TECHNICAL NOTE

Arthroscopic treatment of calcaneonavicular coalition in children

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Summary
Calcaneonavicular coalition is a common source of pain and more or less severe flat and stiff foot in children. Classically, treatment consists in resecting the coalition using a dorsolateral approach. Good quality resection and interposition can prevent recurrence. The most common complications are infection, hematoma and neuroma. Arthroscopy offers a minimally invasive alternative, but the optimal approach remains undetermined. We describe a surgical technique with an approach based on the anterolateral process of the calcaneus, in three cases with 12 months’ follow-up. Arthroscopic resection has certain advantages: recovery is quicker, and the esthetic result is better. For the instrumental portal, skin incision should be superficial, followed by blunt dissection of subcutaneous tissue to avoid superficial peroneal nerve injury. Although longer term follow-up is needed, arthroscopy seems to be an attractive minimally invasive technique in this kind of pathology.

Introduction
Tarsal coalition is a foot deformity caused by bone bridging (Fig. 1). Incidence is estimated at 1% of the general population [1]. Calcaneonavicular coalition is the most frequent form (53%) [1]. Symptom onset, at a mean 8—12 years, is associated with progressive ossification of the coalition [2,3]. In the long-term, it may induce osteoarthritis of the foot and ankle [3].

When conservative management fails, the reference treatment is resection of the coalition [4,5] with a varying amount of interposition of various tissues [6—10]. There may result an esthetic blemish, with a risk of postoperative pain and the inconveniences inherent to cast immobilization. The most frequent complications are infection, hematoma and neuroma [11,12].

Arthroscopy offers an interesting alternative. Complications and recovery time are reduced with such a minimally invasive technique. The optimal surgical approach, however, remains undefined. The present study...
presents our technique and preliminary results with three patients at 1 year's follow-up.

**Surgical technique**

The child is installed in dorsal decubitus, with a cushion under the ipsilateral buttock. A pneumatic tourniquet is applied at the root of the limb. Surgery is performed under image intensification at three-quarters incidence.

The first (visualization) portal is posterior to the anterolateral process of the calcaneus, dorsal to the angle of Gissane (Fig. 2). After dissection by Halsted forceps down to bone contact, a 4 mm arthroscope is introduced. The second (instrumentation) portal, distal to the calcaneal process and lateral to the extensor digitorum longus tendon, is performed under visual control using a needle. A longitudinal subcutaneous dissection by Halsted forceps conserves the extensor digitorum longus and third peroneus tendons and the intermediate dorsal cutaneous nerve (a branch of the superficial peroneal nerve) (Fig. 3). The nerve may first be located subcutaneously with the foot in maximal inversion.

Surgery proceeds downward toward the tarsal sinus. The extensor digitorum brevis muscle is carefully and minimally released using a motorized knife, so as to create a work chamber around the coalition, which is then completely isolated and removed using a motorized burr (Figs. 4 and 5). Care should be taken during excision to avoid cartilage damage at the inferolateral talonavicular joint surface.

To ensure complete and rectilinear resection, a Smilie straight meniscus knife (Fig. 6) or curette may be useful toward the end to remove the deepest part of the bone bridge. Resection edge cauterization and fulguration may be performed (Fig. 7). Complete resection is checked by...

**Figure 1** Right foot calcaneonavicular coalition.

**Figure 2** Visualization portal, posterior to the anterolateral process of the calcaneum (dorsal to angle of Gissane).

**Figure 3** Instrumentation portal. Longitudinal subcutaneous soft tissue dissection to protect the superficial peroneal nerve.

**Figure 4** Visual control of motorized ablation of coalition.
Figure 5  Motorized ablation of coalition by arthroscopic burr.

visualization of the inferior side of the talonavicular joint and calcaneocuboid joint, looking for total absence of coalition and a calcaneonavicular joint space of at least 1 cm. A palpation hook serves as landmark. Joint ROMs at end of surgery are checked on flexion-extension and varus-valgus maneuvers.

