Egyptian Journal of Medical Research (EJMR)

Acquired Adult Flat Foot Deformity Systematic Review

Nasef Mohamed Nasef[a], *Ayman Abd-Elbaset*[a] *and Ahmed Hussein AboElkasem Hamed*[b]

[a] Orthopedic Surgery department, Faculty of Medicine, Beni-Seuf University, Egypt

[b] Orthopedic Surgery department, Beni-Suef General Hospital, Egypt

Abstract:

The goal of this systematic review was to to assess outcomes in individuals with AAFD (focusing on stage II). Three databases were searched for terms referring to the PTTD and AAFD up to and including 31 July 2018. Studies were eligible if they were published in English language and contained data on outcomes of stage II Management. Thirty-two eligible studies were included in this review. The sample size of the treatment trials ranged from 12 to 129 patients, with only two trials having more than 100 participants. The age ranges were wide. Pain, adverse effects, function or disability indices of foot, patients' satisfaction, radiographic parameters, alignment and improvement of foot function, and quality of life were the searched outcomes. Due to clinical and methodological heterogeneity, data were not pooled into meta-analysis. The evidence from the selected studies is currently too limited about each procedure compared to its counterpart to draw definitive conclusions about the use of each intervention for AAFD. Future high quality comparative studies are warranted in this field. Only limited interventions commonly used in practice have been studied and there is much debate over the treatment of symptomatic and asymptomatic adult pes planus.

Keywords: Adult Pes-Planus – Flatfeet – AAFD – PTTD

1. Introduction:

Acquired adult flat-foot deformity is a progressive flattening of the arch of the foot that occurs due to the gradual stretch of the posterior tibial tendon as well as other ligaments supporting the arch of the foot. This problem may progress from early stages with pain along the posterior tibial tendon to advanced deformity and arthritis throughout the hindfoot and ankle. [1]

Patients often experience pain and/or deformity at the ankle or hindfoot. In the earlier stages, symptoms often include pain and tenderness along the posterior tibial tendon behind the inside of the ankle. As the tendon progressively fails, deformity of the foot and ankle may occur. [2]

This deformity can include progressive flattening of the arch, shifting of the heel so that it no longer is aligned underneath the rest of the leg, rotation and deformity of the forefoot, tightening of the heel cord, development of arthritis, and deformity of the ankle joint. [3]

Posterior tibial tendon dysfunction is the most common cause of acquired adult flatfoot deformity. There is often no specific event that starts the problem, such as a sudden tendon injury. More commonly, the tendon becomes injured from cumulative wear and tear. Other risk factors include neurologic weakness, rheumatoid arthritis, hypertension, obesity and diabetes. [4]

Acquired adult flat foot deformity has been classified into four stages; **Stage I:** consists of painful tenosynovitis of the posterior tibial tendon; however, the tendon itself is of normal length and function, **Stage II:** (IIa) consists of a flatfoot deformity with pain and dysfunction of the posterior tibial tendon. (IIb) Patients have normal hindfoot motion, forefoot abduction but are unable to perform a single-leg heel rise, **Stage III**: also includes dysfunction of the posterior tibial tendon. However, in this stage the hindfoot joints are stiff and may be arthritic and **Stage IV**: consists of a stage III deformity with evidence of associated tibiotalar asymmetry because of the prolonged hindfoot valgus deformity. [5]

The diagnosis of posterior tibial tendon dysfunction and acquired flat foot deformity is usually made from a combination of history, symptoms, examination and x-ray imaging. The site of pain, shape of the foot, flexibility of the hindfoot joints and gait are the tools that assist the diagnosis and also assess the severity of the problem. [1]

Advanced radiographic studies, such as MRI, CT, and ultrasonography can provide extra and sometimes helpful information. However, in typical cases of AAFD, an accurate diagnosis can be made based on clinical examination and weight bearing radiographs of the foot. MRI provides an accurate assessment of the status of the soft tissues, including the posterior tibial tendon, the spring ligament, deltoid ligament, and even the functional status of a muscle. [6]

