Tanta Medical Sciences Journal Vol. (1), No. (1), April 2006: PP 89 -104
ISSN: 1687- 5788

Original Article

www.tantamsj.com

Surgical Management of Non-Ischemic Diabetic Heel Ulcers and the Role of Magnetic Resonance Imaging (MRI) In These Cases.

Adel Hussieny Kamhawy , Hassan Abd El-Aty ,* Hanaa Kamel , & **Gamal F. El-Nagar

*Vascular Surgery Unit, Surgery Department, * Radiology and Imaging Department, ** Internal Medicine Department, Faculty of Medicine, Tanta University*

ABSTRACT

Background/Aim: Amputations distal to the heel are minor foot amputations while proximal amputations to the heel are major. Heel ulcers may be superficial but may send infection deep to bone (calcaneus) and/or-Achilles tendon .In the start of the treatment the anticipated outcome is not well known. The Aim of the work is to report our results of management of chronic non-ischemic diabetic heel ulcers including: surgical management in the form of debridement, partial calcnectomy and partial excision of Achilles tendon plus off-loading, edema management and wound management. Role of medical management of diabetes mellitus (DM) and comorbid conditions and to report the role of MRI in diagnosis and management these cases.

Materials and methods: This retospective study involved Sixty patients (33female, and 27 male), mean age 55.87 (range 26-78 years, mode 60 years) with 66 heel ulcers in the 4 year period from January 2002 to January 2006. Diagnosis of neuropathy and vascular state were done. Photographic documentation of the ulcers, Plain-x-ray and MRI were used to diagnose osteomyelitis. In twelve cases partial calcanectomy and in 5 Achilles tendon was partially excised. Regular debridement, wound care and control, management of infection, hyperglycemia, comorbid conditions was performed in all patients plus post-operative off-loading, patient and relatives education. Follow up of the patients. End points of the study were ambulation and independency of the patient, healing of the ulcers, proximal amputation, or death of the patient.

Results: All of the Ulcers were >2 cm^2 surface area with duration > 8 weeks .Most of them were in the right side in the planter aspect. MRI showed osteomyelitis in 12 cases of the calcaneus and they were managed by partial calcanectomy. Foot stability and patient independence was achieved after partial excision of Achilles tendon. Complete healing of the ulcers after one year of management was in 68% of the ulcers. Blow knee amputations were done in 5 cases and above knee in two. Seven patients died within 4 year period due to metabolic, cardiac and cerebral causes.

Conclusion: Multidisciplinary approach including vascular surgery, radiological imaging and internal medicine is crucial to successful treatment through integration of knowledge and experience. Debridement of chronic or infected tissues even if Achilles tendon or calcanei are involved is essential for ulcer healing. MRI has a role in accurate detection of precise area of osteomyelitis allowing proper debridement and partial calcanectomy with little morbidity and major impact on patient and limb outcome.

Key words: Non-Ischemic Diabetic Heel Ulcers, MRI & Diabetic Heel Ulcer.

INTRODUCTION

Heel Ulcers in diabetic patients present a difficult clinical challenge, especially in the elderly and in those with comorbidities, that it is sometimes said that ' Heel Ulcers don't heal'.[1]

The heel is the second leading site for development of pressure ulcers after the sacrum.[2]Costs for heel ulcers are nearly double that of the costs associated with forefoot ulceration [3].

When a person is standing, the weight of the body is transmitted through the heel bones talus and calcaneus to the ground .The heel is the first part of the body to transmit the weight to the ground durin walking.[4]

Atrophy of muscle and fat tissues in patients with diabetes has been proposed as one of the possible factors that increases the risk of ulceration. Researchers have determined that heel thickness in non-ulcerated patients with diabetes is 2 mm less than the heel thickness in non-diabetic patients. Diabetic patients with a history of ulceration have heel thicknesses 3 to 4 mm less than non-diabetic patients. Shock absorption in the heel declines with age. ([5,6]

Foot ulceration is the most common single precursor to lower extremity amputations among persons with diabetes. [7]

Peripheral sensory and autonomic neuropathy in the absence of perceived trauma is the primary factor leading to diabetic foot ulcerations, autonomic neuropathy may commonly result in dry skin with cracking and fissuring, thus creating a portal of entry for bacteria and infection that may spreads through tissue spaces involving the Achilles tendon and into the bone causing osteomyelitis which is the most disaster situation. [8]

Conventional Plain-X ray is of little use in the detection of very early bone infection, MRI (Magnetic Resonance Imaging) is the more superior noninvasive imaging method for the diagnosis of osteomyelitis and soft tissues involvement in diabetic patients .[9]

One study reported a 5-year mortality rate of 68% after lower limb amputation, with lower survival rates in those patients with higher levels of amputation .Following one lower extremity amputation, there is a 50% incidence of serious contralateral foot lesion and a 50% incidence of contralateral amputation within 2–5 years [10].

Good surgical management depends upon good diagnostic imaging, management of hyperglycemia, comorbid conditions, and off-loading aiming at staying one step ahead, avoiding the first amputation and then avoiding the next one.

Multidisciplinary approach including vascular surgery, radiological imaging and internal medicine is crucial to successful treatment through integration of knowledge and experience will lead to effective treatment thereby improving outcomes and limiting the risk of lower extremity amputation. [7]

PATIENTS AND METHODS

Sixty patients (33female, and 27 male), mean age 55.87 (range 26-78 years , mode 60 years) with different grades of heel ulcers according to Wagner classification were retrospectively in 4 year period from January 2002 to January 2006 reviewed.

The key points of the medical history included identifying the initiating trauma, duration of the wound, progression of signs and symptoms, and prior treatment, history of the current and previous wounds. The history included evaluation of blood glucose control, identification and evaluation of co-morbidities, and identification of previous surgical interventions, e.g., prior revascularization, venous surgery, reconstructive foot surgery, and debridement. The physical examination included specific clinical descriptors of the wound, neurological examination, vascular evaluation, detection of foot deformities, and assessment for the presence of edema, soft tissue infection, and osteomyelitis. The contralateral limb and the patients' footwear were also examined.

Every patient was evaluated generally and locally. Palpating pedal pulses was the first clinical test performed to exclude ischemia. Assessing the posterior tibial pulse was the best indication of flow to the heel. Ischemic heel ulcers were excluded when posterior tibial pulse was palpable and ABI > 0.9.

Photographic documentation for the ulcer was done .Description of the ulcer characteristics

included: Site, size, depth, presence of infection, and the healing phase.

