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# Percutaneous Calcaneal Displacement Osteotomy

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## Abstract

The calcaneal osteotomy is commonly used to correct complex foot deformities. The posterior calcaneal displacement osteotomy (PCDO) has been popularized by Koutsogiannis in 1971. The posterior calcaneal displacement osteotomy has the ability to correct the frontal and sagittal plane position of the heel while also providing joint stability and mechanics of both the midtarsal and lesser tarsal joints, therefore stabilizing the foot in all three cardinal planes. The percutaneous posterior calcaneal displacement osteotomy (PPCDO) is performed through four small stab incisions with a gigli saw and provides the same advantages as a PCDO while avoiding potential complications with incision placement, such as wound healing, thermal necrosis, nonunion/delayed union, and damage to neurovascular structures.

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## Keywords

Calcaneal Osteotomy • Percutaneous • Displacement • Varus • Valgus & giggle saw

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## Introduction

The calcaneal osteotomy is commonly used in the correction of complex foot deformities. Calcaneal osteotomies were first described by Gleich in 1893 [1]. The posterior calcaneal displacement osteotomy (PCDO) was made popular by Koutsogiannis in 1971 [2]. It has the ability not

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only to correct the frontal plane position of the heel but also to influence joint stability and mechanics of both the midtarsal and lesser tarsal joints therefore stabilizing the foot in all three cardinal planes [3]. The osteotomy is typically done through a lateral, oblique incision, while the osteotomy is made with a sagittal saw 45 ° to the weightbearing surface from lateral to medial [3, 4]. Postoperative complications include lateral wound dehiscence, sural nerve damage, sural neuritis, delayed union, nonunion infection, and damage of the medial neurovascular structures [5].

The percutaneous posterior calcaneal displacement osteotomy (PPCDO) serves to provide the same advantages present with a PCDO while avoiding complications with incision placement, wound healing, and damage to neurovascular structures [5–9].

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## Indications

Calcaneal valgus, varus, posterior tibial tendon dysfunction, and other calcaneal deformities

The posterior calcaneal displacement osteotomy (PCDO) is the most common method used to treat acquired pes planus deformity with stage II tibialis posterior tendon dysfunction [3, 10]. The PCDO displaces the insertion of the Achilles medial eliminating pronatory forces while creating a supination moment arm around at the subtalar joint. When the posterior tubercle is medialized, ground reactive forces are also placed medial stabilizing the medial longitudinal arch [9, 10]. In a retrospective study of 24 patients who underwent a PCDO for pes planus, Catanzariti et al. found that there was significant improvement of the talo-first metatarsal angle on both AP and lateral X-ray. In addition, in all 24 cases, the talonavicular joint was more congruent postoperatively [11].

Myerson and Corrigan completed a study in 1996 on 32 patients with posterior tibial tendon dysfunction who were treated with a medial slide PCDO with a concomitant flexor digitorum longus tendon transfer. The patients were followed for 20 months. They had an improvement in the AOFAS hindfoot score from

48 preoperatively to 84 postoperatively. Thirty out of Thirty two patients were satisfied with their results [12].

## Calcaneal Varus

A persistent varus position of the heel can lead to chronic lateral ankle instability, peroneal tendonitis, and lateral column overload [13]. The PCDO can also be slid in a lateral direction for correction of varus deformity. In terms of correction of the varus heel, osteotomies are preferred over fusions whenever possible [13, 14]. This procedure has shown good success when combined with other procedures in the treatment of the subtle cavovarus foot [13].

## Loss of Height Status Post-fracture

Following joint depression calcaneal fractures, there is often a loss of hindfoot height. When these fractures are neglected or the height is not restored in the initial repair, a posterior calcaneal osteotomy can be used to shift the posterior calcaneus plantarly therefore restoring the height of the hindfoot [15].

The abovementioned deformities are indications for the open PCDO. These remain the same indications for use of the percutaneous posterior calcaneal displacement osteotomy (PPCDO). The PPCDO can be performed on any patient which the treating physician feels an open PCDO would be beneficial.

