Transverse Dorsal Approach to the Midfoot Joints in Acute Traumatic Injury

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Abstract: A transverse dorsal incision approach to the joints of the midfoot was previously described in a small study of 12 patients by Vertullo et al in 2002. Of those patients, 10 cases were elective procedures and only 2 were cases of acute traumatic injury to the midfoot. Thus, here we studied acute traumatic midfoot dislocations and fractures in a large group of 60 patients. We treated them with a surgical approach, which we feel can provide superior exposure to the midfoot through a single transverse incision rather than through the traditional multiple longitudinal incision approach. We found that of our 60 patients, 55 healed the incision without complications. The remaining 5 patients showed delayed wound healing that required secondary treatment. Five of the patients who healed well had some embarrassment of sensation secondary to either the incision or the trauma. We conclude that this approach for an acutely traumatized midfoot appears safe and carries little risk of wound breakdown or neurological problems. Moreover, we feel that this is an optimal approach not only for elective but also in particular for traumatic cases.

Level of Evidence: Diagnostic Level 3. See Instructions for Authors for a complete description of levels of evidence.

Key Words: midfoot dislocation, acute midfoot trauma, transverse dorsal incision, Lisfranc joint, tarsometatarsal joint

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LEARNING OBJECTIVES

After participating in this activity, physicians should be better able to:

1. Describe the dorsal transverse incision approach to the midfoot joints and compare this approach to the traditional approach utilizing multiple longitudinal incisions.
2. Select patients with acute traumatic midfoot injury who can be appropriately treated with open reduction and internal fixation through a dorsal transverse incision approach.
3. Delineate the advantages of the dorsal transverse approach to the midfoot joints.

HISTORICAL PERSPECTIVE

Traumatic midfoot injuries often require open reduction and internal fixation (ORIF) to restore the alignment of the foot into a rectus position.[1–3] However, surgical correction requires incisions to the dorsum of the foot and is not without risk. Traditionally, multiple longitudinal incisions are used to gain exposure to the multiple joints of the midfoot. Theoretically, these longitudinal incisions result in less compromise of the longitudinally oriented vasculature and tissues. However, this exposure technique brings its own concerns. It can insult the cutaneous blood supply to the skin bridges, placing the skin at risk of necrosis.[2,4,5] Advocates of the longitudinal approach maintain that this technique provides the safest exposure and that avoiding necrosis simply requires that the skin bridge between incisions be as wide as possible. However, this wide spacing can decrease the quality of exposure. Consequently, this inverse relationship between skin bridge size and exposure quality poses a challenge when using longitudinal incisions. Another issue with the longitudinal approach is that the pattern of midfoot injury is almost always transverse, so the incisions lie at 90 degrees to most injury patterns. This offset can impede maximal surgical access for reduction and for plate or screw placement.

In 2002, Vertullo et al[1] were the first to describe an approach that used a single transverse dorsal incision to gain exposure to the tarsometatarsal joints (TMTJ). Their study included 12 patients, but only 2 were cases of acute traumatic injury to the midfoot. Thus we evaluated the utility of their approach using a much larger patient set suffering acute traumatic midfoot injuries. These injuries included Lisfranc joint fractures, dislocations, and more complex injury patterns as depicted in Figure 1. We hypothesized that these patients would do well postoperatively without exhibiting an increased incidence of wound healing or neurological complications.

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FIGURE 1. Presurgical radiograph demonstrating an acute tarsometatarsal fracture dislocation after attempted closed reduction. There is an acute dislocation of all tarsometatarsal joints, as well as all navicular-cuneiform joints.

