Symptomatic Bipartite Medial Cuneiform Treated with Fluoroscopic and Ultrasound-Guided Injections

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Introduction

The bipartite medial cuneiform (BMC) is a rare congenital variant that was first described by Morel in the 18th century [2, 6]. Amongst the many causes of midfoot pain, BMC is primarily an imaging diagnosis that often depends on plain radiographs as the initial diagnostic test. Recognizing a BMC on radiographs can be difficult as the osseous segments are typically well corticated and blend with the remainder of the tarsal bones. Additionally, although there are many fracture patterns at the tarsometatarsal (TMT) joint level including Lisfranc injuries, the cleft between the osseous segments lies in the horizontal plane in contrast to the typical vertical orientation of isolated fractures through the medial cuneiform [9]. The cleft is formed by a pseudoarticulation between the osseous segments. Symptomatic patients typically present with chronic midfoot pain that is exacerbated with ambulation or acute injury typically due to the inherent instability of the pseudoarticulation resulting in stress response and/or

degeneration. When a BMC is symptomatic, treatment has ranged from nonoperative to surgical interventions including fusion and excision, as well as a previously described computed tomography (CT)-guided corticosteroid injection [3]. We believe our case is unique in that the patient underwent imaging using plain radiographs, CT, and magnetic resonance imaging (MRI) as well as successful image-guided injections using fluoroscopy and ultrasound on a bipartite medial cuneiform with a fibrous pseudoarticulation. The procedures and outcomes of minimally invasive fluoroscopic and ultrasound-guided steroid and anesthetic injections have not been previously described.

Case Report

A 43-year-old male initially presented with several years of chronic right midfoot pain that was exacerbated with ambulation and without recent history of trauma. The physical examination revealed normal alignment of the foot with focal midfoot pain on ambulation and a stable first TMT joint. The initial diagnostic workup began with radiographs of the right foot that were followed by CT and MRI scans.

Foot radiographs revealed two corticated osseous segments replacing the normal medial cuneiform that are visible on all projections, but with greatest conspicuity on the AP and lateral projections (Fig. 1a–e). Subsequent CT scan with image reconstructions in the sagittal and coronal planes shows a BMC with a thin well-corticated non-ossified pseudoarticulation (Fig. 2a–c). Sagittal and coronal MRI proton density (PD) sequences reveal the bipartite configuration with a mildly degenerated fibrocartilaginous pseudoarticulation without appreciable bone marrow edema pattern (Fig. 3a–c). The

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Fig. 1. Standard weight-bearing series of foot radiographs in the **a** AP projection without and **b** with outlines of the segments, **c** lateral projection without and **d** with outlines of the segments as well as *arrows* indicating the lucent cleft, and **e** oblique projection of the foot showing how difficult it can be to discern the segments as the bipartition may be easily overlooked or interpreted as a confluence of shadows.

imaging findings at each modality are confirmatory for the diagnosis of a BMC with each study adding slightly different and more detailed depiction of the regional anatomy.

Fluoroscopically Guided Injection

Once the diagnosis was established, the patient underwent a fluoroscopically guided steroid injection of the pseudoarticulation. The foot was positioned with the medial aspect facing upwards, and under intermittent fluoroscopy, the pseudoarticulation was identified. Once localized, the pseudoarticulation was injected using 40mg of triamcinolone and 0.5mL of 0.25% bupivacaine with relief of pain symptoms immediately following the procedure (Fig. 4a–d). Following the initial injection, the patient's symptoms abated for approximately 18 months until he presented with midfoot pain immediately following a soccer injury.

Following the soccer injury, an ultrasound-guided injection was performed—ultrasound rather than fluoroscopic guidance was the technique of choice as determined by the radiologist performing the interventional procedure. The foot was positioned with the dorsal aspect facing upwards. Using a small footprint, high-frequency linear “hockey stick” transducer, the pseudoarticulation of the BMC was found by first anatomically identifying the first metatarsal while gliding the transducer posteriorly through the first TMT directly into the expected location of the medial cuneiform. Once the pseudoarticulation was identified, the transducer was oriented to the short axis of the joint. Using a 25-

gauge needle under sonographic guidance, the cleft was accessed, and 40mg of triamcinolone and 0.5mL of 0.25% bupivacaine was deposited into the pseudoarticulation (Fig. 5a–b) with immediate symptomatic relief. The patient has since been asymptomatic for at least 10 months at the time of this case study.

Discussion

Although the BMC is a rare anatomic variant, its correct identification is essential in diagnosis, particularly in the symptomatic population. The normal medial cuneiform is thought to develop from a single ossification center. However, when there are two ossification centers that fail to fuse, it results in the BMC [8, 10]. With respect to the cuneiforms, ossification begins laterally during the first year of life, followed by the medial cuneiform in the second year, and finally the middle cuneiform in the third year of life [7]. As a BMC is very difficult to diagnosis clinically, it is primarily an imaging diagnosis that depends wholly on recognition of the variant anatomy. However, detection on plain radiographs can be difficult as the osseous segments overlap [11], but careful evaluation of the radiographs will demonstrate two distinct often well-corticated segments in the normal position of the medial cuneiform. Cross-sectional imaging with CT or MRI is definitive in diagnosis and provides further regional anatomic detail and can be revealing of the “E sign” which is formed by the cleft between each of the segments in the horizontal plane [8].