Treatment depends greatly upon a patient's symptoms, functional goals, degree, specifics of deformity and the presence of arthritis. In early stages of the disease that involves pain along the tendon, immobilization with a boot for a period of time can relieve stress on the tendon and reduce the inflammation and pain. Once these symptoms have resolved, patients are often transitioned into an orthotic that supports the inside aspect of the hindfoot. [7]

For patients with more significant deformity, a larger ankle brace may be necessary. If surgery is necessary, a number of different procedures may be considered. The planned surgery depends upon the stage of the disorder and the patient's main complaint. The overall complication rates for these procedures are low. [2]

We designed the present study to evaluate the efficacy of different treatment protocols of acquired flat foot deformity stage II either conservative or surgical, by following up patients for a period longer than nine months after treatment.

2. Materials And Methods:

Search strategy

A three-step search strategy was utilized in this review:

a. An initial limited search of electronic databases (PubMed, Scopus and Google Scholar) were undertaken by two reviewer followed by an analysis of the text words contained in the title, abstract, and of the index terms, keywords, and MeSH terms used to describe article.

b. A second comprehensive search using all identified keywords and index terms were then undertaken by two reviewer across all included databases for all years available up to and including 31 July 2019. Keywords used in the search strategy aimed to capture all past and present variations in terminology for the condition: Flatfoot OR “pes planus” OR “pes planovalgus”. No restrictions or second string limitations were used to further narrow the search.

c. Thirdly, the reference list of all identified reports and articles were searched for additional studies.

Study Selection

By screening of title and abstract of all retrieved articles. After duplicates removal, non-duplicates were screened. outlines studies excluded at each stage of the selection process, full text articles investigating either AAFD were examined for final inclusion. Following this final full text screening, 22 articles met all inclusion criteria and were included in the review.

Inclusion criteria:

1) Study designs; including randomized controlled trials, non-randomized controlled trials, cohort studies, case control studies and cross sectional studies for inclusion.
2) Studies that evaluate the efficacy of different treatment protocols either conservative or surgical, by following up patients for a period longer than nine months after treatment.
3) Studies published in English language.

Exclusion criteria

1) Studies that included stage other than stage II acquired flat foot deformity.
2) Studies that have follow up less than 9 months.
3) Studies that have computer simulation, basic science studies and cadaveric studies.
4) Studies that include patients less than 18 years old.

Data extraction process

Data were extracted into an agreed data extraction table. The extracted data included patient demographics, age of patient, operative techniques, radiographic parameters, outcome measures, primary outcome and complications.

Studies:

Treatment outcomes for AAFD were specified in 22 studies:

1. Six studies of our review had managed their patients using flexor digitorum longus (FDL) transfer and medial

displacement calcaneal osteotomy (MCDO). [8-13]

2. One study performed Flexor halluces longus (FHL) tendon transfer and MDCO [14].

3. Two studies performed FDL tendon transfer, LCL, MDCO, and heel cord lengthening for AAFD cases [15], [16].

4. Three studies out of our twenty-two had performed lateral column lengthening. [17] [18] & [19].

5. Two studies compared lateral versus medial column arthrodesis [20] & [21]

6. Two studies had combined both lateral and medial column arthrodesis; [22] and [23].

7. Five studies managed their patients using various soft tissue procedures.

- Tendon repair depending on the type and location of the injury, then implanted a Kalix endorthesis in the sinus tarsi [24].

- **S**pring ligament reconstruction [25].

- **S**ubtalar arthroereisis (the restriction of the range of motion of a joint) with the Maxwell-Brancheau Arthroereisis (MBA) [26].

- Cobb procedure [27].

- Subtalar arthroereises ± flexor digitorum longus transfer [28].

8. One study used non-operative techniques [29].

3. Results:

Effects of interventions

Due to the differences in the interventions and outcomes reported, data were not pooled. The number of cases included in the review was large and the number of trials classifying stage II into stage (a) and (b) was limited. Age of patients included in the review, ranged from (15 to 89) years old.

