artery:

The radial artery leaves the dorsum of the hand by turning forward between the proximal ends of the first and second metacarpal bones and the two heads of the first dorsal interosseous muscle. On entering the palm, it curves medially between the oblique and transverse heads of the adductor pollicis and continues as the deep palmar arch\(^{(20)}\).

1.4.3.2.2.1. The deep palmar arch:

Is a direct continuation of the radial artery. It curves medially beneath the long flexor tendons and is in contact posteriorly with the metacarpal bones and the interosseous muscles. The arch is completed on the medial side by the deep branch of the ulnar artery. The curve of the arch
lies across the upper part of the palm at a level with the proximal border of the extended thumb.

The deep palmar arch send branches superiorly, which take part in the anastomosis around the wrist joint, and inferiorly, to join the digital branches of the superficial palmar arch\(^{(20)}\).

1.4.3.2.2.2. Branches of the radial artery in the palm:

1- The arteria radialis indicis, which supplies the lateral side of the index finger.

2- The arteria princeps pollicis, which divided into two and supplies the lateral and the medial sides of the thumb\(^{(20)}\).

1.4.3.3. Digital nerves:

Lying immediately deep to the superficial palmer arch are:

*The common palmer digital nerves*: They path distally to the webs, between the slips of the palmer aponeurosis, and divided like the arteries (but proximal to the arterial divisions) into *proper palmer digital nerves*, which lie anterior to the arteries in the fingers. Before terminating they each give a dorsal branch and thereby supply all the five nail beds. Incisions along the margins of the fingers should be sited slightly dorsally to avoid damage to the digital nerves\(^{(22)}\).
The ulnar nerve divides into superficial (cutaneous) and a deep (muscular) branch on the flexor retinaculum. The superficial branch divides into two branches: the medial one supplies the ulnar site of the little finger, the lateral, the cleft and adjacent side of little and ring fingers\(^{(22)}\).

The median nerve enters the palm beneath the flexor retinaculum. Distal to the retinaculum it enlarges and flattens and gives a muscular (recurrent) branch, which curls proximally around the distal border of the flexor retinaculum to supply the thenar muscles. Incision of the synovial sheath of the tendon of flexor pollicis longus in the palm will endanger the nerve if the cut is not kept sufficiently distal\(^{(22)}\).

The median nerve then usually divides into two branches. The medial branch divides again into two and supplies palmar skin, the cleft and adjacent sides of ring and middle fingers and the cleft adjacent sides of middle and index fingers. The later branch supplies the second lumbrical muscle. The lateral branch supplies palmar skin, the radial side of the index, the whole of the thumb and its web on the palmar surface and distal part of the dorsal surface. The branch to the index supplies the first lumbrical\(^{(22)}\).

1.4.3.4. Lymph drainage of the palm of the hand:

The lymph vessels of the fingers pass along their borders to reach the webs. From here, the vessels ascend onto the dorsum of the hand. Lymph
vessels of the palm form a plexus that is drained by vessels that ascend in front of the forearm or pass around the medial and the lateral borders to join vessels on the dorsum of the hand.

The lymph from the medial side of the hand ascends in vessels that accompany the basilic vein; they drain into the supratrochlear nodes and then ascend to drain into the lateral axillary nodes. The lymph from the lateral side of the hand ascends in vessels that accompany the cephalic vein; they drain into the infraclavicular lymph nodes, and some drain into the lateral axillary nodes\(^{(20)}\).

1.4.4. Pathophysiology of the hand infection:

The risks of infection in diabetic patients from bacteria and fungi are increased because of decreased cellular immunity caused by acute hyperglycaemia and circulatory deficits caused by chronic hyperglycaemia. Also, ketoacidosis has a recognized association with impaired phagocytosis and altered white cell chemotactic ability that may render diabetic patients susceptible to bacterial or fungal infections. So organisms enter the hand when there is disruption of the skin which caused by mild trauma, insect or animal bites and by intravenous cannulation\(^{(5,23,24,25,26)}\).

Although, peripheral neuropathy and peripheral vascular disease are not important risk factors in pathogenesis of hand sepsis; hand neuropathy
may occasionally lead to anaesthetic injuries, particularly in certain manual occupations\textsuperscript{(5,6,19,27)}.

Skin infections most commonly derive from direct bacterial inoculation\textsuperscript{(28)}. Secondary spread from contiguous sites and hematogenous seeding are less likely\textsuperscript{(29)}.

Due to mobilization of the hand, the infection may be milked into uninvolved areas and progress further\textsuperscript{(29)}.

Trauma and inflammation cause tissue tension by sequestration of oedema fluid. This in turn impairs tissue oxygenation by compressing the blood vessels, and a vicious cycle may develop that can lead to necrosis within the constrictive sleeves of fascia and skin\textsuperscript{(29)}.

Throbbing pain is a symptom of excessive swelling that demands prompt mechanical relief and not analgesics\textsuperscript{(29)}.

The rigidity of the fingernail causes it to press upon and aggravate any inflammation of the soft tissues surrounding it. The nail fold is often traumatized and becomes secondarily inflamed, leading to a paronychia on the radial or ulnar side\textsuperscript{(29)}.

The most severe infections occur in insulin – dependent diabetic patients or those with chronic renal failure because of protein depletion, poor wound healing, neuropathy and ischemia\textsuperscript{(30)}. 
1.4.4.1. *Abscesses* may develop at deferring levels in the tissue:

1.4.4.1.1. *Subcuticular*: lying immediately beneath the epidermis; this is easily recognized, being a thinly covered pocket of pus under very little tension.

1.4.4.1.2. *Intracutaneous*: it occurs most commonly on the dorsum of the fingers in the form of a boil\(^{(31)}\).

1.4.4.1.3. *Subfascial*: lying beneath the palmar aponeurosis\(^{(31)}\).

The deeper abscesses may, in the necrotic process of the overlying tissue known as ‘pointing’, communicate with more superficial layers. Collar-stud abscesses are so formed. The term indicates that two loci of pus communicate with one another through a narrow channel. In the case of subfascial abscesses, there may develop an abscess with three pockets, one subcutaneous and one subcuticular. The implications surgically are quite clear – the more superficial abscess may be drained and the deeper not recognized, resulting in continued infection\(^{(31)}\).

1.4.5 **Bacteriology of the hand infection:**

The most common infecting organisms are *Staphylococcus* and β-haemolytic streptococci, Gram negative, anaerobic, and mixed infection are seen\(^{(28,29)}\).
K. Ezeldeen et al (1992) Khartoum, regarded his bacteriological profile: Staph. aureus was isolated in 51% of culture, β- hemolytic streptococcus in 11% and no growth in 26% of the swab cultures and (40%) of the diabetic patients in this study had staphylococcal infections\(^{(13)}\).

1.4.5.1 *Staphylococcus aureus*\(^{(28)}\):

Is a Gram +ve coccus about 1\(\mu\)m in diameter, the cocci are mainly arranged in grape like clusters, but some, specially when examined in pathological specimens, may occur as single cell or pairs of cells. The organisms are non sporing, non motile, and usually non capsulated.

1.4.5.1.1 Methicillin Resistant *Staph. Aureus* (MRSA):

MRSA strains are an increasing infection control problem and therapeutic challenge. These strain, which are resistant to all ß-lactam agents, and often to other agents such as the aminoglycoside and fluoroquinolones, commonly colonize broken skin, but can cause the full range of staphylococcal infections. The resistance gene \(meca\) codes for a unique penicillin – binding protein and is transmitted chromosomally. These are predominantly hospital pathogens in debilitated patients, such as those in intensive care units, where the combination of multiple courses of antibiotics and the use of the invasive devices contribute greatly to the risk of acquisition. MRSA is also becoming more common in the community, specially in
long-stay institutions. Glycopeptides (vancomycin or teicoplanin) are the agents of choice in the treatment of systemic infection, but these agents are expensive and may be toxic\(^{(32)}\).

1.4.5.1.2 Enzymes production:

1- Coagulase: which converts plasma fibrinogen into fibrin.

2- Nucleases: break down the DNA.

3- Clumping factor or bound coagulase: a surface associated protein that reacts with fibrinogen.

1.4.5.2. \(\beta\)-haemolytic Streptococcus:

It is a Gram +ve that typically grow as chains or pairs. It is non sporing and non motile. Also it is catalase negative and strong fermenters of carbohydrates. Colonies of \(\beta\)-hemolytic Streptococci surrounded by a free zone, usually several millimeters in diameter, caused by lysis of red blood cells in the agar medium induced by bacterial haemolysins\(^{(33)}\).

1.4.5.2.1. \textit{Streptococcus pyogenes}:

It is exclusively associated with infections in man. It causes a wide range of suppurative infections in the respiratory tract and skin, life-threatening soft tissue infections and certain types of toxin associated reactions. The capsule of \textit{Streptococcus pyogenes} is identical to the
hyaluronic acid of the connective tissue of the host and is not immunogenic\cite{33}.

The bacteria may, in this way, disguise with an immunological ‘self’ substance like:

1.4.5.2.2. Enzymes of \textit{Streptococcus pyogenes}\cite{33}.

1.4.5.2.2.1. C5a peptidase:

It specifically cleaves, and inactivates human C5a, one of the principle chemoattractants of the phagocytic cells.

1.4.5.2.2.2. Streptolysins:

These are streptolysins O (oxygen labile) and S (serum soluble), both of which lyse erythrocytes, polymorphonuclear leukocytes and platelets by forming pores in their cell membrane.

1.4.5.2.2.3. Pyrogenic exotoxin:

Called pyrogenic exotoxin because of their ability to induce fever. SPEA, SPEB and SPEC have been extensively characterized, but there are several others.

SPEA and SPEC are called erythrogenic toxins, as they are responsible for the rash observed in the patients with scarlatina.

1.4.5.2.2.4. Hyaluronidase:
It degrades hyaluronic acid, the ground substance of host connective tissue. This property may facilitate the spread of infection along facial planes.

1.4.5.2.2.5. Streptokinase:

Known as fibrinolysin, is another spreading factor and it activates host plasminogen to plasmin.

1.4.5.2.2.6. Lipoproteinase:

It is also called opacity factor as it induces opalescence in growth media containing serum.

1.4.5.2.2.7. Deoxyribonucleases (DNAases):

They hydrolyse the nucleic acid and may play role as spreading factor by liquefying viscous exudates\(^{(33)}\).

1.4.5.3. E. faecalis:

It is a member of the genus Enterococcus. It is important cause of wound urinary tract infection in hospital and may cause sporadic outbreaks. Bacteraemia carries a poor Prognosis as it often occur in patients with major underlying pathology and in those who are immunocompromised\(^{(33)}\).
1.4.5.4. *Escherichia:*

Strains of *E. coli* and related Gram –ve ‘coliform’ bacteria predominate among the aerobic commensal flora in the gut of humans and animals.

These strains are usually motile and may produce a polysaccharide capsule. They grow well in non-selective media, and most strains ferment lactose producing large red colonies in MacConkey agar. They grow over a wide range of temperature (15-45°C). Certain strains are haemolytic when grown in media containing suitable erythrocytes.

_E. coli_ can be differentiated from other numbers of the _Enterobacteriaceae_ by the ability to utilize certain sugars and by an arrange of other biochemical reaction like indole production and the formation of acid and gas from lactose and other carbohydrates.

Serotyping is based on the distribution of lipopolysaccharide (LPS) or somatic (O) antigens, and flageller (H) and capsular (K) antigens, as detected in agglutination assays with specific rabbit antibodies.

The polysaccharides of the O and K antigens protect the organism from the bactericidal effect of the complement and the phagocytes in the absence of specific antibodies. However in the presence of antibody to K antigen or to both O and K opsonization may occur.
Hemolysin production is an important pathogenic mechanism for release essential ferric iron bands to hemoglobin\(^{(34)}\).

1.4.5.5 *Pseudomonas aeruginosa*:

*Ps. aeruginosa* is a G-ve, non sporing, non capsulated bacilli and usually motile by virtue of one or two polar flagella. It is strict aerobe but it can grow anaerobically if nitrate is available. The organism grows readily in a wide variety of culture media over a wide temperature range and emits a sweet grape-like odor that is easily recognized. Most strains produces diffusible pigments; typically the colony and surrounding media is greenish blue. It can infect almost any external site or organ. Most community infections are mild and superficial, but in hospital patients infections are more common, more severe and more varied\(^{(35)}\).