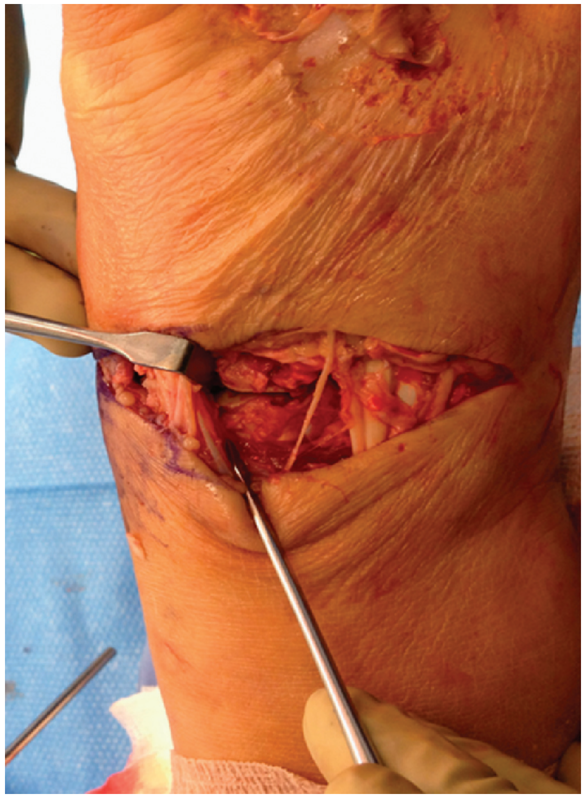

FIGURE 2. An intraoperative dissection depicting the transverse incision approach. Access to the tarsometatarsal joints is achieved through access intervals between tendinous and neurovascular structures.

INDICATIONS AND CONTRAINDICATIONS

This approach is indicated in any case of acute traumatic midfoot injury that requires ORIF or primary fusion of the midfoot joints. This approach may be contraindicated when the soft-tissue envelope is inadequate, or excessive swelling or fracture blisters are present. This approach may also be contraindicated in cases where patients have undergone foot lengthening procedures or previous foot surgery using longitudinal incisions to the dorsal midfoot. However, we do not believe that these contraindications are of any more concern with this technique than they are with the traditional multiple longitudinal incision technique.

PREOPERATIVE PLANNING AND EVALUATION

Planning for this approach includes astute evaluation of all preoperative imaging. This evaluation will assist in planning the extent of the incision needed to reduce and fixate all of the involved joints and fractures. Also, paramount in preoperative planning is the careful evaluation of the skin envelope. Any and all incisions should be carefully considered in the presence of excessive edema or fracture blistering, as this could result in wound healing complications.[6]

PATIENTS AND METHODS

We evaluated 60 patients with acute injury to the midfoot requiring ORIF. These cases included all patients who presented to 1 surgeon with acute traumatic injury to the midfoot between 2006 and 2014 at a level 1 trauma center. The first 15 patients were retrospectively reviewed, and the last 45 patients were prospectively studied. Patients were brought to surgery a median of 14 days after the acute injury occurred. These patients were a mean age of 39 years old (range, 15 to 70 y). Mean follow-up was 9 months (range, 2 to 28 mo).

One surgeon performed all procedures using a transverse incision to the dorsum of the midfoot to gain access to the TMTJs. After ORIF of the injuries, these patients were placed in a jones compression dressing with a posterior and stirrup-type fiberglass splint postoperatively. All patients were followed beyond wound healing. Fifteen of these patients had factors that could have contributed to decreased healing potential including diabetes mellitus, cigarette smoking, poly trauma, active chemotherapy, and morbid obesity.

OPERATIVE TECHNIQUE

The patient is brought to the operating room and placed on the operating table in the supine position. A pneumatic ankle or thigh tourniquet is placed with webril padding. The foot is then scrubbed, prepped with 2% chlorhexidine solution, and draped in the standard fashion. The leg is then elevated and the pneumatic ankle or thigh tourniquet is inflated.

