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ARTICLE

Evaluation of the Outcome of Trans metatarsal Amputation in Diabetic Patients

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Single or multiple toes amputation in diabetic patients with Back ground forefoot gangrene or infection is usually associated with residual infection or ulceration in the remaining toes, Trans metatarsal amputation (TMA) is a viable alternative when performed properly in well-selected patients. It has the advantage of easy lodging of footwear & potentially better functional outcome. Aims of study to evaluate the outcome of TMA in diabetic foot in terms of healing potential, complications, function and patient satisfaction and to put guides to the indications and contraindications of the procedure in diabetic patients. This prospective case study was carried out at Basra Teaching Hospital during the period from October 2016 until December 2018. Total numbers of 25 diabetic patients with 26 feet with forefoot gangrene, infection or ulcer were registered in the study. A total number of 26 feet in 25 diabetic patients were included in the study. Their ages ranged from 38-70 years (mean age 56.2 years). Males were more predominant than females (80% versus 20%). Peripheral neuropathy was present in all patients. Sixteen patients (64%) had type I diabetes versus 9 patients (36%) were type II diabetics. The average healing time was 13.3 weeks (ranged from 3-20 weeks). Failure of TMA & conversion into a below knee amputation was recorded in 3 feet (11.5%). Transmetatarsal amputation (TMA) is a valuable salvage procedure for treatment of forefoot gangrene & infection in well selected diabetic patients. Wound healing is highly unpredicted & not affected by presence or absence of comorbidities. Rehabilitation is promising & all patients with successful TMA were satisfied with their ability for independent walking after a reasonable period of time.

1 | INTRODUCTION

Diabetes mellitus is a common disease all over the words. Approximately 26% of Americans aged 65 years & above have diabetes (1). More than 30% of diabetics have evidence of peripheral neuropathy or vascular disease(2). The complications of long-standing diabetes mellitus often appear in the foot, causing chronic disability2. Foot disease affects nearly 6% of people with diabetes and includes infection, ulceration, or destruction of tissues of the foot(3),(4). The planter surface of the foot is the most common site of ulceration, especially at areas of bony prominence(5). Compared to healthy persons, diabetes mellitus holds a

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15- to 20-fold increased risk of lower extremity amputations and the majority of diabetes amputation are reported to be preceded (up to 85%) by a poor healing ulcer(6) .

Pathophysiology of diabetic foot disease

1. Diabetic peripheral neuropathy: The combination of neuropathy and excess pressure on the plantar foot leads to ulceration(7). Of all patients with diabetes mellitus, 10% have some form of sensory, motor, or autonomic dysfunction at the time of diagnosis; neuropathy develops in 50% of these patients within 25 years of diagnosis(8) .

A-Sensory neuropathy: Sensory neuropathy is the most prevalent and obvious nerve dysfunction seen in patients with diabetes, affecting as many as 70% (8). Early on, patients are usually unaware of the abnormality, but clinical tests will discover loss of vibration and joint position sense and diminished temperature discrimination in the feet(2). Polyneuropathic loss of sensation begins in a stocking distribution of the feet and progresses proximally7. Sensory neuropathy is diagnosed by the inability to perceive the 5.07 Semmes-Weinstein monofilament. Most patients (90%) who cannot feel the 5.07 monofilament have lost protective sensation to their feet and are at risk for ulceration(7).

B- Motor neuropathy: It mostly involves the common peroneal nerve with the resultant loss of tibialis anterior tendon function and foot drop(7). It is also evidenced by the development of claw toes from intrinsic muscle weakness and equinus contracture of the Achilles tendon. These factors transfer stress to the forefoot, resulting in focal high pressures and resultant skin breakdown(8).

C-Autonomic neuropathy: It is the most overlooked manifestation of peripheral neuropathy. It occurs when the autonomic system cannot control the blood vessel tone and the sweat glands in the foot8. Absence of skin oils released by autonomic signals leads to increased susceptibility to fissuring of the skin from mild trauma(1).

2. Hypomobility syndrome: It is the result of excessive glycosylation of the soft tissues of the extremities, which leads to decreased joint range of motion(7).

3. Peripheral vascular diseases: About 60-70% of patients with D.M for over 10 years have peripheral vascular diseases involving both large and small vessels(7).