Types of outcome measures

1) Pain reduction:

Six studies of our review had managed their patients using flexor digitorum longus (FDL) transfer and medial displacement calcaneal osteotomy (MCDO) [8-13]. One of them reported that pain relief was rated as excellent by 75% and good by 16%; the average AOFAS Hindfoot pain subscale score was 35.2 (out of 40 possible) [8]. Another; showed that 97% of cases experienced pain relief [9]. In the same time; another study rated the outcome in 43 patients as good to excellent for pain [10]. On the other hand, the remaining three studies had not measured the pain status in their works [11], [12] & [13].

No description of pain was reported in the study performed by Flexor halluces longus (FHL) tendon transfer and MDCO techniques [14]. This observation was similar to another two studies that performed FDL tendon transfer, LCL, MDCO, and heel cord lengthening for AAFD cases had not reported pain in their work. [15], [16]

Three studies out of our twenty-two had performed lateral column lengthening. The incidence of pain or revision was lower after the introduction of trial metal wedges but this incidence did not reach a statistically significant difference ($p = 0.084$) [17]. Pain was not measured in the remaining two studies [18] & [19].

A couple of studies that compared lateral versus medial column arthrodesis were involved; the first reported that most patients had a decrease in pain or were pain free [20], and the second one did not investigated pain in their patients [21]. Another couple of studies had combined both lateral and medial column arthrodesis, but had not evaluated pain [22], [23].

Five studies managed their patients using various soft tissue procedures. One of them performed tendon repair depending on the type and location of the injury, then implanted a Kalix endorthesis in the sinus tarsi, showing that the most important improvement was observed in pain [24], while the second study used spring ligament reconstruction, finding that the postoperative FAOS pain subscale and was 83.7 (range, 67.9 to 100) [25]. However, another three studies [26], [27] & [28]; had not demonstrated pain conditions in their studies.

One study used non-operative technique to manage AAFD was in the form of Double Upright Ankle Foot Orthosis (DUAFO), showed that average Visual Analog Scale (VAS) pain scale score was 1.9 [29].

2) Adverse effects or complications of interventions:

Six studies of our review had managed their patients using flexor digitorum longus (FDL) transfer and medial displacement calcaneal osteotomy (MCDO). One is the study of Guyton et al.; who reported that one patient had a late tendon transfer failure after developing increasing pain and weakness during a pregnancy 69 month after the procedure [8]. Myersonet al.; showed minimal complications as (hind foot valgus deformity in 6 patient malunion of calcaneal osteotomy, sural neuritis and atrophy of culf muscles in 1 patient). [9] While the other four studies had not measured the complications [10-13]. In addition, Sammarco et al.; who performed Flexor halluces longus (FHL) tendon transfer and MDCO, demonstrated that no patient complained of donor deficit from the harvested FHL tendon, minimal complications were reported as (screw cut out from calcaneal body, broken screw in 1 obese patient, delayed wound healing). [14]

On the opposite side; two studies that performed FDL tendon transfer, LCL, MDCO, and heel cord lengthening for AAFD cases; the former reported that there were no non-unions, and the later had not mentioned complications in their work [15],[16].

Three studies out of our twenty-two had performed lateral column lengthening. Conti et al.; operated their cases with distraction calcaneocuboid arthrodesis technique finding that 50% of patients experienced non-union or osteolysis of the graft with non-union [18]. Ellis et al.; used trial metal wedges in lateral column lengthening reporting that the overall incidence of plantar lateral discomfort was 11.2% after LCL, stiffness of joint and pain along foot [17]. Heaseker et al.; investigated results of lateral Column Lengthening: by calcaneus osteotomy (group I) versus calcaneocuboid distraction arthrodesis (group II) showing that; in group II, thirteen mild calcaneocuboid subluxations were observed. In both groups, one non-union and one wound complication occurred [19].

A couple of studies that compared lateral versus medial column arthrodesis were involved; the first reported that the LCL group achieved lower reoperation rate despite a higher incidence of nonunion and radiographic progression of adjacent joint arthritis than the calcaneal osteotomy group [21], and the second did not investigated complications in their patients [20].