A standard tuning fork (128 cycles/second) was used to detect sensory neuropathy. Results reflect abnormality if the patient was unable to sense the vibration when it was placed firmly on the distal interphalangeal joint.

After trimming of he callus and debridement, ulcers were graded according to Wagner Classification System, in which the foot lesions are divided into six grades based on the depth of the wound and the extent of tissue necrosis[11]

Grade 0: Preulcer. No open lesions skin intact; may have deformities, erythematous areas of pressure or hyperkeratoses.

Grade I: Superficial ulcer. Disruption of skin without penetration of the subcutaneous fat layer. Superficial infection with or without cellulitis may be present.

Grade II: Full-thickness ulcer. Penetrates through fat to tendon, or joint capsule without deep abscess or osteomyelitis.

Grade III: Deep ulcer which may or may not probe to bone, with abscess, osteomyelitis, or joint sepsis. Includes deep plantar space infections or abscesses, necrotizing fasciitis, and tendon sheath infections.

Grade IV: Denotes gangrene of a geographical portion of the foot such as toes, forefoot or heel. The remainder of the foot is salvageable though it may be infected.

Grade V: Gangrene or necrosis to the extent that the foot is beyond salvage and will require a major limb- or life-sparing amputation.

Patients who had acute cellulites and osteomyelitis of the calcaneus demonstrated by MRI from the start without chronic heel ulcers were excluded from this study.

The site of the ulcer: medial, lateral, planter or posterior. The size was measured using the wound measure planimetry from Smith and Nephew, the depth of the heel ulcer was determined using a blunt sterile probe. With gentle probing we could detect dissection of the ulcer into the bone. The presence of odor and exudates and the co-existence of cellulites or fasciitis and ankle swelling were recorded. The color of the ulcer and the presence or absence of granulation tissue noted. Infection of the heel ulcer was diagnosed if a foul smell or purulent discharge was present with other local signs of infection (warmth, erythema, lymphangitis, lymphadenopathy, edema, pain).

Laboratory tests included: fasting or random blood glucose, glycohemoglobin (HbA1C), complete blood count (CBC) with differential count, erythrocyte sedimentation rate (ESR), coagulation profile, and serum albumin level.

Frequent re-evaluation with response-directed treatment was essential. Once healed,the management consisted of decreasing the probability of recurrence.

If there were suspicious of osteomyelitis plain X ray and MRI were requested.

Methodology used in MRI examination:

MR imaging was performed with a 1.5-T super-conducting magnet (Signa; General Electric Medical Systems, Milwaukee, WI). The standerd circular extremity coil was used for all patients (field of view, 16 cm) , (slice thickness 4 mm) , interslice gap 2-3 mm) ,(Matrix size 256 x256 pixels)

The patients were asked about any contraindications for MRI (such as cardiac pace maker, artificial cardiac valves, orthopedic plates) then asked to remove any metallic objects .the patient lie supine with the examined foot & ankle within the coil , the foot was dorsiflexed with the dorsal aspect of the of the foot at right angle to the examination couch.

Protocol of MRI examination including A Scout 3D reconstruction Sagittal T1WI (TR range / TE range of 400-600 / 15-25) as a localizer for subsequent slices. Axial , Sagittal & coronal T1--weighted spin-echo MR images were obtained (TR range / TE range of 400-600 / 15-25 msec) and Axial , sagittal & coronal T2 -WI Images (TR range / TE range 2000-4000 / 80-100 msec) for all patients. Contrast-enhanced fat-suppressed T1-weighted images were obtained using IV contrast agent (Magnevist [gadopentetate dimeglumine]; Berlex Laboratories, Wayne, NJ), administered at a dose of 0.1 mmol/kg of body weight.

Spoiled gradient-recalled imaging with a TR/TE of 500 / 15, a flip angle of 20 °, and a matrix of 256 x 256 pixels was performed using the same

parameters before and after contrast administration. For all T2-weighted and gadolinium-enhanced T1-weighted sequences, fat suppression was accomplished using selective presaturation of lipid resonant frequency.

Fast spin-echo short tau inversion recovery images were obtained with an echo-train length of 8, a TR range/TE_{eff} range of 2000-3000 / 30, an inversion time of 150-160 msec, and a matrix of 256 x 256.

For Surgical debridement:

1-Preoperative evaluation before surgery included glucose control, renal function assessment, and cardiovascular status.

2- General monitored anesthesia was used when needed due to the patient's medical condition and in cases where the patient was insensate the debridement was done in the operating room.

3-Hemostasis was achieved in the form of judicious use of electrocautery. Generally, there was an attempt to avoid ligatures in infections. The wounds were left open, various packing materials and wound dressings plus pressure bandage were used to control blood loss and edema.

Technique of partial calcanectomy: After the induction of general anesthesia, the patient was placed into the prone position. After standard preparation and draping of the extremity, a direct longtudinal incision was made over the inflamed bone in the ulcer area. The incision may be curved medially or laterally to allow incorporation of any ulcers or sinus tracts. The dissection is carried directly down to bone to create full-thickness soft tissue flaps for preservation of blood supply to the skin. Medially, the neurovascular bundle needs to be identified and protected, as do the tendons of the flexor digitorum longus, flexor hallucis longus, and tibialis posterior. Laterally, the peroneus longus and brevis tendons must be identified and protected and with the bone nippler the osteomyelitic bone was excised.

Fig.14-15

In all cases of partial calcanectomy aerobic and anaerobic cultures were taken. The precise location of osteomyelitis was determined pre-operatively by MRI. The infected fragment of bone was removed. The remaining part of the os calcis was then inspected for signs of infection. This technique allowed maintaining the integrity of the rest of calcaneus and foot joints.

Technique of partial resection of Achilles tendon due to massive infection and necrosis was performed while the patient in prone position and under general anesthesia longitudinal 5 cm incision in the healthy skin and deep fascia of the posterior area of the mid-calf and the necrotic tendon was brought from distal part of the leg at the heel mounted by a long clamp through a subfascial tunnel to the incision and then outside the leg. Then the tendon was tracted out the wound to expose the musclo-tendinous junction with gatrocnemius muscle and this junction was cut by electrocautery .we did not use primary closure of the surgical wound. Primary closure prevents further inspection of the wound bed, and it may leave behind dead space susceptible to the formation of a seroma or hematoma that may reestablish the infection.

A compression dressing and then a short-leg splint are applied with the ankle in mild equinus (10–20°) to reduce strain on the tendo-Achilles and overlying skin. Intravenous broad-spectrum antibiotics are started, and continued until intraoperative culture results were available. At that time, one may change to a more appropriate antibiotic based on organism identification and sensitivity. The antibiotics continued for a total of 6 weeks.

