Minimally invasive hallux valgus correction utilizing the Percutaneous Chevron/Akin (PECA®) system: A single surgeon, single center review

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Introduction

Surgical correction of hallux valgus deformity is a common procedure in a foot and ankle surgeon's practice. Reverdin first published a procedure for surgical correction of a bunion in 1881[1] and since that time over 150 different reconstructive forefoot techniques have been described to address hallux valgus[2]. Despite myriad approach options, a Cochrane review in 2004 by Ferrari did not favor one particular approach over another[3]. Furthermore, even with a plethora of open technique options, 15% of patients still suffer following conventional open surgery for bunions with side effects including: pain, stiffness, slow recovery, and other complications[4].

Conversely, minimally invasive surgery (MIS) and percutaneous techniques for hallux valgus correction are gaining popularity and are being utilized more frequently. There are advantages to employing MIS techniques over an open approach, some of which include less pain, decreased joint stiffness, early weightbearing, superior cosmesis with smaller scars, decreased operative time, reduced risk of infection or wound complications, and less overall complications[5]. Like most procedures, MIS and percutaneous hallux valgus surgery has experienced a significant evolution and now exists in a refined third generation status. Vernois and Redfern demonstrated the utility of this generation as a blend of stable rigid fixation and MIS principles that provide a successful and reproducible approach to achieve excellent clinical and radiographic outcomes with high patient satisfaction results along with the aforementioned benefits provided through MIS approach[6].

Once mastered, MIS and percutaneous techniques for surgical correction of hallux valgus offer significant advantages over open approaches. It has been established there exists a learning curve for MIS and percutaneous techniques, especially for surgeons unfamiliar with these techniques[7,8].

The Percutaneous Chevron Akin (PECA®) system by Novastep, Inc. provides surgeons with a user friendly, state-of-the-art percutaneous burr and implant fixation system for successful and reproducible correction of hallux valgus deformities.

Purpose

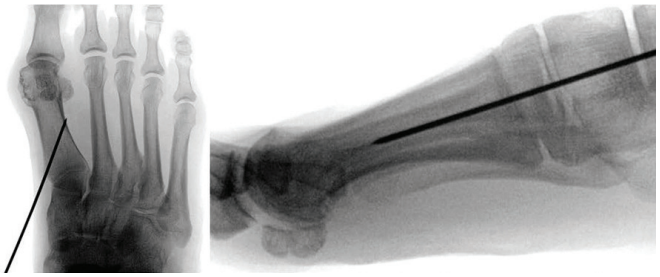
The purpose of this paper is to present a single foot and ankle surgeon's experience with the PECA® system. This includes a review of the surgical technique, and a case series review of multiple patients that underwent hallux valgus correction by the author utilizing the PECA® system.

Surgical Technique

Indications for PECA® include patients with symptomatic mild to moderate hallux valgus deformities that have failed conservative treatment and have been determined to be satisfactory surgical candidates. Contraindications are similar to open conventional approaches and include infection/wounding, open epiphyses, and patients in which the risks of surgery are greater than the potential rewards. It is the author's preference to perform the procedure under general anesthesia and the patient is placed in the supine position on the operating table with the operative lower extremity hanging off the end of the table from mid-calf distal. The non-operative lower extremity is secured on a separate extended arm board and moved out of the surgical field.The procedure can be performed with the surgeon standing or sitting and both approaches offer ready access to the necessary foot pedals which control the burr system and mini c-arm. A tourniquet is not regularly utilized.

Operative setup after sterile prepping & draping protocols.

Osseous and joint landmarks are marked on the operative foot using palpation and image intensification if necessary. It is the author's preference to place a 1.4mm guide wire for the 4.0mm PECA® implant prior to making the first metatarsal osteotomy. This guide wire is placed percutaneously from the proximal medial first metatarsal and is directed distal lateral and ideally parallel with the longitudinal axis of the first metatarsal. The guide wire should be placed bi-cortical and should exit the distal lateral first metatarsal cortex roughly 1cm proximal to the location of the first metatarsal osteotomy. Proper positioning and alignment should be verified on at least AP and lateral views.



