Rare, But Existing Complications after Calcaneal lengthening osteotomy for the treatment of symptomatic planovalgus deformity in children and Adolescent

Raytcho Kehayov[1(✉)], S.Nikolova [1]
[1] Medical University Sofia. Department of orthopedics and traumatology.
USHATO "Prof. B. Boychev", Sofia, Bulgaria
rkehayov@abv.bg

Abstract— Purpose: Description and analysis of the rare, but existing complications from the application of calcaneal lengthening osteotomy for treatment of the symptomatic flatfoot deformity in children and adolescents.

Materials and methods: The procedure of calcaneal lengthening osteotomy has been introduced at the University Orthopaedics Hospital „Prof. B. Boichev"in 1999. The study included 64 children or 92 cases, the average age being 11.61±1.90, and the youngest child being 7 years of age. The deformity is more often found in males, making up 44 or 68.75% of the cases. The females make up 20 of the cases, or more precisely 31.25%. We used angle X-ray measurements of the feet in AP and profile positioning, with a mandatory upright position of the pateints, to figure out the severity of the flatfoot deformity. When grading based on the subjective criteria, we used an instrument called Visual-Analogue-Scale Foot and Ankle (VAS FA). To grade the complications, we applied the clinically based Dindo-Clavien classification, used in orthopaedic surgery.

Results: The average timing for an overall follow-up for all cases is 18.65± 8.29 months. A correction of the CIA appears in all cases that were operated. The average value of the angles at the time of diagnosis of the deformity, the average value was 13.07°, which has risen to 23.25° by the last follow-up session. When analyzing the changes in the MA (angle of Meary), we observed that the angle has decreased to 7.87° in the last follow-up session. The TNCA has decreased with an average of -8.272±5.27°, taking into consideration the high statistical reliability ($p \leq 0.00$). Even though we mark five cases of dorsal subluxation of the distal fragment, we have observed a complication from a degenerative process of the CC (calcaneo-cuboid) joint.

Keywords— calcaneal lengthening osteotomy, calcaneo-cuboid joint, subluxation of the distal fragment.

1. INTRODUCTION

Currently, there is no final consent, concerning the indications for treatment of the symptomatic flatfoot in children and adolescents3. In the case of failed conservative treatment, with persistent pain syndrome or the appearance of new such symptoms, quick or early tiredness with walking or loading, the appearance of callosities or

wounds due to over-support or pressing, which cannot be overcome with orthotic treatment, operative interventions are considered35,36. Two of the many various operative techniques described are most popular: lengthening calcaneal osteotomy and the minimally invasive intervention subtalar arthroeresis (SA). Lengthening calcaneal osteotomy has been described by Evans for the first time. Later on, the technique is interpreted, modified and developed by Mosca, who describes the exact indications for the procedure, the specific location of performing the osteotomy, the size and the shape of the graft.[27,28]

Bussewitz BW et al. (2001) and Mahan K et al. (2001) have turned their attention to the orientation of the osteotomy and its vast importance in protection of the sustenaculum tali. Otherwise, this may cause an iatrogenic fracture of the same, damage to the flexor hallucis longus, and cause tarsal tunnel syndrome, due to the development of a hypertrophic bony callus.

With further advancement of current technologies, new opprotunities for the use of various, in type and biology, grafts are being developed. This includes auto-grafts, allografts and titanium blocks. Fixation of the osteotomy varies from K-wires in the beginning, through to screws, brackets and special designer plates. The understanding of the advantages and disadvantages of every option helps us make the best possible choice of method with the least number of complications. Some of the most commonly found complications are loss of correction (due to resorption of the graft or "disintegration"of the osteosynthetic material), damage of the peroneal tendons (due to inappropriate osteosynthesis), dorsal dislocation of the distal fragment and degenerative osteoarthritis of the calcaneo-cuboid joint (CC).