Attention is then directed to the dorsal aspect of the foot where a transverse incision is made halfway between the first and second TMTJ as described by Vertullo et al[1] (Fig. 2). It is often useful to utilize fluoroscopy of a K-wire to precisely identify the location of the proposed incision. The incision is deepened through the subcutaneous tissue with care being

TABLE 1. Anatomic Boundaries of Dorsal Access Intervals as Described by Vertullo et al[1]

Interval	Medial Boundary	Lateral Boundary	Access
1	Tibialis anterior tendon	Extensor hallucis longus tendon Terminal branch of saphenous nerve Medial branches of superficial peroneal nerve	First TMTJ
2	Extensor hallucis longus Saphenous nerve	Extensor hallucis brevis tendon Deep peroneal nerve and dorsalis pedis artery Medial branches of superficial peroneal nerve	First TMTJ Second TMTJ
3	Extensor hallucis brevis tendon Deep peroneal nerve and dorsalis pedis artery	Extensor digitorum longus tendon Intermediate branch of superficial peroneal nerve	Second TMTJ Third TMTJ
4	Extensor digitorum longus tendon Superficial peroneal nerve	Extensor digitorum brevis tendon	Third TMTJ Fourth TMTJ
5	Extensor digitorum brevis tendon	Peroneus tertius tendon Sural nerve	Fourth TMTJ
6	Peroneus tertius tendon Sural nerve	Peroneus brevis tendon	Fifth TMTJ

TMTJ indicates tarsometatarsal joints.

taken to identify and retract all vital neural and vascular structures. Access to the TMTJs is achieved through the intervals between the neurovascular and tendinous structures as described by Vertullo et al[1] and shown in Figure 2 and Table 1. This single incision can be extended laterally as needed to achieve adequate exposure to the pathology within the tarsal bones. The lateral and/or medial extent of the incision can also be converted to an "L" or "J" with a right angle extension. This is especially useful along the medial column. The fractures and dislocations are fixated using standard AO technique as described by Allgower[7] in the manual of internal fixation and are evaluated using fluoroscopy (Fig. 3).

The incision is then flushed with sterile normal saline solution. The subcutaneous tissues are reapproximated using absorbable suture, and the skin is reapproximated using nylon suture in a tension-sparing fashion such as in the Allgower-Donati suture technique. The leg is then placed in a compressive dressing with posterior and stirrup-type fiberglass splint that remains intact until follow-up.[8]

ANATOMY

As seen in Figure 2, adequate exposure to all of the joints of the midfoot can be gained through a single dorsal transverse incision. The incision can be extended medially or laterally as needed. Meticulous dissection is required as all musculotendinous and neurovascular structures are crossed transversely (Fig. 4). Special attention should be paid to the branches of the superficial peroneal nerve that course across the dorsum of the foot deep within the subcutaneous tissue. The tendon of the extensor hallucis brevis (EHB) is a landmark frequently used for orientation, and beneath the EHB at the

FIGURE 3. Post-ORIF radiograph showing that adequate reduction and fixation of all tarsometatarsal joints and navicular-cuneiform joints have been achieved. The operative limb is in a fiberglass splint described in the text. ORIF indicates open reduction and internal fixation.

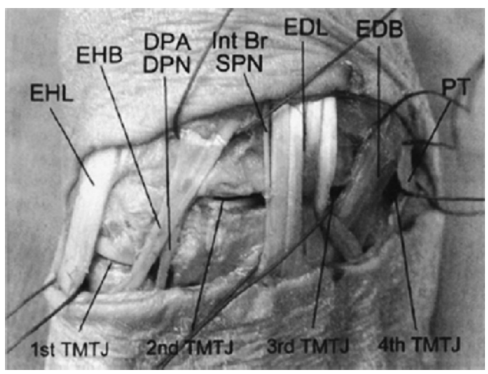

FIGURE 4. A cadaveric dissection demonstrating access to the TMTJs between tendinous and neurovascular intervals. DPA indicates dorsalis pedis artery; DPN, deep peroneal nerve; EDB, extensor digitorum brevis; EDL, extensor digitorum longus; EHB indicates extensor hallucis brevis; EHL, extensor hallucis longus; Int Br SPN, intermediate branch superficial peroneal nerve; PT, peroneus tertius; TMTJ, tarsometatarsal joint. Image taken with permission from Vertullo et al.[1]

