COMMENTARY

Arthroereisis for Flatfoot: Current Status of Our Understanding

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Abstract

Flatfoot deformity can be seen in children as well as adults. Symptomatic flatfoot deformity at any age should be considered for surgical correction. Among the available options, arthroereisis has been gaining popularity in recent times, both as an isolated and an adjunctive procedure. In this commentary, we aim to discuss the history, evolution, biomechanics, controversies, advantages, and disadvantages of this procedure.

Keywords: Arthroereisis, Flatfoot, Flexible flatfoot, Pediatric flatfoot.

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Flatfoot can be broadly divided into childhood or adolescent and adult-acquired flatfoot. Both are different entities and need different strategies.[1,2] The clear definition for the flatfoot is still unclear and confusing and so is the reason for flatfoot turning symptomatic. A similar degree of flatfoot can be asymptomatic in many and symptomatic in some.[3] However, surgical treatment should be considered and offered only for the symptomatic flatfoot.

Manipulation of the subtalar joint with the placement of implant or bone in the sinus tarsi to prevent/block hyper-pronation is referred to as arthroereisis; after extensive use in the developed countries, it is gaining popularity of late in the Indian subcontinent. The important issue is that this procedure is associated with extremes of thought, with some authors speaking highly of its efficacy, while others downplay it as an ineffective procedure. It is important to note that this is primarily indicated for flexible painful childhood or adolescent flatfoot, often in isolation or sometimes combined with other procedures.[4] Some studies document its use in adult-acquired flatfoot, in combination with other procedures,[5,6] but this is not universally accepted.

Historically, the earliest documented procedure exploring the concept of arthroereisis was reported by Chambers in 1946, where a wedge-shaped bone block was placed in the anterior part of the posterior subtalar facet; the principle involved was the prevention of anterior slide of the talus on the calcaneus and achieving abduction block at the subtalar joint level.[7] The Grice procedure, which is an extra-articular arthrodesis of subtalar joint achieved by using a bone block in the prepared sinus tarsi, has a similar concept and was originally used in paralytic foot and relies upon limiting the pronation-abduction at the subtalar joint.[8] Subsequently, Haraldsson in 1965 used a "bone block" in the sinus tarsi for treatment of pes planus, and attributed this to the prevention of hyper-pronation.[9] Baker and Hill by elevation of posterior facet with lateral open wedge osteotomy relied on the similar concept of blocking pronation.[10] It was Lelièvre[11] in 1970 who coined the term "Arthroereisis" and used a bone block similar to Haraldson.

Modern arthroereisis procedures involve the technique of placing implants in place of the bone block into the sinus tarsi and was first demonstrated by Subotnick[12] in 1974 wherein a conical medical grade silastic implant was used; 2 years later, the subtalar arthroereisis peg (STA-peg) consisting of ultra-high molecular weight polyethylene plug was used by Smith and the peg was inserted into the floor of sinus tarsi.[13] In the subsequent 10 years, a variety of implants surfaced in the market, with varying shapes, and with different materials. The concept of using a "screw in" arthroereisis implant with external threads was first described by Valenti who used a polyethylene threaded screw and was popularized as the Valenti procedure as it allowed easier implantation.[14] Maxwell-Brancheau arthroereisis (MBA) implant consisted of a threaded and cannulated cylinder similar to Valenti's design.[15]

The most popular classification system for arthroereisis implants is the one proposed by Vogler in 1987[16] and has three types based on the mechanism of action; self-locking wedge, axis altering implant, and impact blocking devices. Maxwell-Brancheau arthroereisis is a "*self-locking wedge*" type. This implies the introduction of a free-floating device into the sinus tarsi along its axis, which subsequently acts as a wedge and supports the talar neck, thereby inhibiting excessive plantarflexion and adduction of the talus with respect to the calcaneum.[15] The STA-peg by Smith and modified STA-peg by Lundeen utilized the mechanism of altering the axis of the subtalar joint, essentially redirecting the anterior part of the posterior facet by providing a platform and subsequently, preventing a collapse into valgus. Hence, these were called

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"*axis altering devices*,"[13] as they aimed at restoration of the medial longitudinal arch, which is lost in flatfoot. These implants were fixed into the calcaneum on the floor of the sinus tarsi. At the same time, another set of implants were introduced which were fixed in the same way but utilized a different mechanism. These implants were termed "*Impact Blocking Devices*." Sgarlato's silastic "*mushroom*" cap and stem system and Pisani's "*Capped Screw*" implant consisting of a silastic cap and a stainless steel screw belonged to this category of implants. Instead of modifying the axis of rotation of the talus over the calcaneum, these implants functioned by completely blocking the motion.[17] Hence, these implants blocked the hindfoot valgus during foot pronation, but there is no change in the subtalar axis.