Another couple of studies had combined both lateral and medial column arthrodesis. In Brian et al.; 20% had a nonunion at the calcaneocuboid joint, 32% had anesthesia or paresthesia of the sural nerve, and 71% had additional operations [22]. In Chan et al., 2013; complications were not reported [23].

Five studies managed their patients using various soft tissue procedures. Needleman et al.; used subtalar arthroereisis (the restriction of the range of motion of a joint) with the Maxwell-Brancheau Arthroereisis (MBA) sinus tarsi implant showing that high incidence of temporary sinus tarsi pain occurred until the implant was removed [26]. Williams et al.; used spring ligament reconstruction, finding that few complications resulted as superficial & deep woun infection, nerve injury and ankle instability & stiffnes [25]. Zhu et al.; used subtalar arthroereises ± an flexor digitorum longus transfer, finding that no deformity recurrences were found at the time of last follow-up, with the exception of 1 case [28]. However, Knupp et al., and Viladot et al., had not demonstrated complications occurrence in their studies [24], [27].

One study used non-operative techniques to manage AAFD; had not taken complication occurrence into their consideration [29].

3) **Function or disability indices and scores of the foot:**

- **American Orthopaedic Foot and Ankle Society (AOFAS) scores:**

Six studies of our review had managed their patients using flexor digitorum longus (FDL) transfer and medial displacement calcaneal osteotomy (MCDO). Fayazi et al.; showed that American Orthopaedic Foot and Ankle Society (AOFAS) scores improved from a preoperative mean of 50:t14 to a postoperative mean of 89:t10, [11] Guyton et al.; showed that the average score for the four functional symptom categories of the AOFAS score was improved from 35.2 to 72.1 post-operative, [8], and Myerson et al.; showed that AOFAS score at follow-up was 79 points (range, 54–93), [9] & [10]. Wacker et al.; reported that the mean AOFAS ankle/hindfoot rating scale improved from 48.8 before operation to 88.5 at follow-up. [10] However, the other two had not measured AOFAS score [12] and [13].

Sammarco et al; who performed FHL tendon transfer and MDCO, demonstrated the AOFAS hindfoot score improved from 62.4%to 83.6% [14].

Two studies of LaClair et al., and Pomeroy et al.; who performed FDL tendon transfer, LCL, MDCO, and heel cord lengthening for AAFD cases; the former reported that the mean AOFAS ankle hindfoot scale was 90 postoperatively, while the later showed that it was 51.4 preoperatively and had improved to 82.8 postoperatively [15],[16].

Three studies out of our twenty-two had performed lateral column lengthening. Heaseker et al.; investigated results of lateral Column Lengthening: by calcaneus osteotomy (group I) versus calcaneocuboid distraction arthrodesis (group II) showing that; the AOFAS score was higher for lateral column lengthening by calcaneus osteotomy than by distraction arthrodesis of the calcaneocuboid joint (mean, 85 vs. 72, respectively; $P < .02$) at time of last follow-up [19]. Whereas Ellis et al., and Conti et al.; had not measured AOFAS in their work [17],[18].

A couple of studies that compared lateral versus medial column arthrodesis were involved in our review and had not evaluated AOFAS [20], [21]. Another couple of studies had combined both lateral and medial column arthrodesis. In both, AOFAS was not reported [22], [23].

Five studies managed their patients using various soft tissue procedures. Needleman et al.; showed that the average preoperative AOFAS score was 52 and had improved to 87 ($p < 0.001$), [26]. Knupp et al.; showed that the mean AOFAS score increased from 53.2% preoperative to 88.5% postoperative [27]. Viladot et al.; showed that AOFAS scale improved from a preoperative average of 47.2 to an average of 81.6 [24]. Williams et al.; reported that the AOFAS ankle-hindfoot score increased from 43.1 to 90.3 ($p < 0.001$) [25]. Zhu et al.; demonstrated that the average postoperative AOFAS Ankle-Hindfoot Scale score was increased to 85.5% postoperative [28].

One study used non-operative techniques to manage AAFD; showed that the mean AOFAS score was 78.4% [29].