1.4.5.5.1 Virulence factors :

- Proteases play a key role in corneal ulceration.
- Exotoxin and proteases are important in burn infection.
- Phospholipases proteases and alginate are associated with chronic pulmonary colonization.
- Fluorescein or pyoverdin pigments act as bacterial siderosphores\(^{(35)}\).

1.4.5.6 *Klebsiella*:
*K. aerogenes* used for a non motile, capsulated, gas producing stains commonly found in human faeces and in water. It’s growth in an agar is luxuriant, grayish, white and extremely mucoid. The organism grows at temperature between 12-40°C (optimum = 37°C) and are killed by moist heat at 55°C for 30 min. Clinical sepsis caused by *Klebsiella* develops in surgical wounds and in urinary tract.

Clinical isolates of *Klebsiella* characteristically produce β-lactamase that renders them resistant to ampicillin, amoxicillin and other penicillins, but combination of these drugs with β-lactamase inhibitors such as clavulanic acid are usually effective. *Klebsiella* are usually susceptible to cephalosporins specially β-lactamase-stable derivatives such as cefuroxime and cefotaxime and fluoroquinolones\(^{(36)}\).

**1.4.5.7. Bacteroides:**

Gram negative, an anaerobic, non-spore forming, non-motile rods. It is the most common cause of none clostridial anaerobic infection in man. Organisms of *B. fragilis* group are particularly significant, since they are the most commonly isolated and tend to be more resistant to anti microbial agents than most anaerobic\(^{(37)}\).

**1.4.6. Clinical feature of hand infection:**

**1.4.6.1 History:**
1.4.6.1.1. Injury:

The majority of the patients recall the injury, which preceded the infection. In most cases it was trivial and received little or no treatment. Nonetheless, its position and type will indicate the exact diagnosis. In certain less common infections, the surroundings and occupation in which the injury occurred are important, giving the clue to nature of the infection, e.g.:

- Injuries in contaminated water — *Mycobacterium marinum*.
- In an animal slaughter house — *Erysipelothrix rhusiopathia*.
- In dentists and nurses — *Herpes simplex*.
- In barbers — Interdigital pilonidal sinus\(^{(31)}\).

1.4.6.1.2. Time lapse:

Time lapse since injury will often differ according to the infection.

- Cellulitis occurs within 24 hours.
- Tendon sheath infection develops within 48 hours.
- Webs and Deep palmar infections need days to develop.
- Paronychia and Pulp infections develop within 4-5 days.
- Septic arthritis needs up to 2 weeks to develop after injury\(^{(31)}\).

1.4.6.1.2 Symptoms:

1.4.6.1.2.1. *Pain and loss of function*:
Are two of the five cardinal signs of inflammation and are always present in the patient with a hand infection. If pus is present within a confined compartment, the pain will be of throbbing nature. While function will be impaired wherever the infection is seated, the disability is greatest in tendon sheath infection.

1.4.6.1.2.2. Tenderness:

Radiating up to the arm even to the axilla is evidence of ascending lymphangitis. Usually associated with streptococcal infection, this is often present in cases of cellulitis and sometimes in tendon sheath infection and septic arthritis.

1.4.6.1.2.3. General malaise:

Often with associated pyrexia, as a general rule accompanies only those hand infections which show ascending lymphangitis. It is particularly marked in those with cellulitis.

1.4.6.1.2.4. Loss of sleep:

Is an important symptom to seek, for it invariably indicates pus gathering in the tissue.

1.4.6.1.2.5. Coincident symptoms:

Suggestive of predisposing or causative factors, should also be sought, e.g. diabetes\(^\text{(31)}\).
1.4.6.2 Examination:

The three other cardinal signs of inflammation are found on examination, the affected part being red, swollen and hot\(^{31}\).

1.4.6.3 Paronychia:\(^{I,28,31}\)

Paronychia is the most common infection in the hand. This infection involves the soft tissue fold around the finger-nail. It usually results from introduction of \textit{Staph. aureus} into the paronychial tissue by a sliver of nail or hangnail, a manicure instrument, or a tooth. Because of the continuity of this fold with the eponychial tissue overlying the base of the nail, the infection often extends into this region and may continue around to the fold on the opposite side of the fingernail. This rather unusual occurrence is called a run-around infection.

A chronic paronychia is characterized by swollen, red, indurated eponychium with loss of the cuticle, which normally adheres to the superficial surface of the nail. From the resultant open cul-de-sac small quantities of pus can be expressed. Such chronic paronychia are often encountered in those whose employment involves repeated and prolonged immersion in water\(^{31}\).

1.4.6.4 Pulp space infection:
The pulp space lies anterior to the distal phalanx and is divided into loculi containing fat and fatty tissue by septa running from the front of the phalanx to the skin.

A felon is a subcutaneous abscess of the distal pulp of a finger or thumb. There is often, but not always, a penetrating injury preceding a felon. The pain and swelling usually develop rapidly.

Infection within unyielding loculi rapidly builds up painful tension and interrupts the blood supply to the distal phalanx, predisposing to septic necrosis of the bone.

The expanding abscess breaks down the septa and can extend toward the phalanx, producing an osteitis or osteomyelitis, or toward the skin, causing necrosis and sinus somewhere on the palmar surface of the digital pulp.

The complications of the untreated felon include slough of the tactile pulp, sequestration of the diaphysis of the distal phalanx, pyogenic arthritis of the DIP joint, and a flexor tenosynovitis from proximal extension.

Surgical decompression is therefore performed as soon as an abscess is suspected, i.e. if the pulp is tense, swollen or red, or if the patient complains of throbbing pain.
The space over the middle and proximal phalanx may also be infected directly, but this is less common\(^\text{1,28,39,40,41}\).

### 1.4.6.5. Deep Space Infections in the Palm:

There are four confined spaces in the palm of the hand that are subject to infection. Each presents its own characteristic picture and problems.

#### 1.4.6.5.1. Web spaces ("Collar Button") Abscess:

An infection in the web space (collar button or collar stud abscess) usually occurs through a fissure in the skin between the fingers, from a distal palmar callus or from extension of an infection in the subcutaneous area of the proximal segment of a finger. The pain and swelling are localized to the web space and distal palm. The adjacent fingers lie abducted from each other. The swelling may be more prominent on either the palmar or dorsal aspect, depending on the nature of the infection. The term *collar button* is derived from the hourglass configuration of the abscess, which can develop in one of two ways. One process involves a superficial subepidermal collection of pus within a palmar callosity; a sinus forms through the dermis, leaking pus to a second collection point in the fatty tissue of the volar surface of the distal palm. The other way is through a hole in the palmar fascia distally in the region of the superficial transverse metacarpal
ligaments; this creates palmar and dorsal abscesses that are connected through the fascia. Even though the greater swelling often occurs on the dorsal side, one should not be misled into overlooking the more important volar component of this infection.(1)

1.4.6.5.2. Mid palmar space:

It lies in the palm of the hand between the anterior surfaces of the metacarpals and interossei and the palmar aponeurosis. It becomes infected by direct puncture or by spread from web space or by extension of infection from the flexor sheaths of rays 2, 3, or 4. Because the palmar aponeurosis restricts swelling anteriorly, swelling of the hand is disproportionately great on the dorsum, which becomes grossly ballooned. Maximum tenderness is felt anteriorly over those parts of space which are least covered by overlying tissue. Motion of the middle and ring fingers is painful and limited.(1,29,40)

1.4.6.5.3. Thenar space infections:

This process can arise from a penetrating injury, a subcutaneous abscess of the thumb or index finger, a tenosynovitis of the thumb or index finger, or extension of an infection of the radial bursa or midpalmar space. It presents as a marked swelling of the thenar eminence and first cleft, which forces the thumb into abduction. Surgically, this space can be drained from dorsal as well as volar approaches(1).
1.4.6.5.4. **Hypothenar space infections:**

This is an extremely rare entity. It is so unusual that there is virtually no mention of it in the literature. The infection can result from a penetrating injury or a local subcutaneous abscess. It presents as a fullness with considerable tenderness of the hypothenar eminence\(^{(1)}\).

**1.4.6.6. Infections of space of Parona:**

It lies over the pronator quadratous beneath the flexor muscle in the distal forearm. Infection here is usually due to extension of pus from the flexor sheaths of the thumb (radial bursa) or small finger (ulnar bursa). Drainage should be along the ulnar side of the forearm deep to flexor tendons and the ulnar nerve and artery\(^{(29)}\).

**1.4.6.7. Dorsal subaponeurotic and subcutaneous spaces infections:**

The subaponeurotic space lies deep to the extensor tendons on the back of the hand, and the subcutaneous space is superficial to them. Either or both may become infected by puncture, open injury or extension of the infection from the digits and web spaces\(^{(29)}\).

**1.4.6.8. Tenosynovitis\(^{(1,28,37)}\):**
Acute Pyogenic digital tenosynovitis is most frequently a result of direct penetrating trauma, but can also be of heamatogenous origin. The ring, middle and index fingers are the most commonly involved digits. The most common offending organism is *Staph. aureus*.

Kanavel’s cardinal signs of tenosynovitis include:
- Fusiform digital swelling.
- Semiflexed digital posture.
- Significant pain from passive extension of the finger.
- Tenderness along the entire flexor sheath.

Proper management for this closed space tenosynovial abscess is surgical drainage and intravenous antibiotics. A high index of clinical suspicion is requested for diagnosis. Aspiration of the sheath will confirm the diagnosis.

In early cases, systemic antibiotics alone may be considered, but there must be profound resolution within 12 to 24 hrs; otherwise prompt operative drainage is necessary.

**1.4.6.9. Cellulitis:**
Cellulitis in the hand is dramatic in onset. The patient presents with a history of very acute onset of swelling, redness and pain following often a minor injury. He arrives within 12 to 24 hours of the start of infection.

Examination shows that the patient appears ill, pale and sweating often with a marked elevation of temperature.

The most striking feature in the hand is the extensive puffy redness with streaks of lymphangitis often obvious in the forearm. The axillary nodes are enlarged on occasion, but are more often simply tender in the early stages. There may be a haemorrhagic blister present, which can be removed without pain. If a wound is present it is usually unremarkable, exuding only a few drops of serous fluid. Culture of the serous fluid from either the blister or the wound usually yields haemolytic streptococcus. Incision and drainage is never indicated in cellulitis and is indeed meddlesome\(^\text{31}\).

1.4.6.10. **Lymphangitis and adenitis:**

Are most often due to streptococcal infection and require elevation and immobilization as well as antibiotics. Lymphangitis; a red streaks running up to the arm and lymphadenopathy involves the epitrochlear or axillary lymph nodes\(^{29,38,39}\).

1.4.6.11. **Gangrenous infections:**
Various anaerobic organisms can cause gas-producing infections in the hand. Anaerobic or microaerophilic streptococcus is though to cause Meleney’s infection, a rapid swelling and gangrenous change in a digit following an insignificant puncture wound. Classic gas gangrene from clostridial infections can occur after a variety of open wound injuries.

Such problems require immediate opening of the affected part, adequate debridement, and thorough irrigation of the wound. An initial culture prior to administration of antibiotics is essential. The wound must be left open. Appropriate antibiotic therapy must begin immediately. Amputation of the affected part may be required to save the life of the patient.

The diabetic gangrene predominately neuropathic was better cured and the arteriopathic component breaks the medical curing and impose high amputation; diabetic gangrene is more frequent with older people\(^{(1,42)}\).

