SUBSPECIALTY PROCEDURES

EXCISION OF A MIDDLE FACET TARSAL COALITION

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Abstract

Background: Middle facet tarsal coalition is one of the commonly seen tarsal coalitions in clinical practice that can cause pain and associated flatfoot deformity. Excision of the coalition is one of the treatment options for symptomatic cases. Although symptoms may subside in children following a period of immobilization, resection should be considered as a treatment alternative for children and adolescents because of the potential for restoration of subtalar joint movement. The indications for excision of the coalition are not consistently reported in the literature, and the procedure is not always easy to perform. In this article, we describe the steps for a successful excision of a middle facet tarsal coalition.

Description: The incision is marked from 1 cm inferior to the medial malleolus, extending distally to the navicular tuberosity and inferior to the level of the posterior tibial tendon. The coalition is first located by retracting the flexor tendons and the neurovascular bundle. The bone on the surface of the coalition is gradually removed to expose the middle facet. A 2-mm guide pin and a cannulated dilator probe inserted through the sinus tarsi into the tarsal canal that exits anterior to the posterior facet help with identifying the margins of the coalition. The middle facet is then removed either partially or totally, depending on the size, shape, and location of the coalition, until the posterior facet is visualized. Following excision, bone wax is used on the exposed surfaces or fat is inserted to prevent adhesion and recurrent bone formation. If there is an associated flatfoot deformity, additional surgeries, including a medial translational osteotomy or a lateral column lengthening of the calcaneus, a Cotton osteotomy, an arthroereisis, or a calcaneus stop procedure, may be necessary.

Alternatives: The alternative treatment for managing a middle facet coalition is immobilization of the foot in a boot or cast for 6 to 8 weeks to decrease pain. This will not improve the function of the hindfoot, which remains stiff, but may alleviate pain temporarily. Excision of the coalition in combination with other procedures for correction of the flatfoot is an alternative to an arthrodesis of the subtalar joint and works well in children and adolescents, particularly in those with reasonable subtalar joint flexibility. A triple arthrodesis is rarely

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performed for an isolated middle facet coalition, even in adults, unless there is peritalar arthritis and more severe abduction of the talonavicular joint with associated stiffness.

Rationale: The rationale for excision of a middle facet tarsal coalition is to maximize the mobility of the hindfoot, in particular, the subtalar joint. The success of excision of the coalition is associated with the rigidity of the hindfoot and the presence of a flatfoot deformity. The stiffer the hindfoot and the flatter the foot, the less likely is excision of the coalition to be successful. Since the alternative to resection of a middle facet coalition is arthrodesis of the subtalar joint, one must distinguish between feet in which there is mobility, and excision is more likely to be successful, and those that are rigid, for which arthrodesis is preferable. In many feet, however, the size of the coalition is not associated with the flexibility of the hindfoot, and in an extremely rigid hindfoot, we recommend an arthrodesis, even in an adolescent patient. Rigidity increases with increasing age, and it is uncommon to excise the middle facet coalition in adult patients or in a patient in whom subtalar arthritis is evident.

Introductory Statement

Excision of a middle facet coalition aided by insertion of a dilator through the sinus tarsi is a reliable procedure in children to relieve pain and increase mobility of the hindfoot when combined with procedures for correction of the flatfoot deformity.

Indications & Contraindications

Indications

- Patient age between 9 and 16 years is ideal. For patients >16 years, the decision must be made on the basis of the rigidity of the hindfoot¹⁻⁵.
- A flexible hindfoot.
- Absence of subtalar joint arthritis.
- No ankle deformity, e.g., ball-and-socket ankle.

Contraindications

- Adolescents with a very stiff hindfoot, even if the coalition affects <50% of the joint.
- Adult patients, particularly those with a rigid hindfoot. The older the adult, the more likely it is that the hindfoot is stiff, and the results of excision of the coalition are more unpredictable.
- Subtalar joint arthritis.
- A double coalition (middle facet and calcaneonavicular [CN]) associated with severe stiffness.
- Ball-and-socket ankle.

Step-by-Step Description of Procedure

Step 1: Preoperative Planning

Perform a thorough physical examination and imaging, including weight-bearing anteroposterior and lateral radiographs of the foot and ankle, hindfoot alignment radiographs, as well as an anteroposterior radiograph of the ankle for all patients thought to have a hindfoot coalition, as well as a computed tomographic (CT) scan of the hindfoot and ankle.

