Case Study

First tarso-metatarsal joint fusion with PECA-C® screw and PRESSLOCK® compression plating system: A single surgeon, single center review

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Introduction

First tarso-metatarsal (TMT) joint fusion is a versatile procedure that is performed to address hallux valgus, first ray hypermobility, arthrosis, and residual forefoot supinatus occurring in flatfoot deformity correction. It is most vastly studied in the setting of hallux valgus correction and has become increasingly popular, particularly as the importance of correcting frontal plane rotation in hallux valgus becomes better understood.[1] Historically, 1st TMT arthrodesis was not favored due to the necessity of a prolonged period of non-weight bearing. As fixation constructs have improved, early or immediate weight-bearing has been shown to be reliable.[2-4] Non-union rates were previously reported as high as 12% in smaller cohorts, but a larger study showed a 5% non-union rate which is more reflective of the advancements in fixation techniques.[5]

Plate and screw constructs have been proven to be biomechanically sound.[6] Despite this, there is a concern for hardware irritation given the limited soft tissue coverage in this area and its proximity to the tibialis anterior tendon. Hardware removal rates after 1st TMT fusion are reported at 15%.[7] Low profile hardware is essential. Failure to properly countersink the interfragmentary compression screw can lead to dorsal rubbing in shoe gear. Headless screws can avoid screw head prominence, however their circular design requires them to be inserted far into the first metatarsal in order to be fully buried. This can lead to boney ingrowth and make screw removal, if necessary, very challenging. In addition, both anatomic and non-anatomic locking plates can be bulky both dorsally and medially which causes irritation in shoes. Medial plates can also rub on the tibialis anterior tendon and cause discomfort.

PECA-C® screw technology has a unique beveled design that contours nicely with the first metatarsal declination. The beveled design allows for the screw to be fully seated in the first metatarsal without being over buried; this decreases screw prominence without complicating the removal process should that be necessary. The PRESSLOCK® compression plating system offers a low profile locked plating option. The 1.6mm plate thickness decreases plate prominence while still providing solid fixation. In the absence of adequate interfragmentary compression, the slotted holes in the plate can be used to obtain 1.5mm of compression and when secured allow for locking the screw into the plate, a design feature that is novel to this plating system.

Purpose

The purpose of this paper is to review a single surgeon's experience with the use of a PECA-C® screw and PRESSLOCK® compression plating system for first TMT joint fusion.

Surgical Technique

It is the surgeon's preference to perform the procedure under spinal or regional anesthesia with intravenous sedation. The patient is placed on the operating table in a supine position with a bump under the ipsilateral hip. The lower extremity is prepped and draped in the usual sterile fashion and a sterile ankle tourniquet is applied. The extremity is exsanguinated, the tourniquet is inflated and a standard dorsal-medial incision is made over the 1st TMT. The medial dorsal cutaneous nerve is identified and retracted appropriately. The joint capsule of the 1st TMT is incised longitudinally and soft tissue is freed from the joint, taking care to preserve the insertion of the tibialis anterior tendon. A Hintermann retractor is applied to open the joint in cases of arthrosis or limited joint mobility; this is not necessary in cases of hallux valgus with hypermobility of the first ray.

For hallux valgus correction, a sagittal saw is used to resect a laterally based wedge from the medial cuneiform, taking care to avoid over-resection. In cases of 1st TMT arthrosis, a sagittal saw is used to resect the articular cartilage of the medial cuneiform parallel to the joint without resecting a wedge laterally. Care must be taken to avoid plantarflexing/dorsiflexing the cut. A sagittal saw is then used to resect the articular cartilage at the level of the subchondral bone plate from the first metatarsal base.

The joint is irrigated with saline. Subchondral drilling is performed with a 2.5mm drill bit and the subchondral plate is further broken up with an osteotome and mallet in a fish scale technique. The Hintermann retractor, if applied, is then removed.

