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Lower Extremity Alignment and Ankle Instability

Jorge Batista[1], Hélder Pereira[2]

Abstract

Abstract: Ankles instabilities are most commonly seen in young individuals who are involved ins ports activites. For most mild and moderate instablities, a varierty of arthroscopic techniques are available. These techniques yield accpetable results in these cases but in cases with severe instablity, the results are not optimal. At times these severe instablities may land up with ankle or subtalar arthritis. Alignment osteotomies play an important role in these cases and present review focusses on presenting the details of the realignment osteotimies.
Keywords: Ankle Instability, realignment osteotomies

Introduction: Lesions of the lateral ligament complex of the ankle is one of the most frequent sports-related injuries. Generally, the lateral ligament injury progresses favorably with rehabilitation protocols and medical treatment, however, the chronic lateral instability develops as a sequel in almost 30% of these patients.[1,2,3,4]
The use of arthroscopy in ankle ligament repair was first described by Hawkins in 1987.[5]
During the last fifteen years a lot of techniques had been published for surgical repair or reconstruction of the lateral ligaments of the ankle in patients with complains of chronic lateral ankle instability.[6-18]
Open, endoscopic or percutaneous procedures has gained popularity in different parts of the world; however, direct repair or reconstruction of the ligaments was often not an option in combination with calcaneal osteotomies.[12,14,16, 19-23]
The surgical treatment of symptomatic ankle instability can be approach through different techniques: anatomical repairs, non-anatomical procedures and anatomical reconstructions.[6-13,15,23] The Broström procedure is the classic repair of the lateral ligaments and in several occasions is associated with the Gould procedure, which is an augmentation with a proximal advancement of the inferior extensor retinaculum.[9,10] These techniques (Anatomical repairs) are still considered the gold standard for treatment of symptomatic chronic instability.[11-13, 15,23] Although the modified Broström procedure is widely used for the surgical treatment of chronic lateral ankle instability, contraindications have now been suggested after further experience with this direct ligament repair, including failed previous reconstructive surgery, the presence of long-standing ankle instability, generalized ligamentous laxity or increased size or weight.[24-26]. Lateral ankle ligament reconstruction using an allograft or autograft tendon is used for a lot of surgeons and it´s recommended for patients with chronic lateral ankle instability with severely attenuated or deficient lateral ankle ligaments, which are expected to have a poor outcome with direct ligament repair alone.[24-26]
Recently, several authors have reported good results using an arthroscopy-assisted lateral ligament repair[11,13,14,19,23, 27,28] Most of them also attempted to reinforce the repair by using the inferior external retinaculum (IER) but found that this was both technically difficult and added significant surgery time to the procedure.[29,30]
There is also concern that when using the IER, this is not strictly an anatomical repair since its calcaneal attachment is 10 mm anterior to that of the calcaneofibular ligament (CFL) and this may thus restrict full plantar flexion of the ankle. The need to reinforce lateral ligament repair with the IER is therefore debatable.[30,31]
Complications related to the superficial peroneal nerve have been reported with arthroscopic and percutaneous techniques in the ankle.[32-35]
Neuritis of the superficial peroneal or sural nerve, and pain or discomfort due to a prominent anchor or suture knot are the most frequent complications reported.[11,12,14]

Good and excellent results can be obtained by using above techniques in patients with mild, moderate or severe ankle instability, but many patients present severe chronic ankle instability associated with post-traumatic and idiopathic cavovarus deformity on whom conservative and orthopedic treatment failed to show acceptable results.
These patients will develop an ankle osteoarthritis (OA) if the malalignment is not corrected. The problem is that these patients with post-traumatic osteoarthritis and idiopathic cavovarus deformity of the ankle are usually active and youngers if we compare with patients with end-stage degenerative OA of the hip or knee. An optimal treatment option in this group of patients with lower extremities deformities associated with chronic lateral ankle instability is to perform an endoscopic procedure to treat the ligament injury associated with joint preserving surgeries.[36] These procedures include joint debridement, osteochondral resurfacing[37] and corrective osteotomies in order to avoid joint-sacrificing procedures such as ankle arthrodesis and total ankle replacement in

[1]Centro Artroscopico Jorge Batista SA- Club Atlético Boca Juniors, Argentina
[2]Instituto Superior da Maia, Porto, Portugal.