- Begin with a thorough physical examination focused on the alignment of the hindfoot and midfoot, the flexibility of the subtalar joint, the position of the midfoot and hindfoot after reduction of the hindfoot to a neutral position, and the tightness of the gastrocnemius muscle.
- For all patients who are suspected of having hindfoot coalition, including isolated talocalcaneal (TC) coalition, CN coalition, talonavicular (TN) coalition, or double coalition, we recommend that imaging always include weight-bearing anteroposterior and lateral radiographs of the foot and ankle, hindfoot alignment radiographs, as well as an anteroposterior radiograph of the ankle to rule out a ball-and-socket ankle, since the malalignment of the hindfoot with a tarsal coalition can interfere with the ankle development and cause a ball-and-socket ankle or a valgus deformity of the ankle as a result of compression of the lateral epiphysis.
- Perform a CT scan of the hindfoot and ankle, which is also essential for planning purposes, particularly in the presence of a stiff foot in which a double coalition is suspected.
- In rare cases, if a coalition is suspected but no osseous lesion is found on either radiographs or CT scans, then a magnetic resonance imaging scan may be indicated to rule out a fibrous coalition.

Step 2: Patient Positioning

With the patient in the supine position and a bump placed under the contralateral hip, externally rotate the ipsilateral hip and flex the knee to allow the surgeon to work perpendicular to the long axis of the foot.

- Place the patient in the supine position with a bump underneath the contralateral hip.
- Externally rotate the ipsilateral hip, which is usually possible, and flex the knee as it will allow the surgeon to be able to work perpendicular to the long axis of the foot.

Step 3: Incision

After identifying the anterior edge of the medial malleolus and marking the distal point for the incision under the navicular tuberosity, outline an oblique incision beneath the posterior tibial tendon over a length of 5 cm distally and then extend the incision through subcutaneous tissue.

- Identify the anteroinferior edge of the medial malleolus.
- Mark the distal point for the incision distal to the navicular tuberosity.
- Outline an oblique incision 1 cm inferior to the posterior tibial tendon over a length of 5 cm distally toward the inferior edge of the navicular tuberosity (Fig. 1).
- Extend the incision through the subcutaneous tissue.

Fig. 1

Fig. 1 Incision and skin marking.

Step 4: Exposure of the Coalition

After opening the flexor digitorum longus (FDL) tendon sheath, expose the flexor hallucis longus (FHL) tendon inferior to the FDL tendon and retract both tendons to expose the coalition.

- Open the FDL tendon sheath.
- Incise the retinaculum over the tendon proximally and distally and retract the tendon dorsally.
- Underneath the sustentaculum tali, find the sheath of the FHL tendon.
- Incise the tendon sheath and retract the FHL tendon inferiorly.
- Retract the FHL with a wide retractor so that the neurovascular bundle, which lies deep and inferior to the FHL, will be protected during the procedure (Fig. 2).
- Use a periosteal elevator to remove the soft tissue on the dorsal and inferior surfaces of the sustentaculum tali.
- Expose the coalition, which is directly in between the retracted FDL and FHL (Fig. 3, Videos 1 and 2).
- If the coalition extends far distally, then extend the skin incision.
- Be careful not to open the TN joint capsule or to cut the undersurface of the joint capsule, which extends into the spring ligament.

Fig. 2

Fig. 3

Fig. 2 Exposing the FHL tendon inferior to the FDL tendon.

Fig. 3 Retracting both tendons in different directions and exposing the coalition.

Video 1 Exposing the middle facet in a cadaver foot.

Video 2 Demonstration of the 2 tendons and the middle facet, indicating how much bone should be removed from the sustentaculum tali in a cadaver foot.

Step 5: Resection of the Coalition

After the bone on the sustentaculum tali has been removed so that the original middle facet and healthy articular cartilage are seen, insert a clamp, rongeur, or lamina spreader into the sinus tarsi to ensure that there is no bone bridge and check the range of motion to make sure there is complete subtalar joint mobility.

- Carefully use a chisel and rongeur to remove the bone on the sustentaculum tali until the original middle facet is seen (Videos 3 and 4).
- In a partial or fibrous coalition, removal of bone on the sustentaculum tali may be all that is required until healthy cartilage is visible on the deep aspect of the dissection, at which point the remainder of the middle facet with normal articular cartilage should be seen.
- If the coalition has been removed, insert a small straight clamp, rongeur, or lamina spreader into the sinus tarsi from medial to lateral (Videos 5, 6, and 7).
- Ensure that there is no bone bridge between the excised coalition and the anterior edge of the posterior facet.
- Check the range of motion at the completion of the dissection to ensure that there is complete subtalar joint mobility.

Video 3 Initial ostectomy of the coalition during surgery.

Video 4 Locating the middle facet joint line.