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## Physical Exam and Preoperative Evaluation

A thorough history and physical examination should be performed with focus on lower extremity vascular, neurological, dermatological, and biomechanical examination. The patient should be examined standing and fully weightbearing in addition to the traditional exam if possible. The hindfoot is assessed for deviation in either a varus or valgus position. The single and double heel rise

test can be performed to assess pathology of the posterior tibial tendon. Standard, 3-view X-rays of the foot and ankle should be taken and evaluated. There are various methods described for analyzing X-ray angles. The calcaneal pitch angle is evaluated on lateral radiograph. In flatfoot deformity, this angle approaches 0, while in cavovarus this angle is increased with normal 0–20 [16]. The talo-first metatarsal or Meary's angle (normal 0–10) and the talocalcaneal or Kite's angle (normal 20–25) are measured on both AP and lateral radiographs. Both increase with foot pronation [16]. Ankle radiographs, AP, mortise, and lateral, should be taken to evaluate for a varus or valgus ankle position. Long leg axial X-rays are taken to assess for any varus or valgus position of the heel.

## Complications with Open Posterior Calcaneal Displacement Osteotomy

### Neuritis

The typical incision for a PCDO is placed obliquely on the lateral aspect of the calcaneus. The incision and soft tissue dissection can lead to fibrosis in the area which can lead to painful nerve symptoms [5]. A study by Greene et al. in 2001 evaluated 22 below the knee cadaver limbs after an open PCDO. Their results found that, on average, four anatomic structures and a minimum of two structures crossed the osteotomy site. Their final recommendations concluded that the medial calcaneal osteotomy be performed in a restrained manner and with great care. Moreover, the traditional osteotomy exits medially. The surgeon must be cautious as to not overaggressively exit medially as the medial neural and vascular structures can easily be violated [6].

### Wound Dehiscence

The tissue present on the lateral aspect of the heel is relatively thin. This can lead to wound dehiscence and complications postoperatively [15].

## Thermal Necrosis

During a bone cut with power equipment, a large amount of heat is generated within the bone. This temperature elevation can lead to irreversible damage to the organic matrix of the bone. This temperature response can have adverse effects on the ability of the bone to heal [17].

## Surgical Technique

The necessary equipment needed to perform the percutaneous posterior calcaneal displacement osteotomy (PPCDO) consist of a #15 blade, curved Kelly hemostat, straight hemostat, tonsil hemostat, 12 in. flexible gigli saw, large cannulated cancellous screw set, and appropriate suture for closure. Also the use of a fluoroscopy unit will be needed to perform this osteotomy (Fig. 1).

There are a number of structures to be concerned with on the medial aspect of the calcaneus when performing a calcaneal osteotomy. On the lateral aspect, the sural nerve and its branches are in the vicinity of the calcaneal displacement osteotomy. The peroneal tendons are on the lateral aspect of the calcaneus; however, they are more anterior to the osteotomy; therefore, the peroneal tendons are not a concern while performing the percutaneous posterior calcaneal osteotomy. The



**Fig. 1** The needed equipment consist of a flexible gigli saw and handles. A large curved and a small curved hemostat, a large straight and a small straight hemostat, a tonsil hemostat, and a quarter-inch osteotome

approach of this percutaneous procedure is performed through four small stab incisions placed deep and away from neurovascular structures. Tunnels are created when performing this procedure, and the tunnels should be deep to the neurovascular structures when performing the osteotomy.

The plantar aspect of the foot is also of concern. The origin of musculature, ligaments, and nerves all are in close proximity to the exit site of the foot with the gigli saw. The posterior tibial nerve, artery and venous structure typically run more distal than the proposed osteotomy site and are usually not an issue when performing the percutaneous osteotomy. It is of the utmost importance for the surgeon to be aware of these structures and not to violate them.

