Quantifying Loss of Correction in Pediatric Patients after an Evans Calcaneal Osteotomy: Is Acute Overcorrection Necessary?

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STATEMENT OF PURPOSE

The Evans calcaneal osteotomy is a powerful correction of transverse plane deformities in the pediatric flatfoot, but has shown some loss of correction in the post-operative period. This is likely due to graft subsidence, mentioned in Evans' original report.[1] Due to presence of correction loss, questions arose as to whether intraoperative overcorrection should be performed to compensate for the suspected loss. Additionally, if overcorrection is needed, how much overcorrection should be obtained? The aim of this study was to quantify loss of correction in the post-operative period in pediatric patients undergoing Evans calcaneal osteotomies and to determine whether acute overcorrection in these patients is necessary to maintain ideal post-operative position.

LITERATURE REVIEW

Evans Calcaneal Osteotomy

Originally reported in 1975, the Evans Calcaneal Osteotomy serves as a means of correction of the calcaneo-valgus foot.[1] Evans' goal of the osteotomy was to equalize lengths of the medial and lateral column in order to restore medial longitudinal arch integrity.[2] The osteotomy was originally described as an opening wedge in the calcaneus, 1.5cm from the calcaneocuboid joint.[1] Autografts, allografts, xenografts, and synthetic wedges have all been described in literature.[3]

Graft Subsidence

In his original report, Evans described a potential complication as sinking of the graft into the calcaneus.[1] This is also called subsidence, and typically occurs in the first 6 post-operative weeks.[4] A study by Samartzis et al found post-operative subsidence of the cervical spine in 96% of patients and quantified it as 1mm in each graft.[4] Although thoroughly studied in the spine, it is rarely reported in foot and ankle literature. In a study by Myerson et al, 11 calcaneal osteotomies with tricortical allograft were studied and no evidence of further graft resorption was noted at 2.5 months.[5] Graft subsidence has been reported in the first 9 post-operative weeks, but no efforts have been made to quantify this subsidence in the lower extremity.

Radiographic Effects of the Evans Osteotomy

Sangeorzan et al studied radiographs of 7 patients that underwent Evans osteotomies and determined, due to Evans' powerful transverse plane correction, talar coverage and overall calcaneal length were significantly affected.[6] However, coronal and sagittal plane angles were also affected. In a pediatric population where growth throughout a study period is inevitable, relying on radiographic angles instead of calcaneal length is necessary. Additionally, Sangeorzan did not explore potential loss of correction. There appears to be no reports in literature comparing pediatric pre- and post-operative radiographs after Evans Calcaneal Osteotomies.

FINANCIAL DISCLOSURES

No financial disclosures

METHODOLOGY & PROCEDURES

Retrospective review of 18 patients and 28 feet that underwent an Evans Calcaneal Osteotomy over a 5-year span by a single surgeon (RB). Surgical procedure was performed as a dorsolateral sinus tarsi approach and a calcaneal osteotomy approximately 1.5cm proximal to the calcaneocuboid joint. Trial implants were used to observe the desired correction, and placement of a fresh-frozen bicortical allograft wedge was achieved with or without the use of fixation. Radiographs were obtained from within 2 months prior to surgery, within 1 week after surgery, and an average of 6.5 months after surgery. Total follow up for each patient was >1 year. Radiographic angles were evaluated by a single author and statistical analysis utilizing the chi square test was performed where <0.05 was statistically significant.

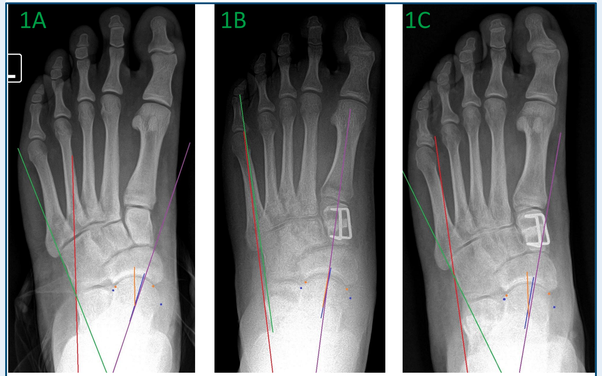
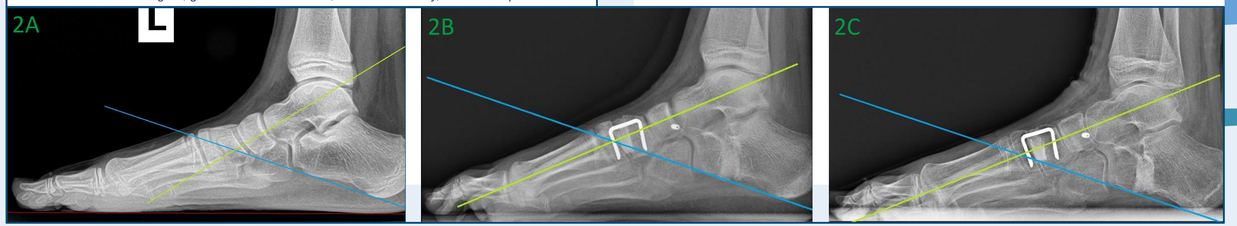


Figure 1. Pre-operative (A), immediate post-operative (B), and final post-operative (C) lateral radiographs from a 17 year old male that underwent an Evans calcaneal osteotomy with a 12mm bicortical allograft, Cotton osteotomy, and Kidner procedure.