- **Other scores or indices:**

Myerson et al.; used short Form Health Surgery (SF-36) to evaluate patients postoperatively [9]. Niki et al; compared preoperative and postoperative Japanese Society for Surgery of the Foot (JSSF), SF-36 scores and Foot Function Index (FFI). [12] Williams et al.; reported that the overall SF-36 was 77.3 (range 37.8 to 95.6) [25]. Lin et al.; reported that patients were evaluated with SF-36, Foot Function Index (FFI), and a custom questionnaire, finding that the mean FFI score was 18.4 [29]. Other functional or disability indices or scores of the foot were not measured in the other studies included in our review.

4) Assessed radiographic parameters

Weight-bearing radiographs AP, lateral, medial oblique, ankle, and hindfoot alignment views are routinely done.

Measurements on the AP view consist of talar first metatarsal angle, calcaneocuboid abduction angle, as well as talar head coverage when evaluating the amount of pronation and forefoot abduction [30]. The talonavicular coverage angle can be used to assess the extent of midfoot abduction [31]. Measurements on the lateral view include talar first metatarsal angle **(Meary's angle)**, calcaneal inclination angle and calcaneal pitch angle [32].

Six studies of our review had managed their patients using flexor digitorum longus (FDL) transfer and medial displacement calcaneal osteotomy (MCDO). One of them showed that the improvement of radiographic alignment (arch height and hindfoot alignment) of the foot was commonly noted, however, only 50% of patients felt the conformation of their foot had noticeably changed, and only 4% felt the improvement to be significant. [8]

Myerson et al.; showed that correction was significant (p <.05) in all assessed weight-bearing radiographs (AP, lateral) evaluated [9]. Niki et al., 2012; obtained eight measures of foot alignment from weight bearing radiographs after surgery [12].

Note: Values are mean +/- SD (n = 30) unless otherwise indicated. APTC, anteroposterior talocalcaneal; APTMT, anteroposterior talo –first metatarsal; TNC, talonavicular coverage; LTC, lateral talocalcaneal; LTMT, lateral talo –first metatarsal; CP, calcaneal pitch; DMC5MT, distance between medial cuneiform and fifth metatarsal; TBC, tibiocalcaneal; NS, not significant. Statistical significance was accepted at p<.01 for each test.

Rosenfeld et al.; show improvement of MRI measurement from 16% preoperative to 22% post-operative [13]. The other two studies had not mentioned radiographic assessment [10],[11]. Sammarco et al; who performed Flexor halluces longus (FHL) tendon transfer and MDCO, demonstrated that the weightbearing radiographs revealed no statistically significant improvement [14].

Two studies that performed FDL tendon transfer, LCL, MDCO, and heel cord lengthening for AAFD cases; the former reported improvement in radiographic measurements demonstrate maintenance of correction of the adult acquired flatfoot, the medial cuneiform to fifth metatarsal distance improved from -0.2 mm preoperatively to 7.6 mm postoperatively, similarly, the talonavicular distance improved from 19.4 mm preoperatively to 10.9 postoperatively, four feet (14%) displayed radiographic signs of calcaneocuboid arthritis at follow-up, and only one was symptomatic requiring calcaneocuboid joint fusion, and the later assessed radiograph measurements demonstrateing statistically significant correction of the pes planovalgus deformity, as well as maintenance of the correction [15],[16].

Three studies out of our twenty-two had performed lateral column lengthening. Heaseker et al.; investigated results of lateral Column Lengthening: by calcaneus osteotomy (group I) versus calcaneocuboid distraction arthrodesis (group II) showing that; all radiological results were significantly better at time of follow-up in both groups (except for talocalcaneal angle in group I), although no significant differences were noted in the amount of change in radiographic measurements between the groups [19].

In a couple of studies that compared lateral versus medial column arthrodesis were involved in our review, the former had measured six parameters of foot alignment from weightbearing radiographs, and the later demonstrated improvement in the lateral talar first metatarsal angle and the anteroposterior talonavicular coverage angle [20],[21].

Another couple of studies had combined both lateral and medial column arthrodesis; showed that five of six parameters that had been used to assess correction of the deformity radiographically Radiographic Evaluation on the anteroposterior radiograph, the talo-first [22], [23].