The patient should be placed on the operating table in the supine position. The surgeon will make four small marks where the proposed incision sites will go: two on the lateral aspect of the calcaneus and two on the medial aspect of the calcaneus. Palpate the plantar medial calcaneal tubercle; make a small mark along the lines of the proposed osteotomy approximately 5 mm distal to the inferior border of the calcaneus. Palpate the posterior, superior aspect of the calcaneus medially. Make a small mark within the resting skin lines posterior to the posterior neuromuscular structures and anterior to the Achilles tendon. Direct your attention to the lateral aspect of the calcaneus. Make the inferior mark along the lines of the proposed osteotomy and parallel with the medial inferior incision approximately 5 mm distal to the plantar lateral cortex of the calcaneus. Palpate the posterior superior aspect of the calcaneus laterally. Make a skin mark here following the resting skin lines. This mark is made posterior to the course of the sural nerve and peroneal tendons and anterior to the Achilles tendon.

The first stab incision is made at the inferior medial calcaneal mark – just below the inferior cortex of the calcaneus. This stab incision is made along the direction of the proposed osteotomy and full thickness. Using a large curved hemostat, bluntly deepen the incision down to the bone of the calcaneus. Next, with the curved, blunt end of the hemostat, create a tunnel in the direction of the

superior incision site making sure that the tip of the hemostat is directly over the calcaneal bone and blunt dissection is performed from inferior to superior along the medial wall of the calcaneus. This blunt dissection should separate the medial wall of the calcaneus from the subcutaneous tissue and neurovascular structures essentially keeping the tunnel deep to the neurovascular structures. It is important to keep the tip of the hemostats against the calcaneus while tunneling. Next, remove the hemostat from the inferior, medial incision site, and insert the tonsil hemostat from the inferior medial incision site to the superior, medial site of the calcaneus. The tonsil hemostat is longer, is thinner, and allows for easier manipulation within the tunnels. Once the superior medial landmark is reached, tent the skin and make a small stab incision within the resting skin line. The tip of the tonsil hemostat is then exited out the incision site. This is the site that the gigli saw will be introduced. The tip of the tonsil hemostat is exited out through the wound; open the jaws of the tonsil hemostat and clamp a 12 in. flexible gigli saw. Rotate the tonsil hemostat one quarter turn so that the loop of the gigli saw is flat or parallel with the calcaneus as it makes it easier to pull the gigli saw through the tunnel. Pull the hemostats inferiorly through the tunnel and through the inferior incision. One loop of the gigli saw is now exiting the medial inferior incision. Unclamp the tonsil hemostat from the end of the gigli saw (Fig. 2).

Redirect your attention back to the superior medial incision. Using the straight hemostat, bluntly tunnel across the superior aspect of the calcaneus. This tunnel is made anterior to the Achilles tendon, posterior to the posterior facet of the calcaneus in Kagers' triangle, and posterior to the neurovascular structures. Be sure to keep the straight hemostat on the superior aspect of the calcaneus while tunneling across from medial to lateral. Once the straight hemostat is across the lateral soft tissues, tent the skin at the lateral superior skin mark and make a stab incision within the resting skin line. Remove the straight hemostat from the medial aspect of the foot. Reenter the straight hemostat through the superior lateral incision, follow the tunnel just made, and exit



**Fig. 2** The tonsil hemostat is entering the inferior medial calcaneus incision. The tonsil hemostat is completely against the medial wall of the calcaneus and entering out the superior medial incision site. The tonsil hemostat should exit out the superior medial incision site with the tip of the tonsil hemostat. With the tips of the tonsil hemostat, the assistant surgeon should place the loop of the gigli saw into the tips of the tonsil hemostat. The surgeon should clamp the jaws of the tonsil hemostat shut, rotate the tonsil hemostat one quarter turn so the loop of the gigli saw is flat against the wall of the calcaneus when pulled through the inferior medial incision

the superior medial incision with the tips of the straight hemostat. Open the tips of the straight hemostat and place the free end of the gigli saw into the tip of the straight hemostat. Clamp down and pull the hemostat back through the tunnel exiting the superior lateral incision pulling the end of the gigli saw through the superior lateral incision. Unclamp the straight hemostat. At this time the one free end of the gigli saw should be free at the inferior medial incision site and the other free end should be free at the lateral superior incision site (Figs 3, 4, and 5).