2. MATERIALS AND METHODS

The procedure of calcaneal lengthening osteotomy has been introduced at the University Orthopaedics Hospital „Prof. B. Boichev"in 1999. The study included 64 children or 92 cases, the average age being 11.61±1.90, and the youngest child being 7 years of age. The deformity is more often found in males, making up 44 or 68.75% of the cases. The females make up 20 of the cases, or more precisely 31.25%. Both feet are affected equally. In 51 cases or 55.43%, lengthening calcalneal osteotomy has been performed on the right foot and in 41 cases, or 44.67%, on the left foot.

To define the degree of severity of the deformity, we used angle measurements on radiographs. On the AP radiographic image we define the Talo-Navicular Coverage Angle (TNCA) or the angle of coverage of the head of the talus. In profile stress radiography, we define the following: 1. Calcaneal Inclination Angle (CIA), also known as the Calcaneal Pitch, 2. Lateral Talo-IMT Angle or angle talus-I MT bone (MA).

When grading the subjective criteria, we have used an instrument called the Visual-Analogue-Scale Foot and Ankle[32] with the following characteristics: a questionnaire, based on 20 questions, requiring clearly subjective answers; three different categories of questions (pain n=4; function n=11; other complaints n=5) and a result, received on the basis of the Visual-Analogue Scale Foot and Ankle (VAS FA).

Statistical and descriptive methods, accepted in behavioral and social sciences, have been used to summarize, present and analyze the data.

We applied a clinically based classification of Dindo-Clavien, used in orthopaedic surgery[11], to grade the complications.

In our technique, a lamina spreader is used for performing the distraction between the two fragments of the open osteotomy. A 0.5mm K-wire or a Steinemann pin is placed beforehand, from the tuber calcanei, through the osteotomy and the calcaneocuboid joint, to stabilize the distal fragment and to prevent its dorsal subluxation.

In 24 of the cases, treated with lengthening calcaneal osteotomy, a modified technique of Evans-Mosca with an allograft, an additional metal osteosynthesis – a cannulated screw – and immobilization with a cast for the period of bone consolidation has been used. An X-plate Synthes® type osteosynthesis has been used in 10 of the cases and an H- plate Arthrex® type osteosynthesis in 57 of the cases.

3. RESULTS

In the current study, the data from the last follow-up examination of all patients has been reported, as well as placed in the patient files, including the radiographic findings.

The timing of follow-up sessions covers the period from the start date of the treatment up to the last follow-up examination. The average timing of the follow-up for all cases is 18.56 ± 8.29 months. The minimum timing of the follow-up sessions is nine months and the maximum is 48 months.

A correction of the CIA appears in all cases that were operated. The average value of the angles at the time of diagnosis of the deformity was 13.07°, which has risen to 23.25° at the last follow-up session. This has been calculated with a high statistical reliability ($p \leq 0.00$). The average CIA for these cases, accepted as a final result is 23.25±5.418°.

When analyzing the changes in the MA (angle of Meary), the data from the Paired Samples Test show similar results. This angle decreases with an average of -6.75±4.52°. This is once more given with a high statistical reliability ($p \leq 0.00$). The average angle has decreased from 14.62°, before the operation, to 7.87° at the last follow-up session.

The TNCA, which we have considered as one of the most important subjective criteria for correction of the flatfoot deformity, changes as follows: from an average pre-operative value of 16.38°, to a 8.11°, at the final follow-up examination. This angle has decreased with an average value of -8.272±5.27°, with a high statistical reliability ($p \leq 0.00$).

In subjective grading of the effect of the treatment, we have taken into consideration the summarized results from the questionnaire and the VAS FA (visual analogue scale foot and ankle). The points increase as follows: from a pre-operative average of 58.92 to 88.60 post-operatively and at the last follow-up examination, or an average of 29.67±8.92, which is with a high statistical reliability ($p \leq 0.00$).

We have not reported cases of profound post-operative infection, slow consolidation or absence of consolidation in the group of lengthening calcaneal osteotomies. We have

had three cases of superficial infection of the wound in the same group, treated with antibiotic therapy. Even though we reported five cases of dorsal subluxation of the distal fragment (Fig. 1) and (Fig. 2), we have not observed complications of a degenerative process of the CC (calcaneo-cuboid) joint, as with the presence of complaints during the last follow-up session.

