

Avascular necrosis of the first metatarsal head in adolescence: A case report

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Abstract

Rarely, the first metatarsal head will develop avascular necrosis, and there are numerous etiological factors that have been linked to this condition. We describe a 16-year-old female's case of idiopathic avascular necrosis of the first metatarsal head. We performed a joint-sparing procedure using subchondral drilling

and a dorsal extra-articular closing-wedge osteotomy at the metatarsal neck after conservative treatment failed to provide pain relief. Following an 8-month checkup, the girl's pain had subsided and she had resumed her sport activities.

Introduction

Avascular Necrosis (AVN) of the First Metatarsal (MTT) head is an uncommon condition and it occurs most often as a complication after capital osteotomy in correction of hallux valgus deformity. Idiopathic osteonecrosis of the first MTT head in adolescent are rare and treatment is challenging.^{1,2} Many conditions have been proposed as predisposing factors of AVN, including trauma, hemoglobinopathies such as sickle-cell disease, steroid therapy, Cushing's disease, alcoholism, Gaucher's disease, Caisson's disease, and irradiation.^{3,4} However, etiology remains elusive. We described a case of an idiopathic AVN of the 1st MTT in adolescent treated by dorsal closing-wedge osteotomy, which to the authors' knowledge has not been described before.

Case Report

A 16-year-old volleyball player female complained of pain and swelling in her left first Metatarsophalangeal Joint (MTPJ) for 5 months. The joint was painful with movement and the active Range Of Motion (ROM) in the MTPJ was restricted to 20° in plantarflexion and 10° in dorsiflexion. No history of trauma, alcoholism, diabetes mellitus, or use of corticosteroids was referred. An Anteroposterior (AP) radiograph showed that the first MTT head was flattened, while an oblique radiograph revealed subchondral radiolucency with surrounding sclerosis, which were characteristic of ANV (Figure 1). According to the classification system defined by Smillie,⁵ radiographic staging was assessed as stage 2, while Magnetic Resonance Imaging (MRI) showed an abnormal low signal intensity at the distal head on the T1-weighted image with a combination of low and high signal intensity on T2-weighted images (Figure 2). A conservative treatment with non-weightbearing and analgesics was initiated. However, the patient was still reporting pain at the first MTPJ after 7 months, and surgical treatment was selected based on the failure of conservative methods. Supplementary Computed Tomography (CT) scan was performed for preoperative planning and revealed no fracture line and no loose intra-articular bodies. We performed a joint-sparing procedure through a dorsal approach. We found that the head was compromised by half its diameter (Figure 3). A joint debride-

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Figure 1. Initial foot radiographs showing central flattening of the first MTT head (A) and a subchondral radiolucency with surrounding sclerosis (B).

ment of prominent osteophytes and delaminated areas of cartilage was carried out, with subchondral drilling and a dorsal extra-articular closing-wedge osteotomy at the metatarsal neck secured with a Kirschner wire to reorienting the plantar cartilage into the central joint and preserving the plantar hinge. The defect left after reduction of the metatarsal head was filled with cancellous autograft bone. Postoperatively, the patient was able to walk with full weightbearing, wearing a surgical shoe, and we removed the K wire after 30 days. The postoperative course was uneventful, and fusion was obtained after 8 months (Figure 4). The patient was satisfied with the treatment at the latest follow-up of 8 months, and the pain in the first MTPJ was completely relieved. The ROM had improved in dorsiflexion of 40°, while postoperative plantarflexion remained 20°. However, the patient was able to resume full volleyball activity.

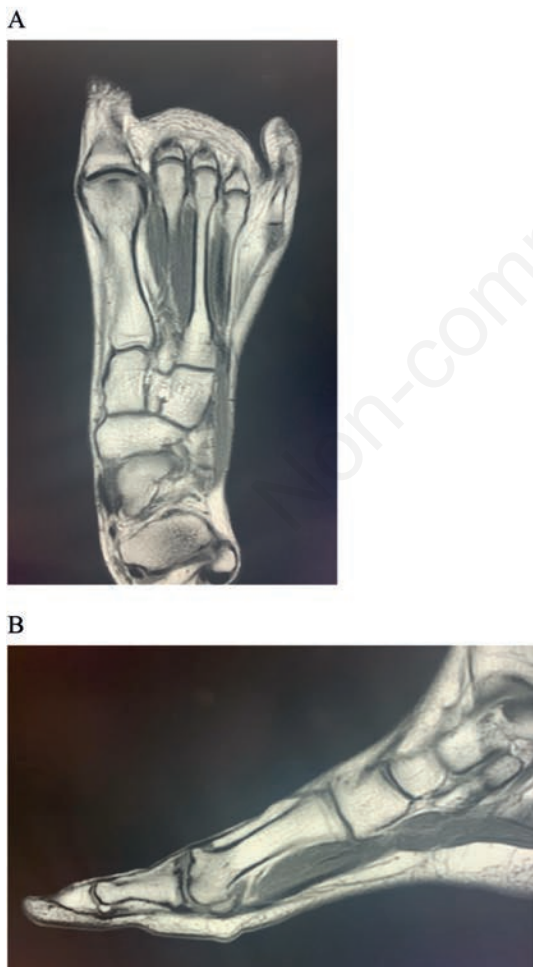


Figure 2. Abnormal low signal intensity at the distal head on the T1-weighted image at MRI.



Figure 3. Intraoperative finding of central MTT head collapse.



Figure 4. Postoperative foot radiographs at 8 post-operative months showing bone union at the site of dorsal osteotomy (B).