Address of Correspondence:
Dr Jorge Pablo Batista, MD,
Centro Artroscopico Jorge Batista SA- Club Atlético Boca Juniors, Argentina.
Email: jbatista20@hotmail.com


Dr. Jorge Batista

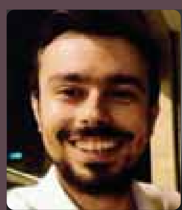
Dr. Hélder Pereira

Figure 1: Patient with ankle arthrosis associated with intra-articular varus deformity. AP X-Ray pre (1) and post op supramalleolar osteotomy (SMOT) (2)

the future.[38,39]
Valderrabano et al.[40] performed an aetiological, clinical and radiographic review of 33 ankles with ligamentous post-traumatic ankle OA. The majority of the patients (85%) had injuries of the lateral ankle ligaments and 15 % had injury of the medial and medial-lateral ligaments. The mean latency time between injury and end-stage ankle OA was 34.3 years. In this study, lateral ankle sprains in sports were the main cause of ligamentous post-traumatic ankle OA with significant concomitant varus malalignment of the hindfoot.[39]
Supramalleolar or inframalleolar osteotomies are being used to correct lower extremity, ankle and foot deformities in adults to prolong ankle function and avoid the need for an ankle arthrodesis. The goal of these procedures is to realign the limb in the setting of these deformities and to redistribute the loads on the ankle joint, thereby improving the biomechanics of the lower extremity.[40]
Although the current literature is lacking data on sports activity after realignment surgery for varus or valgus ankle OA, the restoration of pain free sporting activity may be possible.[41,42]
The goal of supramalleolar or inframalleolar osteotomies is to realign the low extremity deformity and to redistribute the loads on the ankle joint, improving the biomechanics of the lower limb.

Supramalleolar osteotomies.

This procedure is indicated to correct the deformity above or below the ankle joint, and in ankle arthrosis associated with intra-articular varus or valgus deformity (Fig 1). When the patient is standing, the center of force transmission is medialized in a varus ankle and lateralized in a valgus ankle. The forces within the joint are amplified by activation of the triceps surae. The posterior tibial tendon and the Achilles tendon may become an invertor in patients with varus deformities and specifically the Achilles tendon may be an evertor in patients with valgus deformities, thereby exerting an additional deforming force on the hindfoot.[43]
In patients with tibia or hindfoot varus deformity, an osteotomy can be used to correct the malalignment and to prevent the development of degenerative changes, or in cases with ankle osteoarthritis, to modify joint mechanics and shift loads onto intact articular cartilag.[40]

Table 1: Supramalleolar Osteotomies

INDICATIONS	CONTRAINDICATIONS
• Asymmetric ankle osteoarthritis with varus/valgus deformity and ≥50% preserved tibiotalar joint surface	**Absolute**
• Osteochondral lesion of the medial/lateral tibiotalar joint	• Severe ankle osteoarthritis with >50% of cartilage damage of joint surface
• Physeal growth arrest	• Severe hindfoot instability
• Autoimmune arthropaties	• Acute/chronic infection
• Tibial fracture malunion	• Severe vascular deficiency
• Realignment before total ankle arthroplasty	• Severe neurologic deficiency
• Tibiotalar arthrodesis malunion	• Neuropathic disorders
• Residual paralytic deformities	**Relative**
• Congenital talipes equinovarus sequelae	• Patient noncompliance
• Hemophilic arthropathy	• Elderly Patients
	• Moderate or severe osteoporosis
	• Smokers
	• DBT
	• Chronic skin abnormalities or soft tissue defects

The goal of supramalleolar osteotomy is to maintain the weight-bearing axis of the lower extremity centered over the tibio-talar and subtalar joints in both the coronal and sagittal planes in order to realign the hindfoot, and to improve the direction of the force vector of the triceps surae. Supramalleolar osteotomy is also a very useful adjunct to the correction of an intra-articular varus deformity associated either with recurrent ankle instability or congenital distal tibia vara.
Indications [Table 1]:
The main indication for supramalleolar osteotomy in patients with chronic ankle instability associated is asymmetric varus ankle without OA or with degenerative changes with at least 50% preserved tibiotalar joint surface.
Supramalleolar osteotomies can also be used to optimize alignment of total ankle arthroplasty or ankle arthrodesis in the treatment of end- stage ankle OA.
Contraindications:
Patients with hindfoot instability that a ligament repair or reconstruction is not performed is an absolute contraindication. If we planning to perform a supramalleolar osteotomy we must repair or reconstruct the lateral ligaments.
Severe vascular and neurologic deficiency in the affected extremity, inflammatory disease, neuroarthropathy, osteoporosis, and acute or chronic infection of the ankle are absolute contraindications.
Patient age > 65 years and smokers are relative contraindications for supramalleolar osteotomy.