1.4.6.12. Bone and joints infections:

1.4.6.12.1. Septic arthritis\(^{(31)}\):

Septic arthritis should be suspected in the presence of a wound overlying the finger joints dorsally. If such a wound continues to discharge small quantities of sero-purulent fluid more than a week after the original injury then suspicion should approach certainty.
By far the most common cause of septic arthritis is a human ‘bite’. Septic arthritis can develop without such a wound or indeed any recent injury. In such a situation, the surgeon should be mindful of less common causes of septic arthritis, such as gonorrhea, and of the non-infective causes of acute arthritis, including gout and rheumatoid disease. The clinical features of septic arthritis are:

- Swelling out of proportion to the inflammation present in the skin around the wound and, at later stages.
- Restricted motion in the joint; this is often surprisingly slow to develop but eventually both flexion and extension will produce pain.
- Instability will be evidenced latterly by increased laxity in the collateral ligaments; this motion may be accompanied by crepitus.
- Discharging sinuses will develop if drainage is not instituted.
- Radiological changes, only the first of which is apparent in the initial two weeks, are, in sequence:
  - Dorsal soft tissue swelling evident on lateral views.
  - Decalcification of the juxta articular bone.
  - Narrowing of the joint space.
  - Progressive fragmentation of the bone ends.
It should be emphasized that instability, sinuses, x-ray changes and even severe pain on motion may not be present at the stage when the patient with septic arthritis can best be helped. The surgeon therefore must have a high degree of awareness when disproportionate swelling accompanies a wound in the appropriate site and which continues to discharge long after injury. Culture of the effusion from the wound and also of the synovial fluid when the wound is explored is mandatory\(^{(31)}\).

**1.4.6.12.2. Osteomyelitis:**

Osteomyelitis is almost always the result of the direct involvement of bone from an adjacent wound infection, adjacent joint infection, or tenosynovial infection. Injuries that penetrate directly into the bone can also cause osteomyelitis. Hematogenous osteomyelitis is rare in the hand, probably because of the widespread use of antibiotics to treat the kinds of infections elsewhere in the body that might produce a bacteremia. The most common of these organisms is *Staph. aureus*.

The incisions or approaches depend on the location of the bone involved. In the phalanges a midaxial incision is preferred, whereas in the metacarpals dorsal approaches work best. The infected areas are curetted if
they are soft enough, but cortical drill holes may be needed so that a small window can be removed. All infected bone, as well as any sequestra, must be removed. Postoperatively, the wound can be packed open and allowed to heal by secondary intention after removal of the packing. An alternative regimen that is preferred whenever possible is constant irrigation of the site with sterile saline through a 16-gauge polyethylene catheter. The wound is closed over the catheter while a Penrose drain is placed at the opposite end of the incision to allow egress of the fluid\(^{(1)}\).

1.4.6.13. **Persistent infection:**

A part from unusual organisms, there are several factors which cause infection to persist despite treatment.

1.4.6.13.1. Inadequate drainage is by far the most common and is most likely to occur.

- When incision has been performed too early, that is, before throbbing and sleep loss indicated pus accumulation.
- When the incision has not been made over the point of maximum tenderness.
- When all pocket have not been drained – this is especially common when a collar-stud abscess has developed.
- Where the drainage incision has been allowed to heal too soon, leaving a cavity. This is prevented by copious, repeated irrigation
through an indwelling catheter introduced through adjacent healthy skin.

1.4.6.13.2. *Presence of a foreign body, sequestrum of bone or slough.*

1.4.6.13.3. *Ischaemia of the limb:*

1.4.6.13.4. *Continued trauma to the part:*

   *This may be iatrogenic, unintentional or factitious.*

1.4.6.13.5 *Generalized systemic disorders:*

   Sufficiently severe to prevent wound healing should be immediately apparent. However, a full physical examination with special laboratory studies should be undertaken in all persistent infections where no cause is located.

1.4.6.13.6 *Uncommon organisms:* have been recorded as causing hand infections:

   - *Mycobacterium* (*fortuitum, kansasii, marinum*, and others) have been reported in recent years involving tendon sheaths, bursae, joints, fascia and bone in that order of frequency. The more chronic forms may be mistaken for gout or rheumatoid disease.

   - *Histoplasmosis* and *Coccidioidomycosis*: both of the tendon sheath.
These are merely examples of a much wider range of uncommon flora, which may complicate the management of a hand infection. In all instances of infection resistant to treatment the active guidance and participation of the bacteriologist should be sought in establishing the diagnosis\(^{(31)}\).

1.4.7. Treatment of the hand infection:

Most diabetic hand infections are non-specific, confined to the soft tissues, and respond to broad spectrum parenteral antibiotic therapy. When surgery is necessary, most patients do not require amputation\(^{(43,44)}\).

Before referring the patient to surgery the diabetologist should carefully evaluate the presence of complications, cardiovascular, renal and neurologic disorders in particular. Generally no problems are posed by patients with NIDDM undergoing elective surgery. For more demanding patients and for those with IDDM the most effective and ready treatment is the continuous intravenous infusion of glucose, insulin and potassium. With this regimen, it is possible to perform surgery in diabetics with low risk\(^{(47)}\).

1.4.7.1 Principles of surgical treatment:

1.4.7.1.1 Incision and drainage of abscess:

1.4.7.1.1.1. Incision:
The type and placement of incisions must not only allow direct access to the abscess but also follow accepted surgical principles of hand surgery.

All incisions should permit easy extension in any direction in case the magnitude of the problem is greater than anticipated.

The incision or its extension should not transverse any flexion crease at or approaching a right angle, lest a contracture develop.

The approach should avoid injuring the vessels, nerves, or tendons.

The incision should be planned to avoid compromising the blood supply to an adjacent area or leaving a sensitive scar, especially in an important tactile area.

Wounds should be made large enough and should be zigzagged when necessary to avoid secondary contractures\(^{(1,29)}\).

1.4.7.1.1.2. Drainage of abscess:

1.4.7.1.1.2.1 Simple rules of drainage:

- Do not wait for fluctuant swelling in hand infections.

- Pus is present, even when it cannot be seen, if:
  
  i. The patient complains of throbbing pain.

  ii. He has lost a night’s sleep.
In the presence of pus, always incise over the point of maximum tenderness. If pus cannot be seen through the skin, the point of maximum tenderness should be sought by gentlest pressure with a blunt probe (31).

1.4.7.1.2. The tourniquet (1): All procedures should be carried out under tourniquet control. Before inflating the tourniquet, the arm should be elevated for several minutes; however, forceful exsanguination using an elastic wrapping is contraindicated since this can force bacteria into the circulatory system and seed other areas of the body.

1.4.7.1.3 Anaesthesia (23): Most upper extremity anaesthesia is performed with local or regional anaesthetics. Lidocaine or bupivacaine without vasoconstrictive agents is used to perform digital nerve blocks. Digital anaesthesia distal to the PIP joint can be obtained by injection of an anaesthetic into the tendon sheath at the A1 pulley. The hand can be anaesthetized with a wrist block, or the entire extremity can be anaesthetized with an axillary block.

1.4.7.1.4 Magnification:
It is possible to achieve magnification up to 6x with magnification lens on glasses frame. However, magnification lens becomes too heavy for mounting if more than 6x magnification is needed\(^{(49)}\).

1.4.7.1.5. Systemic antibiotics:

The need of antibiotics is determined by the extent of the infection. If the process is already localized, simple drainage may be all that needed\(^{(29)}\).

The choice of antibiotics depends on the source of infection. In view of the common frequency of staphylococci, flucloxacillin, which is not inactivated by penicillinase, is usually the first choice. Should streptococcal infection be suspected on account of rapidly spreading lymphangitis, large amount of benzyl penicillin are given. If rapid resolution did not occur, the antibiotic should be changed, e.g. to erythromycin or second generation cephalosporin, and consideration given to draining of infection\(^{(40)}\).

Although the use of antibiotics in the hand infections is extremely valuable, these agents a lone will effect a cure in only a very few cases and only under specific conditions. If the problem is diagnosed within the first 24 to 48 hours of onset, high doses of systemic antibiotics – with appropriate splinting to rest the affected part – can arrest the condition. Beyond this time, such success is unlikely because of thrombosis of the local small vessels and certain anatomic peculiarities in many areas of the hand.
Once culture and sensitivity result are known, the antimicrobial agent can be changed. It need not be continued for more than 7 to 10 days, except in those where osteomyelitis is present. Although initially it is best given intravenously, the oral route can be used after 2 or 3 days\(^1\).

**1.4.7.1.6 Aftertreatment:**

Immediately after surgery the hand is wrapped with bulky layers of gauze to hold it in the position of function and to pad the wound. A metal, plaster, or fiberglass splint is applied to support the wrist. The hand is continuously elevated after surgery. Active motion of digits is begun as soon as possible. The dressing usually is first changed between 24 and 48 hours after drainage and then is changed daily or every other day. Moist dressing may help remove infected drainage. Mask and gloves should be worn during dressings to prevent further contamination. After several days, further debridement of necrotic material may be necessary if the infection is extensive. As soon as drainage has ceased and healthy granulation tissue appears, the wound is secondarily closed; a free skin graft may be necessary, but usually only when a skin slough has occurred\(^{50}\).

**The standard aftercare:**

The incisions are left open and are allowed to close by secondary intention. When allowed to do this, all wounds are managed in virtually the
same manner, including packing for 48 to 72 hours, followed by saline soaks and exercises\(^{(1)}\).

### 1.4.7.2 Surgical treatment of hand infections\(^{(2)}\):

#### 1.4.7.2.1 Operative methods of paronychia:

**1.4.7.2.1.1 No incision:**

The eponychial fold is elevated from the nail gently by flat, blunt instruments such as the flat portion of a malleable or metal probe or a Freer elevator. This separation is carried far enough proximally to permit the proximal edge of the nail to be seen (Fig. 1-2A). The proximal one-third of the nail is removed by transecting it with scissors. The pus is then evacuated, and a gauze packing is inserted beneath the fold to keep the cavity open. After 48 hours the wick is removed, and warm saline soaks are begun.

**1.4.7.2.1.2. Single incision:**

An incision is made in the paronychial fold, starting at its midpoint and extending proximally into the eponychium as far as the base of the nail (Fig. 1-2B). The blade is directed away from the bed and matrix. The eponychium is elevated gently, and the proximal one-third of the nail is separated bluntly from the bed and matrix and excised with scissors. A
gauze wick is inserted under the fold and removed after 48 hours. Warm saline soaks are then begun.

1.4.7.2.1.3. Double incisions:

Incisions are made on each side of the nail, starting at the midpoint of each paronychial fold and continuing proximally as far as the base of the nail (Fig1-2C). With the use of the flat end of a malleable metal probe or Freer elevator, the entire eponychial fold is gently elevated as a flap to expose the base of the nail (Fig1-2D). The proximal one-third of the nail is removed with scissors after separating it from the bed and matrix. Gauze packing is inserted under the flap of eponychium (Fig1-2E) and is removed 48 hours later, at which time warm saline soaks can be started.
Fig. 1-2  (A) Elevation of the eponychial fold with a flat probe to expose the base of the nail. (B) Placement of an incision to drain the paronychium and to elevate the eponychial fold for excision of the proximal one-third of the nail. (C–E) Incisions and procedure for elevating the entire eponychial fold with excision of the proximal one-third of the nail. A gauze pack prevents premature closure of the cavity.
1.4.7.2.2. Operative treatment of chronic paronychia\(^1\):

If the problem persists despite the best medical efforts, eponychial marsupialization as described by Keyser and Eaton may be useful. Under digital block anaesthesia and tourniquet control, a crescent-shaped incision is made beginning 1mm proximal to the distal edge of the eponychial nail fold and extending proximally for 5mm (Fig. 1-3A). It should be symmetrically shaped, extending to the edge of the nail fold on each side (Fig. 1-3B). All thickened tissue down to, but not including, the germinal matrix is excised within the confines of the crescent. The infected and obstructed matrix is thus completely exteriorized and allowed to drain. The dressing is changed at 2 to 3 days. Epithelialization occurs over the next 2 weeks with daily wound care. Complete nail improvement can take 9 to 12 months to occur.