In the case of hallux valgus, the intermetatarsal (IM) angle is reduced by applying pressure to the medial first metatarsal head while adducting the hallux. A 1.6mm K-Wire is then inserted into the proximal-medial metatarsal shaft and the K-Wire is moved dorsally to derotate the first metatarsal in the frontal plane. The wire is then driven across the 1st TMT for temporary stabilization and fluoroscopy is used to verify appropriate IM angle reduction, sesamoid position and sagittal plane alignment. In the case of 1st TMT arthrosis without deformity, the joint surfaces are opposed and a 1.6mm K-Wire is driven from the medial first metatarsal into the cuneiform for temporary stabilization.

A 1.4mm guidewire for a 4.0mm PECA-C® screw is then placed across the 1st TMT from dorsal-distal to plantar proximal. Guidewire placement is verified with fluoroscopy on AP and lateral views (figure 1). The guidewire is then measured and the appropriately sized PECA-C® screw is selected, usually 2-4mm less than the measured length to ensure that the screw can be fully seated without being too long. The near cortex is drilled with the 3.2mm cannulated drill bit and the PECA-C® screw is inserted over the guidewire. Appropriate screw insertion is achieved when the screw is fully seated in the first metatarsal with the bevel side up; this will ensure that there is no dorsal screw prominence (figure 2). The screw driver is designed to correspond with the screw orientation so it is easy to determine the orientation of the bevel. In the case of hallux valgus correction, it is important to maintain pressure on the medial first metatarsal head during screw insertion; this will ensure that IM angle reduction is maintained during screw placement. AP and lateral fluoroscopy is used to verify screw placement prior to proceeding.

Figure 1. IM angle reduction is temporarily held with an obliquely placed 1.6mm K-Wire. The guidewire for the 4.0mm PECA-C® screw is then placed centrally across the 1st TMT.

Figure 2. PECA-C® screw is inserted until the bevel side is up and it is flush with the dorsal cortex of the 1st metatarsal.

A rongeur is then used to flatten the medial aspect of the 1st TMT and remove any boney prominences that may interfere with PRESSLOCK® plate placement. A two-hole universal fusion straight PRESSLOCK® plate is then contoured to the medial 1st TMT with plate benders. A locking tower is then threaded into each plate hole and the plate is oriented obliquely on the medial TMT such that the distal hole is inferior on the 1st metatarsal and proximal hole is superior on the medial cuneiform (figure 3). This ensures that the plate and screw construct avoids the interfrag PECA-C® screw. The proximal hole is drilled first with the 2.5mm drill bit and the drill bit is left in place to maintain plate position. A second 2.5mm drill bit is used to drill the distal hole and the appropriate size 3.5mm locking screw is inserted. The proximal hole drill bit is then removed and the appropriate size 3.5mm locking screw is inserted proximally. The locking compression feature of the PRESSLOCK® plate is not utilized in this setting because compression is achieved with the PECA-C® screw prior to plate placement. If additional compression is needed the oblique hole can be used in a compressive fashion and will still provide the benefit of a locking construct since the unique design allows for compression and the security of a locking plate. Fluoroscopy is used to verify appropriate plate placement and alignment.

Figure 3. Medial plate placement across the 1st TMT.

If necessary, an additional incision is made distally over the medial eminence of the first metatarsal head and the eminence is resected with a sagittal saw. Lateral release / medial capsulorrhaphy is performed as needed. Closure is then performed in layers and the ankle tourniquet is deflated. The patient is placed in a well-padded posterior splint.

The post-operative course consists of 4 weeks of non-weightbearing (6 weeks if multiple TMT fusions) to the operative extremity followed by 4 weeks of weight-bearing in a boot. Patients begin to transition to a surgical shoe or supportive athletic shoes at 8 weeks post-operatively depending on edema. Physical therapy begins at 4 weeks post-operatively for scar tissue mobilization and 1st metatarsophalangeal joint range of motion. High impact activities are avoided for at least three months; after that time patients return to all activities as tolerated.