TABLE 2. Data for Patients Treated by Open Reduction and Internal Fixation for Their Acute Midfoot Injuries

Injury Type	No. Patients (60 Patients Total)	Average Age	Patients With Comorbidities	Mean Time to Surgery (d)	Delayed Healing	Embarrassment of Sensation
Isolated Lisfranc joint fracture/dislocation	40	36	7	13	2	4
Isolated navicular fracture	3	41	0	20	1	0
Multiple complex foot fractures/dislocations	17	36	9	18	2	1

Sixty patients with various types of acute traumatic injury to their midfoot joints were all successfully treated by open reduction and internal fixation through a transverse dorsal incisional approach.

level of the midfoot lie the dorsalis pedis artery and deep peroneal nerve.

Depending on the number of joints that require attention, up to 6 access intervals can be created between the longitudinal musculotendinous and neurovascular structures seen in Table 1.[1] We did not typically require ancillary incisions, however, on some occasions we extended the main incision longitudinally along the medial column as previously noted.

POSTOPERATIVE MANAGEMENT

All operative extremities were places in a modified Jones dressing splint that consists of webril padding, bulky cotton roll, elastic compression bandages, and a splint.[8] The dressing remained intact until the first postoperative office visit that took place within 14 days. Skin sutures were routinely removed at the first postoperative visit. These patients remained non–weight-bearing in a CAM walker for 10 to 12 weeks, or until radiographic signs of healing were noted in cases where fractures were present.

COMPLICATIONS

There were minimal complications encountered during this study (Table 2). Of our 60 patients, 55 healed the incision without complications. The remaining 5 patients had delayed wound healing requiring secondary treatment. Three of these patients required oral antibiotics and local wound care alone. One had dehiscence of the incision that required surgical debridement with primary closure. One required a split

FIGURE 5. Healed transverse incision of a 52-year-old male after open reduction and internal fixation of a midfoot fracture dislocation.

FIGURE 6. Posttraumatic swelling with fracture blisters experienced by many patients suffering from severe lower extremity injury.

thickness skin graft of the surgical wound. Notably, this patient had originally suffered a severe crush injury with loss of soft tissue in the midfoot, thus the need for our secondary treatment cannot be attributed solely to the incision technique.

Among the patients who healed well, 5 had some transient embarrassment of sensation secondary to either the incision or the trauma. Three exhibited diminished sensation in the peroneal nerve distribution, whereas 2 had diminished sensation in the medial dorsal cutaneous nerve distribution. None of these patients developed complete sensory loss of any region of the foot. Given the energy imparted with these injuries, we cannot definitively correlate these changes of sensation with the use of the transverse incision.

RESULTS

Of the 60 patients evaluated in this study, 55 (92%) patients experienced healing of the incisions without complications (Fig. 5). The remaining 5 (8%) patients exhibited wound healing complications that required the secondary treatments detailed above. Five (8%) of the patients who healed well experienced transient embarrassment of sensation to the foot.

None of the patients in this study developed impairment of function secondary to neurological compromise. Patients with comorbidities such as diabetes, a smoking history, or poly trauma showed no increased incidence of complications. All patients were followed past complete healing of the incision. The mean time of follow-up was 9 months (range, 2 to 28 mo).

The prospective nature of this study required treatment of all acute midfoot injuries regardless of the trauma's severity. Multiple patients experienced high-energy mechanisms, including fall from a height, crushing injury, motor vehicular accident, etc. Many had exorbitant swelling and/or fracture blisters (Fig. 6). Yet, despite the injury's severity, only 5 (8%) of our patients exhibited wound healing complications that required secondary treatment (Table 2). Moreover, although 5 patients (8%) had a transient embarrassment of sensation, all patients healed with sensation intact to the foot. In fact, given the high-energy mechanisms that caused these injuries, we cannot definitively correlate all these changes of sensation to the use the transverse incision technique.