1.4.7.2.3. Operative Methods of felon\(^1\):

1.4.7.2.3.1. Fish-Mouth incision:

An incision is made beginning in line with the most proximal visible portion of the nail, on the side of the digit dorsal to the apex of the interphalangeal joint flexion crease (Fig. 1- 4A). It is continued distally,
staying parallel to the volar edge of the underlying phalanx as it curves around the fingertip onto the opposite side, ending at a point identical to the starting one. The entire volar flap is carefully raised from the phalanx with a knife until the abscess is encountered. A clamp is then inserted into the cavity, and the vertical septa are ruptured bluntly to ensure that no pocket of pus has been missed. After debridement of the necrotic tissue and irrigation of the cavity, the wound is packed open with a gauze wick. Two days later the pack can be removed and soaks started. The wound will eventually close by secondary intention.

Although this incision has been recommended for severe infections, it has virtually no place in the treatment of this lesion. It often leaves an unsightly, tender scar, and it can produce a slough of the tactile pad, if not performed precisely as described, or a bulbous mobile pad, making it difficult for the patient to pick up objects.
Fig. 1-3
Epiphyseal marsupialization for chronic paronychia. (A) Lateral view showing the area of wedge-shaped excision. Undisturbed matrix is stippled. (B) Dorsal view of the crescent-shaped area of excision extending to the margins of the nail folds on each side.
1.4.7.2.3.2. J, or Hockey Stick, incision:

An incision is made just dorsal to the midlateral line on the ulnar side of the finger, starting at a point 1cm distal to the level of flexion crease of the distal interphalangeal joint. The incision is extended distally, following a plane close to the junction of the pad and the nail bed, around the fingertip to the corner of the nail on the nail bed, around the fingertip to the corner of the nail on the opposite side of the digit (Fig. 1-4B). The pulp
tissue and septa are separated from the periosteum of the phalanx, thus allowing all septa to be opened for drainage. After irrigation, the wound is kept open with a gauze wick. The pack is removed and soaks are begun at 48 hours.

The best indication for using this incision is an extensive or severe abscess. Because it crosses the fingertip, it is too elongated for routine use; it can produce a sensitive, disabling scar at the fingertip.

1.4.7.2.3.3. Through-and-through Drainage:

An incision is made just distal and dorsal to the distal interphalangeal joint flexion crease on the ulnar aspect of the finger. It is continued distally halfway around the fingertip, incising at the pulp – nail bed junction in the tip itself (Fig. 1-4C). A 1-cm counterincision is made on the radial side to establish through-and-through drainage. This is achieved by rupturing the vertical trabeculae in the pulp by spreading with a pointed clamp. A wet gauze wick is extended through both incisions and is removed after 2 or 3 days to permit commencement of warm saline soaks. This approach is rarely needed since adequate drainage can be achieved by a single incision. Therefore, a second or counterincision is usually superfluous.

1.4.7.2.3.4. Volar Drainage:
After the site of greatest tenderness and tension has been localized by palpation with the tip of a probe, a transverse incision 4 to 5mm long is made over the side of a central abscess (Fig. 1-4D). If the point of the abscess is lateral, the incision should be longitudinal but not across the flexion crease. If a volar sinus is present, an elliptical incision is made at its location to excise the necrotic edges of the tract. Occasionally a collar button effect will be present, with an intact epidermis containing the pus that has leaked through a sinus in the dermis; in such cases this should be the site of incision. The knife should only be allowed to penetrate the dermis while a clamp is used to spread the subcutaneous tissue. This minimizes the risk to the digital nerves.

An alternative volar approach is to place a longitudinal incision in the midline of the tactile pad (Fig.1-4E), extending from a few millimeters distal to the interphalangeal joint flexion crease to the end of the palmar surface of the underlying bone. The blade is gently inserted deeper until the abscess is encountered; then the opening is enlarged to the limits of the abscess.

Proponents of the volar approach maintain that the use of wicks is not necessary and that petrolatum gauze or zinc oxide ointment over the wound, with a dressing change every 3 days, is sufficient postoperative care.
The volar approach is most appropriate in the face of an existing sinus. The major disadvantage of such volar incisions is the risk of a sensitive scar on the tactile surface of the digit. With the use of a transverse incision, injury to the digital nerves can occur.

1.4.7.2.3.5. Unilateral Longitudinal Incision:

An incision is made on the ulnar side of the digit (radial side in the thumb and small finger), dorsal to and 0.5cm distal to the distal interphalangeal joint flexion crease. It is continued distally in a straight line to within 0.5cm of the medial edge of the nail, ending at a point slightly beyond the start of the free, unattached distal part of the nail (Fig. 1-4F). It does not cross over the fingertip. The incision is deepened along a plane just volar to the palmar cortex of the phalanx until the abscess is entered. The opening in the cavity is enlarged until adequate evacuation is achieved. A gauze pack is placed in the cavity for 2 days; then it is removed and soaks are begun.

1.4.7.2.4 Operative Methods of web space\(^{(1)}\):

1.4.7.2.4.1 Curved Longitudinal Incisions:

The incision is begun just proximal to the ulnar end of the proximal flexion crease of the radial digit of the two involved fingers (Fig. 1-5A). It
is continued proximally and ulnarward, stopping just distal to the midpalmar crease overlying the metacarpal of the ulnar digit involved. After the skin is divided, the subcutaneous tissue is spread with a clamp until pus is encountered. The opening in the abscess is enlarged longitudinally. Compression is applied to the dorsum of the web space by the surgeon while the wound is retracted. Increased drainage can be seen in the depth of the wound if there is a deep collar button abscess. A second incision is then made on the dorsum. It begins at the level of the midphalangeal joints but lies between the metacarpals, and is extended distally in a straight line to end at the base of the involved web, a distance of 1 to 1.5cm (Fig. 1-5B). The deep tissues are divided in a plane toward the palmar abscess. When the dorsal collection is entered, the opening is enlarged in the direction of the wound. After the pus has been evacuated and the wound irrigated, drains are placed into both wounds; these are gauze wicks. The hand is dressed in a compressive dressing with a plaster splint; this is removed in 48 to 72 hours and soaks are started. Active motion is encouraged.

A modification of this approach is a longitudinal volar incision between the metacarpals. This provides a less adequate exposure to the volar aspect of the abscess.

1.4.7.2.4.2. Volar Transverse Approach:
A transverse incision is made in the proximal flexion crease of the more ulnar of the two involved fingers. A longitudinal extension may be added between the metacarpal heads of the two digits (Fig. 1-5C). The deep dissection is as previously described. The dorsal approach may be needed as well.

The disadvantage of this incision is the placement of the transverse limb at the flexion crease. If this part of the incision is inadvertently carried too far into the web, a web space contracture can result.

1.4.7.2.4.3. Volar and Dorsal Drainage with Irrigation:

This is the technique preferred by the author. A zigzag incision is made on the palmar surface, starting just proximal to the web and stopping just distal to the midpalmar crease (Fig. 1-5D). The flaps are reflected and the deep tissues dissected in the web while the digital arteries and nerves are retraced to either side. The superficial transverse metacarpal ligament and other fibers of the palmar fascia are divided to allow ample exposure of the volar and dorsal compartments of the dumbbell-shaped abscess. A 1.5-cm dorsal longitudinal incision is made between the bases of the proximal phalanges. Generous communication between the two incisions is established. A 16-gauge polyethylene catheter is placed into the palmar wound and sutured to the skin to
Prevent accident removal. The volar wound is sutured around the catheter. A small Penrose drain is placed into the dorsal wound. Manual irrigation with saline is done to be certain that the irrigating solution exists dorsally. The hand is dressed in a compressive dressing and supported with a plaster splint. Continuous irrigation with sterile saline at the rate of 100ml/hour is maintained for 48 hours. The outflow spills onto the dressing. The hand is then inspected, and if it is found to be free of infection, the catheter and drain are removed. Exercises are started in a dry dressing.
Fig. 1-5

(A) Curved longitudinal volar incision for drainage of a web space abscess. (B) Dorsal incision to be used in conjunction with (A). (C) Volar transverse incision. This incision can cause a web space contracture due to the transverse limb near the margin of the web. (D) Volar exposure. Used with the dorsal incision shown in (B).
1.4.7.2.5. Operative methods of mid palmar space infection:\(^1\):

1.4.7.2.5.1. Transverse Incision in the Distal Crease:

An incision is made in or parallel to the distal palmar crease overlying the third and fourth metacarpals (Fig. 1-6A). The nerves and arteries are protected, and the flexor tendons of the ring finger are used as a guide to the midpalmar space. The dissection is continued on either side of these tendons until the abscess is opened. After the purulence is evacuated, a drain is brought from the space through the skin. This drain is removed 48 to 72 hours later, and soaks and exercise are begun. Active motion of the fingers is emphasized.

1.4.7.2.5.2. Distal Palmar Approach Through the Lumbrical Canal\(^1\):

A longitudinal incision is made on the palmar surface of the third web space (between the middle and ring fingers) (Fig.1-6B). It extends from just proximal to the web itself and ends just distal to the midpalmar crease but does not touch or cross it. A clamp is inserted into the wound and directed proximally down the canal of the third lumbrical, dorsal to the flexor tendons, until the midpalmar space is entered and pus is encountered.
After adequate evacuation of the space, a drain is placed for 48 hours. Aftercare is the same as that already described.

1.4.7.2.5.3. Combined Transverse and Longitudinal Approach\(^{(1)}\):

An incision is made parallel to the distal palmar crease between the second and third metacarpal heads. It is extended transversely to the fourth metacarpal and then continued proximally just radial to the hypothenar eminence (Fig. 1-6C). The palmar fascia is divided, and the digital nerves and arteries, as well as the superficial palmar arch, are protected. With the use of the flexor tendons of the ring finger as a guide, the surgeon obtains access to the space by passing on either side of the tendons. After the abscess is evacuated, a drain is left in place for 48 hours. Routine aftercare is then begun.

1.4.7.2.5.4. Longitudinal Approach\(^{(1)}\):

A slightly curved incision is made in the midpalm, beginning just proximal to the distal palmar crease in line with the third ray. This extends proximally and slightly ulnarward, paralleling the thenar crease (Fig. 1-6D). After the palmar fascia is split and the superficial palmar arch and the
digital arteries and nerves are protected, the surgeon identifies the flexor tendons to the ring finger. The space is entered by going on either side of these tendons. After the cavity is evacuated, a drain is placed into the wound for 48 hours. Aftercare is as outlined earlier.
1.4.7.2.6. Operative methods of Thenar

Fig. 1-6 (A) Transverse distal palmar exposure of the midpalmar space. (B) Approach to the midpalmar space through the lumbrical canal. (C) Combined longitudinal and transverse approach. (D) Longitudinal approach to the midpalmar space.
1.4.7.2.6.1. Volar Transverse Approach:

An incision is made parallel to and 2 cm proximal to the midphalangeal joint flexion crease of the thumb, in the distal third of the thenar eminence (Fig1-7A). It is placed toward the web. The digital nerves are directly subcutaneous in this region and must not be injured. The dissection is deepened bluntly toward the space between the first and second metacarpals, toward the proximal third of the palm. After the volar compartment has been decompressed, a clamp is directed dorsally over the distal margin of the adductor pollicis into the space between it and the first one Penrose drain is placed into the dorsal space and another into the palmar compartment. Both drains exit through the incision and are removed after 48 hours. Standard aftercare is then started.

1.4.7.2.6.2. Thenar Crease Approach:

An incision is made on the palmar surface of the hand just adjacent and parallel to the thenar crease on its side (Fig1-7B). Great care must be exercise to avoid damaging the palmar cutaneous branch of the median nerve, and the motor branch of the median nerve, which lies subcutaneously in the proximal part of the incision, and the motor branch of the median nerve, which lies somewhat deeper near the juncture of the proximal and middle thirds of the approach. The deeper dissection is performed bluntly
toward the adductor pollicis until pus is encountered. After the area has been
drained adequately, the dissection is extended over the distal edge of the
adductor to decompress the first dorsal interosseous space. Two Penrose
drains are placed as previously described and are removed after 48 hours.
The standard aftercare program is then undertaken.

1.4.7.2.6.3. Dorsal Transverse Approach:

An incision is made on the dorsum of the first web at the middle of
a line between the distal ends of the metacarpals of the thumb and index
finger (Fig.1-7C). Pus is usually encountered once the incision divides the
skin. The approach is deepened between the first dorsal adductor interval
and volarly over the distal edge of the adductor (if necessary). A single drain
is usually adequate for 48 hours before the routine postoperative regimen is
begun.