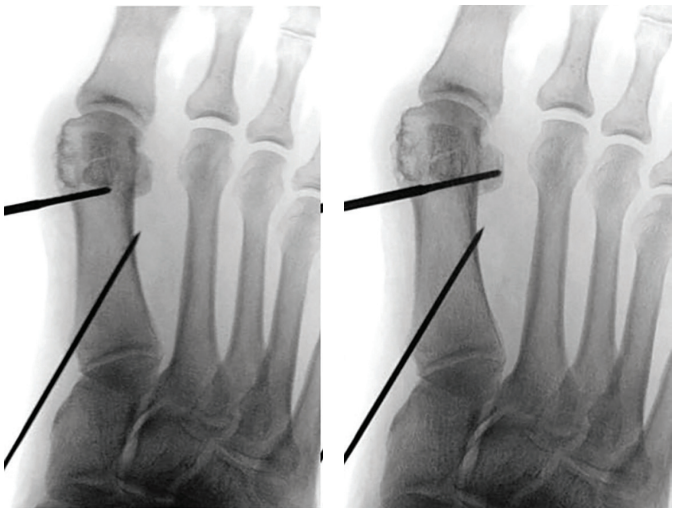
Placement of a 1.4mm guide wire 1cm proximal to first metatarsal osteotomy.

Following appropriate placement of the guide wire, attention is then directed to the distal medial first metatarsal metaphysis at the osteotomy location. A percutaneous incision is made, followed by blunt dissection down to the underlying bone. The Novastep 2.2mm x 22mm cutting burr is then introduced. The distal first metatarsal osteotomy can be made in a modified chevron orientation or a transverse style osteotomy. The surgeon should keep in mind that If the capital fragment will be shifted a width of 75-100% then there will be less bone-on-bone contact and the type of osteotomy is less important. If the capital fragment is shifted laterally 75% or less, then a modified chevron type osteotomy may be more ideal to provide more stability with bone-on-bone contact.

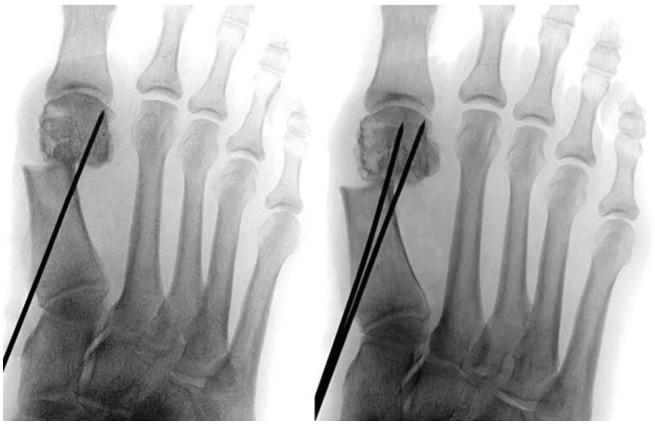
This author most commonly performs a simple transverse osteotomy. The osteotomy should be made within the distal first metatarsal metaphyseal bone proximal to the sesamoid complex. It is imperative the surgeon pay particular attention to the angulation of the cutting burr when making the osteotomy, as this will affect the potential for lengthening/shortening, as well as sagittal plane positioning of the capital fragment. A transverse osteotomy also provides ability for correction of frontal plane deformities (allows for triplanar correction when indicated). The surgeon should also keep in mind that 2-3mm of bone will be lost when making the osteotomy with a cutting burr, as opposed to 1mm loss of bone through use of a traditional saw blade. Thus, the orientation and direction of the cutting burr is crucial when making the osteotomy.