Video 5 Insertion of a rongeur into the sinus tarsi to help with opening up the middle facet and further debridement.

Video 6 Using an osteotome and a rongeur to debride the remnant coalition.

Video 7 Removing as much remaining bone as possible from the middle facet until complete visualization and mobility of the medial subtalar joint are achieved.

Step 6: Opening the Coalition with a Dilator

To open the coalition and demonstrate the margins of the coalition and the anterior edge of the posterior facet, make a 5-mm incision on the lateral side of the foot over the sinus tarsi, divide the soft tissue, insert a 2.5-mm guide pin or a probe from a subtalar arthroereisis set through the sinus tarsi into the tarsal canal, push the probe through until it exits on the medial side of the foot, and insert a dilator from the 8-mm arthroereisis set over the guide pin and push it medially through the medial side of the foot.

- Be aware that in many patients, it is very difficult to identify the deep and the proximal extent of the coalition (Fig. 4).
- When it is difficult to identify the extent of the coalition, be careful not to damage the posterior facet or remove excess bone from the medial aspect of the undersurface of the talus.
- If identifying the margin of the coalition is difficult, then force the coalition open from the lateral side of the foot.
- Make a 5-mm incision on the lateral side of the foot over the sinus tarsi (Video 8).
- Divide the soft tissue with a hemostat.
- Insert a 2-mm guide pin or a probe from a subtalar arthroereisis set through the sinus tarsi into the tarsal canal (Video 8)⁶.
- Push the probe through until it exits on the medial side of the foot. If it does not pass easily, then use a mallet to push it through the remaining osseous bridge (Video 9).
- Note that the guide pin or probe always exits posterior to the middle facet and immediately anterior to the posterior facet.
- Insert a dilator from the 8-mm arthroereisis set over the guide pin and push it medially through the medial side of the foot.

Fig. 4

Fig. 4 A coalition with an unclear boundary.

Video 8 Making the sinus tarsi incision on the lateral side for the dilation procedure in a cadaver foot and inserting a dilator into the tarsal canal of a patient's foot during surgery.

Video 9 Inserting a dilator into the tarsal canal of a cadaver foot.

- By using this dilation method, it is easy to open the coalition and demonstrate the margins of the coalition and the anterior edge of the posterior facet (Figs. 5, 6, and 7, Video 10).
- Proceed with the resection until it is possible to see through the tarsal canal and sinus tarsi from the medial side of the foot.
- Insert a smooth lamina spreader from the medial side into the tarsal canal and gradually open up the debrided middle facet to visualize both the remainder of the middle facet (if present) as well as the posterior facet (Fig. 8, Video 11).
- Use a rongeur to remove as much remaining bone as possible from the middle facet until complete visualization and mobility of the medial subtalar joint is achieved (Video 6 and 7). A large high-speed burr can be used for resection of a middle facet coalition; however, we prefer to use an osteotome and a rongeur to remove bone because it is easier to identify the margins of the coalition without potential damage to either the posterior facet or the FHL tendon.

Fig. 5

Fig. 6

Fig. 7

Fig. 8

Fig. 5 Using the dilator method to help open the coalition.

Fig. 6 Removal of the coalition under the guidance of the dilator.

Fig. 7 Removal of the entire coalition, with the posterior facet visible on the left side of the dilator.

Fig. 8 Using a lamina spreader from the medial side to open up the posterior facet.

Video 10 The dilator is inserted and exits medially, anterior to the posterior facet, in a cadaver foot.

Video 11 The insertion of a smooth lamina spreader from the medial side into the tarsal canal gradually opens up the debrided middle facet to allow visualization of both the remainder of the middle facet (if present) as well as the posterior facet.

Step 7: Check Subtalar Joint Movement

After removal of the coalition, ensure that there is no restriction of the subtalar joint motion; if there is even slight stiffness, look for an additional tarsal coalition and remove it.

- After removal of the coalition, check to be sure that there is no restriction of the subtalar joint motion (Videos 12 and 13).
- If the hindfoot remains even slightly stiff, then consider looking for an additional tarsal coalition, in particular, a CN coalition.
- An additional coalition should have been visible on the CT scan; however, it is possible that there is an associated fibrous CN coalition, which should be removed using a standard lateral sinus tarsi approach.
- After excising the middle facet coalition, use either bone wax on the raw cancellous bone surface or interposition of a piece of fat tissue to prevent adhesion and recurrence of the coalition (Figs. 9, 10, and 11, Video 14).
- We prefer using bone wax to making another incision and harvesting fat tissue from another part of the body such as the proximal part of the leg or retrocalcaneal space.
- Other material with which we have no experience can also be used for interposition⁷.