Metatarsal angle was corrected from a mean of 26 ± 12 On the lateral radiograph, the talo-first metatarsal angle was corrected from a mean of 23 ± 14 degrees preoperatively to a mean of 8 ± 8 degrees postoperatively and the calcaneal pitch angle was corrected from a mean of 13 ± 6 degrees to a mean of 21 ± 6 degrees ($p < 0.001$ for both angles). With the numbers available, no significant difference could be detected between the preoperative and postoperative talocalcaneal angles (mean, 39 ± 8 degrees preoperatively compared with 38 ± 10 degrees postoperatively; $p = 0.2$) on the lateral radiograph. In Chan et al. study; satisfaction was not reported [23].

Needleman et al.; showed that correction after surgery was significant (p <0.001) in the three radiographic parameters evaluated for correction with MBA and final correction [26]. Williams et al.; reported that standard weight bearing radiographs were improved [25].

Zhu et al.; demonstrated that average preoperative talar-first metatarsal angle and talonavicular coverage angle were −13.9° and 38.3°, respectively [28]. The average postoperative angles were 1.6° and 11.2°, respectively (P <.01), while the other two had not assessed radiological parameters as outcomes [24], [27].

One study used non-operative techniques to manage AAFD; the study of Lin et al.; had not assessed their patients radiographically [29].

5) Alignment and improvement of foot function:

Six studies of our review had managed their patients using flexor digitorum longus (FDL) transfer and medial displacement calcaneal osteotomy (MCDO). One of them showed that the improvement of arch height and hindfoot alignment of the foot was commonly noted, however, only 50% of patients felt the conformation of their foot had noticeably changed, and only 4% felt the improvement to be significant [8]. Myerson et al.; showed that 87% experienced improvement in the arch of the foot [9]. Niki et al.; obtained eight measures of foot alignment from weightbearing radiographs after surgery [12]. Wacker et al.; showed that the outcome in 36 patients was rated as good to excellent for alignment. The other two studies had not mentioned alignment [11] and [13]. In addition, Sammarco et al.; who performed Flexor halluces longus (FHL) tendon transfer and MDCO, demonstrated that the procedure showed inability to improve the height of the medial longitudinal arch [14].

Two studies of LaClair et al., and Pomeroy et al.; performed FDL tendon transfer, LCL, MDCO, and heel cord lengthening for AAFD cases; they had not evaluated alignment [15],[16].

Three studies out of our twenty-two had performed lateral column lengthening and had not evaluated foot's alignment [17],[18]&[19].

A couple of studies that compared lateral versus medial column arthrodesis were involved in our review, one evaluated six parameters of foot alignment that measured from weightbearing radiographs [21], the second showed that the LCL group achieved greater realignment initially and maintained correction better over time than the calcaneal osteotomy group, and both techniques effectively corrected deformity without disrupting the essential joints of the hindfoot and midfoot [20].

Another couple of studies had combined both lateral and medial column arthrodesis. Brian et al.; had not alignment as an outcome [22], while Chan et al.; reported that correction of hindfoot valgus alignment obtained in flatfoot reconstruction is primarily determined by the MCO procedure and can be modeled linearly [23].

Williams et al.; showed improvement of hindfoot alignment and eversion strength [25]. The other four had not investigated alignment [24], [26], [27], & [28].

One study used non-operative techniques to manage AAFD; they had not evaluated foot alignment [29].

6) Quality of life measures

Sex studies of our review had managed their patients using flexor digitorum longus (FDL) transfer and medial displacement calcaneal osteotomy (MCDO). Fayazi et al.; demonstrated that no patient had difficulty with shoe wear; however, 17% required routine orthotic use consisting of a molded shoe insert. [11] Guyton et al.; reported that function was felt to be markedly improved as all patients except three could perform a single-leg toe rise at follow-up, a maneuver none could perform preoperatively and clinically assessed subtalar motion remained 81:t 15% of the contralateral side in those patients with unilateral disease. [8] Myerson et al.; reported that 94% showed improvement of function, 84% experienced improvement in the ablilty to wear shoes comfortably without shoe modifications or orthotic arch support. Rosenfeld et al.; showed that management produced a satisfactory improvement in hindfoot function. [13] Wacker et al.; showed that it yielded good to excellent results for function. Niki et al.; had not mentioned function conditions in their work. [12] Moreover, Sammarco et al.; who performed Flexor halluces longus (FHL) tendon transfer and MDCO, showed that it yielded good to excellent results for function. [14]