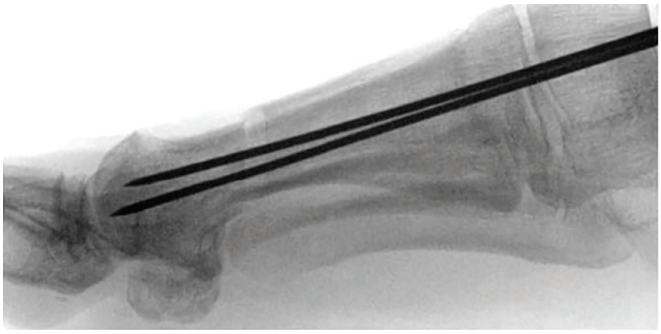
Following completion of the osteotomy, the capital fragment is translated laterally to reduce the first intermetatarsal angle dependent upon the patient's degree of deformity.
This can be accomplished through distal distraction on the great toe, stressing the hallux in varus, and simultaneously employing either the PECA® reduction wire or the rigid metallic double-tipped reduction tool against the medial aspect of the capital fragment for maximum lateral translation.
The first metatarsal head can be adjusted in the frontal plane for any rotational deformity that may be present. This permits triplanar correction of the deformity and can be accomplished by rotating the hallux (through supination/pronation) which will rotate the first metatarsal head due to the soft tissue attachments that have not been violated through a percutaneous technique.

Once anatomic frontal plane rotation and satisfactory triplanar correction is achieved, the previously placed guide wire is then advanced into the distal lateral head of the first metatarsal. It is again imperative that this first wire be bi-cortical within the proximal first metatarsal prior to entering into the capital fragment, as this is what imparts the necessary stability to the osteotomy. A second guide wire is then placed along the proximal medial first metatarsal and directed into the central portion of the metatarsal head. This second wire (and subsequent implant) is added for stability and to prevent rotation, but does not need to be bi-cortical.



Novastep 2.2 x 22mm cutting burr & appropriate orientation for metatarsal osteotomy.





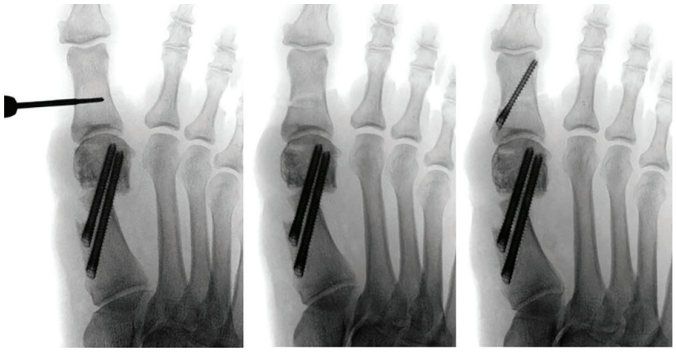
Lateral displacement of first metatarsal capital fragment with advancement of guide wires into metatarsal head.

The guide wires are then measured with the depth gauge, and typically 2-4mm is taken off the length for the definitive implants. This is followed by drilling with a 3.2mm cannulated drill and placement of the appropriate 4.0mm PECA® implants. The author's preference is to use two 4.0mm implants for the first metatarsal osteotomy, but one 4.0mm implant with a second 3.0mm implant is an alternative in patients with smaller anatomy. The medial osseous eminence and medial first metatarsal overhang is then resected utilizing the Novastep 3.1mm wedge burr.

A percutaneous Akin osteotomy is then performed if indicated.
A percutaneous incision is made along the medial aspect of the proximal phalanx of the hallux at the proximal metaphyseal/diaphyseal junction. The Novastep 2mm x 12mm cutting burr is utilized to make the medially-based closing wedge osteotomy while maintaining the lateral cortex intact. The medial portion of the osteotomy is closed to reduce the valgus deformity, followed by placement of a 1.0mm guide wire for the 3.0mm PECA® implant. Position and length of the guide wire should be verified on multiple views using image intensification.