Inframalleolar osteotomies.

In patients with symptomatic foot and ankle malalignment, the calcaneous osteotomies play an important role in restore hindfoot biomechanics (Fig 2). Osteotomies through the calcaneus body not only realign the tuberosity but also redirect the pull of the Achilles tendon making it a corrective rather than a deforming force.[43]
Different types of posterior calcaneal osteotomy are used for calcaneal realignment. Calcaneal osteotomy is an extra-articular procedure that is used in the correction of cavovarus and planovalgus foot deformity and it is usually performed through a lateral approach.
Complications are rare with this procedure, but wound dehiscence, delayed union, and soft tissue or peroneal tendon fibrosis along the osteotomy site can occur and have been presented.[44]
Dwyer popularized calcaneal osteotomy for the correction of cavovarus foot alignment in the 1950s. The original description was that of a removal of a laterally-based wedge to produce a neutral or valgus position of the heel. The wedge is taken proximally to the posterior articular facet.[43,45,46]
Patients with symptomatic foot and ankle malalignment can relieve their symptoms with a calcaneus osteotomy due to this correction restore the hindfoot biomechanics.
Closing wedge osteotomies (Dwyer) or single plane translational osteotomies (Sliding osteotomies) are performed through open or endoscopic techniques associated with an anterior ankle arthroscopy procedure in the majority of the times to treat the intraarticular associated lesions but without repair or reconstruct the ligaments injuried.[45-49]

Indications [table 2]:
The main indication for a corrective osteotomy of the calcaneus is a cavovarus or planovalgus foot deformity due to a malaligned calcaneus with a flexible subtalar joint.
In patients with chronic ankle instability associated, an endoscopic or open repair of the ligaments injured are indicated.
Contraindications:
The main contraindication to calcaneal

Figure 2: AP, Lateral and axial X-Ray view of a calcaneous osteotomy fixed with step plate (Inframalleolar osteotomy)

osteotomy include pre-existing subtalar arthritis. In the presence of subtalar arthritis, subtalar arthrodesis alleviates pain and an extra-articular osteotomy is required.
Relative contraindications include smoking, diabetes, peripheral vascular disease obesity, and poor skin conditions

Endoscopic ATFL repair combined with supramalleolar/inframalleolar osteotomies.
Chronic lateral ankle instability has been suggested to be an etiologic factor in the development of ankle arthritis.[50,51] Long term ankle incongruency or instability presumably increases ankle contact stress that exceeds the capacity of the ankle joint to repair itself or adapt.[52] Excessive varus or valgus alignment of the calcaneus or distal tibia has been shown to alter contact characteristics and ligament strain at the level of the ankle joint and therefore has the potential to contribute to ankle arthritis.[53,54]
Morscher in 1986 presented one of the few articles in which he suggests a combination of fibulotalar syndesmoplasty with osteotomy of the calcaneus according to Dwyer in cases of patients with chronic ankle instability after a supination trauma with a pathological calcaneus varus as opposed to physiological calcaneus valgus.[55]
A combination of endoscopic lateral ligament repair of the ankle associated with supramalleolar or inframalleolar osteotomies according with the deformity of the lower extremity involucrated results in very good satisfaction rate of the patients[23], with complete restore to activities of they daily life and in a lot of cases allow them to return to sports activities. This double procedure would restore adequate lateral ankle stability and correct the cavovarus deformities in cases with severe lateral ankle ligaments injuries and deformities, which are expected to have a poor outcome with direct ligament repair alone.
Indication [Table 3]:
The indication for this combined procedure were patients with severe chronic ankle instability associated with post-traumatic and idiopathic cavovarus deformity on patients on whom conservative and orthopedic treatment failed to show results.