Make the fourth stab incision at the lateral inferior incision mark along the lines of the proposed osteotomy just slightly inferior to the inferior lateral cortex of the calcaneus and parallel to the medial inferior incision site. Bluntly deepen this incision down to the calcaneal body with a hemostat. Once again make a tunnel superiorly toward the superior incision, being sure to keep the tip of the hemostat against the body of the calcaneus and to separate the periosteum from the subcutaneous tissues and neurovascular structures. The incision site and tunnel should be



**Fig. 3** This is a medial view after the gigli saw has been passed through from superior medial to inferior medial. A straight hemostat is used entering into the superior medial incision site and is inserted from medial to lateral. It is very important that the surgeon uses the tips of the straight hemostat to maintain contact with the superior aspect of the calcaneus as the hemostat is directed from medial – lateral

posterior to the peroneal tendons and sural nerve; thus there should be no potential harm to the peroneal tendons or sural nerve. This tunnel again is deep to the neurovascular structures. Remove the hemostat and insert the tonsil hemostat from inferior, lateral incision into the tunnel and exit the superior lateral incision on the lateral aspect of the calcaneus. Open the tip of the tonsil hemostat; insert the loop of the gigli saw into the tip of the curved tonsil hemostat. Rotate the tonsil hemostat one quarter turn (to keep the loop of the end of the gigli saw parallel to the calcaneus so it pulls through the tunnel with greater ease) (Fig. 6). Pull the tonsil hemostat back through the tunnel out the lateral inferior incision. Release the hemostat. Hook the gigli saw handles to the loops of the gigli saw on the medial and lateral aspects of the foot. Pull the gigli saw taut with tension to be sure there is no kink in the gigli saw and also to have equal amounts of the gigli saw exiting each inferior incision. The gigli saw should now be taut and lying right against the calcaneus, deep to all neurovascular structures, across the superior aspect, and along the medial and lateral body of the calcaneus (Fig. 7).

Using a fluoroscopy unit, take a lateral view of the foot. This will ensure proper placement of the



**Fig. 4** This is a lateral view of a straight hemostat coming from medial to lateral tenting the skin prior to making an incision superior and lateral on the lateral aspect of the foot. The hemostat should tent the skin anterior to the Sural Nerve and Peroneal Tendons and posterior to the Achilles Tendon to identify the “safety zone” prior to making the lateral superior incision



**Fig. 5** From the medial view of the calcaneus, the straight hemostat is entered from the lateral superior aspect of the calcaneus and exiting out of the medial, superior calcaneus. The assistant should place the loop of the free end of the Gigli saw into the jaws of the straight hemostat. The straight hemostat then will bring the Gigli saw across the superior aspect of the calcaneus and exiting out of the superior, lateral incision site



**Fig. 6** This is a lateral view of the tonsil hemostat inserted from the inferior lateral incision site. The tonsil hemostat should be directed superiorly against the lateral aspect of the wall of the calcaneus. Once the tips of the tonsil hemostat exit out of the superior lateral incision site, the assistant surgeon should place the loop of the Gigli saw into the jaws of the tonsil hemostat. The tonsil hemostat should be rotated one quarter turn so that the loop of the Gigli saw lies flat against the wall of the calcaneus as it pulled from superior - inferior on the lateral aspect of the calcaneus and exiting through the inferior lateral incision site



**Fig. 7** The surgeon has the Gigli handles hooked to the Gigli saw with tension; at this time an intraoperative lateral view should be taken to be sure this is the desired position of the Gigli saw for the proposed osteotomy

saw and demonstrate the angle of the proposed osteotomy. Check to be sure there are no kinks in the saw and that the saw is in the desired placement. It is now time to perform the osteotomy. The placement of the incisions ensures that the osteotomy is performed in the proper plane which should be inclined posteriorly at  $45^\circ$  to the plantar surface of the rear foot (Fig. 8).