4. Immune system impairment: Poor cellular defenses, such as abnormal phagocytosis, altered chemotaxis of WBCs, and a poor cytotoxic environment (due to hyperglycemia) to fight off bacteria, lead to difficulty in fighting off infection once it has developed(7).

5. Metabolic deficiencies: Reduced total protein less than 6.0 g/L, WBC count less than 1500 cell/ mm(3), and albumin levels less than 2.5 g/L result in poor healing potential. These parameters must be normalized with nutritional support prior to any surgical intervention in diabetic patients(7), (11).

The treatment modalities can be

1. Non-operative

Shoe modification: It is indicated as a preventive measure when signs of potential ulcers are present. There are many types including deep or wide shoes, custom insoles, rocker bottom soles, etc. The rocker sole shoes are the best to reduce the plantar pressure on the forefoot(12).

Wound care: The dressing should provide a moist environment, Absorb exudates, Act as a Barrie and Off-load pressure(8).

2. Operative treatment

Drainage of deep infections often is necessary to prevent tissue necrosis, clear the area of infection, and achieve wound healing without tension(8). Osteotomy with or without tendoachillis lengthening Midfoot collapse may require osteotomy of bony prominence if stable deformity, or midfoot fusion if midfoot instability is present(7),(8) .Equinus contracture is very common, and Achilles lengthening will offload the midfoot/forefoot(7). Achilles lengthening is indicated in7Recurrent forefoot/midfoot ulceration and Ulceration with equinus deformity.

Indications

McKittrick19, 22& associates proposed three basic indications for TMA

1-Gangrene of one or more toes, without inflowing on to the foot.
2-A stabilized infection or open wound involving the distal portion of the foot.
3-An infected lesion in a neuropathic foot.
4-forefoot infection with or without osteomyelitis, traumatic injuries, forefoot deformity, and malignancy(23).

Contraindications18, 24Include

1-Tracking proximal infection, as cellulitis.
2-Lymphangitis.
3-Any gangrenous changes in the plantar skin proximal to the metatarsophalangeal crease.

Technique

The standard Transmetatarsal approach involves a transverse fish-mouth type incision with a longer plantar flap to allow for wound closure23; however, if there was extensive plantar soft tissue damage then the flaps were closer to the same length5.The incision runs from fifth metatarsal mid-shaft laterally to the mid-shaft of the first metatarsal medially through a mid-plane axis(18).

The toes are removed at the metatarsophalangeal joints and osteotomy of the metatarsals in a beveled fashion dorsal-distal to planter-proximal at the junction of their middle and distal thirds. The metatarsals should be removed in a cascading fashion with the second metatarsal osteotomy only a few millimeters shorter than the first metatarsal, while each successive cut is 2 to 3 mm shorter than the previous medial metatarsal. The fifth metatarsal should be even shorter (4 to 5 mm shorter than the fourth) 1. The metatarsals are cut with a saw, and the bony ends are rounded and smoothened with a bone nibbler1, 18. The nerves are identified and should be divided well proximally so that their cut ends fall proximal to the end of the bones. The tendons are divided under tension so that they retract into the foot. As an alternative, suturing of the flexor and extensor tendons to each other to form a myoplasty can be performed. A drain may be used as necessary(1).

The long plantar flap is brought over the ends of the bones and sutured to the dorsal flap with interrupted non-absorbable sutures. “Contouring” skin tags at the medial and lateral edges must be avoided because this may jeopardize the blood supply to the flap. This excessive tissue disappears with time1.A light compressive dressing is applied and the foot is placed in a carefully padded posterior splint with the ankle in neutral to slight dorsiflexion(1),(5).

Postoperative care:

An appropriate follow-up check is needed when the patient is discharged, special attention is paid to viability of amputation stumps and regular wound inspection. Partial weight bearing with a crutch is advised as the general condition of the patient and wound status would allow(18).

Complications:

Outcome of transmetatarsal amputations are unpredictable even in the hands of the most skilled and experienced surgeons(23). Although a TMA is preferable to below knee amputation, there are several risks associated with a TMA, particularly the difficulty in predicting successful wound healing. The surgical failure rate of TMA can be defined as the absence of any healing, or the need for higher amputation within three months of TMA(20).