According to the classification of the post-operative results and complications, clinically based on Dindo-Clavien11, our results land in the group with a second degree, i.e. these are patients, requiring ambulatory surveillance due to proven complications, leaving the results of the performed surgery unaffected.

(Fig.1) Correction no a flatfoot deformity, with a dorsal subluxation of the distal fragment of the osteotomy.

(Fig.2) Correction of the flatfoot deformity, fixation with an H- plate Arthrex® and dorsal subluxation of the distal fragment and osteotomy.

4. DISCUSSION

Osteotomies of the calcaneus and partly the procedure of lengthening calcaneal osteotomy remain the most-studied and most-commonly applied operative techniques, which truly have the opportunity to align the damaged morphology of the foot, without a particular risk of early arthritic changes in the symptomatic flatfoot. These surgeries are extra-articular and conserve the mobility of the joints in the foot.

Although the absence of complications in our study, there are numerous authors, which announce a high prevalence of complications in the lengthening calcaneal osteotomy group.[3,4,12,13,17,19,20] This is most probably associated with the high incidence

of the calcaneo-cuboid subluxation. In opposition to these reports, there are studies, demonstrating a decrease in the degree of subluxation through time and a minor effect on the clinical complaints and symptoms.[36,37]

In our study, we report a lower percentage of this complication. We found a worsening of the clinical symptoms and development of late arthritic changes of the joint. Concerning re-operation, we reported such, whilst several authors point to loss of correction as the primary cause of secondary interventions.[22,36]

Zeifang et al. (2006) report, that in only two of nine feet with a CC subluxation, the congruency of the joint recuperates to a normal state. We believe that the percentage of subluxation of the CC joint continues to decrease as we increase the follow-up sessions without development of osteoarthritis of the joint. Even though Bussewitz (2013) on the basis of research on cadavers, reports that in lengthening calcaneal osteotomy the pressure in the CC joint does not increase beyond physiological boarders. Other reports, studying CC subluxation made surgeons attempt at prevention of this complication through decreasing the size of the bone graft.[3,4,5,10] Dumontier et al. (2005) report, that the dorsal capsule of the CC joint has a pseudodiverticular swelling, which plays an important role in the developing subluxation. This complication is clearly observed in approximately a bone graft of 10- to 12mm in size or the associated degree of distraction. Xia (2013) suggests that the ideal size of the graft is 8mm in lengthening calcaneal osteotomy, through measuring the peak pressure.

5. CONCLUSION

Based on our results and data obtained from medical literature, we have found that the procedure of lengthening calcaneal osteotomy gives relatively good clinical and radiographic results, although the surgery requires a lengthy post-operative recuperative period. The complications of the lengthening calcaneal osteotomy procedure are associated with intra- and post-operative subluxation of the calcaneo-cuboid joint, which requires its additional stabilization. The size of the applied distraction should not exceed 8mm. If the correction is insufficient, additional procedures should be applied "a la carte."

Presented are reports, documenting the decrease in the degree of the calcaneo-cuboid subluxation with time. The current advancements are aimed at the development of both implants and operative techniques.

Overall, the positive conclusion is that the good results from the operative interventions are possible, when they are applied appropriately and to the right patient.

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7. AUTHORS

Raytcho Kehayov, M.D. Ph.D., is member of the Bulgarian Orthopedic and Traumatology Association (BOTA), the Bulgarian Association of Foot and Ankle Surgery (BAFAS) and EFAS. He works as an orthopaedic surgeon at USHATO "Prof. B. Boychev". He is an Assistant Professor at the Department of Orthopedics and Traumatology, Medical University Sofia, Sofia, Bulgaria.

Sofia Nikolova M.D. is member of the Bulgarian Orthopedic and Traumatology Association (BOTA) and the International Society of Aesthetic and Plastic Surgery (ISAPS). She is a medical resident in Plastic, reconstructive and aesthetic surgery and works at the University Orthopedic Hospital „prof. Boycho Boychev". She is a PhD candidate at the Department of Orthopedics and Traumatology, Medical University of Sofia, Sofia, Bulgaria.