

Evans Osteotomy Without Bone Graft in Stage IIB Adult Flatfoot Deformity

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ABSTRACT

Objective: to evaluate the radiological and functional outcomes one year after surgery in a consecutive series of patients diagnosed with stage IIB adult-acquired flatfoot deformity who underwent Evans osteotomy without the use of bone graft. **Materials and Methods:** Two groups of patients were retrospectively evaluated: group 1 (spacer plate, n=12) and group 2 (PEEK cage, n=14). The mean age was 47 years (SD 18) in group 1 and 54 years (SD 12) in group 2. **Results:** 26 patients (28 feet) were evaluated; 14 (84%) of the patients were women. Radiographic measurements—calcaneal pitch angle, (lateral) talocalcaneal angle, (AP) talocalcaneal angle, talonavicular coverage angle, medial column height, lateral column length—yielded statistically significant differences between preoperative measurements and those taken one year after surgery. The mean score on the AOFAS scale one year after surgery was 96 (SD 4.70) in group 1 and 95 (SD 4.98) in group 2. Regarding the visual analog scale, it was 1.2 (SD 0.42) in group 1 and 1.16 (SD 0.46) in group 2. **Conclusions:** According to the results obtained, we conclude that Evans osteotomy without the use of bone graft manages to preserve the corrections obtained in the medium term, using either spacer plates or PEEK cages.

Keywords: flatfoot deformity; Evans osteotomy; lateral column lengthening

Level of Evidence: III

Osteotomía de Evans sin injerto óseo en el pie plano estadio IIB del adulto

RESUMEN

Objetivo: Evaluar los resultados radiográficos y funcionales al año de la cirugía, en una serie consecutiva de pacientes con diagnóstico de pie plano valgo estadio IIB, sometidos a una osteotomía de Evans sin injerto óseo. **Materiales y Métodos:** Se evaluó, en forma retrospectiva, a dos grupos de pacientes: grupo 1 (placa con espaciador, n = 12) y grupo 2 (celdas de PEEK, n = 14). La edad promedio era de 47 años (DE 18) en el grupo 1 y de 54 años (DE 12) en el grupo 2. **Resultados:** Se evaluó a 26 pacientes (28 pies operados); 20 (77%) eran mujeres. Las mediciones radiográficas: ángulo de inclinación del calcáneo, ángulo astrágalo-calcáneo (perfil), ángulo astrágalo-calcáneo (frente), cobertura astragalonavicular, altura de la columna medial, longitud de la columna externa, arrojaron diferencias estadísticamente significativas entre las determinaciones preoperatorias y al año de la cirugía. El puntaje promedio de la escala de la AOFAS al año fue de 96 (DE 4,70) en el grupo 1 y de 95 (DE 4,98) en el grupo 2. El puntaje en la escala analógica para dolor fue de 1,2 (DE 0,42) en el grupo 1 y 1,16 (DE 0,46) en el grupo 2. **Conclusiones:** De acuerdo con los resultados obtenidos, concluimos en que la osteotomía de Evans sin el uso de injerto óseo logra preservar las correcciones obtenidas en el mediano plazo utilizando placas con espaciador o celdas de PEEK.

Palabras clave: Pie plano; osteotomía de Evans; elongación; columna externa.

Nivel de Evidencia: III

INTRODUCTION

Adult pes planovalgus (PPV) is a relatively common condition in the foot and ankle specialty; it affects 20-30% of the general population, and it is more frequent in females around the fifth or sixth decade of life.¹ Although the etiology can be attributed to systemic inflammatory, developmental, or neuromuscular diseases, and even trauma, posterior tibial tendon dysfunction remains the most common cause.

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Clinically, stage IIB is characterized by loss of the medial longitudinal arch, hindfoot valgus, forefoot abduction, too many toes sign, and inability to invert the hindfoot when raising the heels while standing (heel rise test).²⁻⁴

In 1989, Johnson and Strom⁵ classified posterior tibial tendon dysfunction into three stages; later this classification was modified by Bluman et al.⁶ who added stage IV. One of the surgical procedures proposed for the treatment of stage IIB is the lengthening of the lateral column by means of the Evans osteotomy, indicated only in patients with a flexible deformity.