Table 2: Inframalleolar Osteotomies (Dwyer/ Lateral sliding calcaneal Osteotomies)

INDICATIONS	CONTRAINDICATIONS
• Cavovarus foot	**Absolute**
• Planovalgus foot	• Severe ankle osteoarthritis with >50% of cartilage damage of joint surface • Osteoarthritis of the subtalar joint • Irreducible hindfoot instability
• Osteochondral lesion of the medial/lateral tibiotalar joint	• Idiopathic or posttraumatic varus of the distal tibia
• Severe ankle osteoarthritis with <50% of cartilage damage of joint surface	• Acute/chronic infection
• Severe chronic ankle instability	• Severe vascular deficiency
• Failure in previous ankle instability surgeries	• Severe neurologic deficiency
•	• Neuropathic disorders
• Residual paralytic deformities	**Relative**
	• Patient noncompliance
	• Elderly patients (>65-70 y)
	• Moderate or severe osteoporosis
	• Smokers
	• DBT
	• Chronic skin abnormalities or soft tissue defects

Contraindication:
The absolute contraindication was osteoarthritis of the subtalar joint, however there were relative contraindications too: Irreducible hindfoot instability, deep or superficial infections, neurovascular impairment of the lower extremity, Charcot arthropathy, severe osteoporosis, elderly patients, diabetes mellitus and smokers.

Preoperative Assessment

Clinical Evaluation
Surgical planning begins with physical examination of the patient. Clinical, and radiologic examinations were performed before surgery to objective the presence of mechanical instability and associated pathologies.
Evaluate the alignment of the lower limbs clinically results essential with the patient standing (Fig 3). Furthermore, in some cases, the deformity is exacerbated with the patient in the tiptoe position, and this is important to recognize in order to evaluate if the deformity is affected by the contraction of the posterior tibial tendon or the eccentric pull of Achilles tendon. Tenderness and pain on palpation of the lateral gutter and lateral ligament region are common in this pathology.
Pain is exacerbated during the weightbearing and when the patient intent to walk, run or jump.
Medial and lateral ankle stability is assessed with the patient sitting. Clinical talar tilt test and anterior drawer test and overall limb alignment was assessed with attention to any concomitant knee or tibia deformity that may have contributed to the hindfoot mal-alignment.
Passive and active joint motion are measured with the objective of stablish some degree of deficit in dorsi or plantar flexion. Limited ankle ROM can be secondary to gastrocnemius or Achilles contractures that can both addressed at the time of surgery

Radiologic evaluation.
Planning of the extremity correction starts with full-length radiographs of the bilateral lower extremities.
Antero-posterior and lateral radiographs of the feet and ankles were taken to exclude ossicles, malleolar or talar old fractures that can result from ankle sprains.
Saltzman´s view in 20º and 45º were performed to evaluate the alignment of the limbs of all the patients pre and post op.
The most important aspect of preoperative planning is assessment of the origin of the deformity.[56] A complete clinical and radiographic evaluation of the lower extremity from the hip through the foot is imperative for identifying the deformity.
For preoperative planning the calculation of the degree of surgical correction is recommended using weight-bearing anteroposterior and lateral radiographs of the ankle. One of the most important radiographic parameters for quantification of the supramalleolar varus or valgus deformity is the medial distal tibial angle or distal tibial surface angle (TAS). The tibial plafond on the antero-posterior (AP) radiographic view forms an angle of 90º (R=86º-93º) with the mechanical axis of the tibia called the distal tibial ankle surface angle (TAS). On the lateral radiograph, this angle is referred to as the tibial lateral surface angle (TLS), normal averaging 80º (R=78º-82º) (Fig 4). When performing a distal osteotomy, the surgeon should be to restore the TAS and TLS back to within normal values when compared with the contra- lateral limb.[39,40,57,58]
Multiplanar deformities are not the topic of these chapter but often involve coronal and sagittal components, which can result in a combination of ankle varus, valgus, recurvatum, procurvatum, translation, and rotation and in these cases the types of deformities are measured and described by the center of rotation and angulation (CORA).
Another radiographic parameter which should be considered for the pre-operative planning is the talar tilt. The talar tilt is defined as the difference between the distal tibial ankle surface angle (TAS) and the tibiotalar angle (normal value 91.5 ± 1.2°). In neutrally aligned ankles the talar tilt should be less than 4°. [59,60] The angle of

Figure 3: Patient with mal alignment of the lower limbs (cavo-varus deformity)