A measurement is obtained with the depth gauge and typically 2mm is taken off the measurement for the definitive 3.0mm PECA® implant. A 2.0mm cannulated drill is then utilized over the guide wire, followed by placement of the appropriately sized 3.0mm PECA® implant. A surgical pearl that this author likes to employ is to advance the 1.0mm guide wire out the distal lateral aspect of the proximal phalanx and clamp with a hemostat prior to drilling so that the wire doesn't pull out with the drilling process.

Two 4.0mm PECA® implants placed followed by medial osseous prominence resection with 3.1mm wedge burr.



Novastep 2 x 22mm cutting burr is utilized to make the Akin osteotomy, followed by placement of a 1mm guide wire and subsequent definitive 3.0mm PECA® implant.

Multiple final views are then obtained using image intensification, including at least AP, oblique and lateral views. These views should confirm appropriate placement of implants, stable osteotomies, and satisfactory correction of the previous bunion / hallux valgus deformity (this would include a congruous first metatarsophalangeal joint, no further prominent medial eminence, physiologically straight hallux with straight medial forefoot border, normalized sesamoid position, and reduction of first intermetatarsal angle with anatomic triplane alignment of first ray). A percutaneous soft tissue lateral release can also be employed at this time if indicated, however it is the author's experience that this is required less then fifty percent of the time with this approach.

A sterile compression bandage is applied to the operative foot and ankle with the hallux splinted in neutral position. The patient is permitted to bear weight immediately following surgery in a rigid postoperative shoe. Sutures are typically removed at the two-week postoperative visit.

First postoperative weightbearing x-rays are obtained at 4-6 weeks, which is when the patient is permitted to return to regular supportive shoegear. Next postoperative x-rays are obtained at three months, and then again at 6 months if needed.

Radiographic and clinical appearance at 3-month postoperative follow-up visit.

Preoperative and postoperative weightbearing radiographs following MIS surgical correction with Novastep's PECA® system.

Radiographic and clinical appearance at 3-month postoperative follow-up visit.

CASE SERIES

Patient 1: A 51-year-old active female patient with symptomatic moderate bunion / hallux valgus deformity of left foot presented after failing conservative treatment. She is a regular recreational runner. She had a surgical history inclusive of an open bunionectomy with "Z" osteotomy on her right foot. She underwent left foot surgical correction using the Novastep MIS / percutaneous bunion system and PECA® implants as described previously. No peri-operative complications were noted. She was weightbearing as tolerated in a surgical shoe for 4 weeks postoperative and then transitioned into regular supportive shoegear (tennis shoe).

Preoperative clinical and radiographic weightbearing appearance of left foot.

Incision comparison at 1 week postop in same patient for right foot open "Z" bunionectomy versus left foot Novastep MIS PECA® procedure.

The patient was seen at her regular 6-week postoperative follow-up visit and was noted to be full weightbearing in regular shoegear with no pain and minimal swelling. She was able to do a double and single heel rise (see image) and had no complications.

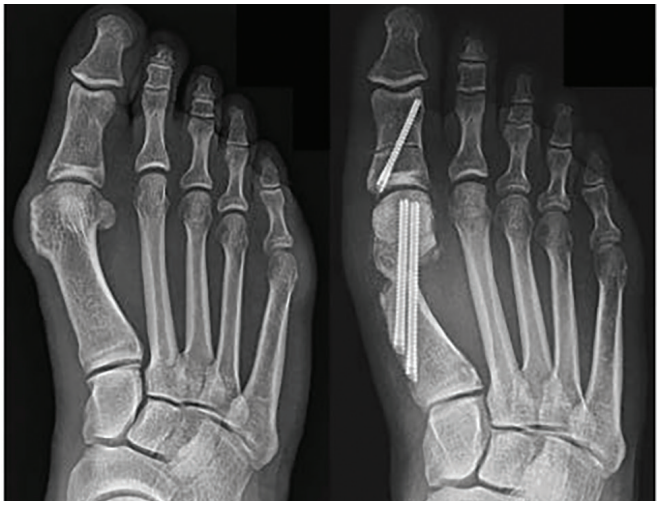
Weightbearing clinical image of left foot 6 weeks postoperative following Novastep MIS PECA® procedure.

