Transmetatarsal Amputation for First Ray Ulceration or Osteomyelitis: A definitive procedure

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Statement of Purpose

Prior publications have indicated high rates of re-amputation after partial first ray amputation in patients with diabetes mellitus and peripheral sensory neuropathy[1,2]. In response, transmetatarsal amputation (TMA) has been proposed as an index procedure; however, details of its durability have been rarely published. This case series details surgical outcomes of TMA for first ray ulceration or osteomyelitis.

Methodology & Hypothesis

A retrospective review of all TMAs performed at our institution over an 8 year period was undertaken to identify diabetic patients with peripheral neuropathy who underwent TMA for first ray ulceration or osteomyelitis of the 1st metatarsal rather than partial first ray amputation. Patients were excluded from review for vascular compromise. Ten patients (11 TMA procedures) meeting inclusion and exclusion criterion were identified. Formal chart review was performed collecting demographic, surgical, and follow-up data including time to heal, number of re-ulcerations, and number of re-amputations.

It was hypothesized that a well-balanced TMA for first ray ulceration or osteomyelitis would provide a reliable residual foot preventing more proximal amputation.

Procedure

Management of all patients was performed via a standardized protocol. Prior to intervention, operative extremities underwent surgical preparation with a chlorhexidine gluconate 4% scrub and an iodine impregnated alcohol paint.[3] Aggressive debridement was performed, followed by irrigation via pulsed lavage with Bacitracin impregnated normal saline. Microbiological and pathological specimens were collected including a clearance fragment of bone from the residual first metatarsal in cases of osteomyelitis. Definitive amputation was staged in cases of osteomyelitis to ensure clear osseous margins as well as when soft tissue required time for demarcation. If a staged procedure was required, after the initial incision and drainage, the surgical site was packed with polymethylmethacrylate antibiotic-loaded cement beads which were explanted at time of definitive procedure.[4] All surgeons performed the TMA as described by Terashi et al. by removing osseous structures sequentially from medial to lateral preserving the intrinsic musculature and accompanying vascular structures.[5] The plantar flap was closed in layers over a drain using retained intrinsic musculature to cover the residual metatarsals. Selective soft tissue balancing procedures were then performed to ensure a plantigrade and stable residual foot structure.[6-9] Patients remained hospitalized on bed rest until removal of indwelling drain. All patients remained non-weight bearing to the operative extremity until full incisional healing was noted.

Literature Review

Individuals with diabetes mellitus and peripheral neuropathy are at high risk for development of forefoot ulcerations. These ulcerations can be difficult to mange secondary to poor pedal hygiene, repetitive plantar stresses, difficulty obtaining appropriate offloading, and inadequate vascular supply. The first ray is especially prone to skin breakdown[10-12].

When soft tissue breakdown or underlying infection necessitates amputation, a partial first ray amputation is often performed in an effort to maintain the length of the residual foot thereby reducing the patient's overall metabolic demand and subsequent mortality rate. However, prior literature has challenged the durability of partial 1st ray amputations. A 2012 systematic review of partial 1st ray amputations performed by Borkosky and Roukis identified a 19.8% re-amputation rate of which 32.6% were amputations at the transmetatarsal level and 29.1% at the below knee level[1]. Subsequent retrospective review of cases at our institution revealed a 69% re-ulceration rate, 42.4% proximal amputation rate and 47.5% mortality rate within a mean of 34.6 months[2]. In response, TMA was proposed as an index procedure.

However, a TMA is not without its pitfalls. A review of the literature reveals a high rate of complications and re-amputations following TMA. In a retrospective review of 101 cases, Pollard and colleagues reported post-surgical complications in 87.1% of cases[13]. This could be attributed to a myriad of causes including persistent host factors for delayed healing (i.e. protracted hyperglycemia, malnutrition, vascular insufficiency, etc), and/or unattended structural or dynamic imbalances of the residual foot[14]. Systematic review and meta-analysis by Thorud et al. suggested reoperation and reamputation rates of 26.9% and 29.7% respectively. These results lead the authors to suggest caution in performing primary TMA[15].

It needs to be noted that these articles detailing outcomes after a TMA fail to delineate between individuals with diabetes mellitus and peripheral neuropathy from those with concomitant vascular compromise.

This case series is dedicated to investigating the durability and reliability of TMA for first ray ulceration or osteomyelitis using the modified TMA technique and soft tissue balancing employed at our institution.

Figure 1. Pre-operative radiographs

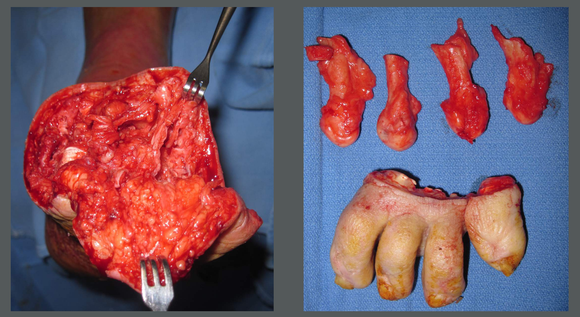

Figure 2. Example of forefoot dissection and residual plantar soft tissue flap with retained intrinsic musculature and associated vasculature.

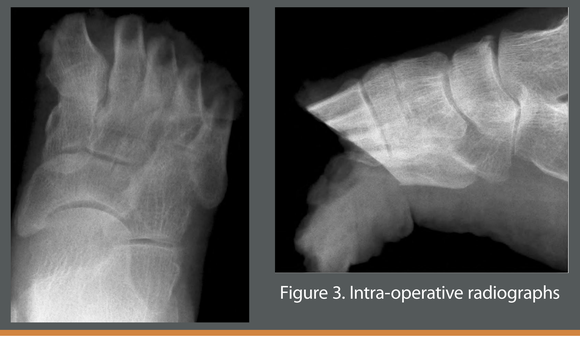

Figure 3. Intra-operative radiographs

Results

Ten patients (11 TMA procedures) were identified for inclusion in the study. Nine patients were male and 1 female with an average age of 57.8 years at the time of the index procedure. Laterality was left for 6 and right for 5. Six TMAs were closed primarily and 5 were staged. Adjunct tendon balancing procedures were performed for 4 patients and 5 TMAs. The mean time to heal was 175.8 days. Re-ulceration was recorded in 5 patients and 6 TMAs at an average of 330.8 days after healing index procedure. Local wound cares were sufficient to heal 4 of the re-ulcerations, 1 remains ulcerated, and 1 has been lost to follow-up. No reoperations or reamputations were required.

Analysis & Discussion

The literature suggests that an isolated first ray amputation in the diabetic, neuropathic population lacks durability leading to high re-ulceration and re-amputation rates. The healing rate of a TMA as an index procedure varies depending on persistent host factors for delayed healing and structural or dynamic imbalances of the residual foot. This case series evaluates TMA durability within a specific subset of patients with diabetes mellitus, peripheral neuropathy, but without vascular compromise. TMAs were performed using a literature based protocol, taking care to preserve intrinsic musculature and vascular supply. Structural or dynamic imbalances of the residual foot were systematically addressed in an attempt to provide a stable, plantigrade foot. In our review, Primary TMAs for first ray pathology resulted in a 0% reoperation and re-amputation rate suggesting a modified TMA as a viable alternative to a first ray amputation to preserve limb function and prevent more proximal amputations.

Weaknesses of this study includes its retrospective nature, short follow-up and small sample size. While a single TMA protocol was in use for all surgeries, multiple surgeons performed the TMA's introducing variability to the study. Despite these short comings, given the promising results further prospective investigations are warranted.

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