Table 3: ATFL Repair combined with Inframalleolar Osteotomies (Dwyer/ Lateral sliding calcaneal Osteotomies)	
INDICATIONS	CONTRAINDICATIONS
• Cavovarus foot (Hindfoot deformity)	Absolute
• Moderate or severe chronic ankle instability	• Severe ankle osteoarthritis with >50% of cartilage damage of joint surface • Osteoarthritis of subtalar joint • Irreducible hindfoot instability
• Osteochondral lesion of the medial/lateral tibiotalar joint	• Idiopathic or posttraumatic varus of the distal tibia
• Failure of previous conservative or orthopedic treatments	• Acute/chronic infection
• Severe ankle osteoarthritis with <50% of cartilage damage of joint surface	• Severe vascular deficiency
• Failure in previous ankle instability surgeries	• Severe neurologic deficiency
	• Neuropathic disorders
	Relative
	• Patient noncompliance
	• Elderly patients (>65-70 y)
	• Moderate or severe osteoporosis
	• Smokers
	• DBT
	• Chronic skin abnormalities or soft tissue defects

the lateral calcaneal wall can be used as a measure of calcaneal malalignment (e.g., in-framalleolar deformity). Hintermann suggest obtaining a Saltzman view in 20º and 45º for assessment of hindfoot alignment.[43,61] (Fig 5)

The use of CT scan or Magnetic Resonance Imaging (MRI) are not essential, but we use in all patients in order to identify associated intraarticular pathology, defining necessary additional surgical procedures such as treating intraarticular free bodies, ligament insufficiency or tendinous pathology. In cases of hindfoot arthrosis with or without instrumentation, the use of SPECT-CT has simplified the study of these complex cases since the examination is able to suggest the origin of the pain.[62,63] (Fig 6)

SURGICAL TECHNIQUE:

Anterior ankle arthroscopy. (Endoscopic Anterior Talofibular Ligament Repair through 2 portals)

The patients were placed in supine position, both the hip and the knee were extended with the ankle on the tip of the table to allow flexion-extension movement during the surgery. A pneumatic tourniquet located on the ipsilateral tight is insufflated to 300 mm hg in order to exsanguinate the lower extremity. General or subaracnoid anesthesia is often used. Anterior ankle arthroscopy was performed using only the two classic anteromedial and anterolateral portals described by Prof. v Dijk[63,64] (Fig. 7). Distraction of the ankle was not used during this arthroscopic procedure routinely. A 4-mm 30° arthroscope is introduced through anteromedial portal. The ankle is positioned in maximum dorsiflexion to relax the capsular joint and to obtain the optimal view of the lateral gutter.

In this position, anterolateral portal is made by transillumination taking care of the superficial peroneal nerve. We explored the anterior talocrural joint and treated the associated pathology (synovial processes, osteochondral lesions, tibial spurs, osteophytes and talar beaks) (Fig. 8).

Prior to reattach the ligament, it should be defined if the anterior talofibular ligament (ATFL) present a partial or complete lesion and if the calcaneofibular ligament (CFL) is broken. (Fig.9) The remnant of the anterior talofibular ligament (ATFL) should be repaired under direct arthroscopic visualization.

The footprint for the fibular attachment of the lateral collateral ligaments is debrided with a shaver or a curette introduced through the anterolateral portal. (Fig.10)

Perform the hole on the footprint in the distal tip of the fibula through the indicators of the anchor by drilling. The drill was directed from anterior to posterior, and parallel to the plantar plane as well as the plane of the lateral gutter (Fig 11). A suture passer Mini Scorpion (Arthrex Inc., Naples, FL, USA), a 2:0 or 0 nonabsorbable suture, and a 4,5mm knotless anchor (Foot Print Ultra 4.5 mm, Smith & Nephew Plc) were used for ligament repair. (Fig 12)

The Mini Scorpion suture passer is introduced through the anterolateral portal, and under direct arthroscopic visualization, the remnant ATFL is penetrated from lateral to medial with a double suture. The suture is pulled back with the Mini Scorpion gripper through the anterolateral portal. (Fig 13). Pull back the suture to be sure if there is a firm and acceptable capture of the remnant tissue. The limbs of the suture are passed through the hole in the upper side of the knotless anchor. Be careful that the tension of the suture can be modified only before introducing the anchor. Once the anchor is introduced by impaction, the tension of suture cannot be modified. Cut the remnant suture with a specific endoscopic scissor. (Fig 14)

Calcaneal osteotomy.

In patients with inframalleolar deformities we suggest add this procedure to the endoscopic ATFL repair. The objective of the translational osteotomies of the calcaneus is to realign the posterior part of the foot tripod through a simple transverse osteotomy at the body of the calcaneus. The tuberosity can then be translated laterally in order to correct the varus of the hindfoot. We suggest translating the calcaneal tuberosity while the ankle is in full plantarflexion to relax the Achilles tendon.