Fig. 2. CT images of the foot in the **a** coronal and **b** sagittal planes revealing bipartition of the medial cuneiform with smooth well-corticated margins and a focal non-ossified coalition present laterally in the pseudoarticulation as seen in the coronal plane, and **c** sagittal CT reconstructed image through the level of the fibrous coalition which was taken more laterally at the BMC.

When observed incidentally, the finding of a BMC often has no clinical significance, but should be differentiated from the numerous fracture dislocation patterns at the TMT joint level, especially the typical vertically oriented isolated fracture of the medial cuneiform that demonstrates irregular and sharp margins in contrast to the horizontally oriented well-corticated margins of the BMC [9]. The combined osseous segmental volume in a BMC is also larger than the volume of the normal

Fig. 3. MRI images of the foot using PD sequences in the **a** sagittal plane without and **b** with outline of the segments demonstrating the “E sign” which is formed by the clefts between the segments and intermediate cuneiform, and **c** coronal MR PD image showing the BMC with the low-signal focal fibrous coalition.

medial cuneiform with the dorsal “os cuneiforme dorsale” being slightly smaller in size than the plantar “os cuneiform naviculare” [4]. The pseudoarticulation between the segments is usually bridged by a cartilaginous synchondrosis, fibrous syndesmosis, or a combination of these two [1, 5, 7]. Due to the fibrocartilaginous union, instability may occur

Fig. 4. **a** Lateral fluoroscopic image of the foot prior to needle placement shows the lucent cleft between the two segments (*arrows*) of the BMC, **b** needle placement into the cleft between the segments, **c** injection of Omnipaque-300 contrast following the cleft of the BMC and tracking into the naviculocuneiform joint (*arrow*), and **d**) injection of the corticosteroid confirms the washout of contrast in the cleft which confirms that the medication was deposited into the cleft.

precipitating a stress reaction and/or degeneration resulting in pain symptoms for the patient. The lack of overt bone marrow edema pattern in our patient would suggest that the pain generator is likely due to early arthrosis and less likely due to stress reaction—at least at the initial visit, as this is when the MRI was performed. MR imaging was not performed at the time of the second injection, and therefore, it is unknown if the patient developed a stress response at the pseudoarticulation as a result of the soccer injury.

Various symptomatic treatments have been previously described in the literature including surgical resection of the dorsal segment [5], fusion using a transcortical screw [1], or a CT-guided corticosteroid injection [3]. Each of these interventions has been reported as successful treatments in symptomatic patients. Resection is usually performed when the dorsal segment comprises 30% or less of the combined segmental volume [5]. In our case, resection of the dorsal segment could not be performed as the

osseous segments were of near equal size, and resection in this case could compromise the first TMT joint. Perhaps fusion across the pseudoarticulation would be a future consideration provided that there was persistent pain and/or progression of arthrosis.

Our case demonstrates that both fluoroscopy and ultrasound can be used to successfully deliver the medication. When performed using fluoroscopic guidance, placing the foot with the medial side facing upward towards the ceiling serves as the preferred access to the pseudoarticulation. A 25-gauge needle is best due to the superficial location and narrow cleft between the segments. The needle should be placed in the pseudoarticulation with a small injection of contrast to confirm the intraarticular position, followed by injection of the corticosteroid of choice (Fig. 4a–d). Ultrasound benefits from the lack of ionizing radiation and portability, but is user dependent. A small footprint “hockey stick” or a high-frequency linear “17-5” transducer (Fig. 6)

Fig. 5. **a** Short-axis image through the BMC pseudoartication shows the dorsal segment and the plantar segment prior to needle placement or injection of medication with mild synovitis extending from the pseudoartication as indicated by *arrowheads*. **b** Following needle placement into the pseudoartication (*arrow*) and injection of anesthetic and corticosteroid, there is filling of the pseudoartication with anechoic fluid and distention of the overlying capsule (*arrowheads*).

may be used to visualize the pseudoartication in the perpendicular plane and allows for short-axis needle placement into the joint in real time.

Fig. 6. Photograph depicting the short-axis orientation of a small footprint “hockey stick” ultrasound probe at the level of the pseudoartication.

Potential shortcomings of these procedures would include incorrect needle placement or a nontherapeutic result. However, no single technique has yet been established as the definitive standard of care.

In conclusion, we provide further evidence in the form of a single case report that minimally invasive, image-guided corticosteroid injections of the pseudoartication of a symptomatic BMC can be a useful alternative or adjunct to future surgery.

Disclosures

Conflict of Interest: Anukul Panu, MD, FRCPC, Gabrielle Konin, MD, Gregory Saboeiro, MD, and Robert Schneider, MD, have declared that they have no conflict of interest.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 [5].

Informed Consent: Informed consent was waived from all patients for being included in the study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

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