1.4.7.2.6.4. Dorsal Longitudinal Approach:

A straight or slightly curved longitudinal incision is made in the
dorsum of the thumb cleft, starting near the web and extending proximally
along the radial margin of the first dorsal interosseous muscle (Fig.
1-7D). The dissection is continued deeper into the interval between the first
dorsal interosseous and the adductor pollicis, at which point pus should be
encountered. After thorough irrigation and debridement of the abscess, a
drain is brought out through the skin incision. This is removed after 48 hours and the postoperative regimen begun.

1.4.7.2.6.5. Combined Dorsal and Volar Approach:

Two incisions are made: one dorsally, which is the slightly curved longitudinal approach described above, and one volarly, which parallels the thenar crease. Each approach is used to drain the corresponding half of the space. A separate drain is used for each incision, but through-and-through drains are not employed.
Fig. 1-7  (A) Volar transverse approach to the thenar space. Nerve injury is a potential complication. (B) Thenar crease approach. Nerve injury can result from this approach. It has the added disadvantage of limited drainage of the space behind the adductor pollicis. (C) Dorsal transverse approach. A contracture of the web space can result if this incision is placed too close to the edge of the web. (D) Dorsal longitudinal approach to the thenar space.
1.4.7.2.7. Operative methods of Hypothenar space infections\textsuperscript{(1)}:

An ulnar approach is used, with the incision made on the most ulnar aspect of the palm, starting just proximal and medial to the ulnar end of the midpalmar crease (Fig1-8). This is continued in a straight line proximally, to end 3cm distal to the wrist flexion crease. The incision is deepened to the level of the hypothenar fascia. This layer is divided in the line of the incision, and the abscess should be directly beneath it. After the purulence has been evacuated, a drain is placed in the wound for 48 hours, after which time the routine postoperative regiment begins.
Fig. 1-8 .0. Approach to the hypothenar space.
1.4.7.2.8. Operative methods of flexor Tensosynovitis\(^{(1)}\):

1.4.7.2.8.1. Open Drainage:

A midaxial incision is made in the finger, usually on the ulnar side; in the thumb and small finger, the radial side is used. The incision begins dorsal and distal to the distal flexion crease of the finger and extends proximally to the web space (Fig. 1-9A). The digital artery and nerve are kept with the volar flap. The dissection proceeds toward the tendon sheath dorsal to the neurovascular structures. When the tendon sheath is visualized, the synovium between the A3 and A4 pulleys is incised. Cloudy serosanguinous fluid or frank purulence is encountered. Another incision is made in the palm over the tendon to drain the cul-de-sac. It is either longitudinal between the proximal flexion crease of the finger and midpalm crease, or curved. Transverse incision in the palmar crease is an acceptable alternative. The tensosynovium between the pulleys is excised from the palm to the distal phalanx, but the annular pulleys are left undisturbed. The wound is irrigated thoroughly with saline or an antibiotic solution. The wounds are kept open with drains, and a compressive dressing and plaster splint are applied. After 48 hours, the wounds are inspected. The drains are removed, and saline soaks with active exercise are started.

1.4.7.2.8.2. Single Incision for Antibiotic Instillation\(^{(1)}\):

A transferred incision is made in the palm over the involved finger, just distal to or in the transverse mid palmar crease (Fig. 1-9B). It is similar to the incision used for trigger finger release. A 16-gauge polyethylene catheter is introduced into the sheath at it is proximal end and passed far enough distally to prevent its being dislodge during the postoperative
treatment. The wound is closed around catheter. Over the next 48 to 72 hours 0.2ml of an antibiotic solution is introduced into the sheath every one to 2 hours. After this time if the signs of infection have resolved, the catheter is removed and an exercise program started, emphasizing active motion to prevent loss of tendon function.

1.4.7.2.8.3. Distal drainage with proximal instillation of antibiotics\(^{(1)}\):

The tendon sheath is inspected via a short transverse incision over its distal end just proximal to the distal flexion crease (Fig. 1-9C). The sheath is opened and the purulence evacuated. A needle is introduced into the proximal end of the sheath in the palm, and, when there is no resistance to its advance, and antibiotic solution is flushed from proximal to distal until the fluid comes through clear. The wound is closed and the needle withdrawn. The hand is immobilized for a few days, then active exercises are begun.
Fig. 1-9. Incisions for drainage of tendon sheath infections. (A) Open drainage incisions. (B) Single incision for instillation therapy of tendon sheath infection. (C) Sheath irrigated via needle proximally and single distal incision. (D) Incisions for through-and-through intermittent irrigation. (E) Closed tendon sheath irrigation technique. (F) Closed irrigation of ulnar bursa.
1.4.7.2.8.4. Through-and-Through Intermittent Antibiotic Irrigation:

An incision is made near and parallel to the distal flexion crease (Fig.1-9D). The tendon sheath is visualized by retracting both neurovascular bundles to their respective sides. A transverse incision in the sheath allows the fluid to drain. A transverse counterincision is made in the distal palm over the proximal end of the sheath. A polyethylene catheter with holes cut along its length is inserted well into the sheath. The sheath and its contents are then flushed with antibiotic solution until there is no more pus.

The catheter is sutured in place so that a repeat irrigation can be done on the following day. In severe infections a continuous drip is attached to the catheter and run at one drop per second for 24 to 48 hours. Then the catheters are removed and exercises started.

1.4.7.2.8.5. Closed Tendon Sheath Irrigation:

A zigzag incision is made in the distal palm over the proximal end of the sheath. The sheath is opened at the proximal margin of the A1 pulley. A second incision is made on the ulnar midaxial side of the finger in the middle and distal segments. Access to the distal end of the sheath is obtained through a plane dorsal to the digital artery and nerve. The sheath
is resected distal to the A4 pulley. A 16-gauge polyethylene catheter with a single opening at its end is inserted under the A1 pulley in the palm for a distance of 1.5 to 2 cm (Fig. 1-9E). The catheter is sutured to the skin and the wound closed around it. The sheath is irrigated copiously with saline. A small drain is brought from the tendon through the skin distally and sutured to the skin. The wound is closed around the drain. The system is flushed again to test its patency. The hand is dressed and splinted, with the catheter brought out of the dressing and connected to a 50-ml syringe. The dressing is arranged so that the drain can be seen distally. The system is tested just prior to the patient's leaving the operating suite. Postoperatively, the sheath is flushed manually with 50 ml of sterile saline every 2 hours for 48 hours. At this time the digit is inspected. If signs of infection have abated, the catheter and drain are removed, the wounds dressed lightly to avoid impending motion, and exercises started. If any doubt exists, the irrigation may be continued for an additional 24 hours. Complete motion can be expected in a week.

In the thumb, the proximal part of the sheath is exposed through a thenar crease incision. The distal centimeter of the transverse carpal ligament is incised to allow access to the passage of the flexor pollicis
longus through the wall of the canal into the thenar eminence. The catheter is placed in this opening.

The advantages of this method are (1) primary wound healing (not provided by the others—especially open drainage), (2) thorough mechanical irrigation of the sheath (not accomplished with a single incision), (3) relief from concern about empirical selection of an effective antibiotic solution, (4) accurate placement of the catheter rather than blind probing with a needle, and (5) rapid return of function with minimal inconvenience to the patient, as opposed to the prolonged morbidity associated with healing by secondary intention.

1.4.8. Prevention\(^{(5)}\):

The prevention of hand infection in diabetic patients achieved by:

1- Glycaemic control: aggressive glycemic control may be a vital control measure for upper and lower limb sepsis in general.

2- Education:

- Education, still the most important preventive tool in underdeveloped countries, should remain an integral part of prevention, be simple and repetitive, and targeted at both health care workers and patients.
- Diabetic patients should be educated on proper hand and foot care and the importance of consulting a doctor or presenting to a clinic immediately at the onset of hand or foot-related symptom.

3- Simple care, motivation, education, and action by diabetic patients are essential in protecting the feet and hand from infections.

1.4.9 Situation in Sudan:

In Sudan, there are no published data before in hand infection in diabetic patients; a part from K. EZELDEEN et al who published data on management of hand infection in Khartoum in which 150 patients with hand infection were studied, 15 patients of them were diabetics.
OBJECTIVES

1- To study the clinical presentation and risk factors of hand sepsis in diabetic patients in KTH and Gaber Abu Izz center.

2- To identify:
   
   i. The causes of hand sepsis in diabetic patients.
   
   ii. The causative organisms.
   
   iii. The management of hand sepsis.
   
   iv. The outcome of hand sepsis.
PATIENTS AND METHODS

This is a prospective analytic hospital based study on the clinical patterns of hand infections in diabetics. This study was performed on 75 diabetic patients with hand sepsis, who attended Khartoum Teaching Hospital and Gaber Abu Izz specialized centre for diabetes during the period between Sep. 2002 and Sep. 2003. The aims and methodology of the study were explained to the patients and their consent was obtained. Patients data were collected by direct interview using clinical protocol of database consisting of questionnaire, clinical examination and investigation.

The clinical protocol included:

I) Patient’s personal demographic data.

II) History:

- Duration of diabetes mellitus.
- Types of DM.
- Habits of patients.
- Cause of the sepsis.
- Site of infection.
• Associated diseases like: renal failure, DSF, cardiovascular problems, like hypertension, heart failure, IHD, cardiomyopathy and DVT.

III) Clinical presentation:

• Pain and its site, duration and nature.
• Fever.
• Tenderness.
• Swelling.
• Abscess.
• Ulcers.
• Gangrene.
• Involvement of hand spaces.
• Involvement of forearm and arm.
• Axillary lymph node enlargement.
• Peripheral neuropathy.
• Peripheral vascular assessment.

IV) Examination:

• The peripheral vascular assessment include the radial pulse in the upper limb, Dorsalis pedis and posterior tibial arteries in the lower
limb. This assessment done clinically by palpation of these pulse and the result recorded either palpable or not.

- The neurological assessment done by:
  - Asking the patient about parathæsia, burning sensation and loss of sensation.
  - Sensibility to pin brick, nylon monofilment test which have force of 10gm, light touch using cotton, vibration sensation using a tuning fork of 128µhz and position sensation.

V) Investigations: The patients were submitted to the following investigations:

  - Hemoglobin (Hb%) level.
  - TWBCs.
  - Blood glucose either random or fasting blood glucose levels.
  - Urine for sugar and acetone.
  - Radiological studies (X-Ray).
  - Microbiological studies in the form of wound swab for culture and sensitivity.
  - Others like blood urea, serum creatinine, coagulation screening and Doppler studies of peripheral vessels.

VI) Management: Include the following:
1- Hospital admission and its duration.

2- Surgery either:
   - Drainage and debridment.
   - Amputation.

3- Anaesthesia: The type either local or general.

4- Antibiotic therapy.

5- Control of DM: Achieved either by insulin, oral hypoglycemic agents or diet control.

6- Physiotherapy: Passive physiotherapy was done during the dressing of the wound and the patients were encouraged to do it at home.

7- Outcome:
   - Patients were followed up during their stay in hospital, attendance for dressing or by telephone and the outcome were elicited in form of:
     - Healing and its duration.
     - Impairment of the function of the affected part.

- The wounds of the patients were dressed by normal saline and povidone iodine and covered by sterilized dressing and this repeated till the wound healed. The patients were advised to elevate their affected part.
Post-operative or post-dressing pain was controlled by diclofenac sodium in injectable or tablets forms.

The data was collected and entered in a computer system for analysis using SPSS programme.

RESULTS

Seventy-five diabetics with hand infection were studied, 40 (53.3%) were males and 35 (46.7%) were females, with male to female ratio of 1.1:1.0. The ages of the patients range between 25 years and 84 years, with a mean of 49.4 ± 12.6 years (Table 1).

Thirty-five (46.7%) patients were housewives and 14 (18.7%) patients were employees, (Table 2).

The duration of D.M. ranged between 4 months and 30 years with a mean of 10.0 ± 8.1 years. Thirty-four (45.2%) patients had D.M. for more than ten years (Table 3).