**Fig. 8** An intraoperative lateral view of the gigli saw around the calcaneus prior to performing the osteotomy. The surgeon needs to check the location of the saw at this time to be sure that this is the appropriate alignment of the desired osteotomy

Grip the gigli saw handles and perform the osteotomy. It is extremely important that the surgical assistant stabilizes the lower leg, dorsiflexes the ankle, and dorsiflexes the digits in order to tighten the plantar fascia and Achilles tendon. By dorsiflexing the digits, this engages the plantar fascia as well as the plantar soft tissues to stabilize the plantar aspect of the foot and calcaneus. By dorsiflexing the ankle joint, this engages the Achilles tendon in order to stabilize the superior calcaneus by engaging dynamic stabilization. Again, this is vital to the osteotomy as the calcaneus needs to be stabilized in order for the osteotomy to be performed with ease.

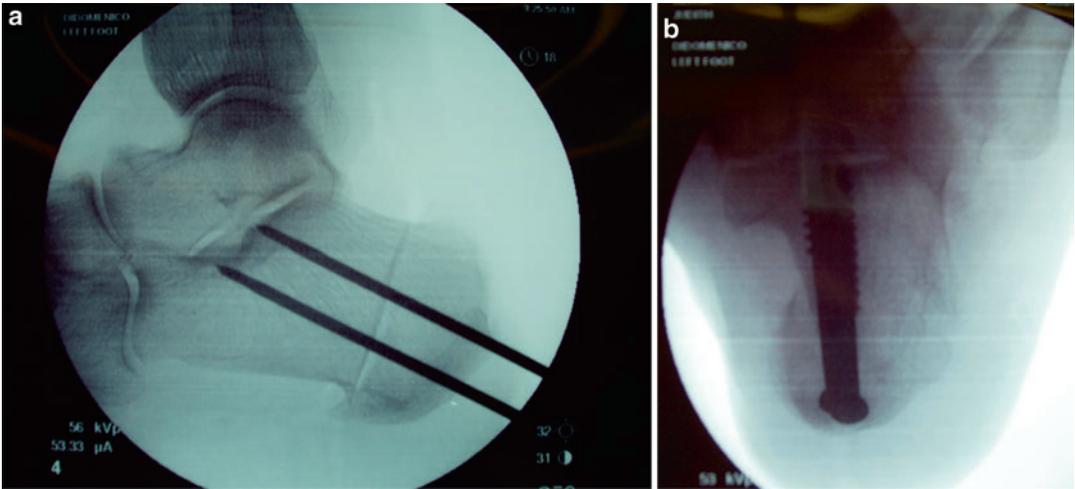
Prior to the beginning of performing the osteotomy, the surgeon must be sure the assistant is stabilizing the calcaneus as previously described, and the surgeon should have tension on the gigli saw exiting out of both the medial and lateral medial and lateral inferior incisions. The surgeon needs to begin moving his/her arms from this position (surgeon elbows are along his/her ribs), and as the saw advances inferiorly through the calcaneus (this occurs very quickly – estimated 3–5 s), the surgeon should widen his/her arms (away from his/her ribs) as the loop of the gigli saw (starting position) converts



**Fig. 9** The surgeon hands and arms must get wider as the osteotomy proceeds toward the plantar calcaneus. The gigli saw is positioned around the medial, lateral, and superior calcaneus prior to beginning the osteotomy in a “loop” fashion. As the osteotomy proceeds, the “loop” of the gigli saw goes from a “loop” around the calcaneus to straight. If the surgeon does not do this and continues to pull planetary, the surgeon risks violating the inferior structures

into a straight line by the time the gigli saw exits the inferior cortex (Fig. 9). Once the inferior cortex is penetrated, the surgeon must stop in order to avoid harming the plantar structures and skin. As the surgeon advances toward the plantar aspect of the calcaneus, extreme care should be taken to not exit the calcaneus forcefully and violate the vital plantar structures. The surgeon should be able to feel the completion of the osteotomy as there is definite difference in how the gigli saw passes through the body of the calcaneus compared to the plantar cortex. If unsure of the level of the osteotomy, the surgeon may stop, and a lateral view can be taken with fluoroscopy to assess the progress of the osteotomy. Once the osteotomy is completed, cut one end of the gigli saw as close to the skin as possible and pull the opposite end of the saw out of the foot.