The lateral column is made up of the fourth and fifth tarsometatarsal joints, the cuboid, the calcaneocuboid joint, and the calcaneus.

The Evans osteotomy is performed 1.5–2 cm proximal to the articular surface of the calcaneocuboid joint,⁷ and the diastasis can be maintained by placing a tricortical bone graft,⁸ plates with a spacer plus bone graft, or other less widespread alternatives, such as PEEK (polyetheretherketone) cages originally designed as an interbody spacer for spinal arthrodesis surgeries (Figures 1-3).⁹⁻¹²



Figure 1. Evans osteotomy.



Figure 2. Plate with a spacer.

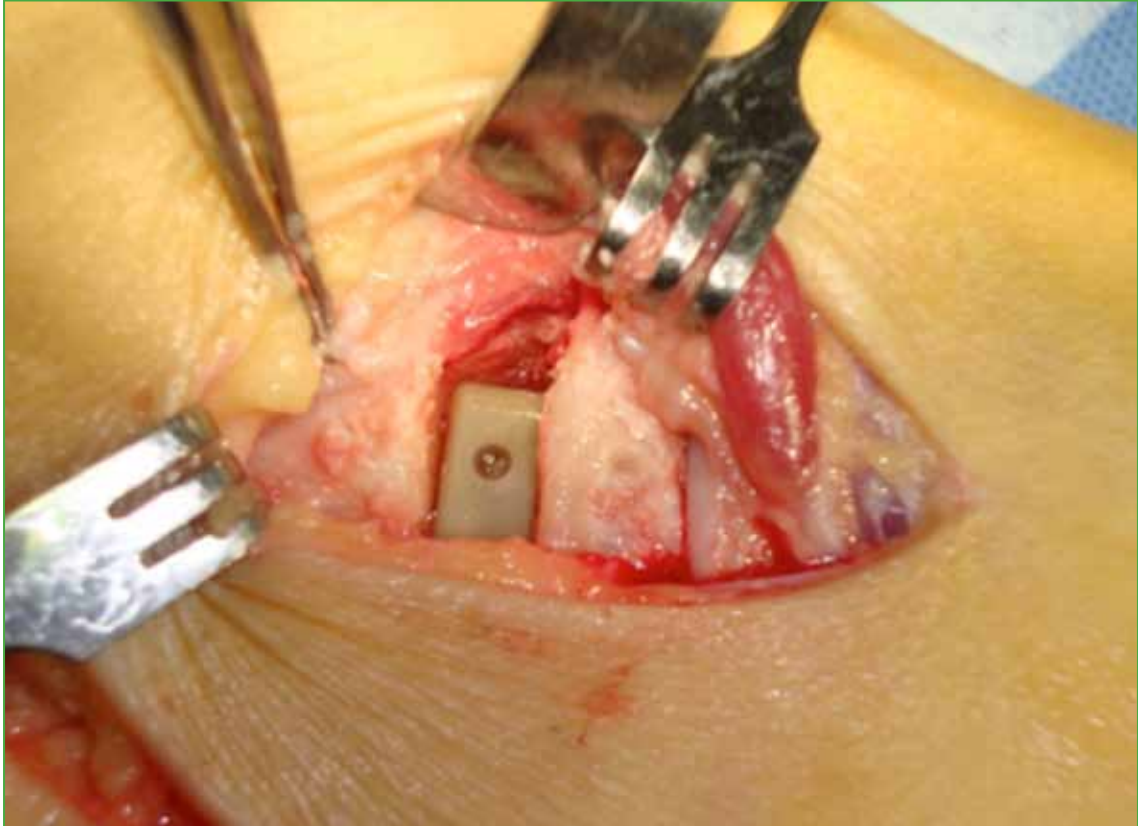


Figure 3. PEEK cage.