The possible complications include

1-Postoperative skin breakdown & poor wound healing.
2-Decreased stability20.
3-Infection and the need for higher level of amputation.
4-Heterotopic ossification12.

2 | PATIENTS & METHODS

This prospective study was carried out at Basra Teaching Hospital through the period from October 2016 until December 2018. A total number of 26 feet in 25 patients with different forms of diabetic forefoot lesions were registered. A transmetatarsal amputation (TMA) was performed in all 26 feet (one patient underwent bilateral two-stage TMA). The age of the patients at the time of surgery ranged from 38 to70 years. All patients were admitted to the orthopedic surgical ward as an elective case. A detailed history was taken from all patients. A thor-

ough general physical examination was performed in every patient, in addition to the local examination of the affected limb. Evaluation of the neurological status of the foot was assessed by Clinical signs of peripheral neuropathy as dry shiny skin & loss of normal hair distribution of the foot, Testing for two points discrimination and Testing with 5.07 Semmes Weinstein Monofilament. Evaluation of the vascular status of the foot was assessed by: Palpation of the pedal pulses, Measurement of the Ankle Brachial Index and Doppler ultrasonography (performed in six patients with undetectable pedal pulses).

Routine preoperative laboratory investigations were done for each patient, including complete blood count, renal function tests and liver function tests (LFT), HbA1c, serum albumin level & viral markers. Plain radiographs of the chest & the affected foot were performed in every patient searching for bone destruction due to infection or Charcot neuropathic changes.

The level of amputation was decided depending on the clinical ground regardless the presence or absence of pedal pulses.

Surgical technique: Antibiotics in form of ceftriaxone: 1gram was infused intravenously before the induction of anesthesia. The operation was performed with the patient in supine position. The type of anesthesia was spinal or regional in all patients. Tourniquet was never used. The classical fish mouth incision with long plantar flap & primary skin closure was used in 23 feet. Equal dorsal & plantar flaps were fashioned in the remaining 3 feet, leaving the wound open for secondary closure procedures due to unfavorable skin condition & the presence of short plantar flap. Osteotomy of all five metatarsals was performed distal to the level of proximal metaphyseal-diaphyseal junction of the metatarsals using small size osteotome, followed by ligation of the major vessels & excision of the remaining tendons.

Throughout the procedure, surgical dissection & handling of the skin & soft tissues were gentle to preserve the vascularity of the remaining parts of the foot. Copious irrigation of the wound with 1-2 liters of normal saline was used in all patients. After securing hemostasis & insertion of a redivac drain, widely spaced wound suturing without tension was performed in all cases that had long plantar flap. Dressing & well-padded back slab was then applied.

3 | RESULTS

There were 26 feet in 25 diabetic patients. Age of the patients at time of presentation ranged from 38-70 years (mean 56.2 years). There were 20 males (80%) & 5 females (20%). Type I D.M. presented in 16 patients (64%) & type II D.M. in the remaining 9 patients (36%). The duration of the diabetes ranged from 5-25 years (mean 13.4 years). The mean HbA1c for the patients at time of presentation was 9.3 % (range from 7.3 – 12.3 %).

Other associated comorbidities were reported in 15 patients (60%), whereas the remaining 10 patients (40%) had no comorbidity apart from D.M. Among these 15 patients, 9 patients (60%) had only one comorbidity, 4 patients (27%) had three comorbidities & two patients (13%) had two comorbidities.

Cigarette smoking was reported in 15 patients (60%). About one third of these patients (33.3%) were heavy smokers with more than 40 cigarettes per day.

In the affected 26 feet, left side involvement was reported in 17 (65.4%) & right side in 9 feet (34.6%). Peripheral neuropathy was present in the all 26 feet (100%) as evident by the inability to perceive 5.07 Semme's Weinstein monofilament testing & abnormal two point's discrimination tests. Impalpable pedal pulses were present in 6 feet (23%). History of previous partial amputation of one or more toes of the affected foot was reported in 8 feet (30.8%).