Two studies performed FDL tendon transfer, LCL, MDCO, and heel cord lengthening for AAFD cases, the former provided symptomatic relief and lasting correction of the pes planovalgus deformity, and the later found that at intermediate follow-up, combination of these procedures provided correction of the symptoms and deformity associated with posterior tibial tendon insufficiency [15], [16].

Three studies out of our thirty-four had performed lateral column lengthening [17], [18] and [19]; a couple of studies that compared lateral versus medial column arthrodesis [20], [21], and another couple of studies had combined both lateral and medial column arthrodesis [22]; [23], and they all had not reported function changes in their studies.

Needleman et al.; reported that 78% of patients had favorable clinical outcomes were reported [26]. Knupp et al.; showed that all patients had improved function because of increased stability of the first ray, the overall clinical results were excellent in 41.0%, good in 54.5%, fair in 4.5%, and poor in none [27]. None of the patients had decreased power of the anterior tibial tendon compared to the contralateral foot, and 86% were able to wear shoes without shoe modifications. The other three had not investigated function [24], [25], [28].

One study used non-operative techniques to manage AAFD; one of them defined success as being brace-free and avoiding surgery which was 69.7% and 15.2% were unable to completely wean from a brace [29].

Table (1): Summary of Radiographic Parameters, [8].

	Preoperative	**Postoperative**	**Significance**
Talo-1st Metatarsal Angle (AP)	21.1 ± 8.1	7.2 ± 9.9	<0.001
Talo-2nd Metatarsal Angle (AP)	31.1 ± 9.0	16.3 ± 11.6	0.005
Talo-Navicular Coverage Angle (AP)	22.1 ± 10.3	10.3 ± 11.0	<0.001
Talo-1st Metatarsal Angle (Lateral)	20.4 ± 10.6	12.7 ± 8.9	<0.001

Table (2): Radiographic assessment: [12]

Parameter	Preoperative	Postoperative	p value a
APTC	17+/-6.2	18+/-6.2	NS
APTMT	15.8+/-6.9	13.4+/-4.9	NS
TNC	30.8+/-5.1	27.1+/-5.6	NS
LTC	50.3+/-5	50.9+/-6.4	NS
LTMT	23.7+/-8.8	14+/-6.7	0.005
CP	13.3+/-4.1	16.9+/-4.2	NS
DMC5MT	8.8+/-4.8	11.8+/-3.9	NS
TB	15.9+/-4.3	4.2+/-3.5	<0.001

Table (3): Difference in mean radiographic improvement between groups: [19].

Radiographic variable	Group I (n ¼ 16 feet in 14 patients)	Group II (n ¼ 19 feet in 19 patients)	P-Value
TMT angle (anteroposterior view)	8.3+/-6.3	11.8+/-7.6	0.176
TMT angle (lateral view)	10.2+/-10.4	11.2+/-11.4	0.799
Talonavicular coverage	20.6+/-11.4	16.3+/-11.8	0.315
Talocalcaneal angle	6.5+/-9.1	2.6+/-8.7	0.219

Table (4): Comparison of Preoperative and Postoperative radiographic parameters:

Parameter		Preoperative	Postoperative	P value
A/P	FirstTarsometatarsal Angle	18.5° (9.0-29.0)	11.6° (0.8-29.4)	0.015
	Talonavicular Percent Uncoverage	38.7° (15.0-75.0)	27.2° (5.0-50.0)	0.103
	Talonavicular Coverage Angle	34.4° (12.0-66.0)	19.8° (8.9-34.4)	0.003
Lateral	Calcaneal Pitch	3.9° (0.0-10.0)	8.7° (3.1-25.2)	0.002