Figure 4: Tibial ankle surface (TAS) (A) and tibial lateral surface (TLS) (B) angles on the AP and lateral radiographs in a normal patient without deformities. (C)

Figure 5: Fig 5. (A)Measurement of the talar tilt in a patient with inframalleolar varus deformity.(B) Saltzman´s incidences in 20º and 45º

Figure 6: (A) Coronal CT scan in a patient with cavo-varus deformity. (B) T1 Sagittal images of MRI. Tibial spurs, exostosis and talar beak can be identified

After endoscopic ATFL repair, the patient may be repositioned in either the lateral position and a removable bump under the ipsilateral hip allows the leg to be internally rotated. To types of approach can be used for osteotomies. An “L shaped” mini extensile lateral incision or an oblique incision. With oblique incisions in lateral surgical approaches to the calcaneus, nerve injuries have been well studied in the anatomy and trauma literature and can result in transitory or permanent irritation along the course of the sural nerve at the heel with neuroma formation and distal dysesthesia.[65,66]

We prefer an “L shaped” mini extensile lateral incision to elevate a full thickness skin flap in order to expose the lateral calcaneous cortex (Fig 15). This preserves the integrity of the lateral calcaneal artery reducing the risk of edge ischemia, infection, and wound breakdown. There is a safe zone defined by Talusan and colleagues that is established by projecting anteriorly 11 mm from a line drawn between the posterosuperior apex of the calcaneus and the plantar fascia origin. The incision should be made directly in the middle of the tuberosity at the anterior edge of the safe zone (Fig 16).

Several variations of the calcaneal osteotomy exist for the correction of hindfoot varus (Fig 17). Dwyer (1959) originally described the removal of a wedge from the lateral wall of the bone while leaving the medial side intact as a periosteal hinge. This osteotomy is intrinsically stable and could be performed with minimal fixation. The use of a lateral shift allows the surgeon for greater correction and adequate stability. A 5–10 mm lateral-based wedge of bone is removed prior to the osseous stabilization (Depending of the hindfoot deformity). It displaces the weight-bearing portion of the heel laterally while redirecting the plantar surface into more valgus. Carmont consider that this technique is advantageous when there is overloading on the lateral edge of the heel.[43,67]

Other procedure that can be use is a lateral sliding calcaneal osteotomy. A single plane translational osteotomy was made initially with an oscillating saw and finished with a bone chisel. Be careful in order to avoid over-penetration of the saw blade toward medial neurovascular structures. The osteotomy is then gently distracted with a laminar spreader. The osteotomy was stabilized with a blocked staple plate or two cannulated screw followed by wound closure. (Arthrex Inc., Naples, FL, USA) (Fig 18)

A compressive bandage and a walking boot keeping the ankle in 90 degrees is indicated in all patients and maintained for 6 weeks. Crutches are used for three weeks. No weight bearing was indicated for two weeks. Fourteen days after surgery the patients showed partial weight bearing, and after this time gradually full weight bearing was allowed.

Thromboprophylaxis was used in patients who were over 30 years old.

Balance training and proprioceptive exercises were encouraged. Before starting sports activities, when patients experienced ankle instability and a giving way sensation, they were advised to delay their sports activities and were encouraged to concentrate more on balance training and peroneal strengthening exercises.

Clinical research studies show good results of calcaneal osteotomies, most of which include the procedure associated with other techniques.

Kraus described a modification of lateral closing wedge technique combined with lateral translation to minimize the amount of shortening from wedge resection and presented a very good results with this combination technique.[67]

Barg and Valderrabano presented very good results with Dwyer osteotomies in 31patients. All of them had a substantial inframalleolar cavovarus deformity with preoperative moment arm of the calcaneus of -17.9 ± 3.3 mm, which improved significantly to 1.6 ± 5.9 mm and a significantly improved of The American Orthopaedic Foot and Ankle Society score and pain relief.[48]

The most important complications with calcaneal osteotomies include under correction, nonunion and local complications to the sural nerve and skin (Komman 1992). Tarsal tunnel syndrome has been associated too with lateralizing calcaneal osteotomy in patients with greater translation of the osteotomy and osteotomies performed more anteriorly on the tuberosity.[43,68]

Overcorrection is an uncommon complication and has been reported only in one case for a planovalgus foot overcorrected into varus by medial slide osteotomy.69 Screw heads can cause pain if are placed in the posteroinferior tuberosity and are potential sources of hardware related pain.[70]

Supramalleolar osteotomy.