Fig. 9

Fig. 10

Fig. 11

Fig. 9 Interposition of a piece of fat to prevent recurrence.

Fig. 10 Resected coalition with fat interposition.

Fig. 11 Application of bone wax to the medial exposed bone surface to prevent adhesion and tendon irritation.

Video 12 After removal of the coalition, there should be no restriction of the subtalar joint motion.

Video 13 After removal of the coalition, note that the hindfoot regained full range of motion.

Video 14 Application of bone wax on the raw cancellous bone surface to avoid adhesion.

- Ensure that the medial wall of the calcaneus is shaved smooth with either a rongeur or osteotome and is covered with bone wax to prevent friction of the FHL and FDL tendons.
- The sheaths of both tendons do not need to be repaired. Since the sustentaculum tali is removed, the FHL will relocate slightly dorsally, lying adjacent to the FDL on the medial side of the calcaneus, which will not be an issue for the long-term function of either tendon (Fig. 12).

Fig. 12

Fig. 12 The position of the FDL and FHL tendons after coalition resection.

Step 8: Additional Procedures

After the coalition has been removed, the foot is very flexible, and the medial support of the subtalar joint is compromised because of partial or complete removal of the sustentaculum tali; if there are associated foot deformities, consider performing at least 1 additional procedure.

- Following removal of the coalition, the foot is very flexible, and the medial support of the subtalar joint is compromised because of partial or complete removal of the sustentaculum tali.
- If there are associated foot deformities, consider performing ≥ 1 of the following procedures: an arthroereisis procedure, a calcaneal stop procedure, a medial displacement calcaneal osteotomy, a lateral column lengthening for correcting hindfoot valgus plus midfoot abduction, a Cotton osteotomy for correcting fixed forefoot supination, and a gastrocnemius lengthening for correcting an associated gastrocnemius contracture.
- If there is a dorsal beak on the talar neck, which is caused by constant tension on the dorsal capsule and TN ligament⁸⁻¹⁰, perform a resection through a small dorsal incision to avoid impingement of the osteophyte on the deep peroneal nerve, causing pain.
- Close the subcutaneous tissue with 4-0 interrupted Vicryl sutures (Ethicon), and close the skin with 4-0 absorbable chromic sutures.

Step 9: Postoperative Treatment

Immobilize the foot in a large bulky bandage that incorporates a posterior plastic splint; remove the bandage at 10 days and apply a boot that is worn for 4 to 6 weeks.

- Immobilize the foot in a large bulky bandage with a posterior plaster splint incorporated.
- Remove the bandage at 10 days and apply a boot.
- Plan the rehabilitation according to whether associated procedures were performed.
- If no additional procedures were performed, have the patient begin bearing weight and performing range-of-motion exercises as soon as tolerated.
- Instruct the patient to wear the boot for 4 to 6 weeks.
- Have the patient begin a formal program of supervised physical therapy to maximize inversion and eversion of the subtalar joint at 6 weeks postoperatively and continue until motion and strength has been recovered.
- When the transition from the boot to a shoe is made, advise the patient to wear a firm stiff-soled shoe or a running shoe.
- An orthosis with good medial support is recommended for comfort for 6 months following the procedure.

Results

Good to excellent long-term results after resections of TC and CN coalitions and insertion of interpositional graft in 24 patients (32 tarsal coalition resections) were reported by Khoshbin et al.¹¹. According to our experience, excision of an isolated middle facet coalition in children and adolescents provides long-term satisfactory restoration of the subtalar joint function. For an adolescent patient with a painful coalition and a flexible hindfoot that has been refractory to immobilization, resection of the coalition is always preferable to arthrodesis. However, it is important to bear in mind that in almost every patient, at least 1 additional surgery needs to be performed to correct associated deformities and to prevent collapse of the medial arch. Reports in the literature have noted that the size of the coalition ($<50\%$ or $\geq 50\%$ of the joint surface) is an important factor determining whether to choose a coalition resection or an arthrodesis procedure^{8,12-14}. However, we believe that the stiffness of the hindfoot is the key to planning whether to do a resection or an arthrodesis³. We have seen patients with a coalition involving up to 100% of the joint surface with some mobility of the hindfoot retained; hence, they were treated successfully with coalition removal (Figs. 13-A through 13-H). On the other hand, a foot with a moderately sized middle facet coalition can be very stiff. This may be associated with the age

Fig. 13-A

Fig. 13-B

Fig. 13-C

Fig. 13-D

Fig. 13-E

Fig. 13-F

Fig. 13-G

Fig. 13-H

Figs. 13-A through 13-H A 12-year-old patient with bilateral middle facet coalition. Symptoms were more severe in the right foot. **Fig. 13-A** Photograph of both feet showing the bilateral hindfoot valgus deformity. There is, in addition, a protrusion on the medial side of each foot below the medial malleolus, which is the enlarged middle facet and is a common clinical finding associated with the coalition.

