Current Treatment Options for AVN (Freiberg's Infraction) of the Second Metatarsophalangeal Joint

Nehal Modha, DPM, AACFAS; Fahad Rahman, DPM; Warren Windram MS, DPM, FACFAS, D.ABFAS

HCA Florida Westside Hospital

Introduction

Avascular necrosis (AVN) of the second metatarsal is a debilitating condition characterized by the loss of blood supply to the bone, leading to cellular death and potential collapse of the affected metatarsal head. This study presents a comprehensive review of contemporary literature to elucidate the spectrum of treatment options available for managing AVN of the second metatarsal.

Methods

A comprehensive literature review was completed by the authors using Google Scholar, Pubmed, Cochrane Review, and Science Direct using a combination of phrases related to the title of this article that focused on surgical and non-surgical approaches, evaluating their efficacy, long-term outcomes, and complications.

Histopathology

There is a general consensus that avascular necrosis, particularly of the 2nd metatarsal head, is of a multifactorial nature. These causes include microtrauma, abnormal biomechanics, and vascular insufficiency. Trauma and suboptimal biomechanics can be concomitant as the abnormal biomechanics of the foot can cause abnormal weight bearing and overload to the 2nd metatarsophalangeal joint with increased trabecular stress. Patients with anatomic variant vasculature lacking proper arterial flow to the 2nd metatarsal head can also be predisposed to avascular necrosis. A useful classification system described by Smillie in 1967 classifies the disease progression in 5 stages with increasing levels of arthrosis, joint destruction, and bone absorption.

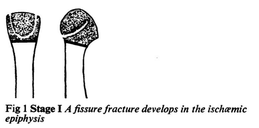

Fig 1 Stage I *A fissure fracture develops in the ischæmic epiphysis*

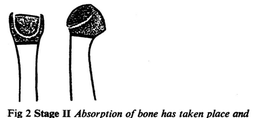

Fig 2 Stage II *Absorption of bone has taken place and the central portion begins to sink into the head, altering the contour of the articular surface*

Fig 3 Stage III *Further absorption has occurred and the central portion sinks into the head leaving projections on either side. The plantar articular cartilage remains intact*

Fig 4 Stage IV *The plantar isthmus of articular cartilage has given way and the loose body separated. Fractures of the lateral and dorsal projections have occurred. Restoration of the anatomy is no longer possible. The epiphysis is probably closed at this stage*

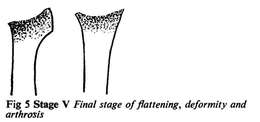

Fig 5 Stage V *Final stage of flattening, deformity and arthrosis*

Surgical vs Nonsurgical Treatment

Nonsurgical treatment is most effective in the early stages of this disease. The goals are symptom relief, limit deformity, and prevent progression to end stage arthritis. Conservative management includes protected weightbearing (cast, CAM boot, stiff soled shoe), activity modification, non-steroidal anti-inflammatories. Orthotic modifications including a metatarsal bar to offload the metatarsal head may be used in the early stages as well with good symptomatic relief. Bone stimulators can be used as an adjunct depending on availability and cost.

If conservative measures fail to restore function and relieve pain or if there is advanced, late-stage disease present, then there is an array of surgical methods that can be explored for these patients. The procedures can be separated into joint sparing vs joint sacrificing. There is no consensus for primary procedure selection, but procedures can be separated into different categories depending on joint deformity, morphology, age, functional demands, and concomitant pathology. Joint sparing can be used in the early stages of the disease while joint destruction is reserved for late stage or failure of joint sparing procedures.

Joint Sparing

Options for preserving the joint include cartilage replacement or transfer, osteotomy to decompress the joint, debridement, marrow stimulation, core decompression. These can be performed as lone procedures or adjunctively depending on surgeon evaluation of articular surface and advanced imaging.

Core decompression is used to relieve intraosseous pressure as well as to promote revascularization of the necrotic bone. Dolce et al described a case report of a 34-year-old woman who underwent core decompression of a early AVN of the 2nd metatarsal head. A 0.045-inch K-wire was utilized to drill holes into the metatarsal head as well as the proximal phalangeal base. Radiographically, cessation of the AVN was noted as well as resolution of all symptoms the patient was experiencing before. At 5-year follow-up, the patient continued to be pain-free. In other bones such as the femur, favorable results were yielded with earlier decompression, therefore providing the argument for use of this method for early AVN of the second metatarsophalangeal joint that has failed conservative measures.

Debridement is done for impingement issues or intra-articular loose bodies. This can be done open or through an arthroscopic approach. This technique has limited usage in second metatarsophalangeal joint pain, mainly reserved for the aforementioned reasons. With extensive joint adaptation, articular disruption, and/or collapse of the metatarsal head, joint debridement has little use in correction for that pathology.

Intra and extra-articular osteotomies can be done of the metatarsal head to shorten, rotate, or dorsiflex the metatarsal head to decompress the joint and lessen the load on the metatarsal head. Favorable long-term outcomes are seen with osteotomies if the articular surface is preserved.

Joint Destructive

Options for end stage disease should be explored when joint sparing procedures fail to relieve pain or if there is end stage disease not amenable to joint sparing techniques. These options include metatarsal head resection, autogenous or allograft joint interpositional arthroplasty, implant arthroplasty, or metatarsophalangeal joint fusion.

Metatarsal head resection may improve pain but can lead to unfavorable long-term outcomes due to biomechanical instability caused by shortening of the 2nd metatarsal. Additionally, resection of the metatarsal head obviates any possible additional reconstructive procedures.

Interpositional arthroplasty is done with the use of autogenous or allograft material that act as a spacer in the joint to prevent pain, allow mobility, and create space in the arthritic joint. Examples of allograft tissues used for interpositioning in the literature include but are not limited to joint capsule, extensor digitorum longus, extensor digitorum brevis, and peroneus longus tendon.

Implant arthroplasty is more of a historically used procedure which had poor long-term outcomes and mixed short-term results. Implants can be made of titanium, ceramic, or silicone material.

Metatarsophalangeal joint fusion is seldom used but allows reliable pain relief. This procedure is reserved for patients with severe degenerative joint disease who fail joint sparing procedures, have significant deformity, and have low ambulatory demands. Possible complications include transfer metatarsalgia, gait dysfunction, and stress fractures. This procedure is a means to salvage the second ray and to avoid resection of the metatarsal head

Complications

- Recurrence of deformity, progression to degenerative joint disease, implant subsidence, transfer metatarsalgia, stress fracture, non-union.

Conclusion

AVN of the 2nd metatarsal is an uncommon but debilitating disease that brings forth frequent discussion regarding treatment options. Conservative methods should always be exhausted before pursuing surgical treatment to attempt to achieve pain relief and restore functional mobility. Once conservative treatment is no longer a viable option, the proper surgical procedure should be selected with careful consideration to patient age, joint disease progression, clinical evaluation, imaging modalities, comorbidities, foot biomechanics, and patient functional goals. Careful consideration should be taken into selecting a procedure which allows the anatomy to be amenable to further reconstructive procedures if necessary.

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