CASE SERIES

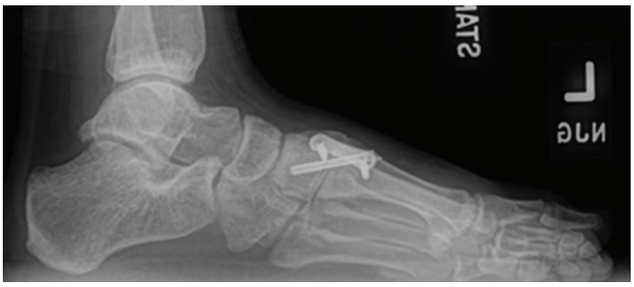
Patient 1: A 46 year old healthy, active male presented with left 1-3 TMT arthrosis. He underwent 1-3 TMT arthrodesis with PECA-C® / PRESSLOCK® fixation of the 1st TMT and PRESSLOCK® compression fixation of the 2nd and 3rd TMT. He was non-weight bearing for 6 weeks followed by weight bearing in a boot for 3 weeks. Complete union radiographic union was achieved at 15 weeks. No perioperative complications were noted. He was discharged from clinic at 15 weeks post-op and was allowed to return to activities without restrictions.

Figure 4. Pre-op and post-op images demonstrating 1-3 TMT fusion. The 1st TMT was fused with PECA-C® / PRESSLOCK® fixation and the 2nd and 3rd TMTs were fused with PRESSLOCK® compression plating alone.

Patient 2: A 17 year old healthy female presented with a painful right foot hallux valgus deformity with 1st ray hypermobility. She underwent Lapidus bunionectomy with PECA-C® / PRESSLOCK® fixation. Her post-operative course was complicated by wound irritation from rubbing in a boot, therefore she was kept non-weight bearing for 5 five weeks in a surgical shoe. She transitioned to weight bearing in a surgical shoe at the five week mark and transitioned into regular shoes at 9 weeks post-op. She achieved radiographic union at nine weeks. Her post-operative IM angle reduced to 8.7 degrees, down from 14.5 pre-operatively.

Figure 5. Pre-op and post-op images demonstrating hallux valgus correction with PECA-C® / PRESSLOCK® fixation.

Patient 3: A 15 year old healthy female presented with a painful left foot hallux valgus deformity with 1st ray hypermobility. She underwent Lapidus bunionectomy with PECA-C® / PRESSLOCK® fixation. She was non-weight bearing for 4 weeks and then transitioned to weight bearing in a boot for 2 weeks. She was allowed to transition out of the boot and into a surgical shoe at 6 weeks post-op. Full radiographic healing was achieved at 10 weeks; at that time she returned to normal shoe gear and all activities as tolerated. No perioperative complications were noted. Pre-op IM was 12 degrees and post-op IM angle measured 7 degrees.



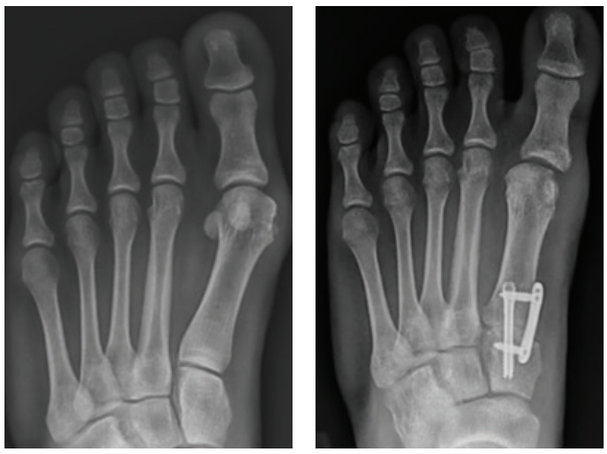


Figure 6. Pre-op and post-op images demonstrating hallux valgus correction with PECA-C® / PRESSLOCK® fixation.

Patient 4: A 77 year old healthy female presented with hallux valgus deformity and end-stage 2nd and 3rd TMT arthrosis. She underwent 1-3 TMT arthrodesis with PECA-C® / PRESSLOCK® fixation of the 1st TMT and PRESSLOCK® compression fixation of the 2nd and 3rd TMT. She was non-weight bearing for 4 weeks and then allowed to transition to 50% weight bearing in a boot because of difficulties maintaining full non-weight bearing status. She was allowed full weight bearing in a boot at 7 weeks and was transitioned out of the boot and into a surgical shoe at 11 weeks post-op. Radiographic union was achieved at 14 weeks post-op; at that time she was allowed to return to normal shoe gear. Pre-op IM was 13 degrees and post-op IM angle measured 9 degrees. No perioperative complications were noted.

