Minimally Invasive Metatarsal Osteotomy as an Alternative to Transmetatarsal Amputation

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Statement of Purpose

Patients with diabetes are at an increased risk of amputation, especially if they have previously undergone amputation or ablative surgery on the ipsilateral foot. Minimally invasive surgical (MIS) procedures, like metatarsal osteotomies, are promising for reducing plantar pressures, treating neuropathic ulcers, promoting wound healing and potentially preventing further amputations. This study aims to demonstrate MIS lesser metatarsal osteotomies as an alternative to more invasive procedures, such as transmetatarsal amputations, in healing neuropathic ulcers, preventing recurrence, and avoiding partial foot amputation.

Level of Evidence: 4

Literature Review

Diabetes accounts for approximately 50% of lower extremity amputations worldwide with 85% of these cases preceded by foot ulcers [1]. Patients with diabetes have a 25% lifetime risk of developing foot ulcers, often complicated by neuropathy and peripheral arterial disease [2]. Increased plantar pressures prolong healing times and contribute to recurrent ulceration.

Surgical resection is the most definitive means of infection eradication; however, it disrupts foot biomechanics and increases the risk of re-ulceration and additional amputations. Recent studies indicate that MIS lesser metatarsal osteotomies can effectively offload plantar pressures from diabetic foot ulcers through smaller incisions and with less associated complications. A systematic review involving 189 total patients by Biz et al., demonstrated that MIS metatarsal osteotomies had a 91.9% healing rate and 7.2% recurrence rate [3]. Similarly, Tamir et al. demonstrated a reduction in peak pressures by 33% and accelerated healing time of an average of 3.7 weeks [4]. Therefore, compared to traditional ablative procedures, MIS osteotomies offer a reduction in re-ulceration risk while also preserving foot biomechanics.

Methods

A retrospective chart review was conducted on a total of six diabetic patients with peripheral neuropathy who developed plantar foot wounds following an ablative procedure. Ablative procedures included digital amputations, metatarsal resections or ray amputations. Inclusion criteria required patients to have chronic plantar ulcers that persisted despite conservative treatment. Exclusion criteria included non-diabetic or non-neuropathic patients, and those who did not undergo an initial ablative procedure (Table 1). Outcome measures included re-ulceration rates, time to complete wound healing and duration of being ulcer-free.

Inclusion Criteria	Exclusion Criteria
Diabetic	Non-diabetic
Neuropathic	Non-neuropathic
Underwent initial ablative procedure	No initial ablative procedure
Had transfer lesion as a result of initial ablative procedure	
Underwent subsequent MIS procedure	

Table 1. Inclusion and exclusion criteria for the subjects included in the study

Results

Our study included a total of six patients, all of whom underwent an initial ablative procedure in the setting of infection and had subsequently developed a plantar foot wound which necessitated a MIS metatarsal osteotomy to offload the area of ulceration.

Average time to fully heal the wound was 63.50 days. The average length of time in ulcer remission was 320.67 days. Average follow-up time was 384.17 days. At the last follow-up visit, the initial ulcer remained healed in all patients.

N	T1DM vs T2DM	Neuropathic?	Initial Ablative Procedure(s)	Initial Ulcer Location Before MIS	MIS Procedure Performed	Days to Fully Healed	Length of Remission (DAYS)
1	Type 2	Yes	Right foot 1st and 2nd digit amputation at MTPJ Free tissue transfer for coverage of right foot wound	Sub 3rd metatarsal head	Right 3rd metatarsal floating osteotomy	28	130
2	Type 2	Yes	Right foot debridement of 1st metatarsal head and 1st proximal phalanx base	Right plantar 3rd metatarsal head	Right 2nd, 3rd and 4th metatarsal floating osteotomy	57	238
3	Type 2	Yes	Remote history of first MPJ resection. Left 5th digit arthroplasty (11/4/20); Left 3rd digit distal phalanx resection at DIPJ (11/3/21)	Left plantar 3rd metatarsal head	Left 3rd metatarsal floating osteotomy	85	228
4	Type 2	Yes	Left foot debridement with biopsy of 1st metatarsal (10/31/2019); left foot bone debridement with wound vac (11/4/19); Left foot debridement down to bone with Integra (11/13/19)	Sub 3rd metatarsal head	Left 3rd metatarsal floating osteotomy	30	382
5	Type 2	Yes	Right open 1st met resection and debridement of abscess (6/29/2020)	Right plantar 2nd metatarsal head	Right 2nd, 3rd and 4th metatarsal floating osteotomy	26	698
6	Type 2	Yes	Left hallux amputation and 1st metatarsal head resection (9/23/2022)	Left plantar 2nd metatarsal head	Left 2nd, 3rd, 4th DMMO	155	248

Table 2. Pertinent data regarding demographics, procedures and outcomes

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Amongst the six patients that were evaluated, none had re-ulcerations that required further operations (Table 3).

Avg. Time to Heal (DAYS)	Length of Remission (DAYS)	Avg. Follow-up (DAYS)
63.50	320.67	384.17

Table 3. Average time to heal, length of remission and follow-up time (in days)

Analysis and Discussion

Diabetic foot ulcers can be challenging to manage especially in those with neuropathy, peripheral arterial disease and impaired immune response. Traditional metatarsal osteotomies involve large incisions which may increase the risk of surgical site infections and re-ulceration. Past studies demonstrate that up to 41% of patients that undergo traditional metatarsal resections develop recurrent ulcers [5]. MIS techniques offer smaller incisions, shorter recovery times and reduced surgical trauma leading to improved outcomes.

Our study supports these findings with all patients achieving complete ulcer healing and prolonged ulcer-free durations. These procedures may also be performed in the outpatient setting which can minimize hospital stays and reduce overall healthcare costs. Given the success rates and safety profile observed in our study, MIS techniques should be considered in clinical practice for diabetic patients with plantar ulcers.

References

[1] Khalfalla MA, Fakhr ME, Abdallah AM. Risk of re-ulceration and reamputation after minor lower extremity amputation in type 2 diabetes: systematic review/meta analysis. Med J Cairo Univ. 2021. 89(1): 83-90
[2] Baysal O, Msangi WJ, Gunar B, Erol B. Does re-amputation following lower extremity amputation in diabetic or dysvascular patients negatively affect survival? Marmara Med J. 2022. 35(1): 73-78.
[3] Biz C, Belluzzi E, Crimì, Bragazzi NL, Nicoletti P, Mori F, Ruggieri P. Treatment of plantar diabetic forefoot ulcers (PDFUs): a systematic review and meta-analysis with meta-regressions. Appl Sci. 2021. 11(20):9628
[4] Tamir E, Tamar M, Ayalon M, Koren S, Shohat N, Finestone AS. Effect of mini-invasive floating metatarsal osteotomy on plantar pressure in patients with diabetic plantar metatarsal head ulcers. Foot Ankle Int. 2021. 42(5):536-543.
[5] Molines-Barroso RJ, Lazaro-Martinez JL, Aragon-Sanchez J, Garcia-Morales E, Beneit-Montesinos JV, Alvaro-Afonso FJ. Diabet Med. 2013. 30(8):973-976.