The assistant may now stop dorsiflexing the digits and ankle and begin to plantar flex the ankle. This removes the dynamic tension and stabilization and allows the surgeon to displace the free posterior calcaneus to the desired position. By plantar flexing the ankle and removing the tension, this allows the surgeon to manipulate the posterior aspect of the calcaneus into the



**Fig. 10** (a) Intraoperative radiograph of a lateral view with guidewires inserted across the osteotomy site. (b) Intraoperative radiograph of a calcaneal axial view

demonstrating the corruption obtained in the osteotomy and following insertion of two large cancellous screws

desired position with very little resistance. Once the surgeon finds the corrected position, the assistant should dorsiflex the ankle and toes. This will again lock the plantar fascia and Achilles tendon and stabilize the posterior calcaneal fragment in desired position. With the assistant now dorsiflexing the foot and ankle to tighten the plantar fascia and Achilles tendon to stabilize the osteotomy in place via dynamic stabilization, two guidewires are driven in perpendicular to the osteotomy site, from the large cannulated cancellous screw set through the plantar posterior/inferior aspect of the foot. Using fluoroscopy check the wire placement with a lateral, calcaneal axial, and anteroposterior views to be certain that the guidewires are in the body of the calcaneus. The surgeon should try to purchase the subcortical bone just inferior to the posterior calcaneal facet with the guidewire. This bone allows for strong screw purchase. Once the desired placement is achieved, make two stab incisions at the entrance site of the wires. Deepen the incisions down to the calcaneus. Measure and drive two cannulated cancellous screws. Once again check the screw position with fluoroscopy using lateral, calcaneal axial, and anteroposterior views. It is very important not to violate the posterior facet

of the calcaneus. Close all incisions with typical wound closure (Fig. 10).

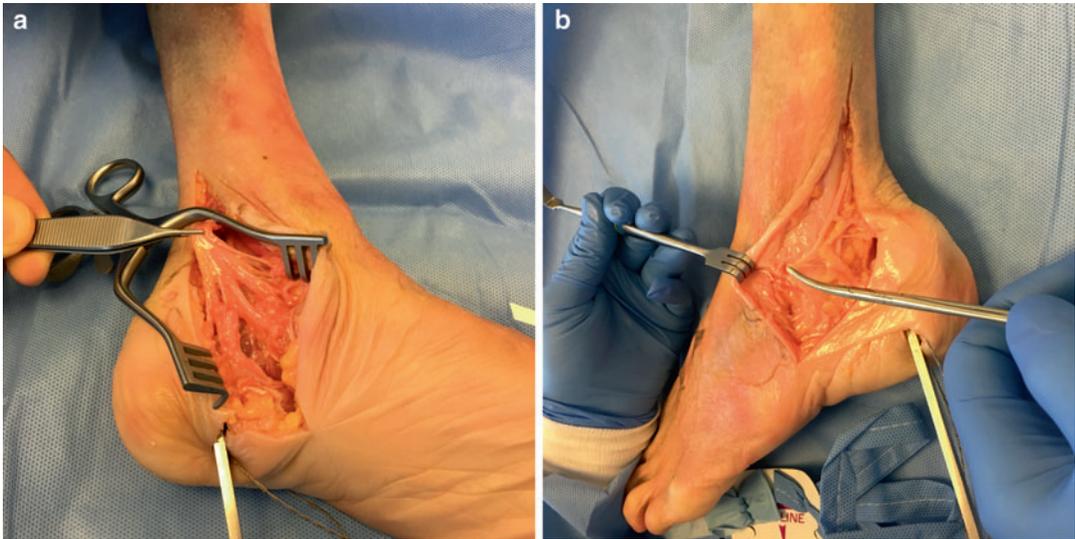
Ancillary procedures will dictate the course of postoperative management. If the osteotomy was performed as an isolated procedure, the patient can be placed in a cast boot with partial weightbearing until the osteotomy is healed. Physical therapy is recommended after the osteotomy site is healed to strengthen the surrounding musculature.