The patient was made non-weight bearing on the affected extremity for one week and then off-loading which was individually suitable. We did not use total contact casting in these cases.

Edema was managed by correction of the systemic factors such as hypoalbuminemia , improving the renal function and locally by pressure bandage. (Fig. 21)

Adequate blood sugar control with insulin is the first step in the management of most heel ulcers. The target would be Hb A1C of <7%.Blood pressure <130/80, control of dyslipedemia and albumin level to be above 3g/dL.

The ulcers were dressed with saline-moistened gauze to provide a moist environment plus

collagenase ointment and local antibiotic ointment when indicated.

Methods of off-loading were variable according to patient attitude, activity, preference and ulcer criteria. Patient and relatives education regarding foot hygiene, skin care, and proper footwear were done.

RESULTS

This study involved Sixty patients (33female, and 27 male), mean age 55.87 (range 26-78 years, mode 60 years) with different grades of 66 heel ulcers in the 4 year period from January 2002 to January 2006.

All patients had peripheral neuropathy which was diagnosed by history of insensate loss of foot slippers and different abnormal sensations of polyneuropathy (PNP).

All patients could not perceive the vibration of the standard 128 Hz tuning fork placed at the medial maleolus or at the metatarso-phalangeal joint of the big toe, two point discrimination test, or touch test in the planter aspect of the foot. No patient with ischemic limb was included in this study.

Blood glucose level was high in all patients at first presentation (>300 mg/dL) in spite of receiving hypoglycemic drugs: insulin in 44 cases and oral therapy in 16 cases (Fig.28).

Right lower limb was involved in most of the heel ulcers in 45/66: 69%, left side in 15/66: 22%, bilateral involvement in 6/66: 9% of the cases (Fig.30)

In all cases the duration of the ulcer before first presentation to us was > 8 weeks (mean 6 months).

Size of the ulcer in all cases was > 2cm^2 (mean 7.5 cm^2).According to Wagner classification there were : Grade 1: 5cases ,Grade 2: 26 ,Grade 3 : 15 case , Grade 4 : 20cases (Fig. 31).

Most common site of the ulcer was in the planter aspect of the foot followed by the posterior aspect (Fig. 32).

Twenty three patients were hospitalized and the mean stay was 12 days (range from 2-21 days).

Main surgical interventions were devided into 3 groups: group I: included 43 patients with 49 heel ulcers who underwent only regular debridemant. Grroup II: included 12 patients who underwent partial Calcanectomy, Group III: included 5 patients who underwent partial resection of infected necrotic Achilles tendon.

Culture and sensitivity was done for 17 patients (group II and group III) and the culture results demonstrated a variety of infecting organisms. Of the 17 feet with positive results from intraoperative cultures, 9 (53%) had polymicrobial infections. Thirteen (76%) of the 17 feet grew out Staphylococcus aureus (S. aureus). Four (23.5%) cultures were positive for Pseudomonas species. Three (18%) cultures were positive for Proteus mirabilis. Two (11.5%) cultures were noted to have Enterococcus species. Citrobacter species and Group B Streptococcus also were identified. All patients were treated with antibiotics. Those with positive culture results were treated with at least a 6-week course of appropriate antibiotics.

Overall, 45 heel ulcers out of 66 (68%) of 66 feet healed completely and 7 (10.6%) were healing, at the time of last follow-up and progressing well with dressing regimens. Five (8%) of 66 went on to have a BKA (two after partial calcanectomy, one after Achilles tendon resection , and two heel ulcers). Two patient (3.3%) had an AKA. Seven patients (11.6%) died within the period of follow up without ulcer complications but due to metabolic and cerebro-cardiovascular strokes.

Fig. 1: Neuropathic planter heel ulcer.

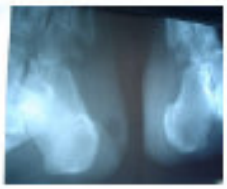

Fig. 2: Plai-X ray showing soft tissue defect.

Fig. 3: Off-loading by felted foam.

Fig. 4: Healing of the ulcer.

Fig. 5: Healed bilateral heel ulcers.

Fig. 6: Immediate post-operative after partial resection of Achilles-tendon.

Fig. 7: Another case of partial resection of Achilles-tendon.

Fig. 8: Heel ulcer and partial resection of Achilles-tendon.

Fig. 9: Healing of the ulcer.

Fig. 10 : Nearly healed ulcer and complete wound healing at the proximal site of tendon resection

Fig.11: Foot stability of the patient in Fig.8-11

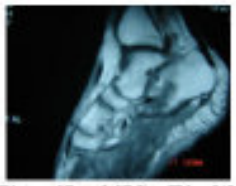

Fig. 12: MRI, T1 W. image: Osteomyelitis of anterior part of the calcaneus.

Fig. 13: MRI, T2 W. image: Osteomyelitis of anterior part of the calcaneus.

Fig. 14: Intra-operative photo for partial calcanectomy, incision through the ulcer.

Fig. 15: Intra-operative photo for partial calcanectomy, rippling of the infected bone.

Fig. 16: Plain-X ray, notice heel ulcer.

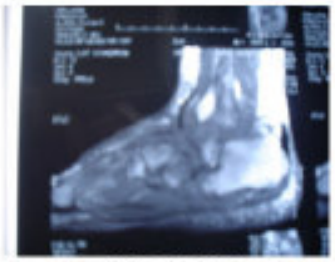

Fig. 17: MRI, T1 W. image: Osteomyelitis of anterior part of the calcaneus with cellulites.

Fig. 18: MRI, T2 W. image: Osteomyelitis of anterior part of the calcaneus with cellulites.

Fig. 19: Heel ulcer before treatment.

Fig. 20: After treatment.

Fig. 21: Pressure bandage to reduce edema

Fig. 22: Lateral heel ulcer.

Fig. 23: MRI, T1 W. image: Osteomyelitis of lateral part of the calcaneus .

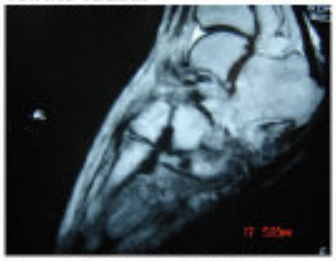

Fig. 24: MRI, T2 W. image: Osteomyelitis of lateral part of the calcaneus.

Fig. 25: Pre-treatment heel ulcer

Fig. 26: Healing of the ulcer in previous photo.