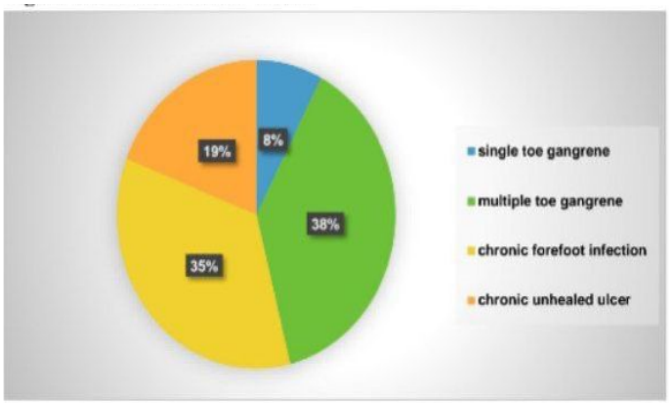

Figure 1:- *Indications for TMA*

Table:1. *Stanmore Harold Wood Mobility Grading Scale (28).*

Grade	Description
Grade 1	Has abandoned limb wearing or uses only a cosmetic limb.
Grade 2	Wears a prosthesis only for transfers or to help with nursing. Walks only with a therapist or carer.
Grade 3	Walks indoors only, using walking aids (for example, sticks, crutches or Zimmer frame). Negligible walking outdoors (only with help and support of others).
Grade 4	Walks indoors and outdoors, though regularly uses walking aids.
Grade 5	Walks independently indoors and outdoors with no walking aids except occasionally for confidence to cover difficult terrain or weather conditions.
Grade 6	Normal or near normal gait.

Table:2. *Demographic data*

	Number	Percentage
Males	20	80%
Females	5	20%
Type I D.M.	16	64%
Type II D.M.	9	36%
	Range	**Mean**
Age (years)	38-70	56.2
HbA1c (%)	7.3-12.3	9.3

Table:3. *Comorbidities presents with D.M. in 25 patients*

Risk factor	Number of patients	%
Hypertension	14	56
Ischemic heart diseases	5	20
Chronic kidney diseases	1	4
Peripheral vascular diseases	6	24

Table: 4. *Smoking habits in 25 diabetic patients*

No. of Cigarettes/day	Number of patients	%
Less than 20	2	13.3
20-40	8	53.4
More than 40	5	33.3
Total	15	100

Table:5. *Demographic & clinicle comparison between successful & faild TMA in 25 patients (26feet)*

Variable	Successful		Failed	
Age (Average in year)	54.4	(38-70)	69.3	(68-70)
Mean HbA1c (Average in %)	8.9	(7.3 – 10.6)	11.7	(11 – 12.3)
Previous amputation	5/23	21.7%	3/3	100%
Heavy smoking (more than 40/day)	2/22	13.7%	3/3	100%
Peripheral neuropathy	23/23	100%	3/3	100%
Negative pedal pulses	3/23	13%	3/3	100%

Table:6. *Complications in 23 feet with successful TMA*

Complication	Number (foot)	Percentage
Wound dehiscence	4	17.4%
Superficial infection	3	13%
Infected sinus	1	4.4%
Total	8	34.8 %

The indications for TMA in this study were: multiple toes gangrene in 10 feet (38%), chronic forefoot infection in 9 feet (35%), chronic unhealed forefoot ulcer in 5 feet (19%) & gangrene of a single toe (extensive big toe gangrene with necrosis & infection extending to the dorsum of the foot) in 2 feet (8%).

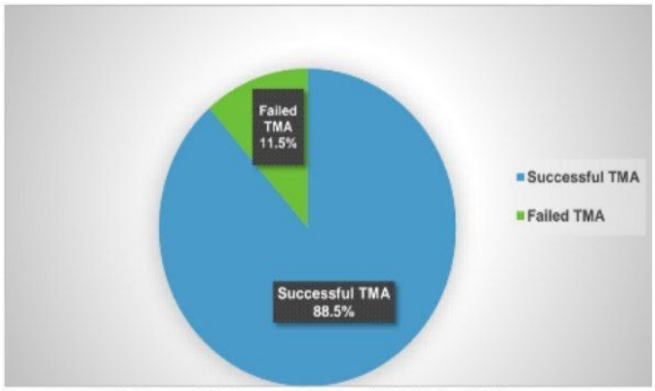

Figure 2:- *Success rate of TMA In 26 feet*

The classical fish mouth incision with primary closure of the wound was performed in 23 feet (88.5%) & in the remaining 3 feet (11.5%), the

wounds were left opened for secondary closure procedures. Successful outcome with complete healing of the stump & independent walking without walking aids was obtained in 88.5% of the operated upon feet (23 feet in 22 patients), whereas failure of the procedure & conversion into a more proximal limb amputation (below knee amputation) was recorded in 3 feet (11.5%).

