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Calcaneal lateral column lengthening osteotomy for symptomatic flexible flatfoot in children and adolescents: a systematic review.

Osteotomia de alongamento da coluna lateral do calcâneo para tratamento do pé plano flexível sintomático de crianças e adolescentes: revisão sistemática.

Thiago Coelho Lima[1]; José Batista Volpon[1]

A B S T R A C T

Flexible flatfoot is a common condition in small children, which shows a strong tendency to spontaneously correct with their growth or to become moderate or mild in adults, which will not cause future problems. However, in a small number of cases, this condition is more severe, does not improve spontaneously, which may cause mechanical impairment, deformity, and, eventually, pain. In such cases, surgical treatment should be considered. The aim of this systematic review was to evaluate the literature results on the treatment of the symptomatic flexible flatfoot in children or adolescents through a very frequent procedure: calcaneal lateral column lengthening osteotomy, A systematic electronic search in PubMed, Web of Science, Cochrane, CINAHL, SciELO, SCOPUS and LILACS databases was performed. We searched articles published between March 1975 and September 2016. After applying the eligibility criteria, the selected publications were evaluated in relation to their clinical and radiographic results and complications. We found 341 articles in the mentioned databases, but selected only eight studies, according to the inclusion and exclusion criteria. These studies included a total of 105 patients and 167 treated feet. Only three authors performed prospective studies, but without case-control or randomization. The majority of publications were descriptive studies or case series (level of evidence III or IV), with great methodological variations, but with a high satisfaction rate on the part of both patients and surgeons in relation to the results. However, more prospective and randomized studies are required, with adequate control groups and validated evaluation criteria.

Keywords: Flatfoot. Osteotomy. Bone Lengthening. Calcaneus. Review.

INTRODUCTION

Despite being a frequent affection, the flexible valgus flatfoot does not show objective diagnostic criteria[1]. It is characterized by the loss or inversion of the medial longitudinal plantar arch associated with valgus hindfoot and supination of the forefoot. Flexible flatfoot occurs when there is subtalar joint and foot mobility, so that the deformity can be reversed by maneuvers standing on the tiptoes or at the lateral border of the foot, or simply not bearing weight[2].

Most children are born with flatfoot, but the medial plantar arch mainly develops between two and six years of age[3]. However, some individuals do not show any spontaneous correction. The therapeutic approach of symptomatic flatfoot in children may be conservative with prescription of analgesics, anti-inflammatories, physiotherapy, adequate footwear, and orthoses[4]. However, there is no scientific evidence that these measures act to correct the deformity[5], maybe they are only palliative.

Surgical treatment is indicated for older children with symptomatic flexible flatfeet in which there is interference in daily life physical activities or gross deformities that interferes with footwear[6]. Among the various surgical treatments, calcaneal lateral column lengthening osteotomy is widely used for the flexible flatfoot treatment. Evans[7] conceived the technique in 1959, but it was published only in 1975.

1 - University of Sao Paulo, School of Medicine of Ribeirao Preto, Department of Biomechanics, Medicine and Rehabilitation of the Locomotor System, Ribeirao Preto, SP, Brazil.

He believed that the lateral column of the valgus flatfoot was shorter than the medial column. Thus, the purpose of the surgery is to equalize the length of the lateral and medial columns, which leads to the correction of the forefoot abduction and, consequently, of the talonavicular subluxation. Sangeorzan *et al*. performed Evans osteotomy in cadavers and found a significant improvement of the talonavicular coverage angle and of the talometatarsal and calcaneal angles[8]. However, in addition to the disadvantages related to osteotomies and those of the iliac graft harvesting, Evans osteotomy shows a longer learning curve and has a potential risk of joint damage, mainly because there are morphological variations of the subtalar joints[9].

Initially, Evans used autologous tibial graft, without implants to achieve correction[2]. Mosca[10] modified the technique by performing a more obliquely oriented calcaneal osteotomy, not in parallel to the calcaneocuboid joint. Mosca used a tricortical graft, obtained from the iliac crest and fixed with Steinmann pins. Currently, the allogenic bone graft is widely used for calcaneal lateral column lengthening[11], with good results in terms of graft healing[12].

The objective of this systematic review was to evaluate the results of literature reports on the treatment of severe flatfoot in children or adolescents, through Evans technique[7].