Fig. 27: Simple method of off-loading

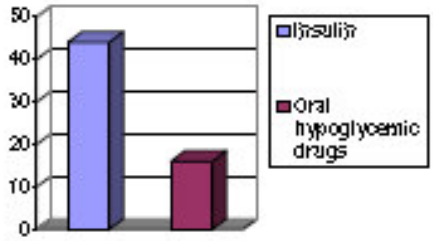

Fig. (28) Hyperglycemic control

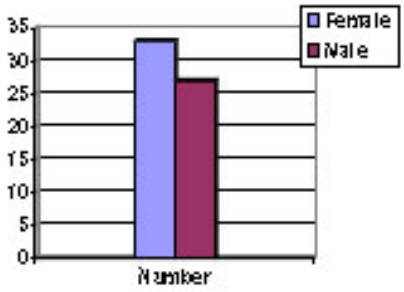

Fig. (29) Sex Distribution

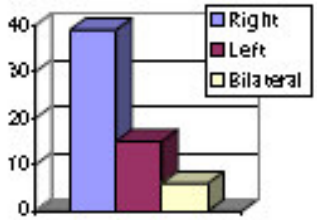

Fig. (30) Affected Lower Limb Side

Fig. (31) Degrees of Heel Ulcers

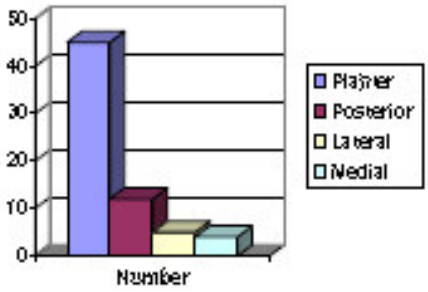

Fig. (32) Location of the ulcer

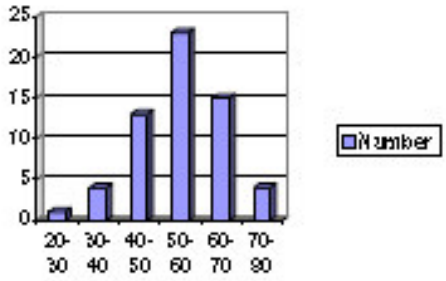

Fig. (33) Age criteria

DISCUSSION

In this study the mean age of the patients was 60 years, and there were no gender prevalence and that is the same in the literature and all patients were neuropathic without ischemia.

The right lower limb and the planter ulcer were the most common indicating that the mobile patient depends more and the repetitive trauma occurs more in the dominant limb specially in the planter aspect. We asked ourselves why these heel ulcers with long duration and sometimes more than years and did not heel, in spite of healing of these ulcers after our management by simple procedures such as debridement, off-loading and wound management plus medical condition improvements in few months. The general condition affects the wound healing and sometimes the wound (specially infected one) affects the general condition of the patient. Wound healing and infection control will be significantly impaired in the hyperglycemic, anemic, toxemic diabetic patient. The control of hyperglycemia is very crucial in these patients. Insulin is used to control blood glucose especially during the time of stress and the dose is individualized and depends on patient factors and response. [12]

Drugs that control hyperglycemia have also other beneficial effects to the wound healing. Insulin is working as a growth factor; metformin improves fibrinolysis, lipoprotein profile and endothelial dysfunction.[13] Also gliclazide has antioxidant and antithrombotic effect, it reduces vascular inflammation and adhesion molecules.

Glycemic control is judged by the current recommendation for the level of Hb A1c to be around the 6% which is equal to blood glucose 135 mg/dL.[14]

Good glycemic control may reduce above all plasma levels of triglycerides, but several data underline the central role of aggressive lipid-lowering therapy with statins that may reduce cardio- vascular events by 22% independent of baseline lipid levels, generally the combination of statins plus α fibrate is recommended when triglycerides are above 320 mg/dL.[16,17]

Hypertension as a comorbid condition in diabetic patients must be reduced to a level below 130/80 according to the guide lines for cardiovascular prevention.[15] Angiotensin converting enzymes inhibitors, angiotensin receptor blockers and α –blockers have a positive effect on glucose and lipid metabolism.[15]

Nutrition is just as important for preventing pressure ulcers as it is in treatment. Appropriate nutritional and hydration status of the patient is essential for preventing skin breakdown. Our policy for albumin level control is coinciding with other reports [18,19]

It was essential in this study to determine the vascular status where a palpable posterior tibial pulse was the best clinical indication of blood flow to the heel and ankle brachial indexes >0.9 because ulcer healing needs good blood perfusion and surrounding good quality skin.

Description of the ulcer characteristics on presentation was critical for the mapping of its progress during treatment [7, 20]. Photographs of the wound were of great value, especially as an aid in monitoring progress.[7,21,22] We followed this method of ulcer description and documentation based on the word: if you did not document it, you did not do it.

We followed the current recommendations for culture and sensitivity with curettage of the wound base for specimen [7].

The aim of the classification of the foot wound is to facilitate appropriate treatment to help to monitor healing progress, and to serve as a way to communicate in standardized terms.

Several systems of ulcer classification are currently in use. Although no single system has been universally accepted, and none have been validated prospectively[7], the classification system most often used was described and popularized by Wagner[11] and we used this system in this study.

Another hybrid method for classifying diabetic foot lesions has been popularized by the University of Texas and has been retrospectively validated within that center [23,24].

All systems are generally predictive of outcome since increasing grade and stage of wounds are less likely to heal without amputation [24].

Most of our group of patients had advanced stage, but the rate of amputation was not high even with the bony or Achilles tendon involvement.

Edema interferes with wound healing by decreasing the diffusion rate of oxygen and nutrients from the capillaries to the cells [25]. The factor of edema contributes to the development of 37 % of foot ulcers. [26] Edema may be reversed with aggressive medical treatment of cardiac conditions, bed rest and leg elevation compression stockings.[26] In this study we managed foot and leg edema by correction of the underlying systemic cause: albumin level to be > 3g/dL, improving renal function, lymphotropic drugs and locally by using pressure bandage .

Surgical intervention can generally be classified as curative, ablative, or prophylactic.[27] Curative surgery aims at healing of a non-healing ulcer or a chronically recurring one when off-loading and standard wound care techniques are not effective[22] and includes those used to resect infected bone as an alternative to partial foot amputation[22]. Operations frequently performed in this regard include partial calcanectomy in this study[27]. Ablative surgery, often synonymous with amputation [28].