The patient was placed in supine position with a pneumatic tourniquet located on the ipsilateral tight insufflated to 300 mmhg in order to exsanguinate the lower extremity. Both the hip and the knee were extended with the ankle on

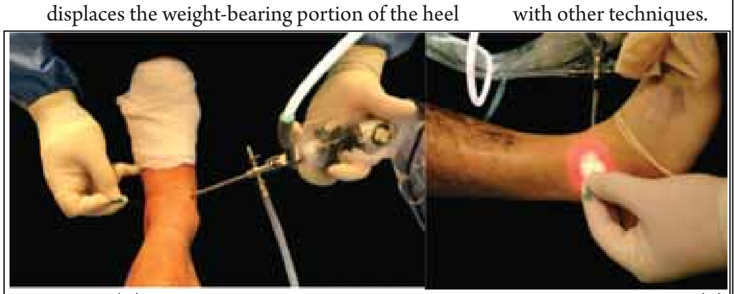

Figure 7: (A) Anteromedial and anterolateral portal with the ankle in 90º. (B) Superficial peroneal nerve visualized by transillumination.

Figure 8: Different types of intraarticular pathology associated with chronic ankle instability and malalignment of the lower limbs

Figure 9: Chronic proximal ATFL insertional rupture (Big picture). ATFL and CF rupture with visualization of the peroneal tendons (above) and normal ATFL (Below)

Figure10: Curettage of the fibular ATFL foot print

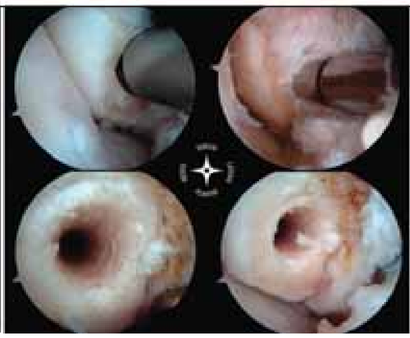

Figure11: Performing the hole on the foot print of the ATFL attachment

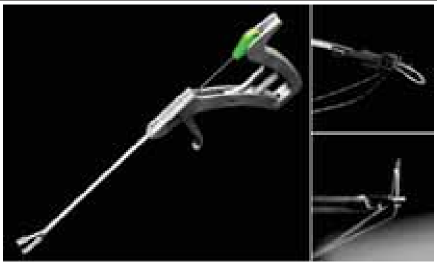

Figure 12: Suture passer Mini Scorpion (Arthrex Inc., Naples, FL, USA)

Figure 13: Catch the remnant tissue with the suture passer and then the suture is pulled back to test a good capture

the tip of the table to allow flexion-extension movement during the surgery. We identify and perform landmarks on the anterior joint line, which is easily palpated by moving the joint through plantar and dorsiflexion. A perfect lateral fluoroscopic image should be obtained.

Ankle varus deformity may be associated with chronic ankle instability, and the deformity can be tibial, calcaneal or intra-articular.

In patients with supramalleolar varus deformities, the surgeon can choose from two surgical options: medial opening wedge osteotomy or lateral closing wedge osteotomy (anti-varus osteotomy). (Valderrabano)

We prefer medial opening wedge osteotomy but, prior to perform the tibial osteotomy, anterior ankle arthroscopy is performed in order to assess if the cartilage degeneration of the joint is > or < 50% (Fig 19). If necessary, loose bodies are removed and anterior ankle impingement is debrided. Endoscopic ATFL repair or arthroscopic ligament reconstruction with gracillis tendon can be performed in some patients. The medial opening wedge osteotomy is indicated in cases with a varus deformity less than 10°.

Figure 14: The anchor is introduced by impactation, the tension of suture can not be modified after this procedure. The remanent suture is cut with an specific endoscopic scissor.

An 8- to 10-cm longitudinal incision is centered along the medial malleolus and carried proximally in line with the tibial crest. The saphenous nerve and vein are typically anterior to the incision, but branches may need to be addressed. A full-thickness flap is most reliable in avoiding injury to the anterior neurovascular structures. The sheath of the posterior tibial tendon is incised to allow posterior retraction of the tendon and visualization of the distal tibia. Once adequate exposure of the tibia is achieved, soft tissue structures must be protected to avoid iatrogenic injury. Using fluoroscopy, only one Kirschner wire is necessary for orientation and saw blade guidance and it is positioned parallel to the joint surface to act as a reference during correction.