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## Discussion

The percutaneous displacement osteotomy provides many advantages over the typical open technique. Power saws can cause thermal necrosis of bone and adjacent soft tissues. The gigli saw provides a low-energy alternative which is also minimally invasive while respecting the periosteum [18]. The percutaneous gigli saw osteotomy technique was first described by Paly in 1991 on the tibia [18, 19].

The percutaneous osteotomy also reduces the chance of postoperative neuritis and scar entrapment neuralgia associated with the open procedure. In a cadaveric study by DiDomenico, Anain,



**Fig. 11** (a) A cadaver dissection was performed medially following a percutaneous posterior calcaneal osteotomy. The posterior medial neurovascular structures can be isolated and one can see there was no harm to the neurovascular structures. (b) A cadaver dissection was

performed laterally following a percutaneous posterior calcaneal osteotomy. The sural nerve and peroneal tendons can be isolated and one can see there was no harm to the structures

and Wargo-Dorsey, 20 below-knee cadaveric specimens were evaluated after undergoing the PPCDO. There was found to be no iatrogenic damage to the medial plantar nerve, lateral plantar nerve, medial calcaneal nerve, or sural nerve. Additionally, there was no damage found to the posterior tibial artery or venous structures [5] (Fig. 11).

A study by Rungprai et al. compared the outcomes of open and percutaneous endoscopically assisted calcaneal osteotomies in 252 consecutive patients. Their findings concluded that both procedures provided a significant improvement in function outcomes, but the percutaneous group resulted in lower rate of wound infection, sural nerve injury, and painful scar formation [20].

The percutaneous calcaneal osteotomy remains a viable choice in treating conditions in which a surgeon would normally opt for the open procedure. The percutaneous method offers advantages such as better cosmesis, decreased lateral wound complications, decreased sural neuritis, increased bone healing, and less blood loss and minimizes the risk of postoperative infection.

## Pitfalls and Bailouts

Complications with this procedure are few. The gigli saw used must be flexible as it can kink as the surgeon manipulates and inserts the gigli saw around the superior medial and superior lateral calcaneus. There is a significant difference in terms of flexibility from different manufactures. We recommend the use of the Depuy 12 in. gigli saw due to its flexibility. It is also recommended to have a quarter-inch straight osteotome present. This can be used to pry the osteotomy apart and/or complete the osteotomy if any difficulties are encountered when trying to manipulate the posterior aspect of the osteotomy.

For the surgeon who is not experienced in this particular procedure, two guidewires can be placed in the calcaneus as an osteotomy guide. This is not necessary but can be helpful in guiding the surgeon through the osteotomy. The guidewires are placed along the lines of the desired osteotomy.

If the assistant is not holding the leg and foot very stable and not fully dorsiflexing the ankle

and toes, it is possible the gigli saw can get stuck in the bone partially through the osteotomy. This will occur because the motion of the gigli saw (while performing the osteotomy) will mobilize the foot and often times the gigli saw will get stuck within the bony structure because the calcaneus is not stabilized. It is extremely important that the calcaneus is stabilized. If this does occur, cut one end of the gigli saw close to the skin and pull out the other end. At this time use the same incisions and insert a new gigli saw within the same tunnels. Be sure to have the assistant dorsiflex the toes/ankle and stabilize the leg very well.