METHODS

The research strategy consisted in the systematic electronic search in seven bibliographic databases (PubMed, Web of Science, Cochrane, CINAHL, SciELO, SCOPUS, and LILACS) from March 1975 to September 2016. Articles published in Portuguese, English, French, Italian, and Spanish were included.

We used MeSH and DeCS descriptors in English, Portuguese, and Spanish: 'foot'/ 'pé'/ 'pie'; 'flatfoot'/ 'pé chato'/ 'pie plano'; and 'osteotomy'/ 'osteotomia'/ 'osteotomía'. And the following keywords: 'flexible'/ 'flexível'/ 'flexible'. In addition, we utilized Google Scholar search tool and the following Italian terms: 'piede piatto', 'piede valgo', 'piede piatto de ll'infanzia', 'piede piatto dell'adolescenza', 'piede pronato', 'osteotomia del piede', and 'arco plantare'. And in French: 'pied plat', 'pied plat valgus', 'ostéotomie du pied', 'pied plat de l'enfant', and 'pied plat de l'adolescent'.

We excluded studies related to adult population (older than 20 years), flatfoot caused by tarsal coalition, congenital bone deformities or iatrogenic hypercorrection of the crooked foot, associated congenital and/or neurological affections, and previous surgeries in the foot. Narrative review, systematic review, and meta-analysis articles were also excluded.

RESULTS

The systematic search in the electronic databases resulted in 341 articles. After applying the eligibility criteria, eight studies were selected[13-20] (Figure 1), with a total of 105 patients and 167 treated feet, and a mean postoperative follow-up of 34.8 months (minimum of 6 and maximum of 156 months). The minimum age at the time of surgery was six years and the maximum age was 18 years. Only three authors performed prospective studies[14,16,19].

Four studies used autogenous bone graft[13,15,16,18] and the other studies used allogeneic graft[14,17,19,20], with fixation in four studies[13-16]. Two studies (14 patients and 25 feet) evaluated clinical results according to the surgeons' criteria, with excellent and good results in 80.2%, fair in 11.1%, and poor results in 8.7%[13,16]. Two other authors[4,16]