Fifty-eight (77.3%) patients had type II D.M, 17 (22.7%) patients had type I D.M (Fig. 1). Six (8.0%) patients were newly discovered at the time of the infection.
Twelve (16.0%) patients were snuffers, 6(8.0%) patients were smokers and 3(4.0%) patients were alcoholic.

The cause of hand infection was unknown or spontaneous in 36(48.0%) patients and due to trauma in 31(41.0%) patients (Table 4).

In 39(52.0%) patients the infection involved the left hand and the right hand in 36(48.0%) patients.

Thumb involvement occurred in 19(25.3%) patients, in 12 patients of them the infection in thumb of the right hand and in 7 patients in the thumb of the left hand. Middle finger involvement occurred in 18(24.0%) patients, in 6 patients of them the infection occurred in middle finger of the right hand while in 12 patients it occurred in middle finger of the left hand (Table 5); more than one finger can be involved in the same patient.

Sixty-five (86.7%) patients presented with swelling, 58(77.3%) patients had throbbing pain and 27(36.0%) patients presented with fever.

Physical sings like swelling, hotness and tenderness were more seen in wrist (Table 6).

The clinical types of the hand infection were paronychia in 21(28.0%) patients, pulp space infection in 21(28.0%) patients (Table 7).
About complications of hand infection, 7 (9.3%) patients presented with diabetic ketoacidosis, 8 (10.7%) patients had dry gangrene, one patient had gas gangrene and 2 (2.7%) patients developed osteomyelitis (Table 8). Radial pulse was palpable in all the patients, while dorsalis pedis and posterior tibial arteries pulsations were palpable in 64 (85.5%) patients.

Thirty-four (45.3%) patients had peripheral neuropathy in the lower limbs and 5 (14.7%) patients had peripheral neuropathy affecting the upper limb. One (7.7%) patient of those 5 patients underwent amputation (Table 9). Six (8.0%) patients had cardiovascular problems, four of them underwent amputation (Table 9).

The hemoglobin levels of the patients ranged between 6.6 gm and 15.1 gm with a mean of 11.5 ± 1.6 gm. The white blood cell count done in 28 (37.3%) patients and it ranged between 2100 and 25,100 WBCs/mm³ with a mean of 7633.9 ± 5479.0 WBCs/mm³. X-ray was done in 9 (12.0%) patients and showed osteomyelitis in 2 (2.7%) patients.

The estimation of random blood glucose level done in 45 (60.0%) patients, it ranged between 130- 567 mg/dl with a mean of 319.7 ± 111.2 mg/dl. The fasting blood glucose level done in 28 (37.3%) patients and it ranged between 114- 430 mg/dl with a mean of 234.2 ± 76.6 mg/dl.
Swab taken from the wound for culture in 66(88.0%) patients, showed no growth in 19(25.3%) patients. *Staphylococcus aureus* was isolated in 31(41.3%) patients and *β hemolytic streptococcal* infection in 4(5.3%) patients. (Table 10).

Of the thirteen (17.3%) patients who underwent amputation, 11(84.6%) had swabs for culture. Of those 11 patients, 3(27.3%) had no growth and 4(36.4%) patients had staphylococcal infection (Table 10).

The bacterial count showed *Staph. aureus* had 100% sensitivity to ceftazidine, streptomycin and ceftriaxone, while had 94.4% sensitivity to chloramphenicol (Table 11). *β- haemolytic Streptococcus* had 100% sensitivity chloramphenicol, ceftazidine, cefotaxime, streptomycin and ceftizoxime (Table 11).

Twenty-two (29.3%) patients were admitted to the hospital. The hospital stay ranged between 1- 40 days with a mean of 7.9 + 10.4 days.

Surgical treatment included; drainage and debridement in 62(86.7%) patients and amputation in 13(17.3%) patients, in 2 of them the level of the amputation was above elbow, in one patient of them the amputation done below elbow while in 10 patients the amputation involved the fingers (either the whole finger or the distal phalanx) (Table 12).

Local anaesthesia using either digital or field block done in 49(65.3%) patients and general anaesthesia done in 18(24.0%) patients.
Twenty (26.6%) patients received intravenous antibiotics, 38 (50.7%) oral antibiotics and in 17 (22.6%) patients, the oral antibiotics followed the intravenous ones. The duration of the antibiotic therapy ranged between 5 - 33 days with a mean of 10.4 ± 3.8 days.

Diabetic control was done using soluble insulin in 47 (62.7%) patients, oral hypoglycaemic drugs in 24 (32.0%) patients and diet control in 4 (5.3%) patients.

The dose of the insulin ranged between 15 - 80 units/day with a mean of 33.5 ± 13.0 units/day. The dose of oral hypoglycemic drug (Glibenclamide) ranged between 5 - 15 mg/day with a mean of 6.3 ± 2.9 mg/day.

Sixty-two (82.7%) patients were followed in whom complete healing occurred in 60 (80.0%) patients, with duration of healing ranged between 1-24 weeks with a mean of 5.4± 4.4 weeks (Table 13).

Forty-two (56.0%) of the wounds healed between 1-5 weeks; 2 (4.8%) patients of them had peripheral neuropathy in the upper extremity, 2 (4.8%) patients had cardiovascular problems and none of them had renal failure (Table 14).
Table (1): The age distribution of the diabetics with hand sepsis (n=75)

<table>
<thead>
<tr>
<th>Age in years</th>
<th>No. of patients</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 - 30</td>
<td>8</td>
<td>10.6</td>
</tr>
<tr>
<td>31 - 40</td>
<td>11</td>
<td>14.6</td>
</tr>
<tr>
<td>41 - 50</td>
<td>21</td>
<td>28.1</td>
</tr>
<tr>
<td>51 - 60</td>
<td>24</td>
<td>32.1</td>
</tr>
<tr>
<td>61 - 70</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>71 - 80</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>81 - 90</td>
<td>2</td>
<td>2.7</td>
</tr>
</tbody>
</table>

(Mean = 49.4 ± 12.6 years)

Table (2): Occupational of the diabetics with hand sepsis (n=75)

<table>
<thead>
<tr>
<th>Occupation</th>
<th>No. of pts</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>House-wife</td>
<td>35</td>
<td>46.7</td>
</tr>
<tr>
<td>Employee</td>
<td>14</td>
<td>18.7</td>
</tr>
<tr>
<td>Occupation</td>
<td>No. of Patients (n=75)</td>
<td>Percent</td>
</tr>
<tr>
<td>------------</td>
<td>------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Manual worker</td>
<td>11</td>
<td>14.7</td>
</tr>
<tr>
<td>Merchant</td>
<td>7</td>
<td>9.3</td>
</tr>
<tr>
<td>Farmer</td>
<td>5</td>
<td>6.7</td>
</tr>
<tr>
<td>Retired</td>
<td>2</td>
<td>2.7</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>75</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Table (3): The duration of the D.M among diabetic patients with hands sepsis

<table>
<thead>
<tr>
<th>Duration of D.M (in years.)</th>
<th>No. of patients (n=75)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 4</td>
<td>25 (33.3%)</td>
</tr>
<tr>
<td>5 - 9</td>
<td>15 (20.0%)</td>
</tr>
<tr>
<td>10 - 14</td>
<td>9 (12.0%)</td>
</tr>
<tr>
<td>15 - 19</td>
<td>12 (16.0%)</td>
</tr>
<tr>
<td>20 - 24</td>
<td>11(14.6%)</td>
</tr>
<tr>
<td>25 - 29</td>
<td>1 (1.3%)</td>
</tr>
</tbody>
</table>
(Mean of duration of the DM = 10.0 ± 8.1 years)

Table (4): The causes of the hand infection.

<table>
<thead>
<tr>
<th>Cause</th>
<th>No. of patient</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spontaneous</td>
<td>36</td>
<td>48.0</td>
</tr>
<tr>
<td>Trauma</td>
<td>31</td>
<td>41.3</td>
</tr>
<tr>
<td>Venous cannulation</td>
<td>3</td>
<td>3.0</td>
</tr>
<tr>
<td>Burn</td>
<td>2</td>
<td>2.7</td>
</tr>
<tr>
<td>Animal bite</td>
<td>2</td>
<td>2.7</td>
</tr>
<tr>
<td>Insect bite</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>75</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table (5): The involvement of the fingers in diabetics with hand sepsis

(n= 75)
### Table (6): proximal physical signs on diabetics with hand sepsis (n=75)

<table>
<thead>
<tr>
<th>Sign</th>
<th>At wrist</th>
<th>At forearm</th>
<th>At arm</th>
<th>At axilla</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swelling</td>
<td>65(86.7%)</td>
<td>18(24.0%)</td>
<td>3(4.0%)</td>
<td>0(00.0%)</td>
</tr>
<tr>
<td>Hotness</td>
<td>54(72.0%)</td>
<td>18(24.0%)</td>
<td>2(2.7%)</td>
<td>0(00.0%)</td>
</tr>
<tr>
<td>Tenderness</td>
<td>65(86.7%)</td>
<td>14(18.7%)</td>
<td>4(5.3%)</td>
<td>0(00.0%)</td>
</tr>
<tr>
<td>Abscess</td>
<td>45(60.0%)</td>
<td>0(00.0%)</td>
<td>0(00.0%)</td>
<td>0(00.0%)</td>
</tr>
<tr>
<td>Ulcer</td>
<td>30(40.0%)</td>
<td>0(00.0%)</td>
<td>0(00.0%)</td>
<td>0(00.0%)</td>
</tr>
<tr>
<td>Dry gangrene</td>
<td>9(12.0%)</td>
<td>2(2.7%)</td>
<td>0(00.0%)</td>
<td>0(00.0%)</td>
</tr>
<tr>
<td>Gas gangrene</td>
<td>0(00.0%)</td>
<td>1(1.3%)</td>
<td>0(00.0%)</td>
<td>0(00.0%)</td>
</tr>
</tbody>
</table>
Table (7): The anatomical site and clinical presentation of hand sepsis in diabetics (n= 75)

<table>
<thead>
<tr>
<th>Clinical presentation</th>
<th>No. of patients</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paronychia</td>
<td>21</td>
<td>28.0%</td>
</tr>
<tr>
<td>The pulp space infection</td>
<td>21</td>
<td>28.0%</td>
</tr>
<tr>
<td>Infection of the other parts of the finger</td>
<td>30</td>
<td>40.0%</td>
</tr>
<tr>
<td>Web space infection</td>
<td>7</td>
<td>9.3%</td>
</tr>
<tr>
<td>Mid palmer space infection</td>
<td>11</td>
<td>14.7%</td>
</tr>
<tr>
<td>Thenar space infection</td>
<td>10</td>
<td>13.3%</td>
</tr>
<tr>
<td>Hypothenar infection</td>
<td>6</td>
<td>8.0%</td>
</tr>
<tr>
<td>Space of Parona infection</td>
<td>4</td>
<td>5.3%</td>
</tr>
<tr>
<td>Dorsal subapon and subcuta. Space infection</td>
<td>12</td>
<td>16.0%</td>
</tr>
</tbody>
</table>

L.N enlargement 5(6.7%)
Table (8): The complications of hand infection in diabetics with hand sepsis

<table>
<thead>
<tr>
<th>The complications</th>
<th>No. of patients</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetic ketoacidosis</td>
<td>7</td>
<td>9.3%</td>
</tr>
<tr>
<td>Dry gangrene</td>
<td>8</td>
<td>10.7%</td>
</tr>
<tr>
<td>Gas gangrene</td>
<td>1</td>
<td>1.3%</td>
</tr>
<tr>
<td>Osteomyelitis</td>
<td>2</td>
<td>2.7%</td>
</tr>
</tbody>
</table>

Table (9): The associated illnesses and the amputation

<table>
<thead>
<tr>
<th>Illness</th>
<th>No. of patients (n= 75)</th>
<th>Amputation (n =13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripheral neuropathy in upper extremity</td>
<td>5 (6.7%)</td>
<td>1 (7.7%)</td>
</tr>
<tr>
<td>Cardiovascular problem</td>
<td>6 (8.0%)</td>
<td>4 (30.8%)</td>
</tr>
<tr>
<td>Renal failure</td>
<td>2 (2.7%)</td>
<td>0 (00.0%)</td>
</tr>
<tr>
<td>D S F</td>
<td>3 (4.0%)</td>
<td>0 (00.0%)</td>
</tr>
</tbody>
</table>
Table (10): The type of organism and the amputation

