Review Article

An Update Management of Pes Planus and Pes Cavus

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Abstract

This review article provided an update on managing pes planus and pes cavus, two common foot deformities caused by an imbalance of the forces acting on the foot. The article described the stages of adult-acquired flatfoot deformity and its causes, risk factors, and treatment options, including conservative and surgical approaches. The report also provided information on the clinical and radiological assessment of the condition and the use of various modalities such as orthotics and braces, physical therapy, and medication.

Keywords: Biomechanic; flexible; pes cavus; pes planus; rigid

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Introduction

Foot is one of the crucial structures for weight bearing, thus any deformity of the foot will then lead to difficulty in walking and changes in biomechanics. One of the important part of the foot is its arches. The foot arch structures and its dynamicity are important for the functions of the foot. Ker et al. has demonstrated that the elasticity of the foot arch is vital for locomotion, more so during running (1). In a normal foot, the medial longitudinal arch (MLA) should be higher than the lateral longitudinal arch (LLA). The curvature of the medial longitudinal arch varies during weight bearing hence an imbalance of the forces acts on the foot will result in either pes planus or pes cavus deformity (2).

Pes Planus

Pes planus, or flat foot, is a condition of the foot where the curvature of the medial longitudinal ligament is flatter than normal in which the sole comes to either near complete or complete contact while standing on the ground (3) (Fig. 1). If the deformity develops after skeletal maturity, it is known as adult-acquired flatfoot deformity or AAFD; whereas constitutional flatfoot usually occurs congenitally. AAFD is commonly caused by posterior tibial tendon (PTT) insufficiency (4). Other causes of AAFD include fracture or dislocation, tendon laceration, tarsal coalition, arthritis and neuroarthropathy. Typically, pes planus deformity will result in a combination of plantar sag, abducted midfoot and hindfoot valgus (5,6,7).

AAFD usually affects female more than their male counterparts (7). Risk factor of developing AAFD includes obesity, diabetes, hypertension and those involved in high impact sports (8).

Staging

Kenneth A. Johnson and David E. Strom described the first three stages of adult acquired flatfoot deformity in 1989 (9), and it was Myerson who improvised by adding the fourth stage to the former staging in 1997 (10). Staging is made by both clinical and radiological assessment.

Patients of stage I and stage II will usually present with a flexible deformity whereas stage 3 and stage 4 patients often have a fixed or rigid deformity. In Stage I, patient typically presents without arch collapse, but

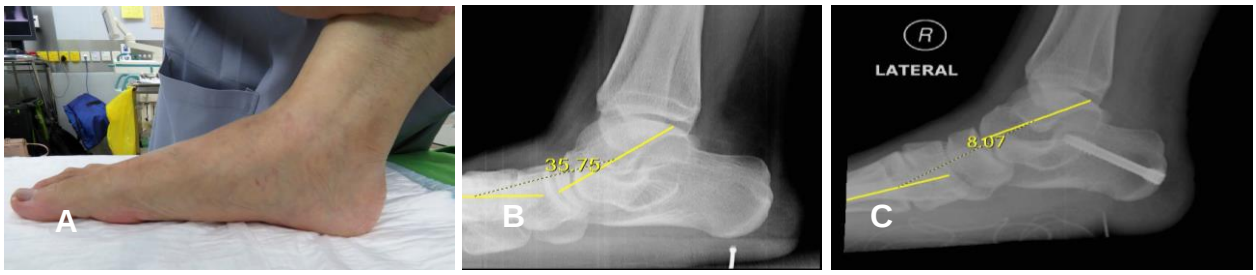

FIGURE 1: (A) Right foot pes planus with collapsed medial arch (B) Lateral radiograph showed talonavicular collapse and decreased first tarsometatarsal angle pre-operatively (C) Lateral radiograph showed improved first tarsometatarsal angle (Meary's angle) post calcaneal osteotomy.

often with low-lying arch that has been there since young. Stage II involves inversion of the talonavicular joint and hindfoot, follows by a standing anteroposterior radiograph of the foot to assess talonavicular uncoverage. Stage III presents with rigid deformity over talonavicular, subtalar and calcaneocuboid joints, which is not correctable beyond neutral. Stage IV is when there is ankle joint valgus deformity. Presence of ankle arthritis will further subdivide stage IV to IVa or IVb, depending on the presence of ankle arthritis.

Management

Pes planus deformity can be treated either conservatively or surgically. Most of the patients affected by AAFD at any stage undergo a conservative treatment first. The modalities should include administration of oral analgesics, non-steroidal anti-inflammatory drugs (NSAIDS), corticosteroid infiltration, shoe modification or usage of orthotics and braces, which include arch and ankle brace, low-articulating foot orthoses (LAFO) and casts. In physical therapy, it should focus on highly repetitive exercise, aggressive plantar flexion motion, proprioception training and strengthening exercise that involves all below-knee muscles; posterior tibial, peroneal, anterior tibial and gastrocsoleus complex muscles. Brace is seldom recommended beyond two months due to it is being cumbersome and causes restriction in motion.

Stage I

Indication for surgery is meant for those patients who do not respond to conservative treatment. The aim of the surgery is to halt the progression of tenosynovitis in order to prevent tendon rupture. Traditionally, surgery will involve debridement of the synovitis, tenosynovectomy, release the sheath of the PTT, and debridement of the PTT including excision of flap tears and repair of longitudinal tears, if any.

Stage II

The surgical treatment for stage II typically involves both soft tissue and bony reconstruction. Numerous surgical options have been described, such as repair of the torn tendon, tendon transfer or tenodesis that involve either flexor halluces longus or flexor digitorum longus can be considered, repair of spring ligament, medial calcaneal osteotomy, lengthening of the lateral column and arthrodesis of the subtalar or the midfoot.