Contrary to this author's postoperative orders, patient relates she returned to running activity at nine weeks postoperative. She was seen last at 13 weeks postoperative and continues full weightbearing activity (as well as running) without complication. Due to her high activity level, she has a future follow-up at 6 months postoperative to repeat x-rays, ensure complete healing of osteotomies, and for close monitoring.

Weightbearing preoperative x-ray and 3-month postoperative x-ray following PECA®.

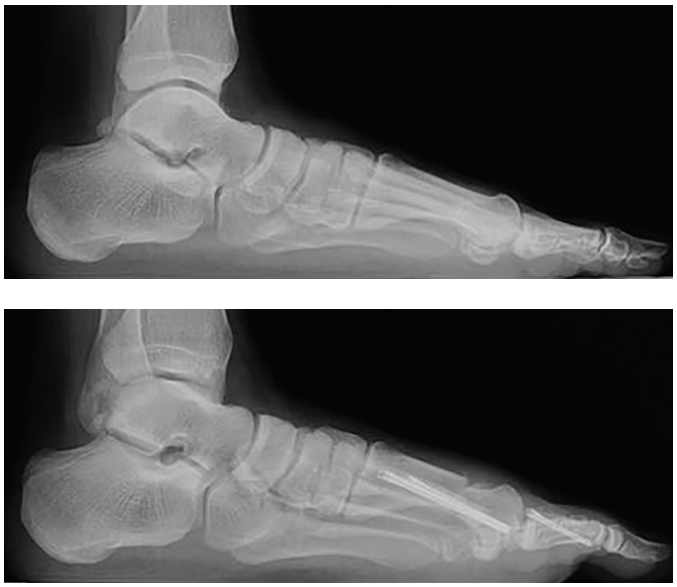
Patient 2: A 44-year-old healthy active male presented with symptomatic bilateral feet moderate bunion / hallux valgus deformities. His right foot was more symptomatic than his left, and he had already failed prior conservative treatments. He enjoys playing basketball, working out with free weights, and keeping healthy with various aerobic exercises. His deformities had been chronic and slowly progressive, and upon consultation in clinic he desired surgical correction of his deformities.

Symptomatic bilateral feet moderate bunion / hallux valgus deformities.



Preoperative and 4 weeks postoperative weightbearing AP radiographs left foot.

He underwent right foot surgical correction using the Novastep MIS /percutaneous bunion system and PECA® implants. No perioperative complications were noted. He was immediately weightbearing as tolerated in a rigid postoperative shoe following his procedure. His external skin sutures were removed at 2 weeks postoperative, and he was instructed to do sagittal plane range of motion exercises to the great toe joint and continue full weightbearing to his postoperative foot in his surgical shoe. Follow-up weightbearing radiographs of his right foot were obtained at four weeks. He was permitted to return to regular supportive shoegear at six weeks postoperative, with return to weightlifting exercises but no running/ballistic activity. He will be seen again at 10 weeks postoperative for repeat weightbearing radiographs and has been scheduled to proceed with surgical correction of his left foot bunion deformity in similar MIS fashion shortly after his next follow-up appointment.



Preoperative and 4 weeks postoperative weightbearing lateral radiographs left foot.

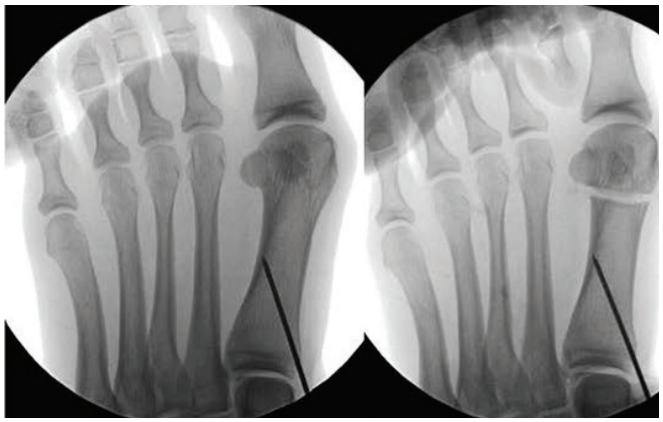
Patient 3: 17-year-old healthy active female with symptomatic left foot mild bunion / hallux valgus deformity. Patient is a multi-sport athlete in high school with history of previous right foot open modified McBride bunionectomy and first metatarsal “Z” osteotomy.