The subtalar joint, consisting of the posterior, middle, and anterior articulation between talus and calcaneus, has a complex motion wherein all the movements are interlinked and hence all the three implant designs have a combination of effects and not truly the type as proposed by Vogler.[16] The overall 3-D bony anatomy and the ligaments control the complex supination-pronation movement.[18] With pronation movement, there is associated talar adduction, plantar flexion, and anterior sliding of talus onto calcaneus and when the lateral process of talus abuts the sinus tarsi, maximum pronation is achieved. The reverse occurs during the supination movement.[19] The whole concept behind arthroereisis is to prevent hyper-pronation by placing the implant which blocks the lateral talar process and sinus tarsi before going for extreme valgus/hyper-pronation of the hind foot. This results in not only vertically re-orienting the calcaneum under the talus but also correcting the plantar flexion and medial deviation of the head of the talus in flatfoot.[20] This potentially leads to the prevention of midfoot and hindfoot deformities.

Despite the numerous publications, the general acceptability of the procedure is limited, and the debate continues. The quality of evidence is low at present, and most of the studies are of short follow-up duration;[21,22] some have established good clinical results and radiological correction with few complications and need for reoperation.[23–25] In a recent 15-year follow-up study involving 34 pediatric patients by Mazzotti et al.,[26] the results were promising and have shown a physiological footprint and a proper hindfoot alignment in 70% of patients; 30 out of 34 patients (88.2%) were satisfied with the procedure.

Despite recent acceptability, a consensus or definitive guidelines for its use in children or adults has not been achieved. Moreover, in children, the literature suggests an optimum age ranging somewhere between 8 years and 12 years and even up to 14 years.[27,28] Additionally, in patients with skeletal maturity, the proposed long-term positive effects need to be scientifically validated. Caution is advised against the use of arthroereisis as an isolated procedure. The role of such a procedure seems to be limited to an adjunct to soft tissue procedures.[29] The need for the implant to maintain correction after healing of the soft tissue procedure appears questionable and should be further evaluated.

Literature suggests a complication rate of arthroereisis ranging from 30 to 40%.[30,31] Sinus tarsi pain and loss of fixation being the most frequently encountered complications. The mechanism of pain is not well understood; however, it is believed it commonly occurs due to irritation of the surrounding soft tissue and bone supplemented by inappropriate implant size or poor fixation.[31,32] These as well as other complications, including osteonecrosis, subtalar arthrosis, overcorrection, and implant-related complications,[33] frequently warrant an implant removal procedure.[34] Despite the complications, one must not overlook some of the advantages with arthroereisis, such as being a relatively painless procedure with low infection risk and rapid return to daily activities, which has made it more popular in recent times.[31] It involves a relatively simple technique without a steep learning curve and an option of easy implant removal.[31,35] It has also been shown that painless and full range of motion is possible, even after implant removal. Moreover, the procedure is also associated with low infection risk.[35,36]

Despite the advantages, the procedure has not been able to achieve widespread acceptability among foot and ankle surgeons. Meanwhile, the proponents of this procedure continue to publish and propagate it. There seems to also be regional variations in the rate of use of arthroereisis procedure where traditionally the European surgeons are using it more compared to its use by the American surgeons and there exists a "publication bias."[37] Surgeries to address flatfoot require a combination of procedures on a case to case basis addressing the lateral, medial, and hindfoot pathologies. There is no standardized protocol and the utilization of this procedure seems to depend more on the individual experience and training of the operating surgeon, which could have led to the certain preference of a particular group of surgeons to this procedure more as compared to others, a "surgeon bias."[37]

However, as far as the Asian Subcontinent is concerned this is a new procedure and gaining popularity off late[38–40] and therefore it is important to understand the evolution, concept, and mechanism of action and the published results of "arthroereisis."

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