This procedure generates a three-dimensional correction, characterized simultaneously by forefoot adduction at the talonavicular joint, midfoot plantarflexion, and hindfoot valgus correction. At present, there are controversies about which is the most adequate method to maintain the distraction of said osteotomy.

One of the main factors for the failure of this osteotomy in the long term is the delay in consolidation or pseudarthrosis, which would result in a loss of the correction obtained.¹³

The objective of this study was to evaluate the radiographic and functional outcomes one year after surgery, in a consecutive series of patients with stage IIB PPV, who underwent an Evans osteotomy without bone graft.

MATERIALS AND METHODS

A retrospective study was carried out on a consecutive series of patients with flexible flatfoot with hindfoot valgus and forefoot abduction (stage IIB PPV), who had undergone lateral column lengthening (Evans osteotomy) without the use of a bone graft, between March 2010 and March 2014, in the Foot and Ankle Medicine and Surgery Sector of the Orthopedics and Traumatology Service of our institution. Patients with revision surgery, systemic diseases, neurological sequelae, or follow-up <1 year were excluded.

The information of the patients was collected from the electronic health records. This study was evaluated and approved by the Ethics Committee of the institution.

Clinical-radiographic study

All patients had preoperative and postoperative radiographic measurements three months and one year after surgery. Functional assessment was performed using the AOFAS scale (American Orthopedic Foot and Ankle Society) and the visual analog scale for pain before surgery and one year after it. The clinical-radiographic evaluations were carried out by two specialists in foot and ankle surgery.

The following measurements were taken:

Lateral radiographs

- *Calcaneal inclination*: it was measured by drawing a line tangent to the lower edge of the calcaneus and another line from the lower edge of the medial sesamoid to the inferior process of the calcaneus. A value from 18° to 20° was considered normal.

- *Medial column height*: it was measured as the distance between the line of the base of the first metatarsal to the line that passes through the inferior border of the medial sesamoid. Values of 20 ± 3 mm were considered normal.

- *Talus-first metatarsal angle*: a line connecting the longitudinal axis of the talus with the axis of the first metatarsal (the longitudinal axis of the talus is measured by placing a midpoint between the superior and inferior face in the center of the articular surface and a midpoint in the neck of the talus). The normal value is $0 \pm 4^\circ$.

Anteroposterior radiographs

- *Talus-first metatarsal angle*: the angle formed by a line drawn by the axis of the first metatarsal and another that passes through the axis of the talus. The normal value is $0 \pm 5^\circ$.

- *Talonavicular coverage*: it is measured as the angle formed by a line drawn perpendicular to the articular surface of the talus and a second line perpendicular to the articular surface of the navicular. The normal value is from 0 to 10°.

- *Length of the lateral column*: a line that goes from the posterior process of the calcaneus to the metatarsophalangeal joint of the fifth toe. The normal value is 160 ± 5 mm in length.

The patients were analyzed in two groups according to the method used for the lengthening of the lateral column: group 1, with a locking plate with a spacer, and group 2, with PEEK cages.

Statistical Analysis

Continuous variables are expressed as median with their respective interquartile range 25-75 and categorical variables, as relative or absolute frequencies. Comparisons between radiographic measurements were made using Student's t-test for paired samples. Preoperative measurements were compared with those obtained at 12 months, and measurements at three months with those at 12 months. A p-value <0.05 was considered statistically significant.

RESULTS

Between March 2010 and March 2014, 77 patients with stage II PPV underwent surgery. In the study, 26 patients were included, 20 (77%) were women and two underwent surgery on both feet (28 feet). The mean age was 47 years (standard deviation [SD] 18) in group 1 and 54 years (SD 12) in group 2.

In 14 feet, an Evans osteotomy was performed with a locking plate with a spacer (group 1), while in the remaining 14 feet, PEEK cages were used (group 2). The surgeries were carried out by the same team of surgeons specializing in foot and ankle pathologies.

The average surgical time was 117 min (SD 4) in group 1 and 104 min (SD 5) in group 2 ($p = 0.05$).