Debridement of necrotic tissue is an integral component in the treatment of chronic wounds since they will not heal in the presence of nonviable tissue and debris and it is one component of curative surgery. Adequate debridement must always precede the application of topical wound healing agents, dressings, or wound closure procedures [7,29,30,31].

Skin ulcers, including diabetic foot ulcers, are included in the category of chronic wounds[7]. The length of time a wound must exist until it is considered chronic is not well defined in the literature but > 4 weeks is defined[7]. The Wound Healing Society defines a chronic wound as one which has failed to proceed through an orderly and timely repair process to produce anatomic and functional integrity [29].

The primary goal in treating the chronic ulcer is to convert it to an acute wound which will then possess the active matrix and cells needed for healing. Types of debridement include: autolytic, enzymatic, mechanical, and surgical. Autolytic dedridement occurs naturally in a healthy, moist wound environment when arterial perfusion and venous drainage are maintained. The efficacy of enzymatic debridement (using topical, proteolytic enzymes) has been questioned in the literature and suffers from a lack of randomized, controlled clinical trials[7]. We used collagenase as an adjunctive therapy in the management of our cases.

The only method which has been proven efficacious in clinical trials is surgical debridement [7] by thorough sharp debridement of all nonviable soft tissue[31,32] and weekly debridement is commonly required.

Debridement has many functions: it decreases the area of infected tissues, stimulates wound healing,and supplys the wound with platelet derived growth factors. [29]

Callus acts like a foreign body and further increases pressure leading to tissue breakdown and ulcer formation under the callus[33]. In Egypt there is no podiatric speciality and it is the job of the vascular surgeon who manages these cases to make foot care.

Diabetic foot infections were classified as non-limb-threatening or limb-threatening. Infections that are not imminently limb-threatening are those with no signs of systemic toxicity, and generally have <2 cm of cellulitis and no deep abscesses, osteomyelitis, or gangrene. Conversely, limb-threatening infections are characterized by extensive cellulitis, deep abscesses, osteomyelitis, or gangrene. [7]

Infections in patients with diabetes are not only common but are often more severe than those found in non-diabetic persons. It is polymicrobial in nature ([7, 21, 28, 34]. These were the findings in the results of bacterial culture and sensitivity tests in our patients.

Even in the presence of adequate arterial perfusion, underlying peripheral sensory neuropathy will often allow the progression of infection through continued walking or delay in recognition ([7].

Pedal ulcerations provide a portal for pathogen entry and therefore can often lead to the

secondary development of infection [35]. Rarely does infection directly cause ulceration in the diabetic foot [15].

The 1% overall frequency of infection as a component cause for foot ulcer is contrasted with a 59% frequency in the reported study of pathways to lower-limb amputation[26].

The necessity for culturing and antimicrobial treatment of clinically uninfected wounds is still under investigation[7] so we did not make culture and sensitivity from Grade I or II Wagner classification.

Due to immunosuppression , in approximately 50% of diabetic patients presenting with significant infection, however, systemic signs (fever and leukocytosis) are absent [36]. Frequently, the only indication of infection is unexplained or recalcitrant hyperglycemia [24,36]. Other patients, however, do present with evidence of systemic toxicity including fever, chills, loss of appetite, and malaise. Such findings in diabetic patients should alert the clinician to the potential severity of infection, often present is an uncontrollable hyperglycemia, despite routine therapy and a loss of appetite [36].

Early surgical treatment of the affected site is typically necessary as an integral part of infection management[7,28]. Limb-threatening infections may have life-threatening complications, especially when left untreated.

In this study, acute infections in the heel even with osteomyelitis but without chronic ulceration were excluded.

Dealing with osteomyelitis is perhaps the most difficult and controversial aspect in the management of diabetic foot infections [37-40]. First among several problems is that the lack of a consensus definition of the disease hinders the comparison of available studies and experiences. Furthermore, the presence of osteomyelitis increases the likelihood of surgical intervention, including amputation, and the long duration of antibiotic therapy [36]

Osteomyelitis impairs healing of the overlying wound and acts as a focus for recurrent infection .Failing to diagnose and properly treat osteomyelitis increases the risk of amputation. [7]

Ulcerations present over bony prominences for more than 2 weeks are at high risk for contiguous bone involvement.[7]

Ulcer size and depth are also predictive of concomitant osteomyelitis. An ulcer area greater than 2 cm^2 has a sensitivity of 56% and specificity of 92% for the diagnosis of osteomyelitis, and in one series, 82% of patients with ulcers more than 3 mm deep had osteomyelitis[36] and all of the ulcers in this study had surface area > 2cm^2 and duration > 8 weeks.

Although bone biopsy is the definitive test for documentation of both the pathologic and microbiologic diagnoses of osteomyelitis, it requires a willing surgeon, involves significant operative risk, and is an expensive procedure. In most hospitals, diagnosis and treatment of diabetic foot infections are based on diagnostic imaging and empirical antimicrobial therapy appropriate for the most common microbial pathogens[36].

MRI has become widely available and provides an excellent means for differentiation between infections of soft tissue and bone. Osteomyelitis causes decreased activity on T1-weighted images and increased activity on T2-weighted images of the involved bone marrow. Overall, MRI has performed better than plain films, bone scans, and tagged leukocyte scans in diagnosing osteomyelitis in diabetic patients with soft tissue infections of the foot. Its sensitivity and specificity were 99% and 83%, respectively [41-45]

Images are obtained in multiple cross sectional planes and different sequences are chosen to best characterize anatomy and abnormalities. Because of the strong magnetic field, patients with pacemakers and other implanted electronic devices are unable to have MRI.

The MRI was able to assist the surgeon by demonstrating which part of the bone or soft tissues were infected and which part could be saved.

In the setting of osteomyelitis, MRI will demonstrate intraosseous edema, represented by increased signal on T2-weighted images. Noncontrast MRI may also demonstrate soft-tissue foci of infection, such as abscesses or areas of cellulitis. Abscesses may also show ring

enhancement on postgadolinium images [41-45]. In this study MRI helped us to localize the area of osteomyelitis in anterior, posterior, medial or lateral part or pole of the calcaneus and directed us to make a very limited partial calcanectomy in 12 cases .All patients were ambulant post-operatively with using special shoes as off-loading. By this simple maneuver we could avoid amputation and its sequalea.

Partial calcanectomy for treatment of the infected os calcis offers patients and surgeons with procedures that offer a distinct advantage over amputations. Patients are able to maintain both the appearance and function of their extremity while still receiving a method of treatment that reliably eradicates their infection. One potential concern in performing these techniques lies in the possibility of leaving behind infected tissue in these often immunocompromised patients. This raises the importance of meticulous and aggressive debridement of all diseased tissue to eradicate the infection but it is easy intra-operatively to distinguish between the diseased and healthy bone. Also all the wounds were left open for healing by granulation tissues, so it was possible to follow up the wound and to make the appropriate care..