Fig. 13-B Preoperative anteroposterior radiograph demonstrating marked abduction of the transverse tarsal joint and uncovering of the talonavicular joint.

Fig. 13-C Lateral alignment radiograph demonstrating the flatfoot and the severe hindfoot valgus.

Fig. 13-D Hindfoot alignment radiographs demonstrating the flatfoot and the severe hindfoot valgus.

Figs. 13-E and 13-F Preoperative coronal (**Fig. 13-E**) and lateral (**Fig. 13-F**) CT scans of the hindfoot showing that the coalition had involved almost the whole middle facet.

Figs. 13-G and 13-H Anteroposterior (**Fig. 13-G**) and lateral (**Fig. 13-H**) radiographs made after the coalition resection procedure was performed in conjunction with a lateral column lengthening calcaneal osteotomy, a medial displacement calcaneal osteotomy, a Cotton osteotomy, and a gastrocnemius recession.

of the patient, an additional CN coalition, a lower cartilage content of the coalition, or inflammatory arthrofibrosis in the region of the middle facet, which could not be revealed on imaging studies^{14,15}. It has been our experience that in severe hindfoot rigidity, excision of the middle facet coalition is more likely to fail (Figs. 14-A through 14-F). As a generalization, the older the patient, the more likely that the hindfoot is stiff and that some other adaptive changes in addition to arthritis have taken place to the morphology of the hindfoot joints, leading to failure of the excision.

Fig. 14-A

Fig. 14-B

Fig. 14-C

Fig. 14-D

Fig. 14-E

Fig. 14-F

Figs. 14-A through 14-F A 13-year-old patient with a middle facet coalition in the right foot associated with marked rigidity of the hindfoot. **Figs. 14-A and 14-B** Preoperative anteroposterior radiograph (**Fig. 14-A**), demonstrating slight dysplastic changes of the TN joint, and lateral radiograph (**Fig. 14-B**).

Figs. 14-C and 14-D Preoperative coronal (**Fig. 14-C**) and lateral (**Fig. 14-D**) CT scans demonstrating that the coalition was approximately 50% of the middle facet.

Figs. 14-E and 14-F Anteroposterior (**Fig. 14-E**) and lateral (**Fig. 14-F**) radiographs made after the coalition was excised. The foot remained very stiff after the coalition resection. A subtalar joint arthrodesis with slight internal rotation of the hindfoot was therefore performed in conjunction with a Cotton osteotomy.

Pitfalls & Challenges

- The most common error with removal of a middle facet tarsal coalition is to leave the foot flat. The flatfoot deformity invariably worsens and is frequently the cause of failure of treatment. Preoperative clinical and radiographic examination not only provides information on the coalition but also shows the alignment, in particular, if there is an associated flatfoot deformity, which helps with the whole surgical plan. If there is obvious flatfoot deformity preoperatively, then additional reconstruction procedure(s) should be considered. However, more information will be needed from physical examination during the surgery after removing the coalition. It is necessary to manually assess both the mobility and the alignment of the hindfoot to see if there is a need to reconstruct the hindfoot. It should be noted, however, that unlike resection of a CN coalition, resection of the middle facet is invariably associated with a worsening of the flatfoot. Therefore, while preoperative images may be predictive of the need to perform additional surgery, we wait until the resection is complete to make the decision as to the extent of the additional flatfoot corrective surgery.
- The alignment of the foot must be restored with one of the procedures outlined above. In our experience, it is rare that the middle facet coalition is removed without at least 1 additional procedure performed to correct deformity.

- In using the method of dilation, which we have previously described⁶, to assist with opening the coalition medially, there may be a risk of causing a fracture. Although we have not encountered such a fracture, it is preferable to remove part of the coalition first before inserting the dilator through the sinus tarsi.
- During the surgery, move the subtalar joint frequently to help identify the boundaries of the coalition.
- Complete resection of the coalition is very important for the success of the surgery. Incomplete resection could lead to poor results^{8,11,16}. Although we are not aware of any investigators using intraoperative CT scanning, this technology can be used to localize and confirm the location and size and shape of the resection. However, intraoperative CT scanning is not widely available, and while the usefulness of this technique cannot be argued, we believe that visual inspection of the medial part of the foot and the mobility of the hindfoot following resection of the coalition are more than sufficient to confirm adequate resection.

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