When analyzing the radiographic variables in group 1 (plates with a spacer) and group 2 (PEEK cages), statistically significant differences were observed between the preoperative measurements and those taken 12 months after surgery, except for the lateral column length variable. (Tables 1 and 2).

Table 1. Radiographic measurements in the preoperative period and 12 months after surgery in group 1 (plates with a spacer) (n = 14 feet)

Measurement*	Preoperative period	12 months after surgery	p
Calcaneal inclination angle	12.70° (10-14)	21.18° (18-27)	<0.05
Talocalcaneal angle (lateral)	16.22° (12-20)	5.9° (0-7)	<0.05
Talocalcaneal angle (AP)	21.86° (19-31)	3.68° (2-9)	<0.05
Talonavicular coverage	23.56° (16-41)	5.6° (2-9)	<0.05
Medial column height	10.75 mm (9-16)	18.51 mm (18-21)	<0.05
Lateral column length	162 mm (157-170)	163 mm (155-167)	0.48

*The values are expressed as median (interquartile range).

Table 2. Radiographic measurements in the preoperative period and 12 months after surgery in group 2 (PEEK cages) (n = 14 feet)

Measurement*	Preoperative period	12 months after surgery	p
Calcaneal inclination angle	12.80° (9-15)	19.32° (15-24)	<0.05
Talocalcaneal angle (lateral)	19.03° (16-23)	5.33° (3-10)	<0.05
Talocalcaneal angle (AP)	22.04° (16-25)	4.15° (3-13)	<0.05
Talonavicular coverage	23.75° (19-44)	7.61° (5-14)	<0.05
Medial column height	13.5 mm (12-15)	21.15 mm (19-26)	<0.05
Lateral column length	168.5 mm (160-173)	169.4 mm (164-171)	0.17

*The values are expressed as median (interquartile range).

The same measurements were taken three months and 12 months after the operation and no statistically significant differences ($p>0.05$) were found in either of the two groups (Tables 3 and 4).

Table 3. Radiographic measurements 3 and 12 months after surgery in group 1 (plates with a spacer) (n = 14 feet)

Measurement*	3 months after surgery	12 months after surgery	p
Calcaneal inclination angle	22.58° (17-26)	21.18° (18-27)	0.71
Talocalcaneal angle (lateral)	2.01° (0-8)	5.9° (0-7)	0.1
Talocalcaneal angle (AP)	3.24° (1-7)	3.68° (1-9)	0.05
Talonavicular coverage	2.9° (2-7)	5.6° (2-9)	0.92
Medial column height	19.90 mm (17-22)	18.51 mm (18-21)	0.88
Lateral column length	163.85 mm (159-168)	163 mm (155-167)	0.39

*The values are expressed as median (interquartile range).

Table 4. Radiographic measurements 3 and 12 months after surgery in group 2 (PEEK cages) (n = 14 feet)

Measurement*	3 months after surgery	12 months after surgery	p
Calcaneal inclination angle	21.16° (18-24)	19.32° (15-24)	0.94
Talocalcaneal angle (lateral)	7.17° (4-11)	5.33° (3-10)	0.94
Talocalcaneal Angle (AP)	4.29° (2-12)	4.15° (3-13)	0.24
Talonavicular coverage	8.27° (4-15)	7.61° (5-14)	0.9
Medial column height	22.95 mm (20-23)	21.15 mm (19-26)	0.89
Lateral column length	167.5 mm (163-175)	169.4 mm (164-171)	0.76

*The values are expressed as median (interquartile range).

When the radiographic measurements were analyzed according to the type of intervention, similar results were obtained in both groups. In the first instance, an improvement was observed in all postoperative measurements when compared with the preoperative ones, and they maintained stability between 3 and 12 months after surgery. These differences were statistically significant, except for the length of the lateral column.

There were no statistically significant differences in the same comparative measurements of both groups in the third and twelfth postoperative months.

The average score on the AOFAS scale was 48.57 (SD 10.44) before surgery and 96 (SD 4.70) a year later in group 1, while in group 2 it was 49.8 (SD 11.61) and 95 (SD 4.98), respectively.