When reviewing the results of treatment by previous authors on the subject of either calcanectomy or treatment of calcaneal osteomyelitis [18,47-49] , our results seem to compare favorably. However, one must bear in mind that our patient population consisted primarily of adult old diabetic patients.

Baumhauer et al [47] reported successful results regarding eradication of infection and resumption of ambulation in 5 out of 6 (83%) patients with diabetes. Smith et al[18] reported successful treatment in 70% of their diabetic patients. Thus, our results (9/12: 75%) are comparable to those previously reported studies.

There are not yet any studies in the literature describing long-term results for these patients in comparison to those undergoing amputations. However, based on the published results in the literature, we believe that limb-sparing surgery, in the form of calcanectomy, for the involved patient population is a well-tolerated procedure with low morbidity, few complications, and good overall patient satisfaction[18,47-49] .

It is a minor procedure with major impact on the limb and life of the patient.

In this study there were 5 cases of partial excision of infected necrotic Achilles tendon by the previously described technique in this report. There are no description of such technique in the literature and we did it as an alternative to amputation and post-operative course was smooth, the foot was stable with good weight bearing and our explanation for that is: the recurrent infection in the area of the tendon replaced it by strong fibrous tissues or, partial fibrous arthrodesis had occurred .All proximal wounds in the area of incision of musculo-tendinous junction healed uneventfully. In the literature rupture and deep infection following treatment of total Achilles tendon rupture had poor outcome and was devastating [46].

Our job is to treat and to help to prevent these cases as much as possible.

Foot ulcers preceded 84% of the amputations [26] but its prevention is easier than to treat them. Patient education assumes a primary role in this scheme, high tech devices will never be a substitute for thorough skin care.

We advised our patients to do regular follow up. Regular visits to the vascular surgeon is an opportunity to reinforce appropriate self-care behavior as well as allowing early detection of new or impending heel and foot problems [50].

Successful healing should follow if (1) pressure is relieved from neuropathic foot ulcers, (2) the arterial inflow is adequate, and (3) any infection is treated by debridement of infected tissue and appropriate antibiotic therapy[30].

Offloading was imperative to initiate wound healing and protect the heel throughout the healing process.

Researchers have shown that using a standard hospital head pillow beneath the legs to suspend the heels off the bed surface is more effective than many specialty products[24].

Because the cost of a major amputation is generally greater than the cost of treating an ulcer [7,28] .

It is critically important to remove the patient from the shoes that caused the ulcer. A study[26] supports the major role that minor trauma (repetitive stress and shoe pressure) plays in the causal pathway to ulceration ,so we examined patient's footwear in the affected and contra-lateral limb.

We prescribed therapeutic shoes with pressure-relieving insoles, or by felted foam insole with a defect tailored according to the site and shape of the ulcer agreeing with another study [50]..

The goal of amputation is either preservation of life or improving the quality of life by replacing a dysfunctional foot with prosthesis. Below-the-knee amputation is an ideal level in such cases; the objective is direct reconstruction of the residual limb for an artificial prosthesis. The major value of below-the-knee amputation is the presence of a knee joint capable of tolerating the forces involved in walking; thus, reducing the energy requirement and improving walking ability in these patients.[4] The most of amputation procedures in our study was below knee(5cases out 7 proximal amputations) .

The reported risk of lower extremity amputations (LEA) in diabetic patients ranges from 2% to 16% depending on study design and the population under investigation [51-53]

Rates of LEA in persons with diabetes can be 15–40 times higher than those found in persons without diabetes. The same risk factors which predispose to ulceration can also generally be considered as contributing causes for amputation [51,55,56].

The best predictor of amputation is a history of previous amputation. A past history of a lower extremity ulceration or amputation increases the risk for further ulceration, infection, and subsequent amputation [52,57 We tried and try to avoid this primary amputation and its sequences when possible .

CONCLUSION

Extensive debridement to reach the healthy tissues, off-loading and management of infection lead to healing in most of chronic non-ischemic heel ulcers.

Multidisciplinary approach including vascular surgery, radiological imaging and internal medicine is crucial to successful treatment through integration of knowledge and experience

MRI has a role in accurate detection of precise area of osteomyelitis allowing proper debridement and partial calcanectomy with little morbidity and major impact on patient and limb outcome.

Debridement of chronic or infected tissues even if Achilles tendon or calcaneus is involved is essential for ulcer healing.

Control of hyperglycemia and co-morbid conditions are essential for ulcer healing.

Patient, relatives, care-giver education and cooperation have a positive impact on the outcome.

REFERENCES

1-Chipchase SY, Treece KA, Pound N, Game FL and Jeffcoate WJ: Heel Ulcers don't heal in diabetes. Or do they? Diabetes Medicine (2005) 22:1258

2. Bloomgarden ZT. The diabetic foot. *Diabetes Care* 2001; 24(5):946-51.

3. Tourtual DM, Riesenberg LA, Korutz CJ, et. al. Predictors of hospital acquired heel pressure ulcers. *Ost/Wound Manage* 1997; 43(9):24-40.

4- Younes NA,Albsoul AM ,and Awad H: Diabetic heel ulcer : a major risk factor for lower extremity amputation. Ostomy Wound Management (2004) 50:50-60.

5. Kinoshita H, Francis PR, Murase T, Kawai S, Ogawa T. The mechanical properties of the heel pad in elderly adults. Eur J Appl Physiol Occup Physiol. 1996; 73(5):404-409.

6- Hsu TC, Wang CL, Shau WY, Tang FT and Chen CY: Altered heel-pad mechanical properties in patients with Type 2 diabetes mellitus. (2000) Diabetic Medicine, 17, 854-859

7- American Diabetes Association. Consensus development conference on diabetic foot wound care. Diabetes Care 22:1354–1360, 1999.

8- Shaw, J.E., Boulton, A.J.M. The pathogenesis of diabetic foot problems. An overview. Diabetes 46 (suppl.):S58–S61, 1997.

9- Enderle MD, Coerper S , Schweizer HP, Kopp AF ,Correlation of imaging techniques to histopathology in patients with diabetic foot syndrome and clinical suspicion of chronic osteomyelitis: The role of high-resolution ultrasound . Diabetes Care 22:294–299, 1999.