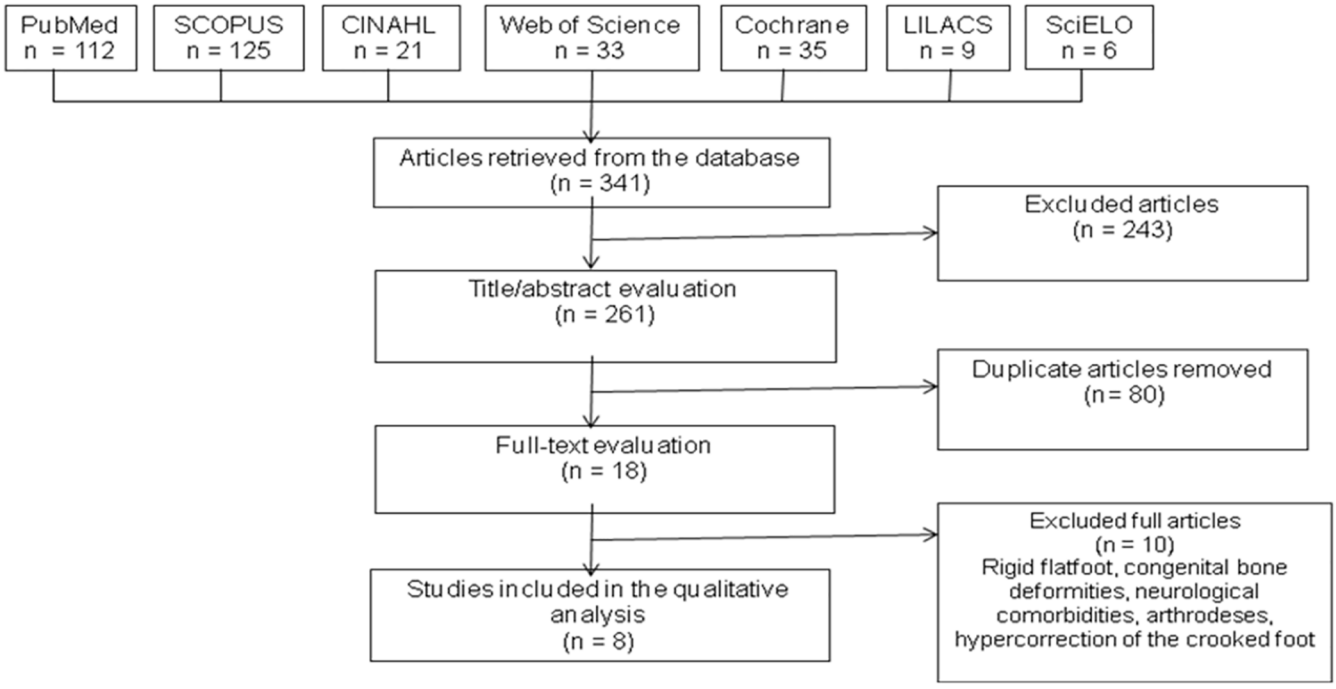

Figure 1. *Research flowchart in the databases. After applying the eligibility criteria, eight articles were included in this review.*

evaluated patients' satisfaction after calcaneal lateral column lengthening osteotomy (total of 28 patients and 43 feet). Among these patients, 30.95% were very satisfied, 60.45% satisfied, 2.45% indifferent, and 6.25% unsatisfied. Only two studies used specific questionnaires. Viegas *et al*. evaluated 17 patients (34 feet) with the questionnaire of the American Orthopedic Foot and Ankle Society (AOFAS) and scored 68.59 in the preoperative period, 85.76 in the three-month postoperative period, and 96.35 in the eight- to 48-month postoperative period, with an increase of 27.76 points[19]. Chong *et al*. evaluated eight patients (11 feet) who had undergone calcaneal lateral column lengthening osteotomy, with an average follow-up of 12.9 months. The authors applied the Oxford Ankle Foot Questionnaire for Children (OxAFQ-C) with parents and children. There were preoperative scores of 47.9 (parents) and 59.6 (children) and postoperative scores of 70.1 (parents) and 86.7 (children)[14].

Radiographic Results

Radiographic measurements are objective data for pre- and postoperative evaluation of the valgus flatfoot. However, in the reviewed literature, there was no uniformity regarding the evaluated parameters, type of measured angles, and evaluation period. In view of these limitations, the most frequently evaluated parameters are presented in table 1.

Complications

The total complication rate was 20.9%, being the most frequent complications were operative wound dehiscence (19%) and residual pain (17.2%) (Table 2). In addition to the complications presented in the following table, others were reported, such as hypoesthesia, calcaneocuboid subluxation, and varus of the forefoot.

Table 1. *Radiographic measurements evaluated before and after calcaneal lateral column lengthening surgery.*

Radiographic measurements	CI	LTC	TC	TMT	LTMT	TD	TNC
Studies (n)	7	6	5	6	3	3	3
Feet (n)	158	142	121	123	48	57	88
Preoperative average*	10	46	35	24	20	35	32
Postoperative average*	20	40	21	9	7	22	8
Range*	+11	-6	-14	-16	+13	-13	+23

*CI: calcaneal inclination angle[14-20]; LTC: lateral talocalcaneal angle[14,15,17-20]; TC: talocalcaneal angle[14,15,17-19]; TMT: talo-first metatarsal angle[14-20]; LTMT: lateral talo-first metatarsal angle; TD: talar declination angle[15,16,19]; TNC: talonavicular coverage angle[18-20]; * Angles in degrees.*

Table 2. *Complications of calcaneal lateral column lengthening osteotomy.*

Parameters	Values
Studies with complications (n)	8[13-20]
Patients (n)	105
Feet (n)	167
Age (years)	6 to 18
Follow-up (average in months)	34.8
Patients with complications (n)	22[13-20]
Complication rate	20.9%[13-20]
Residual pain	Average: 17.2%[13,15,18] Range: 3% to 37.5%
Operative wound dehiscence	Average: 19%[14,20] Range: 9% to 29%
Sural neuritis	2.8%[16]
Pseudoarthrosis	Average: 7.1%[16,18,20] Range: 3% to 12.5%
Bone-graft displacement	9%[14]

DISCUSSION

The conservative approach for the treatment of severe flexible flatfoot in childhood and adolescence seems to be ineffective[5], but may relieve pain in cases where parents do not wish surgical correction. A Cochrane review[4] evaluated the efficacy of non-surgical interventions (orthoses, insoles, special footwear, physiotherapy) for the treatment of flexible flatfoot in children. It was concluded that the articles published from 1970 to 2011 were of poor quality and that the efficacy evidence of conservative treatment for flexible valgus flatfoot in children was very limited.