Regarding the visual analog scale for pain, the results in group 1 were 5.08 (SD 1.13) before surgery and 1.12 (SD 0.42) after one year; and 5.6 (SD 0.42). 0.80) and 1.16 (SD 0.46), respectively, in group 2. In both cases, the measurements were statistically significant.

Complications were divided into early and late. In group 1, one patient had a wound dehiscence and two superficial infections, which were treated with oral antibiotics and healed without complications, and a late complication of asymptomatic calcaneocuboid osteoarthritis that did not require surgical treatment.

In group 2, only late complications occurred: two delayed unions and two losses of osteotomy site reduction. In one patient with delayed union, fusion was achieved, while the other case progressed to nonunion; none had a clinical repercussion that required a new surgery.

DISCUSSION

Evans osteotomy is one of the tools designed for the treatment of adult PPV. Numerous studies have already shown that lateral column lengthening is a determining factor for the correction of forefoot abduction in adult-acquired flatfoot.^{14,15}

The treatment of stage II PPV is the one that generates the most controversy. A 2002 survey of foot and ankle surgeons revealed that 43% would use lateral column lengthening in combination with other procedures to reconstruct a stage IIB flat foot; this highlights the variety in therapeutic approaches.⁹

The results of our study show that the corrections obtained by means of the Evans osteotomy without the use of a bone graft do not change in the short-term follow-up. It is also interesting that all the radiographic variables evaluated before surgery undergo a statistically significant change in the postoperative period, except for the length of the lateral column, which does not show differences when evaluated and compared before surgery and after 3 and 12 months.

This fact coincides with what was published by Kang et al.¹⁶ who found no differences in the length of the lateral column when comparing patients with and without PPV.

Various procedures are used to maintain the space created by the Evans osteotomy. Autologous iliac crest bone grafting is accepted as the best option, although the donor site complication rate is around 20% (pain, neuropraxia, cosmetic problems, hemorrhage, hernias, crest fractures).¹⁷⁻²⁰ The allograft would eliminate complications at the donor site, but would require a longer consolidation time, the availability of a tissue bank, a higher cost, and the risk of transmission of infectious diseases.²¹

Taking into account the morbidity of the donor site and the problems with allografts, Niño Gómez et al.⁸ adopted the use of PEEK cages with autograft for various procedures in foot and ankle surgeries, and achieved bone healing in 21 of 22 patients (mean: 14 weeks).

In our study, consolidation was achieved in three months in 93% of the operated feet; therefore, we can suggest the possibility of dispensing with the use of an autograft or allograft to perform this technique, regardless of the method used to maintain the correction.

Cooper et al.²² reported that compression forces in the calcaneocuboid joint are multiplied eight times above the normal value when a 10-mm lengthening is performed, which is consistent with what was published by Xia et al.,²³ who suggest a diastasis not greater than 8 mm to avoid the risk of osteoarthritis or calcaneocuboid subluxation.²⁴ Although correlating the size of the diastasis and its possible complications was not the objective of this study, we detected one case of calcaneocuboid osteoarthritis in group 1 and two subluxations in group 2. Despite this, none of these late complications had clinical relevance, which is consistent with what was published by Ahn et al.,¹³ who suggested that it is not necessary to correct subluxations, because they would not generate osteoarthritic changes in the medium term.

Regarding the clinical assessment using the AOFAS scale, a statistically significant improvement was obtained in the values one year after the intervention in both groups. No differences were found when comparing both groups 12 months after surgery.

The limitations of our study are its retrospective and observational design with a short follow-up. The correlation between the size of the diastasis obtained and late complications was not evaluated.

CONCLUSIONS

The solution to pain caused by PPV remains under development. Based on the results of this study, it can be concluded that Evans osteotomy using lateral column lengthening is a reproducible and reliable method to reconstruct the normal functional stability of the midfoot and hindfoot, and that both locking plates with spacers and PEEK cages manage to preserve the corrections obtained with the Evans osteotomy in the medium term, without the need for a bone graft.

Conflict of interest: The authors declare no conflicts of interest.

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