Figure 2. Pre-operative (A), immediate post-operative (B), and final post-operative (C) anteroposterior radiographs from a 14 year old male that underwent an Evans calcaneal osteotomy with 12mm bicortical allograft, gastrocnemius recession, Cotton osteotomy, and Kidner procedure.



RESULTS

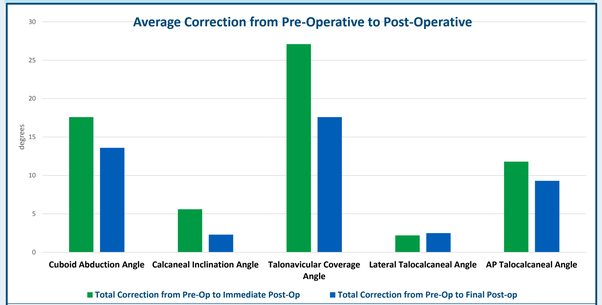


Figure 3. Average immediate correction (green) versus average final correction (blue) for each radiographic angle measured. Differences in immediate to final correction noted on Table 1.

ANGLE	Average Loss of Correction (degrees)	P-value
Cuboid Abduction Angle	4.0	0.0347
Calcaneal Inclination Angle	3.4	0.0367
Talonavicular Coverage Angle	9.4	0.0482
Lateral Talocalcaneal Angle	-0.3	0.3704
AP Talocalcaneal Angle	2.5	0.1200

Table 1. Average amount of correction loss for each radiographic angle when comparing immediate post-operative angles versus final post-operative angles. P-values showing statistically significant loss for the cuboid abduction, calcaneal inclination, and talonavicular coverage angles.

ANGLE	Correction Loss with Fixation Present (degrees)	Correction Loss without Fixation Present (degrees)	P-value
Cuboid Abduction Angle	1.7	4.3	0.0488
Calcaneal Inclination Angle	2.3	3.5	0.0923
Talonavicular Coverage Angle	7.7	9.6	0.1876
Lateral Talocalcaneal Angle	2.3	-0.6	0.0705
AP Talocalcaneal Angle	2.7	2.4	0.4197

Table 2. Average correction loss with presence of fixation versus correction loss without presence of fixation. P-values show a statistically greater loss of correction without presence of fixation in the cuboid abduction angle.

ANALYSIS & DISCUSSION

Determining intraoperative correction for the Evans calcaneal osteotomy can be difficult. Average graft size has been previously studied: Myerson et al found an average size of 10mm.[5] Siddiqui and Lamm described the use of digital software for pre-operative planning of Evans osteotomies, but did not take into account potential for loss of correction.[8]

Cuboid abduction angle and talonavicular coverage angle, which Evans most notably affects due to its transverse plane correction, had the greatest statistically significant loss of correction in our present study. According to these results, consideration should be given for acute overcorrection of the cuboid abduction angle by 4° and talonavicular coverage angle by 9.4°, which should lead to an acceptable loss of correction post-operatively and maintenance of ideal position.

No trends were seen with age of patient nor presence of ancillary procedures. In a report by Jara et al, cadaveric studies show that grafts >10mm wide, increase pressure placed on the graft, possibly leading to further subsidence.[3] However, in our study, graft size was not noted to affect loss of correction. Another factor reviewed was presence of fixation. A retrospective report by Dayton et al compared locking plates versus tricortical grafts and found better preservation of lateral column length with fixation.[7] Similarly, Protzman et al compared wedge locking plates versus tricortical grafts and found better maintenance of midcalcaneal length with fixation, but found more complications in this group.[2] In our study, a statistically significant greater loss of correction was seen in the cuboid abduction angle when fixation was present. However, presence of fixation requires more dissection[3] and can cause peroneal irritation leading to later hardware removal.[2]

LIMITATIONS AND SHORTCOMINGS

The first limitation of our present study is its retrospective design. Secondly, immediate post-operative films, despite taken in a weight-bearing attitude, are not truly weight-bearing and therefore evaluation of immediate versus final correction many not be a fair comparison. True weight-bearing exaggerates talar uncoverage and calcaneal declination. A limitation was that radiographic follow up was limited to an average of 6.5 months. Due to patients' pediatric nature, long-term radiographs were only taken if the symptoms continued. Unmeasured variables, such as influence of other joints and patients' continued growth were also present. Overall, despite the limitations, this study was able to quantify loss of correction in pediatric patients, and potentially lead to further studies on this topic.

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