The approaches are closed by two resorbable sutures on the skin. Early postoperative active and passive foot mobilization is initiated, followed by gradual resumption of weight-bearing according to pain tolerance, under physiotherapy.

Figure 6  Finishing by Smillie straight meniscus knife.

Figure 7  Resection edge cauterization. Final result.

Three children, aged between 11 and 15 years, presenting with complete symptomatic calcaneonavicular coalition, were operated on using the above technique in 2009 and assessed as 1 year’s follow-up. Mean surgery time was 79 minutes (range, 63–94 min), with a mean dose of 3 cGy/cm² (range, 2–4). Mean AOFAS score rose from 58 preoperatively to 91 at FU. No recurrence was observed at end of follow-up.

Discussion

Calcaneonavicular coalition in children may induce pain and restricted subtalar and ankle ROM [10]. It is established that in case of resistance to conservative management, surgical resection is mandatory [3,13].

First Mitchell and Gibson [14] and then Inglish et al. [15] reported around 30% recurrence following resection without filling. This led many authors to consider means of prevention, based on resection extent and quality and on the use of interposition.

Rouvreau et al. estimated that a calcaneonavicular space equal to or greater than 10 mm was mandatory for good resection. In open surgery, however, resecting the deeper part of the bone bridge comes up against a problem of access, and it is at this level that recurrence mainly occurs [10]. In the present cases, the arthroscope was able to check that resection was not only complete but wide (> 10 mm).

Various types of filling have been associated to prevent recurrence [3,6,10,16,17]. Mubarak et al. [10] recently reported good results using abdominal fat. The present cases were treated without filling, and without recurrence at 1 year.

Complications such as hematoma, infection and especially neuroma have been reported with conventional surgery [11,12]. The difficulty of assessing resection quality and extent and also the incidence of postoperative neuroma led certain authors to consider arthroscopic resection.

The technique was first described by Lui in 2006 [18] in a 14-year-old presenting with a too long anterior process (TLAP); no clinical series have been published. Molano et al. [19], in 2009, reported an anatomic series of four cadavers, describing various entry points and their respective degrees
of visibility and possible impact on the extensor digitorum brevis and nerve branches. They also reported a clinical case of arthroscopic resection of calcaneonavicular coalition without filling in a 12-year-old; they were not able to implement the planned instrumental portal between the first and second extensor tendons, thought to entail the least risk to nerve structures. In our opinion, an approach lateral to the extensor tendon after location of the intermediate dorsal cutaneous nerve, with the foot in varus equinus, associated to careful dissection of subcutaneous soft tissue, provides easy access to the coalition, without significant risk to the nerve.

Bauer et al. [20] reported a case of arthroscopic resection in an adult, with the arthroscopic portal dorsal to the angle of Gissane and the instrumental portal distal and medial to the coalition; resection was complete, without recurrence at 2 years‘ FU. Arthroscopy has the advantage of using a minimally invasive approach with easier complete resection of the coalition. This requires creating a work chamber to visualize and access the bone bridge. It is also important, toward the end of the resection, to check completeness, especially in depth, which requires good visualization of the talonavicular and calcaneocuboid joints and checking subtalar range of motion. The absence of any recurrence at follow-up may have been due to the minimally invasive approach in itself, but also to early resumption of walking and the absence of immobilization.

Conclusion
Calcaneonavicular coalition is a frequent cause of painful stiff foot in children. Open resection with or without interposition is the most frequent attitude in case of failure of conservative treatment.

Arthroscopy enables total resection of the coalition, without complications. The approaches can be landmarked by the anterolateral process of the calcaneum. Arthroscopy seems to be an attractive alternative to conventional surgery, although longer follow-up on a larger series will be needed to assess long-term efficacy.

Disclosure of interest
The authors declare that they have no conflicts of interest concerning this article.

References