To date, using the posterior percutaneous calcaneal displacement osteotomy, we have not encountered much difficulty in which an open procedure was needed. If any problem should occur, this can easily be converted to an open procedure by connecting the lateral incisions to produce the traditional incision for the open calcaneal displacement osteotomy.

## References

1. Gleich A. Beitrag zur operativen plattfussbehandlung. *Arch Klin Chir.* 1893;46:358–62.
2. Koutsogiannis E. Treatment of mobile flat foot by displacement osteotomy of the calcaneus. *J Bone Joint Surg Br.* 1971;53:96–100.
3. Niska M, Parks B, Chu I, et al. The contribution of the medial calcaneal osteotomy to the correction of flatfoot deformities. *Foot Ankle Int.* 2001;22:278–82.
4. Chang T, Salk R. Posterior calcaneal displacement osteotomies for flexible pes planus deformity. Chapter 11. Podiatry Institute [www.podiatryinstitute.com/pdfs/Updates\\_2002/2002\\_11.pdf](http://www.podiatryinstitute.com/pdfs/Updates_2002/2002_11.pdf)
5. DiDomenico LA, Anain J, Wargo-Dorsey M. Assessment of medial and lateral neurovascular structures after percutaneous posterior calcaneal displacement osteotomy: a cadaver study. *J Foot Ankle Surg.* 2011;50(6):668–71.
6. Tennant K, Carmont M, Phisitkul P. Modern techniques in lower limb realignment: calcaneus osteotomy. *Curr Rev Musculoskelet Med.* 2014;7:271–6.
7. Lui T. Percutaneous posterior calcaneal osteotomy. *J Foot Ankle Surg.* 2015;54:1188–92.
8. El-Mowafi H. Assessment of percutaneous V osteotomy of the calcaneus with Ilizarov application for correction of complex foot deformities. *Acta Orthop Belg.* 2004;70:586–90.
9. Mendicino R, Catanzariti A, Reevers C. Posterior calcaneal displacement osteotomy: a new percutaneous technique. *J Foot Ankle Surg.* 2004;43:332–5.
10. Lee M. Posterior calcaneal displacement osteotomy for the adult acquire flatfoot. *Clin Podiatr Med Surg.* 2005;22:277–89.
11. Catanzariti A, Lee M, Mendicino R. Posterior calcaneal displacement osteotomy for adult acquired flatfoot. *J Foot Ankle Surg.* 2000;39:2–14.
12. Weinfeld S. Medial slide calcaneal osteotomy. *Foot Ankle Clin Adult Acquir Flat Foot.* 2001;6:89–94.
13. Maskill M, Maskill J, Pomeroy G. Surgical management and treatment algorithm for the subtle cavovarus foot. *Foot Ankl Int.* 2010;31:1057–63.
14. Manoli A, Graham B. The subtle cavus foot, “the underpronator”, a review. *Foot Ankl Int.* 2005;26:256–63.
15. DiDomenico LA. A closer look at the percutaneous calcaneal displacement osteotomy. *Pod Today.* 2006;19(6). [www.podiatrytoday.com/article/5539](http://www.podiatrytoday.com/article/5539).
16. Lee M, et al. Diagnosis and treatment of adult flatfoot: clinical practice guideline. *J Foot Ankle Surg.* 2005;44:78–113.
17. Millon D, LaPointe S, Hitt D. Thermo-mechanical measurements of bone cutting: implications for thermal necrosis. Chapter 51. Podiatry Institute
18. Wardak MM, Wardak E. Percutaneous Gigli saw osteotomy. *Oper Orthop Traumatol.* 2010;22:414–20.
19. Paley D, Tetsworth K. Percutaneous osteotomies osteotome and Gigli saw techniques. *Orthop Clin North Am.* 1991;22:613–24.
20. Rungprai C et al. Outcomes of open and percutaneous endoscopically-assisted calcaneal osteotomies in patients with varus and valgus hindfoot: a comparative study in 252 consecutive patients. *AOFAS 2015 ID 67.*