10- Larsson, J., Agardh, C.-D., Apelqvist, J., Stenstrom, A. Long term prognosis after healed Amputation in patients with diabetes. Clin. Orthop. 350:149–158, 1998.

11- Wagner, W.F. The dysvascular foot: a system for diagnosis and treatment. Foot Ankle 2:62–122, 1981.

12- American Diabetes Association. Insulin Administration. Diabetes Care 92004), 27 (1): s109-s106.

13- Standl E. metformin: drug of choice for the prevention of type 2 diabetis and cardiovascular complications in high risk subjects. Diab Metab (2003); 6s 121-122

14- Rohlling Cl, weiden Hm ,Little RR , England JD , Tennill A , Goldstein DE , defining the Relationship between plasma glucose and bA1c : analysis of glucose profiles and HbA1c in the Diahetes control and complications trial . Dliahetes Care2002; 25; 275-278.

15- De Backer G, Ambrossioni E, Brock-Johnsen K. European guidelines on cardiovascular prevention clinical practice. Third Joint Task Force of European and other societies on cardiovascular disease prevention in clinical practice. Atherosclerosis 2004 ; 173: 381-391.

16- Collins R, Armitage J , Parish S, Sleigh A, Peto R , Heart protection study of cholesterol lowering with simvastatin in 5,963 peoplr with diabets : a randomized placebo controlled trial . Lancet .2003; 361: 2005 -2016.

17- American diabetes association. Management of dyslipedemia in adults with diabetes. Diabetes Care 2001; 24 (suppl 1) s 58-s 67

18- Smith DG, Stuck RM, Ketner L, et al. Partial calcanectomy for the treatment of large ulcerations of the heel and calcaneal osteomyelitis. *J Bone Joint Surg Am*. 1992; 74A:571–576.

19- Leininger SM. The role of nutrition in wound healing. *Critical Care Nursing Quarterly.* 05-01-2002

20- Boulton, A.J., Meneses, P., Ennis, W.J. Diabetic foot ulcers. A framework for prevention and care. Wound Rep. Reg. 7:7–17, 1999.

21- . Grayson, M.L., Gibbons, G.W., Balogh, K., Levin, E., Karchmer, A.W. Probing to bone in infected pedal ulcers: a clinical sign of underlying osteomyelitis in diabetic patients. JAMA 273:721–723, 1995.

22- International Working Group on the Diabetic Foot. *International Consensus on the Diabetic Foot*, Amsterdam, the Netherlands, 1999.

23- Lavery, L.A., Armstrong, D.G., Harkless, L.B. Classification of diabetic foot wounds.J. Foot Ankle Surg. 35:528–531, 1996.

24- Armstrong, D.G., Lavery, L.A., Harkless, L.B. Validation of a diabetic wound classification system; the contribution of depth, infection, and ischemia to risk of amputation. Diabetes Care 21:855–859, 1998.

25- Armstrong DG, Nguyen HC. Improvement in healing with aggressive edema reduction after debridement of foot infection in persons with diabetes. Arch Surg. 2000;135(12):1405-1409

26- Reiber, G.E., Vileikyte, L., Boyko, E.J., Del Aguila, M., Smith, D.G., Lavery, L.A.,Boulton, A.J.M. Causal pathways for incident lower-extremity ulcers in patients with diabetes from two settings. Diabetes Care 22:157–162, 1999.

27- Armstrong DG, and R. G. Frykberg RG. Classifying diabetic foot surgery: toward a rational definition . *Diabetic Medicine (2003) ;* 20 : 329–331

28- Caputo, G.M., Cavanagh, P.R., Ulbrecht, J.S., Gibbons, G.W., Karchmer, A.W. Assessment and management of foot disease in patients with diabetes. N. Engl. J. Med.331:854–860, 1994

29- Mustoe T. Understanding chronic wounds: a unifying hypothesis on their pathogenesis and implications for therapy. Am J Surg (2004) Suppl. 187:65s-70s.

30- Boulton, AJM. Pressure and the diabetic foot: clinical science and offloading techniques. Am J Surg (2004) Suppl. 187:17s-24s.

31-. Steed, D.L., Donohoe, D., Webster, M.W., Lindsley, L., Diabetic Ulcer Study Group.Effect of extensive debridement and treatment on the healing of diabetic foot ulcers. J.Am. Coll. Surg. 183:61–64, 1996

32- Steed, D.L.Debridement .Am J Surg (2004) Suppl. 187:71s-74s.

33- Murray HJ, Young MJ, Boulton AJM: The relationship between callus formation, high pressures

and neuropathy in diabetic foot ulceration. Diabet Med 13:979-982, 1996

34- Lipsky, B.A. Osteomyelitis of the foot in diabetic patients. Clin. Infect. Dis. 25:1318–1326, 1997.

35- Lipsky, B.A ,Berndt AR , Deery HD , et al . Diagnosis and treatment of diabetic foot infections. Clin Infect Diseases (2004); 39:885-910.

36- Schinabeck MK and Johnson JL. Osteomyelitis in diabetic foot ulcers. Postgraduate Medicine. 118:11-14. 2005

37- Jeffcoate WJ, Lipsky BA. Controversies in diagnosing and managing osteomyelitis of the foot in diabetes. Clin Infect Dis 2004; 39(Suppl 2):S115–22.

38- Snyder RJ, Cohen MM, Sun C, Livingston J. Osteomyelitis in the diabetic patient: diagnosis and treatment. Part 1: overview, diagnosis, and microbiology. Ostomy Wound Manage 2001; 47:18–22,

39- Embil JM. The management of diabetic foot osteomyelitis. The Diabetic Foot 2000; 3:76–84.

40- Eckman MH, Greenfield S, Mackey WC, et al. Foot infections in diabetic patients: decision and cost-effectiveness analyses. JAMA 1995; 273:712–20.

41- Ledermann HP, Schweitzer ME, Morrison WB. Nonenhancing tissue on MR imaging of pedal infection: characterization of necrotic tissue and associated limitations for diagnosis of osteomyelitis and abscess. AJR Am J Roentgenol 2002; 178:215–22.

42- Becker W. Imaging osteomyelitis and the diabetic foot.J Nucl Med (1999);43:9-21

43- Craig JG, Amin MB ,Wu K ,et al . Osteomyelitis and the diabetic foot : MR Imaging- pathologic correlation . Radiology (1997); 203 :849-855.

44- . Ledermann HP, Morrison WB, Schweitzer ME. MR image analysis of pedal osteomyelitis: distribution, patterns of spread, and frequency of associated ulceration and septic arthritis. Radiology 2002; 223: 747–55.