We believe the approach used here minimizes the risk of necrosis to the skin while affording exposure that is superior to that offered by traditional longitudinal incisions. Although this transverse incision obviously crosses many vital nerves, vasculature and tendons, meticulous dissection eliminates any potential for damage to these structures. We also believe that incisions made in the foot and ankle should be made parallel to the relaxed skin tension lines. This approach will create a more cosmetically acceptable scar with less contracture. Moreover, this scar is less likely to become hypertrophic[9] and may cause less local shoe irritation.

FUTURE OF THE TECHNIQUE

We recommend the transverse dorsal approach to the TMTJs in cases of acute traumatic injury. This approach affords adequate exposure to the joints of the midfoot without adding risk of wound healing complications or neurological embarrassment. This approach can be utilized in all patients with acute injury to the midfoot who require ORIF and who have not had previous longitudinal incisions, have not suffered significant soft-tissue loss to the midfoot, and do not require midfoot lengthening. We do not feel that comorbidities such as diabetes, a smoking history, or poly trauma are an absolute contraindication to this approach.

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CME QUESTIONS

1. Which of the following is a contraindication to the single transverse dorsal incision approach to the midfoot?
   a. The presence of multiple midfoot fractures
   b. The presence of severe midfoot dislocation
   c. Primary fusion of the midfoot joints is necessary
   d. The presence of a compromised soft-tissue envelope

2. Additional access to the medial column can be achieved by
   a. Making an additional longitudinal incision medially
   b. Making an additional transverse incision medially
   c. Extending the transverse incision medially in an "L" or "J"
   d. Crossing the transverse incision with a longitudinal incision medially

3. Special attention should be paid to the branches of the ______ nerve, which course across the dorsum of the midfoot within the subcutaneous tissue.
   a. Deep peroneal
   b. Superficial peroneal
   c. Tibial
   d. Sural

4. The transverse incision eliminates the risk of
   a. Nonunion of fractures
   b. Dehiscence of wound
   c. Skin bridge necrosis
   d. Painful scarring

5. The transverse incision will likely provide a more cosmetically acceptable scar with less scar contracture because
   a. The transverse incision will not disrupt cutaneus blood supply
   b. The transverse incision can be closed without the use of subcutaneous suture
   c. The transverse incision is made parallel to the relaxed skin tension lines
   d. The transverse incision is not as long as a longitudinal incision

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CME PROGRAM EXAM
December 2015

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Please rate these activities (1 — minimally, 5 — completely)	1 2 3 4 5
This activity was effective in meeting the educational objectives	O O O O O
This activity was appropriately evidence-based	O O O O O
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Please rate your ability to achieve the following objectives, both before this activity and after it: 1 (minimally) to 5 (completely)	Pre 1 2 3 4 5	Post 1 2 3 4 5
Describe the dorsal transverse incision approach to the midfoot joints and compare this approach to the traditional approach utilizing multiple longitudinal incisions	O O O O O	O O O O O
Select patients with acute traumatic midfoot injury who can be appropriately treated with open reduction and internal fixation through a dorsal transverse incision approach	O O O O O	O O O O O
Delineate the advantages of the dorsal transverse approach to the midfoot joints	O O O O O	O O O O O

How many of your patients are likely to be impacted by what you learned from this activity?
O <20% O 20-40% O 40-60% O 60-80% O >80%

Do you expect that these activities will help you improve your skill or judgment within the next 6 months? (1 — definitely will not change, 5 — definitely will change) 1 2 3 4 5 O O O O O

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In monitoring patients O	As a foundation to learn more O
In educating students and colleagues O	In educating patients and their caregivers O
As part of a quality or performance improvement project O	To confirm current practice O
For maintenance of board certification O	For maintenance of licensure O

Please list at least one strategy you learned from this activity that you will apply in practice:

____

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