The average healing time for all feet with successful TMA was 13.3 weeks (ranged from 3-20 weeks). Complications with respect to the wound healing & infection were recorded in 8 out of 23 feet (34.8%) with the successful TMA. All healed ultimately with proper wound care, antibiotic therapy & secondary wound closure.

4 | DISCUSSION

Transmetatarsal amputation (TMA) is a partial foot amputation that is applicable only for selected diabetic foot cases that are presented with the most distal level of gangrene & infection. The presence of non-viable or infected tissues should not extend proximal to the distal half of the metatarsals. Too extensive tissue necrosis or infection is not suitable for this procedure.

In this study, the decision to perform TMA was made only depending on clinical grounds, without the need to do expensive or time-consuming non-invasive test. Important local factors in selecting patients in the current study for TMA were healthy plantar flap, adequate viable soft tissue for coverage, absence of soft tissue infection & adequate proximal vascular status.

The success rate reported in this study was 88.5%, which is comparable to the results obtained by Merribeth Bruntz et al. (5), McCallum et al. (21) & O'Brien et al. (36) which were 86.7%, 91.6% & 73.6% success rate, respectively. In contrast, several authors reported lower success rate with TMA compared to the results of the current study. Anthony et al.26, Pollard et al.27, Landry et al.37, Younger et al.38 & Nguyen et al.39 published a success rate of 44%, 57.4%, 53%, 64.7% & 57%, respectively.

Primary closure by the plantar flap would give a large chance of success in TMA due to the vast arterial supply from the plantar artery. An adequate viable soft tissue with bleeding borders of the wound when debridement & bone resection have been completed ensures high chance of successful TMA. Presence of residual bone infection at or proximal to the site of bone resection is found to be a predictor of failure. This is in agreement with other studies(37),(40) .

Poor healing potential & the need for proximal major amputation (below knee amputation) was reported in 3 patients in the study. All had proximal arterial diseases as evident by abnormal Doppler examinations. Angiogenesis is a vital factor during the process of wound healing after TMA & insufficient vascularity would invite failure. However, diminished or absent pedal pulses in the preoperative period is not by itself a contraindication for TMA since there were 3 feet in the study with absent pedal pulses healed without any problem.

Multiple comorbidities are common in the diabetic patients, especially hypertension, cardiovascular diseases & chronic kidney disease. Renal failure was reported by some authors to be one of the host factors that can predict failure of TMA37,40. The presence of comorbidities was found in this study to have no adverse effect in the patient selection for TMA & in the rate of wound healing.

Advanced age of the patient was found in the current study to have a worse impact on wound healing & increases the risk of conversion of TMA to a major lower limb amputations (below knee or above knee amputations). All three patients in whom TMA had failed had mean age of 69.3 years, compared to 54.4 years in patients with healed TMAs group. This obviously reflect the poor healing ability & occlusive vascular changes associated with advanced age.

Lower glucohaemoglobin (HbA1c) level was found by some authors to improve the success with TMA38. Poor blood glucose control was found to have adverse effect on the TMA healing in this study.

Cigarettes smoking was reported in 60% of the patients in the study, yet 80% of the smoker patients have healed TMA. It was concluded that smoking itself may not affect wound healing but with increasing number of cigarettes smoked per day, the risk of failure of TMA would increase (all three failed TMAs were in patients smoking 40 cigarettes

& more per day).

5 | CONCLUSION

1- Transmetarsal amputation is a valuable salvage procedure for the treatment of forefoot gangrene & infection in well selected diabetic patients.
2-Wound healing is highly unpredicted & not associated with the presence or absence of comorbidities.
3-Complications after TMA with respect to wound healing can be dealt to a large extent with wound dressing & secondary closure procedures.
4-Rehabilitation after TMA is promising & all patients with successful outcome were satisfied with their ability for independent walking after a reasonable period of time.

RECOMMENDATIONS

1-Careful selection of the patients for TMA for obtaining successful outcome.
2- Encouraging orthopedic surgeons to do this type of amputation for the indicated patients to get benefit from its good rehabilitation & independent mobility.

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