45- Morrison WB, Ledermann HP, Schweitzer ME. MR imaging of inflammatory conditions of the ankle and foot. Magn Reson Imaging Clin N Am 2001; 9:615–37, xi–xii.

46-Pajala A, Kangas J , Ohtonen P, et al . Rupture and deep infection following treatment of total Achilles tendon rupture .J Bone Joint Surg (2002); 84: 2016 - 2020.

47- Baumhauer JF, Fraga CJ, Gould JS, et al. Total calcanectomy for the treatment of chronic calcaneal osteomyelitis. *Foot Ankle Int*. 1998; 19:849–855.

48- Brooks K R, Lin SS, Berberian WS, Abidi NA, and Vieira P: Calcanectomy for Treatment of the Infected Os Calcis . Techniques in Foot and Ankel Surgery Volume 3(3), September 2004, pp 165-176

49- Bollinger M, Thordarson DB,. Partial calcanectomy: an alternative to below knee amputation. Foot &Ankle International. (2002); 23:927-932. [Abstract]

50- Zimny S, Schatz H, and Pfohl U. The effects of applied felted foam on wound healing and healing times in the therapy of neuropathic diabetic foot ulcers. Diabetic Medicine (2002); 20:622-625.

51- Frykberg, R.G. Epidemiology of the diabetic foot: ulcerations and amputations. Adv.Wound Care 12:139–141, 1999.

52- Adler, A.I., Boyko, E.J., Ahroni, J., Smith, D.G. Lower-extremity amputation in diabetes:the independent effects of peripheral vascular disease, sensory neuropathy, and foot ulcers. Diabetes Care 22:1029–1035, 1999.

53- Moss, S., Klein, R., Klein, B. The 14-year incidence of lower extremity amputations in a diabetic population: The Wisconsin Epidemiologic Study of Diabetic Retinopathy.Diabetes Care 22:951–959, 1999.

54- Humphrey, L.L., Palumbo, P.J., Butters, M.A., Hallet, J.W., Chu, C., O'Fallon, W.M.,Ballard, D.J. The contribution of non-insulin dependent diabetes to lower extremity amputation in the community. Arch. Intern. Med. 154:885–892, 1994.

55- . Lavery, L.A., Ashry, H.R., van Houtum, W., Pugh, J.A., Harkless, L.B., Basu, S. Variation in the incidence and proportion of diabetes-related amputations in minorities. Diabetes Care 19:48–52, 1996.

56-Resnick, H.E., Valsania, P., Phillips, C.L. Diabetes mellitus and nontraumatic lower extremity amputation in Black andWhite Americans. Arch. Intern. Med. 159:2470–2475,1999.

57- Larsson, J., Agardh, C.-D., Apelqvist, J., Stenstrom, A. Long term prognosis after healed amputation in patients with diabetes. Clin. Orthop. 350:149–158, 1998.

الملخص العربي

العلاج الجراحي لقرح الكعب السكرية المزمنة و دور الرنين المغناطيسي في التشخيص

الخلفيـــة: إن البتر أمام منطقة الكعب هو بتر بسيط و لكن البتر بعده هو بتر كبير.القرح المزمنة بالكعب قـد تكون سطحية و لكنها قد ترسل الالتهابات إلى الأنسجة العميقة خصوصا عظمة الكعب

ووتر أخيل .وفى بداية العلاج لا يمكن التنبؤ بنتيجته

الهدف من البحث: هو تسجيل النتائج لعلاج القرح المزمنة بالكعب عن طريق التنظيف الجراحي ،استئـصال جزئي لعظمة الكعب ، و استئصال جزئي لوتر أخيل بجانب إزالة الضغط عن القرحة و عـلاج التـورم بالاضافه إلى متابعة الجروح وعلاجها وتسجيل دور الرنين المغناطيسي كذلك تنظيم السكر و علاج الإمراض ألمصاحبه

مواد و طرق البحث: شملت هذه الدراسة ٦٠ مريض (٣٣اناث، ٢٧ ذكور) متوسط أعمارهم ٥٥،٨٧ عاما (المدى ٢٦-٧٨عاما ،المنوال هو ٦٠ عاما) و بهم ٦٦ قرحة مزمنة بالكعب تم دراستهم على مـدى أربـع أعوام من يناير ٢٠٠٢ إلى يناير ٢٠٠٦ .تم تشخيصهم بالتهاب في الأعصاب الطرفية و كانت حالـة الـدورة الدموية جيدة . و تم تصوير الحالات فوتوغرافيا لمتابعة مدى تقدمهم .ولقد تم عمل الأشعة السينية و الـرنين المغناطيسي و تشخيص التهاب عظمة الكعب. و في ١٢ حالة تم عمل استئصال جزئي لعظمة الكعب و في ٥ حالات تم عمل استئصال جزئي لوتر أخيل و كان الهدف هو استئصال الالتهاب ،اعتماد المريض علـى نفسه و التئام القرح و متابعة الحالات حتى الالتئام أو البتر الكبير أو الوفاة

النتائج : كانت مساحة كل القرح > سم٢ و عمرها أكثر من ٨ أسابيع. و كانت اغلب القرح في باطن القـدم الأيمن . و لقد اظهر الرنين المغناطيسي التهاب عظمة الكعب في ١٢ حالة و تم استئصالها جزئيـا . و لقـد كانت القدم ثابتة و المريض يعتمد على نفسه بعد الاستئصال الجزئي لوتر أخيل. و لقد تم التئام كامل ل٤٥ قرحة من ٦٦ (٦٨%) . و لقد تم عمل بتر تحت الركبة في ٥ حالات و فوق الركبة في حالتين (١٠،٦% لكل الحالات) و لقد توفى ٧ مرضى (١١،٦%) لأسباب تتعلق بأمراض قلبية أو مخيه .

الاستنتاج : إن طريقة العلاج متعددة التخصصات و التي تشمل جراحة الأوعية الدموية

والتشخيص بالأشعة و العلاج الباطني لهى ضرورية نتيجة لتكامل المعرفة و الخبرة .إن التنظيـف الجراحـي الجيد للجروح المزمنة أو الملتهبة حتى لو شملت وتر أخيل أو عظمة الكعب شيء أساسي للعلاج .الـرنين المغناطيسي له دور كبير في تشخيص التهاب العظام و تحديد المنطقة بدقة مما يجعل التدخل الجراحـي بأقـل المضاعفات و اكبر المزايا الايجابية على أقدام و حياة هؤلاء المرضى .