Using a wide saw blade, the osteotomy is performed under water irrigation to reduce thermal damage during the cut. The osteotomy may be refined using a chisel or osteotome (Fig 20). It should be clearly exposed that 1mm of opening corresponds to 1,3º of correction of the deformity.

The lateral cortex is typically preserved to enhance the intrinsic stability of the osteotomy, and so the intact fibula does not hinder the desired tibial correction.

The gap can be filled with allograft or autograft harvested from the ipsilateral iliac crest bone.

The fixation of the osteotomy is performed using a T- shaped 3.5-mm LCP plate with angular stabilizing screws. Fixation stability is vital to outcomes. (Fig 21)

Patients are strictly non-weight-bearing after the surgery. Deep drain is not routinely used. Sutures are removed between 2 and 3 weeks, based on the degree of soft tissue swelling.

Non-union, delayed union, persistent pain, decreased range of motion, wound complications, superficial or deep late infections, nerve damage, fracture, deep venous thrombosis and compartment syndrome are some of the complications with these procedures. Wound healing problems and infections may be resolved by i.v. antibiotics and/or surgical debridement and irrigation. Intra-operative complications may include injuries of neurovascular structures and tendons. Anatomical knowledge of surgical approaches is required.

Figure 15: “L shaped” mini extensile lateral incision to expose the lateral calcaneous cortex

Figure 16: The incision should be made directly in the middle of the tuberosity at the anterior edge of the safe zone

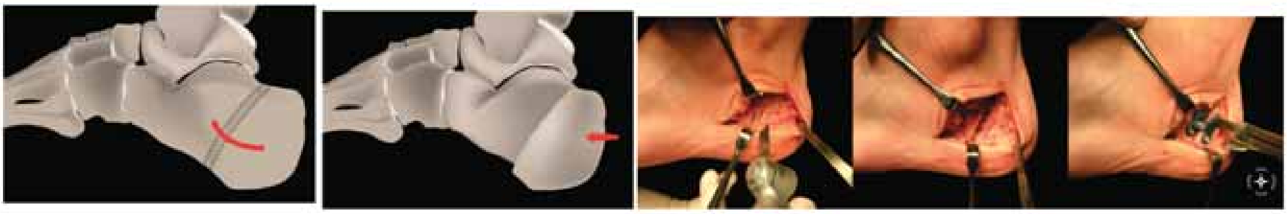

Figure 17: (A) Dwyer calcaneal osteotomy removing lateral wedge. (B) It displaces the weight-bearing portion of the heel laterally while redirecting the plantar surface into more valgus (C) Fixation using plate

Figure18: Osteotomy Stablised with Block Plate

Figure 19: Ankle arthroscopy to assess cartilage degeneration

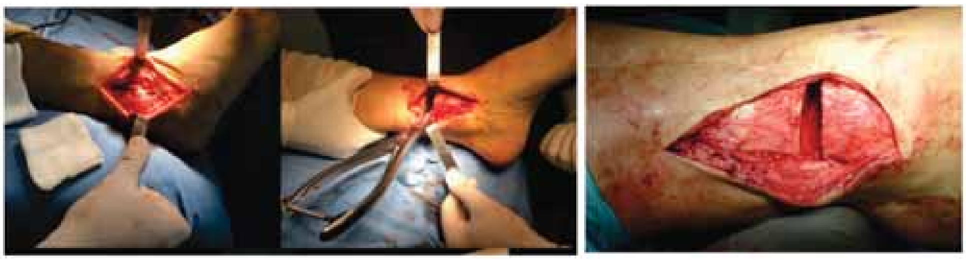

Figure 20a: Using a wide saw blade, the osteotomy is performed. The osteotomy may be refined using a chisel or osteotome

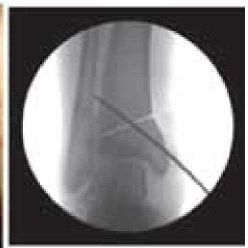

Figure 20b: temporary stabilisation by K wire and correction achieved is checked under C arm

Figure 21: The gap can be filled with allograft or autograft harvested from the ipsilateral iliac crest bone. The fixation of the osteotomy is performed using a T-shaped 3.5-mm LCP plate with angular stabilizing screws

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