<table>
<thead>
<tr>
<th>Culture</th>
<th>No. patients (n =75)</th>
<th>Amputation (n =11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No growth</td>
<td>19 (25.3%)</td>
<td>3 (27.3%)</td>
</tr>
<tr>
<td>Staph. aureus</td>
<td>31 (41.3%)</td>
<td>4 (36.4%)</td>
</tr>
<tr>
<td>B. haemolytic Sterptococcus</td>
<td>4 (5.3%)</td>
<td>1 (9.1%)</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>2 (2.7%)</td>
<td>1 (9.1%)</td>
</tr>
<tr>
<td>E. coli</td>
<td>3 (4.0%)</td>
<td>0 (00.0%)</td>
</tr>
<tr>
<td>Sterpt. Feacallis</td>
<td>3 (4.0%)</td>
<td>1 (9.1%)</td>
</tr>
<tr>
<td>Klebsiella</td>
<td>2 (2.7%)</td>
<td>0 (00.0%)</td>
</tr>
<tr>
<td>Bacteroides</td>
<td>1 (1.3%)</td>
<td>1 (9.1%)</td>
</tr>
<tr>
<td>Polymicrobia</td>
<td>1 (1.3%)</td>
<td>0 (00.0%)</td>
</tr>
</tbody>
</table>

Table (12): Indications and levels of amputation in diabetics with hand sepsis
<table>
<thead>
<tr>
<th>Indication</th>
<th>No. of patients</th>
<th>Above elbow</th>
<th>Below elbow</th>
<th>Finger</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Above</td>
<td>Below</td>
<td>Whole</td>
</tr>
<tr>
<td></td>
<td></td>
<td>elbow</td>
<td>elbow</td>
<td>finger(s)</td>
</tr>
<tr>
<td>Dry gangrene</td>
<td>8 (10.7%)</td>
<td>2</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Gas gangrene</td>
<td>1 (1.3%)</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Severe infection and osteomyelitis</td>
<td>2 (2.7%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Trauma</td>
<td>2 (2.7%)</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>2</strong></td>
<td><strong>1</strong></td>
<td><strong>6</strong></td>
</tr>
</tbody>
</table>

Table (13): The outcome of diabetics with hand sepsis (n = 75)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>No. of patients</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow up</td>
<td>62</td>
<td>82.7%</td>
</tr>
<tr>
<td>Complete healing</td>
<td>60</td>
<td>80.0%</td>
</tr>
<tr>
<td>No healing</td>
<td>2</td>
<td>2.7%</td>
</tr>
<tr>
<td>Normal function after healing</td>
<td>51</td>
<td>68.0%</td>
</tr>
</tbody>
</table>
Impairment of the function of The affected part

<table>
<thead>
<tr>
<th>Duration of healing (in week)</th>
<th>No. of pts (n =75)</th>
<th>Peripheral neuropathy</th>
<th>Cardiovascular problems</th>
<th>Renal failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 5</td>
<td>42 (56.0%)</td>
<td>2 (4.8%)</td>
<td>2 (4.8%)</td>
<td>0 (00.0%)</td>
</tr>
<tr>
<td>6 -10</td>
<td>16 (21.3%)</td>
<td>2 (12.5%)</td>
<td>2 (12.5%)</td>
<td>1 (6.3%)</td>
</tr>
<tr>
<td>11 -15</td>
<td>1 (1.3%)</td>
<td>1 (100.0%)</td>
<td>1 (100.0%)</td>
<td>0 (00.0%)</td>
</tr>
<tr>
<td>16 – 20</td>
<td>0 (00.0%)</td>
<td>0 (00.0%)</td>
<td>0 (00.0%)</td>
<td>0 (00.0%)</td>
</tr>
<tr>
<td>21 -25</td>
<td>1 (1.3%)</td>
<td>0 (00.0%)</td>
<td>0 (00.0%)</td>
<td>0 (00.0%)</td>
</tr>
</tbody>
</table>

DISCUSSION
Hand sepsis in this series affected males more than females; with male to female ratio of 1.1 : 1.0, this matches the result of K. Ezeldeen et al\(^{(13)}\) – Khartoum 1992 which showed males were more affected than female with male to female ratio of 2:1 and in contrast with the result of Z. G. Abbas et al-Dar es Salaam; Tanzania, 1998-2002\(^{(6)}\) which showed 50% of patients with Tropical Diabetic Hand Syndrome were males. This more affection of males is due to the fact that males were more vulnerable to trauma during their work and activities.

The ages of the patients ranged between 25-84 years, with a mean of 49.4 ±12.6 years. This matches the results of Mark H. Gonzales et al\(^{(2)}\) and Z. G. Abbas et al\(^{(6)}\) which showed the average age of the patients was 50 years (range 29-82 years) and 52 years (range 20-89 years) respectively. In this series (53.3%) of the patients were between the age of 21-50 years, which matches with the result of K. Ezeldeen et al\(^{(13)}\) – Khartoum – 1992 which showed (50.7%) of the patients were between the age of 21-40 years. Kour et al\(^{(3)}\) found that 80% of patients aged 60 years or younger. In this study 85.6% of the patients have ages of 60 years or younger and 45(60.2%) patients were between the ages of 41-60 years.

There is no proportionate rise in the incidence of hand infection with age despite the increasing proportion of the population having diabetes.
mellitus with advancing age. Although the incidence of septic hand infections in patients with diabetes spread over wide age spectrum, the highest incidence is in patients between 41 and 60 years of age. This represents the active group of individuals in the work force.

The majority of patients were housewives (46.7%), followed by employees (18.7%) and (14.7%) of the patients were manual workers. This is in contrast with a local study (in which included both diabetics and non diabetic patient with hand infection) done by K Ezeldeen et al (13) who found that the majority of patients were manual workers (42%), followed by school children (20.7%) and housewives (20%).

This affection of the housewives is due to their involvement in house hold duties in which they may sustain minor trauma and laceration and form ports of entrance of organism to immune-compromised diabetic patient.

The duration of D.M. ranged between 4 months and 30 years with a mean of 10.0±8.1 years. This does not matches the result of Z. G. Abbas and et al who found that a median interval since diagnosis of diabetes was 5 years with a range of 2 weeks to 19 years. 54.8% of the patients had D.M. for less than ten years. This may indicates that hand sepsis can occurs in
patient with short duration of the D.M; in contrast to DSF which is one of long-term complications of D.M.

In series 58 (77.3%) patients had type II D.M and 17 (22.7%) patients had type I D.M, this matches Nigerian and Libyan patients with hand sepsis\(^{(5)}\) in whom the type II D.M. was predominant and in contrast with the results of Mark H. Gonzales and et al\(^{(2)}\) who found that insulin dependent patients were predominant. The predominance of the type II D.M. patients in this series due to fact that type II D.M is the commonest type of D.M worldwide. Also this indicate that type II D.M. may be one of the risk factors for development of hand sepsis in Sudanese diabetic patients.

Twelve (16.0%) patients were snuffers, 6(8.0%) patients were smokers and 3(4.0%) patients were alcoholics. The presence of these habits in small numbers of patients indicates that these may not be risk factors for the development of the hand sepsis in diabetic patients.

The cause of hand infection in this series was unknown or spontaneous in 36 (48.0%) patients and due to trauma in 31(41.0%) patients. This is in contrast to a local study done by K. Ezeldeen et al\(^{(13)}\) who found that trauma was the main cause of hand sepsis in 63%, and in one third of patients no aetiological factor could be identified. Z.G. Abbas et al \(^{(6)}\) found that the cause was unknown in 28% of the patients and due to trauma in 26%
of the patients. Mark H. Gonzales et al (2) found that the cause of infection was unknown or spontaneous is the same number of the patients as that due to laceration or crush. Direct inoculation and contamination from inadvertent minimal trauma or breaches of the integrity of the skin, unrecognized by the patients, were believed to be the precipitating events that led to the sepsis.

Three (4.0%) patients developed hand sepsis due to infected site of venous cannulation, two of them had impaired renal function and ischemic heart disease and the third one presented with heart failure and deep vein thrombosis. This may indicate that venous cannulation may be a risk factor for developing hand sepsis in diabetic patients with debilitating disease although the number is small.

Two (2.7%) patients had hand sepsis due to animal bite and both of them developed gangrene, both of them underwent amputation, one had below elbow amputation and the other had right index finger amputation. Although the number is small, animal bite may predispose diabetics with hand sepsis to an amputation.

In this series 39(52.0%) patients had infection involved the left hand and in 36(48.0%) patients the right hand. This matches the results of Kour (3) et al who found that left hands are involved more than right hands.
Thumb involvement occurred in 25.3% of patients, index involvement in 21.3% of patients while middle finger involvement occurred in 24% of the patients. The predominant affection of these three fingers in this series matches the result of Kour \(^{(3)}\) et al who found the thumb, index and middle digits were the most frequently affected fingers. The predominant affection of these three fingers may be due to the fact that these were the commonest fingers involved in the function of the hand, so they were vulnerable to trauma and injuries.

85.3% of the patients presented with swelling, throbbing pain in 77.3% of patients and fever in 36.0% of the patients. The presence of one or more of these symptoms alerts the patient to seek treatment. The presence of throbbing pain in the majority of patients indicates that hand sepsis in diabetes is a painful condition in contrast to painless foot lesions.

Physical signs like swelling, hotness and tenderness which are found in wrist, forearm and arm; indicate the severity of the infection and the spreading cellulitis.

In this series the most commonly encountered types of sepsis were paronychia in 28.0%, pulp space infection in 28.0% of patients and other parts of finger were involved in 40.0% of the patients. Elzeldeen et al\(^{(13)}\) in a local study found that paronychia in (41.3%) of the patients, distal pulp
infection in (2%) of the patients and subcutaneous infection in (30%) of the patients. Kour et al\(^{(3)}\) (Singapore) found that in 64.0% of the patients the site of infection was in a digit, of which 36.0% involved the finger pulp, 4.0% involved the nail, and 24.0% the rest of the digit. The other parts of the finger is involved more in this series than other regions in comparison with a local study (Ezeldeen et al\(^{(13)}\)) because infection of the other parts of the finger in this series include the superficial, subcutaneous and flexor tendon sheath infections.

In this series 8(10.7%) patients had dry gangrene, one patient had gas gangrene and 2 (2.7%) patients had osteomyelitis. This in contrast with the results of Gonzales et al\(^{(2)}\) who studied 46 infections of the upper limb in diabetics, in whom he found wet gangrene in 7 patients and osteomyelitis in 9 patients. Abbas\(^{(6)}\) et al, found 16 patients out of 72 patients had gangrene of the hand. This indicates that there is a low incidence of gangrene and osteomyelitis in Sudanese patients in comparison to others; which may be due to the fact that most of the patients had good blood supply in their upper limbs. In this series 7(9.3%) patients presented with DKA. This indicates that some patients presented late with advanced sepsis or gangrene, which predisposed them to DKA.
All the patients in this series had palpable radial pulsation. This explains that peripheral vascular disease is not a risk factor for development of hand sepsis in diabetes which is in contrast with DSF in which the peripheral vascular disease is a major risk factor.

Upper limb peripheral neuropathy particularly hypoesthesia occurred in 5 (6.7%) patients. This matches a result of Kour et al\(^{(1)}\) (Singapore) who found that 9% of his series had neurologic deficits in the upper extremity. This low incidence of upper limb peripheral neuropathy in diabetics in this series indicates that peripheral neuropathy in upper limb is rare in D.M and rarely can predispose the patient to the hand sepsis.

In this series 2 (2.7%) patients had renal failure and cardiovascular problems. None of those two patients underwent amputation. This is in contrast with the results of Gonzalez and et al\(^{(2)}\) who studied 45 diabetics with upper extremity infections; he found that 8 patients had end-stage renal disease of whom 6 patients required an amputation. This low incidence of renal failure among diabetics with hand sepsis in this series may indicate that renal failure is not a risk factor for the diabetics to develop a hand sepsis or to underwent an amputation.