	Talonavicular Angle	12.0° (2.0-24.0)	0.30° (-8.0-5.3)	0.017
	First Tarsometatarsal Angle	17.0° (0.0-39.0)	11.8° (1.9-20.4)	0.064
	Talocalcaneal Angle	33.4° (13.0-48.0)	35.3° (0.8-44.6)	0.312

4. Discussion:

Acquired adult flatfoot deformity is a progressive flattening of the arch of the foot that occurs due to the gradual stretch of the posterior tibial tendon as well as other ligaments supporting the arch of the foot. This problem may progress from early stages with pain along the posterior tibial tendon to advanced deformity and arthritis throughout the hindfoot and ankle [1]. The aim of this study was to review the outcomes of various surgical and/ or non-surgical procedures used in management of adult acquired flat foot deformity (focusing on stage II). There is a lack of enough comparative studies that have compared the outcomes of various surgical and/ or nonsurgical interventions for adult acquired flatfoot deformity, with stage II.

Summary of findings for the main outcomes, but the clinical importance of the improvements is questionable, and further studies are likely to change the conclusions. There was clinical and methodological heterogeneity across studies that precluded meta-analysis and robust overall conclusions. Furthermore, the small number of relevant trials conducting the same procedure and limited sample sizes precludes firm conclusions regarding any one intervention. Sources of heterogeneity include the age ranges studied, co-morbidities, interventions, and outcome measures chosen.

Methodological issues: the sample size of the treatment trials ranged from 12 to 129 patients, with only two trials having more than 100 participants [9], [11]. With such small sample sizes, it is not possible to draw robust conclusions. This is primarily due to a number of factors including limited number of studies per interventions compared combined with the small sample sizes of the studies. Therefore, as a consequence of data heterogeneity no meta-analysis could be meaningfully conducted. Most comparative studies of the review were single-blind trials with the investigators being aware of the type of intervention received, which may have resulted in performance and detection (assessor) bias. Blinded healthcare providers may also differ from non-blinded ones in their degree of attention to patients, or in their use of alternative forms of care. Follow-up durations varied across the twenty-two trials, therefore making comparisons difficult.

The age ranges differed across the twenty-two studies, with a wide range for the whole review's age ranges, and it is therefore difficult to generalize about various intervention for acquired flatfoot deformity in all adults' age groups

The current review demonstrated a wide range of surgical and/ or non- surgical interventions for adult acquired pes planus. All studies measuring various outcomes are eligible for inclusion in this systematic review. Six studies of our review had managed their patients using flexor digitorum longus (FDL) transfer and medial displacement calcaneal osteotomy (MCDO) [8 -13].

One performed Flexor halluces longus (FHL) tendon transfer and MDCO, had not described pain in their reports [14]. Two studies of [15], [16]; performed FDL tendon transfer, LCL, MDCO, and heel cord lengthening for AAFD cases. Three studies had performed lateral column lengthening [17],[18]&[19]. A couple of studies compared lateral versus medial column arthrodesis were involved; [20], [21]. Another couple of studies had combined both lateral and medial column arthrodesis [22] and [23]. Five studies managed their patients using various soft tissue procedures [24-28]. One study used non-operative techniques to manage AAFD [29].

In the current review various conservative and surgical techniques were searched, with pain, adverse effects, function or disability indices and scores of the foot, patients' satisfaction, radiographic parameters, alignment and improvement of foot function, and quality of life measures were the searched outcomes, and data were not homogenous to conduct any analysis.

5. Conclusion:

The evidence from the selected studies is currently too limited about each procedure compared to its counterpart to draw definitive conclusions about the use of each intervention for AAFD. Only limited interventions commonly used in practice have been studied and there is much debate over the treatment of symptomatic and asymptomatic pes planus.

Recommendations

Based on our findings in this study and in conjunction with that from previous reviews, we suggest that:

- Additional studies on large number of cases should investigate AAFD, with stage II.

- Future high quality comparative studies are required in this field.

- Further studies about each procedure are needed with longer homogenous follow-up durations to guarantee the ability to conduct a systematic review with its data pooled into meta-analysis.

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