The present systematic review is the first to evaluate clinical and radiographic results of studies in which calcaneal lengthening osteotomy was performed in children and adolescents without congenital and neurological affections or with a diagnosis of painful flexible flatfoot. However, the retrieved articles presented poor scientific quality. Most of them were descriptive studies or case series (level of evidence III or IV), which presented methodological variations, including subjective criteria, heterogeneity of radiographic parameters, different implants, and additional surgical procedures, as well as a very variable follow-up period.

Due to the mentioned factors, it was not possible to carry out a meta-analysis. Most of the studies presented retrospective design, without control group. These methodological limitations are important in evaluating whether improvement can be attributed to treatment or to another factor. Among the few prospective studies, none was randomized.

One study compared calcaneal lateral column lengthening osteotomy with calcaneocuboid wedge osteotomy (triple C) and with subtalar arthroereisis[18]. The conclusion was that the two osteotomy techniques presented good clinical and radiographic results, but calcaneal lengthening osteotomy showed a greater correction capacity of the talonavicular subluxation, in spite of presenting more frequent and severe complications. Another study compared the results of arthroereisis and calcaneal lengthening osteotomy and showed a significant improvement in all evaluated parameters, with no statistical differences between the two groups, except for a greater correction of the calcaneal-floor angle in patients submitted to calcaneal lateral column lengthening osteotomy[14]. The authors concluded that subtalar arthroereisis is a procedure that deserves more research, because it presents good results and leads to a faster return to activities, besides being less invasive. There was no comparison between Evans[2] osteotomy (original technique/ 1959) and its modification developed by Mosca[10].

Our main recommendations for future studies on the subject are the following: prospective and randomized design with control group, precise inclusion criteria, standardized additional surgical procedures, defined follow-up period, pre- and postoperative kinematic assessment, validated questionnaires, baropodometry, and standardized radiographs with angles to be evaluated.

CONCLUSIONS

The results presented here show how the flatfoot treatment is still complex. Future studies on the surgical treatment of idiopathic flatfoot should have prospective and randomized design with control group and longer follow-up period. The inclusion criteria should be explicit. The methods of evaluating the results should be objective with radiographic parameters, baropodometry, kinematics, and validated questionnaires. Regarding the calcaneal lengthening osteotomy, there are reports of good clinical and radiographic results, but the studies present poor quality of scientific design.

R E S U M O

O pé plano flexível é condição frequente na criança pequena e apresenta forte tendência para correção espontânea, ou tornar-se moderado ou leve no adulto, o que não causará problemas futuros. Entretanto, em uma pequena proporção de casos a deformidade é mais grave, não melhora, o que pode levar ao comprometimento do desempenho mecânico, deformidade e, eventualmente, dor. Nestes casos o tratamento cirúrgico deve ser considerado. O objetivo desta revisão sistemática foi avaliar os resultados da literatura no tratamento do pé plano flexível sintomático da criança ou adolescente por um procedimento bastante frequente que é a osteotomia de alongamento da coluna lateral do calcâneo. Foi realizada busca sistemática eletrônica nas bases de dados PubMed, Web of Science, Cochrane, CINAHL, SciELO, SCOPUS e LILACS por artigos publicados entre março de 1975 e setembro de 2016. Após aplicação dos critérios de elegibilidade, os artigos selecionados foram avaliados quanto aos resultados clínicos, radiográficos e complicações. Dos 341 artigos encontrados nas bases de dados, apenas oito estudos foram selecionados, segundo os critérios de inclusão e exclusão, com um total de 105 pacientes e 167 pés tratados. Somente três autores realizaram estudo prospectivo, mas sem caso controle ou aleatorização. A maioria das publicações no período avaliado é composta por estudos descritivos ou série de casos (nível de evidência III ou IV), com grandes variações metodológicas, mas com alto índice de satisfação dos pacientes e cirurgiões, em relação aos resultados. Entretanto, são necessárias pesquisas com desenho prospectivo, aleatorizado, grupo controle adequado e critérios de avaliação validados.

Descritores: *Pé Chato. Osteotomia. Alongamento Ósseo. Calcâneo. Revisão.*

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Mailing address:
José Batista Volpon.
E-mail: hc.ortopedia@gmail.com