Three (4.0%) patients had DSF at the same time of their hand infections. None of them underwent amputation. This is in contrast with the result of Kour et al\(^{(1)}\) who found that none of his patient had diabetic foot sepsis at the time of the hand infections in the subsequent follow up period.
The blood investigations taken on admission showed a range of hemoglobin of 6.6 to 15.1 gm/dl with a mean of 11.5 ± 1.6 gm/dl. Kour et al (3) found that the hemoglobin ranged between 11 to 15 gm with none of the patients being anemic.

White blood cell count done in 28 (37.3%) patients and it ranged between 2100 and 251000 WBCs/mm³ with a mean of 7633.9 ± 5476.0 WBCs/mm³. Seven (25%) patients had leucocytosis of more than 9000/mm³. Ezeldeen et al (13) in a local study found that leucocytosis of more than 9000/mm² was found in (15.3%) of patients. Kour et al (3) found that the total white cell counts ranged from 5900 to 15,000 wbc/mm³.

Random blood glucose level in (60.0%) of the patients ranged between 130-567 mg/dl with a mean of 319.7 ± 111.2 mg/dl which matches the results of Abbas et al (6) (Dar es Salam) who found that the median random blood glucose was 280 mg/dl in his patients. Also Kour et al (3) found that all the patients had elevated random blood sugar ranging from 220 mg/dl to 370 mg/dl.

In (37.3%) of the patients the fasting blood glucose level ranged between 114-430 mg/dl with a mean of 240.2 ± 76.6 mg/dl on admission. This indicates that hyperglycemia is the risk factor that predisposes diabetics to hand sepsis.

*Staph aureus* was isolated in (41.3%) of the patients and in (25.3%) of the patients no growth was presented. These bacteriological results were similar to the findings of Ezeldeen et al (13) who found that *Staph. aureus* was isolated in (51%) of the cultures (both diabetic and non diabetic) and in (26%) of swab cultures no growth was present. Also Ezeldeen et al (13) found that the dominance of *Staph.*
*aureus* in diabetic sepsis (40%). This indicates that in Sudanese patients the diabetic hand infections does not differ from non-diabetic hand infection where *Staph. aureus* is the most common causative organism.

In this series gram-negative bacteria were only found in (10.7%) of the patients. This is in contrast with the result of Kour et al\(^{(3)}\) who found that gram negative organisms were the most common organism.

In this series one patient had polymicrobia (2 organisms) in his culture. This is in contrast with the result of Abbas et al\(^{(6)}\) who found that all cultures yielded polymicrobial growth. Although anaerobic cultures were not done routinely for our patients; there was one patient who presented with gas gangrene due to the dog bite, anaerobic culture performed to her, in which anaerobic organism isolated.

Knowledge of the most likely causative organisms combined with familiarity of their antimicrobial susceptibility patterns is necessary to allow you to select a proper antibiotic treatment before the availability of the culture results.

The most effective antibiotics based on culture sensitivity for Staphylococcal infections were ceftazidine, streptomycin, ceftriaxone and chloramphenicol; and for streptococcal infections were chloramphenicol, ceftazidine, cefotaxime, streptomycin and ceftizoxime. Ezeldeen et al\(^{(13)}\) in a local study (1992) found that the most effective antibiotic based on culture and sensitivity result were chloramphenicol and penicillinase resistant penicillins.

However, the empirical use of chloramphenicol and streptomycin is inadvisable since most physicians in Khartoum prefer to limit the use of
chloramphenicol in typhoid fever and streptomycin in treatment of tuberculosis. Also chloramphenicol causes irreversible blood dyscrasia.

In this series (29.3%) of the patients were admitted to the hospital. The hospital stay ranged between 1-40 days with a mean of $7.9 \pm 10.4$ days. Ezeldeen et al (13) in a local study (which included both diabetic and non-diabetic patients with hand infection) found that (30%) of the patients were treated as inpatients with the mean hospital stay of 3.6 days. This may indicates that D.M can prolong the hospital stay of patients with hand sepsis. Gonzalez et al (2) found that the average hospital stay was 18 days (rang, 1-92 days). This indicates that Sudanese patients stay shorter in hospital.

In this series all the patients underwent surgery, (86.7%) of the patient had debridement and drainage. Amputation surgery with loss of a segment of the digit or the whole digit or below elbow or above elbow amputation accounted for (17.3%) of the patients. Abbas et al (6) found that 36 (50%) patients underwent surgery, seven patients of them required amputation of fingers, hand or arm. Kour et al (3) (Singapore) found that surgery was performed in 88% of patients, 76% of whom had debridement and drainage; amputation surgery with loss of a segment of the digit or the whole digit of hand accounted for (12%) of the patients. Gonzalez et al (2) reported that all his patients underwent surgery, (39%) of them required an amputation and there were 3 deaths directly related to an infection, Abbas et al found that (8%) of the patients died. This was in contrast with the results in this series in which found that there was no death and high morbidity and amputation rate had been reported. Early aggressive management with adequate drainage and
debridement is advocated to control the sepsis. Simultaneously, pus and tissues are sent for bacteriologic cultures and sensitivity testing.

Three (4.0%) of the amputees had major upper limb amputations; one of them was 75 years old female had gas gangrene of forearm due to dog bite underwent below elbow amputation, the other two patients underwent above elbow amputation, one was 60 years old male with dilated cardiomyopathy and ischemic heart disease and the other was 60 years old female with heart failure and DVT. Both of them developed dry gangrenes of the forearm.

In this series local anaesthesia either digital or field block was used in (65.3%) of patients, general anaesthesia in (24%) of patients and in (10.7%) of patients the surgery done without anaesthesia. This not matches the results of a local study (which included both diabetic and non-diabetic patients with hand infection) done by Ezeldeen et al(12) who found that, general anaesthesia was used in (15%) of patient, local anaesthesia in (35%) of patients and infusion analgesia using pethidine with or without diazepam in (50%) of patients.

Follow up was completed for 62 (82.7%) patients, (80.0%) of patients had complete healing of their hand ulcer and resolution of inflammation; (2.7%) of patient had ulcers that did not heal and no patient died. Abbas et al found that (80%) of his patients had complete healing of their hand ulcer, (13%) had ulcers that did not heal and (8%) died. Those two patients in this series who’s their ulcers did not heal because they sustained to another trauma in the same previous ulcer during its healing processes. Impairment of the function of the affected part after
healing occurred in 9 (12.0%) patients where Abbas et al during his follow up found that, (52%) of the patients had impaired hand function.

This impairment of the function included mainly failure of the patient to flex his affected finger(s). This may be due to badly performed surgery or fibrosis that complicate healing or the patient had no physiotherapy to the affected finger during the process of healing.

**CONCLUSION**

- The risk factor for development of hand sepsis in diabetic patients were, history of hand trauma, poor glycaemic control, housewives job and type 2 D.M.
- The most commonly encountered types of hand sepsis were paronychia, pulp space infection and involvement of the other parts of the finger in 28.0%, 28.0% and 40.0% respectively.

- *Staph. aureus* was the main bacterium recovered from cultures.

- The bacterial count showed that the most effective antibiotics against staphylococcal infections were ceftazidine, streptomycin, ceftriaxone and chloramphenicol; while antibiotics against streptococcal infections were chloramphenicol, ceftazidine, cefotaxime, streptomycin and ceftizoxime.

- The outcome of hand sepsis in diabetics include: normal function of affected part after healing occurred in 68.0%, impairment of the function of affected part occurred in 12.0% and 17.3% of the patients underwent amputation.

**RECOMMENDATIONS**

- Early and adequate drainage and debridement with antibiotic therapy with good blood glucose control is recommended to control the sepsis.
• Antimicrobial therapy must be effective against Staph. aureus as it the main bacterium recovered from cultures.

• The diabetic housewives, manual workers and employees should be adviced to take care for their hand during their work and activities as they were the groups at risk.

• Diabetic patients with cardiovascular problems who had hand sepsis must have a lot of medical care in order to prevent major upper limb amputation in this group.

• Hand sepsis in diabetic represents a surgical emergency, requiring immediate evaluation by hand surgeon and early, aggressive treatment.

• Patients and health – care providers should be educated about hand sepsis in diabetics to prevent its morbidity and crippling complications.

REFERENCES


3) Kour AK, Looi KP, Phone MH, Pho RW. Hand infection in patients with diabetes; Clinical Orthopaedics and related research 1996; 331: 238-244


HAND SEPSIS IN PATIENTS WITH DIABETES MELLITUS

Serial No. …………… Date ………….. Tel. No.  ………………………

Name ………………………………………. Age  ………………………

Sex : 1) Male  2) Female

**Job:**

1) Manual worker  2) House-wife  3) Employee  4) Farmer
5) Merchant  6) Retired  7) Others ……

**Duration of D.M:**

1) Newly discovered  2) ……… months  3) ……….. yrs

**Type of D.M:**

1) Type 1 D.M  2) Type 2 D.M

**Habits of patient:**

1) Cigarette smoking  2) Snuffing  3) Alcoholic  4) Others

**Cause of hand sepsis:**

1) Spontaneous or unknown  2) Trauma  3) Venous cannulation
4) Burn  5) Animal bite  6) Inset bite  7) Others …..

**Site of infection:**

-  Rt hand ……………………. Lt hand .
-  Fingers involvement:
  1) Thumb ……………  2) Index  3) Middle  4) Ring  5) Small
-  Clinical presentation of finger involvement is:
  1) Paronychia  2) Pulp space infection
3) Infection of the rest of the finger
-  Which hand space involved:
  a) Web space  b) Midpalmar  c) Hypothenar
d) Thenar
e) Space of Parona
f) Dorsal subaponeurotic and subcutaneous spaces.

- Symptoms of patients are:
  1) Swelling  2) Throbbing pain  3) Fever  4) Other

**Local examination:**

At wrist:
1) Swelling  2) Hotness  3) Tenderness  4) Abscess
5) Ulcer  6) Gangrene  7) Others

At forearm:
1) Swelling  2) Hotness  3) Tenderness  4) Abscess  5) Ulcer
6) Gangrene  7) Others

At arm:
1) Swelling  2) Hotness  3) Tenderness  4) Abscess  5) Ulcer
6) Gangrene  7) Others

Axillary lymph node enlargement:  1) Yes  2) No

**Peripheral circulation:**

A- Radial pulse: 1) Palpable  2) Not palpable
B- Dorsalis pedis: 1) Palpable  2) Not palpable
C- Post tibial artery: 1) Palpable  2) Not palpable

**Associated illnesses:**

A- Peripheral neuropathy: 1) In lower limb  2) Upper limb
B- Renal failure: 1) Yes  2) No
C- Associated DSF: 1) Yes  2) No
D- Cardiovascular problems:
1) Hypertension  2) Ischemic heart disease  3) Heart failure
4) Dilated cardiomyopathy  5) DVT  6) Others

**Investigations:**
HB ............gm/dl      TWBe ............... 
Urine for sugar & acetone ...................... 

Blood glucose level at admission:
- Random blood glucose ......................mg/dl.
- Fasting blood glucose .....................mg/dl.

X-ray : 1) Normal   2) Osteomyelitis   3) Fracture   4) Others

**Bacteriological profile:**

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**Management:**
- Hospital admission : 1) Yes  2) No            Duration in ..........days
- Surgery:
  1) Drainage and debridement.
  2) Amputation .......... which part :
     (a) Finger(s)
     (b) Below elbow
     (c) Above elbow
- Anaesthesia : 1) Local   2) General   3) Without
- Antibiotic:
  1) I.V ................. type ..........duration
     ..........days.
  2) Oral ................. type ..........duration
     ..........days.
- Post – operative control of D.M:
1) Insulin .......................... dose
........................units/day.
2) Oral hypoglycaemic drug .............. dose
........................mg/day.
3) Diet control.

- Outcome:
1) Healing .................duration ..................weeks.
2) Impairment of the function of the affected part : 1) Yes  2) No