Discussion

Juvenile idiopathic osteonecrosis at the MTT head, also known as Freiberg's disease, has a multifactorial etiology, including trauma with circulatory impairment, steroid use, blood dyscrasias, pregnancy, Gaucher's disease, Cushing's disease, alcoholism, dysbaric disorders, irradiation, and idiopathic etiology.^{3,4,6} The incidence is low and the most common affected area is the second MTT head (68%), followed by the third MTT and the fourth MTT (27% and 3%, respectively).^{4,5} Whereas secondary osteonecrosis of the first MTT head is a well described complication following distal osteotomy and lateral release for hallux valgus correction, idiopathic AVN of the first MTT head is rarely described in adolescents. Diagnosis is based on pain and stiffness over the MTPJ and the characteristic radiological findings, including head flattening, sclerotic rims at the subchondral bone with crescent-shaped subchondral osteolysis, joint space narrowing, subchondral bony collapse, fragmentation of the head, and eventually progressive degeneration.⁷ Meier and Kenzora proposed a radiographic criterion to stage AVN of first MTT head: precollapse, collapse, and arthritis.⁸ However, stage 1 or precollapse do not proceed always to the next two stages. MRI and nuclear medicine studies (such as three-phase bone scan) show higher sensibility for AVN, especially in the early stages. Nowadays, MRI has been proposed as the gold-standard examination for early diagnosis of AVN.⁴ MRI changes include T1-decreasead signal intensity that is associated with decreased cancellous bone content and heterogeneous T2-increased signal intensity due to hyperemia and edema.^{4,6} A pathognomonic finding on MRI is the double-line sign. Regarding clinical findings associated with AVN, painful joint-space narrowing could occur even in mild cases, while the average loss of motion ranges from 17° to 28°.⁸ The affected joint generally shows effusion and surrounding swelling, and it is tender to palpation.

Several staging and classification systems are been proposed to describe changes in the MTPJ and offer treatment choice for AVN. The Smillie's classification is the most used staging system for Freiberg's disease, and it divides in 5 stage the structural changes of the MTT head observed radiographically.⁵ Stage I represents a fissure fracture of the cartilage with sclerosis between the cancellous surfaces; stage II represents MTT head flattening caused by absorption of cancellous bone proximally and collapse of the central cartilage, while the margins and plantar cartilage remain intact; stage III includes structural compromise of the MTT head with further central MTT head resorption and sinking of articular cartilage, with formation of medial and lateral bony projections; stage IV accounts for involving of the plantar hinge, the medial and lateral projections break off and form loose osseous bodies, and restoration of the anatomy is no longer possible; stage V represents the final stage with arthrosis, flattening and deformity of the MTT head. Based on these criteria, our patient's condition was part of stage II. Nonoperative management is reported to be first line of treatment regardless of the severity of disease at the time of presentation.^{4,7} Conservative treatment include weight bearing restriction, use of oral anti-inflammatory medications, avoidance of high-impact activity, and modification of footwear. In case of more intense pain, a period of immobilization and/or non-weight bearing for up 6 weeks may be advantageous.⁷ Most patients with Smillie stage I to III disease respond well to conservative treatment with long-term success. Operative management are typically performed for advanced stages of disease at initial presentation (Smillie IV-V) or after failure of conservative methods.^{4,7} Smillie reported that restoration of the normal articular surface was possible only for stages 1 to 3.⁵ Nowadays, there is no consensus about the optimal treatment option, although joint-sparing procedures are typically reserved for Smillie stages I to III when there is at least some preserved plantar chondral surface, whereas joint-reconstructing procedures are reserved for severe stages

in presence of advanced degenerative changes of the MTPJ. Joint-sparing procedures include debridement, core decompression, grafting, and metatarsal osteotomy. Osteotomies can be divided into dorsal closing-wedge osteotomies to reorient the preserved plantar cartilage and improve the articulation of the MTPJ and shortening osteotomies that decompress the MTT head. Complications of these procedures are transfer metatarsalgia and decreased ROM with dorsiflexion contractures.^{4,7} Joint-reconstructing procedures include MTT head resection, interpositional tissue arthroplasty such as dorsal MTPJ capsule or autograft tendons, and synthetic implants. Siu *et al.* reported a case of AVN of the first MTT head in a healthy 24-years-old female treated conservatively for 18 months without complications.³ Fu and Gomez described a bilateral AVN of the first MTT head in a 12-year-old female managed operatively with subchondral decompression.¹ Gurevich *et al.* reported successful results with conservative treatment for first MTT idiopathic AVN in a 6-year-old male after 11 months.² Kwon *et al.* presented a case of idiopathic AVN in a 13-year-old active male, who is managed with surgical debridement and decompression after failure of 9-months of conservative treatment, with full ROM and pain disappearance at the final follow-up of 6 months.⁶ The authors concluded that surgical treatment at the early stage could be helpful in adolescent patients. In our case, we decide to perform a joint debridement, a subchondral drilling, and a dorsal extra-articular closing-wedge osteotomy after failure of 7-months of conservative treatment, with satisfactory outcomes at the final follow up of 8 months. The only complication recorded was a restricted plantarflexion of the first MTPJ. A postoperative decreased in plantarflexion was already described by several authors in Freiberg's disease, with a mean value reported of 5°,⁴ and it might be related to the dorsal closing-wedge osteotomy.

Conclusions

AVN of the first MTT head in adolescent may occur with no predisposing risk factors. Treatment is initially conservative, but surgery may be required after failure of improving symptoms and in adolescent patients. No full range of motion in severe cases is often reported in literature. Dorsal closing-wedge osteotomy is a feasible option with good short-term outcome in our patient.

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