Direct repair

Repair is usually indicated in acute rupture. Z-lengthening can be considered at the proximal end of the tendon. Anterior tibial tendon can be used to reinforce direct repair of posterior tibialis tendon.

Tendon transfer

Flexor hallucis longus and flexor digitorum longus can be considered for tendon transfer. Both are alternatives for reconstruction of posterior tibialis tendon, with or without repair or reconstruction of spring ligament.

Calcaneal osteotomy

Medial displacement calcaneal osteotomy shifts Achilles tendon medially, thus decreases the heel valgus and reduces the strain on spring and deltoid ligament. Together with the soft tissue procedure release, patients have reported to have satisfactory outcomes (18).

Lateral column lengthening

Increasing the lateral column by anterior calcaneal lengthening osteotomy improves not only abducted forefoot and hindfoot valgus; it also reserves the medial longitudinal arch.

Arthrodesis

Joint fusion is indicated when soft tissue procedures are less likely to succeed, such in cases of obese patients. Kitaoka et al [19] has demonstrated that good-to-excellent result can be achieved with subtalar fusion following tendon transfer with flexor digitorum longus.

Stage III

In stage III AAFD, arthrodesis is required to address the fixed deformity in order to achieve pain relieve and restore proper alignment of the foot. Triple arthrodesis remains the goal standard (11), but isolated arthrodesis or double arthrodesis can be considered. Isolated arthrodesis of the subtalar joint and talonavicular joint is indicated with arthrosis of respected joint. Double arthrodesis, which involves fusion of the calcaneocuboid and talo-navicular joint is preferred in younger patients.

Stage IV

The surgeries in stage IV AAFD are salvage procedures. Reconstruction of deltoid ligament is difficult and total ankle arthroplasty does not yield good result, as it does not achieve the ligamentous balance. Treatment remains arthrodesis with shoe modification and bracing are required after the surgery.

Pes Cavus

Pes cavus is a condition of the foot characterised by high arch foot, which strictly speaking, does not flatten with weight bearing (Fig. 2). Causes of pes cavus includes malunion of calcaneal or talar fractures, burns, sequealae from compartment syndrome and residual clubfoot. Note that it is also important to screen for any neuromuscular diseases such as cerebral palsy, muscular dystrophy, Charcot-Marie-Tooth disease, poliomyelitis, syringomyelia, spina bifida and spinal cord tumours (13). Mansor et al. (2015) proposed that when a non-uniform loading being applied in different cortex, various patterns of crack can occur due to its effect on the microstructure features (14). Based on this, there is a need of surgical intervention to prevent deformity that can develop due to this problem.

FIGURE 2: (A, B) Left ankle calcaneovarus with subluxated talonavicular and tibiotalar joint; (C) Lateral radiograph of the left ankle pre-operatively; (D, E) Arthrodesis of the left hindfoot and talonavicular was performed

Treatment

The goal of the treatment is to achieve a plantigradable foot that allows an even distribution of the weight. Surgical goals would be to preserve the joints and only use arthrodesis as salvage procedure.

Medical therapy

Non-surgical intervention focuses to realign the hindfoot to offload the lateral border of the foot and to overcome the gastrocnemius tightness; custom orthosis will help to achieve this (15). Gastrocnemius stretching program can be used in the cases of equinus while proprioception training and brace can be used in ankle instability.

Surgical therapy

Soft tissue procedures

When the deformities are flexible and reversible, soft tissue procedures should be considered to balance the affected muscles. The list of procedures corresponds to the underlying problem; Achilles tendon lengthening for global gastrocsoleus contracture, gastrocnemius recession for isolated gastrocnemius tightness, plantar fascia release for plantar fascia retraction.

Tendon transfer is also another option. Peroneus longus to peroneus brevis tenodesis have been recommended to correct forefoot pronation, reduce the first ray plantarflexion and reinforce the weak eversion of the hindfoot (16). Tibialis posterior to tibialis anterior transfer has also been described.

Osteotomies

Once the deformity becomes rigid, osteotomy or arthrodesis must be used in place of soft tissue procedure. Dorsal wedge osteotomy of the first metatarsal is used to decrease the medial forefoot plantarflexion. Midfoot dorsal wedge osteotomy realigns the axes of the talus and first metatarsal. Extra-articular osteotomy such as calcaneal osteotomy can be considered if there is residual varus deformity after midfoot surgery or flexible hindfoot varus. There are multiple options for calcaneal osteotomy, namely medialising and lateralising calcaneal osteotomy, closing wedge Dwyer osteotomy and rotational osteotomy such as Evans and Z-osteotomy.

Associated toe deformities

Girdlestone-Taylor transfer (flexor to extensor tendon transfer) is used to correct the alignment of the toes after midfoot osteotomies and the toes remained mobile. Clawing of the hallux can be corrected via modified Jones procedure (transfer of extensor hallucis lon-gus through first metatarsal neck and arthrodesis of the interphalangeal joint).

Triple arthrodesis

For patients with rigid cavovarus deformity, triple arthrodesis is indicated (17) but to maintain successful result over time, soft tissue balancing by means of tendon transfer must follow.

Conclusion

Non-surgical intervention should be attempted for any reversible and flexible foot deformity. Soft tissue procedures are prioritised if surgery is to be carried out. In cases of osteotomies, joint preservation principles must be observed, with consideration of adjunct soft tissue procedures. Arthrodesis is reserved for rigid and non-flexible deformities. The goal of management in both pes planus and pes cavus is to obtain a painless, plantigrade, shoe-able and balanced foot.

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