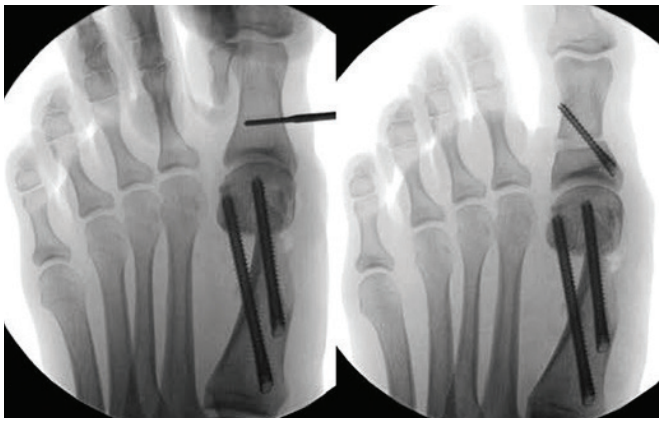
She has demonstrated excellent satisfaction with her previous right foot surgery, but did note some stiffness to the great toe joint within the acute postoperative period.

She desired to proceed with left foot surgical correction of her bunion deformity as it was progressively worsening and affecting her athletic ability as well as activities of daily living.

Preoperative weightbearing AP and lateral radiographs of left foot.

She underwent left foot hallux valgus surgical correction using the Novastep MIS /percutaneous bunion system and PECA® implants. No perioperative complications were noted.





Intraoperative images of Novastep MIS bunion correction using PECA® system.

Clinical images of postoperative left foot at 1 week postoperative follow-up visit.

She was immediately weightbearing as tolerated in a rigid postoperative shoe following her procedure. Her postoperative foot and ankle compression bandage was changed at 1-week postoperative and she related no pain with minimal edema.

Her external skin sutures were removed at 2 weeks postoperative, and she was instructed to do sagittal plane range of motion exercises to the great toe joint and continue full weightbearing to her postoperative foot in her surgical shoe. Patient noted she already could appreciate less joint stiffness at 2 weeks postoperative compared to her prior open right foot bunionectomy procedure.

She will be seen again at her 4-6 weeks follow-up appointment to obtain weightbearing left foot radiographs, and otherwise is doing very well to date.

AP x-ray at 10 weeks.

Lateral x-ray at 10 weeks.

Conclusion

Surgical correction of bunion / hallux valgus deformities is a challenging but common endeavor for foot and ankle surgeons. Employing a MIS or percutaneous approach to correction of these forefoot deformities offers patients and surgeons additional benefits over traditional open approaches, including immediate postoperative weightbearing, less pain, decreased joint stiffness, superior cosmesis with less scarring, and reduced risk of wound healing or other complications. MIS surgery for bunion / hallux valgus correction has evolved and now includes third generation implants and techniques.

The Novastep PECA® system provides a user-friendly system for the surgeon while providing stable osteotomy fixation for the patient with robust beveled headless implants that limit potential for symptomatic or failed hardware. This allows immediate weightbearing and maximizes the surgical corrective power through a minimally invasive approach.
This surgical technique and case series highlight the advantages provided by the PECA® system. Furthermore, PECA® affords the foot and ankle surgeon a reproducible and superior minimally invasive option for achieving excellent clinical and radiographic outcomes with high patient satisfaction results, while providing the aforementioned benefits of a MIS approach.

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