Figure 7. Pre-op and post-op images demonstrating hallux valgus correction with PECA-C® / PRESSLOCK® fixation and 2nd /3rd TMT fusion with PRESSLOCK® compression plating alone.

Patient 5: A 34 year old female with a history of irritable bowel syndrome presented with painful right hallux valgus deformity and first ray hypermobility. She underwent Lapidus bunionectomy with PECA-C® / PRESSLOCK® fixation.

She was non-weight bearing for 4 weeks and then transitioned to weight-bearing in a boot for 3 weeks. At 7 weeks post-op she transitioned into a surgical shoe. Radiographic union was achieved at 10 weeks post-op and she returned to normal shoe gear.

Her post-operative course was complicated by a peroneal vein DVT post-op week two despite prophylaxis with 81 mg aspirin twice daily. She was started on Eliquis and had no further complications. Pre-op IM angle was 13 degrees and post-op IM angle was 8 degrees.

Figure 8. Pre-op and post-op images demonstrating hallux valgus correction with PECA-C® / PRESSLOCK® fixation.

Patient 6: A 40 year old female with Raynaud's disease presented with painful left foot hallux valgus with first ray hypermobility and second metatarsophalangeal joint capsulitis secondary to overload. She underwent Lapidus bunionectomy with PECA-C® / PRESSLOCK® fixation and second metatarsal shortening osteotomy. She remained non-weight bearing for 4 weeks and was transitioned to weight bearing in the boot for an additional 3 weeks. At seven weeks post-op she was given a surgical shoe. At her ten week follow-up appointment she had persistent pain and swelling and x-rays showed incomplete union. Her alignment was maintained and there was no signs of stress shielding around the hardware. A CT scan was ordered which demonstrated 45% joint union with gapping noted dorsally and plantarly. She remains in the surgical shoe and is continuing with vitamin D supplementation. She will follow up again in 3 weeks for repeat imaging.

Figure 9: Pre-op and post-op images demonstrating hallux valgus correction with PECA-C® / PRESSLOCK® fixation. At 10 weeks post-op there is 45% fusion of 1st TMT with gapping noted dorsally and plantarly. There is no stress shielding around the hardware and alignment is maintained.

Patient 7: A 56 year old female with a history of gestational trophoblastic disease, polycystic kidney disease and depression presented with painful left foot hallux valgus and 2nd and 3rd TMT arthrosis. She underwent 1-3 TMT arthrodesis with PECA-C® / PRESSLOCK® fixation of the 1st TMT and PRESSLOCK® compression fixation of the 2nd and 3rd TMT. She was non-weight bearing for seven weeks followed by weight bearing in a boot for 3 weeks. At ten weeks post-op she was given a surgical shoe for edema purposes but was instructed to return to supportive shoe gear as tolerated. Radiographic fusion was seen at her 10 week follow-up. Pre-op IM angle was 14 degrees and post-op IM angle was 10 degrees.

Figure 10: Pre-op and post-op images demonstrating hallux valgus correction with PECA-C® / PRESSLOCK® fixation and 2nd /3rd TMT fusion with PRESSLOCK® compression plating alone.

Conclusion

First TMT fusion is a versatile procedure that is being performed more, particularly in the setting of hallux valgus correction. There are a variety of fixation options, but plate/screw fixation is widely utilized because of its biomechanical strength. Advances in fixation techniques have allowed earlier weight bearing without increasing the rate of non-union.

Given the location and surrounding anatomy, hardware irritation with 1st TMT fusion is a concern. The PECA-C® system offers the foot and ankle surgeon a beveled, headless screw option that contours the declination of the metatarsal cortex and eliminates screw head prominence/stress risers without sacrificing stability. PRESSLOCK® compression plating can be applied to the medial TMT to prevent rotation and its low-profile, 1.6mm thickness decreases medial hardware irritation. The surgical technique and case series demonstrate the ease of use and effectiveness of this construct for 1st TMT arthrodesis. Furthermore, the locking compression feature of the PRESSLOCK® plate can be used for fixation of 2nd and 3rd TMTs with excellent results.

References

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