The stop screw technique—A simple and reliable method in treating flexible flatfoot in children

Joerg Jerosch Dr.med.Dr.h.c. a,*, Jochem Schunck a, Hazem Abdel-Aziz b

a Johanna-Etienne Hospital, Am Hasenberg 46, 41462 Neuss, Germany
b El-Hadra Orthopaedic and Traumatology University Hospital, Alexandria University, Egypt

1. Introduction

Flat foot is a developmental or acquired deformity that is progressive and is characterized by plantar medial rotation of the talus, decrease in the medial arch height, and abduction of the forefoot [1]. It may exist as an isolated pathology or as part of a larger clinical entity as in generalized ligamentous laxity, neurologic and muscular abnormalities, genetic syndromes, and collagen disorders [2]. Pediatric flatfoot can be divided into flexible and rigid categories. Flexible flatfoot can be characterized by a normal arch during non-weight-bearing and a flattening of the arch on stance, it may be symptomatic or nonsymptomatic [3]. The asymptomatic flexible flatfoot may be physiologic or nonphysiologic [4]. Physiologic flexible flatfoot follows a natural history of improvement over time and requires periodic observation to monitor for signs of progression [5,6], while the nonphysiologic type is characterized by progression over time. The degree of deformity is more severe than in the physiologic flexible flatfoot. The amount of heel eversion is excessive; the talonavicular joint is unstable.

On the other hand symptomatic forms of flexible flatfoot produce subjective complaints, alter function, and produce significant objective findings including pain along the medial side of the foot; pain in the sinus tarsi, leg, and knee; decreased endurance; gait disturbances; prominent medial talar head; everted heels; and heel cord tightness [3]. Persistent pronation of the subtalar joint during the propulsive phase of gait is mostly responsible for major deformities in adult life [7]. Hallux valgus, metatarsalgia, tarsal tunnel syndrome, posterior tibial tendon dysfunction, and osteoarthritis of the subtalar and midtarsal joints are often the consequences and the "natural history" of this deformity [8,9].

Initial treatment includes activity modifications and orthoses. Nonsteroidal anti-inflammatory medications may be indicated in more severe cases. Comorbidities, such as obesity, ligamentous laxity, hypotonia, and proximal limb problems, must be identified and managed, if possible [3]. If the clinical response is not satisfactory and all nonsurgical treatment options have been exhausted, surgical intervention can be considered [10–12].

Surgical management of the flexible flatfoot can be grouped into three types: reconstructive procedures, arthrodesis, and arthroereisis. Soft tissue reconstruction of the flexible flatfoot is rarely successful as an isolated procedure. Bony procedures include hindfoot, midfoot, and forefoot osteotomies. Although excellent results from the reconstructive procedures of flatfoot have been described, questions remain regarding successful long-term correction [6].

Extra-articular subtalar arthrodesis is considered the mainstay for the operative treatment of symptomatic flexible planovalgus feet in growing children [13], whereas triple arthrodesis is reserved...
as a salvage procedure for previously failed surgical treatment. Although arthrodesis provides a stable foot and durable correction, eventual transfer of energy to the nonfused joints adjacent to the fusion is of concern [14,15].

Arthroereisis involves limitation of subtalar joint pronation through insertion of a spacer or a screw into the sinus tarsi [16–18], the screw can achieve correction by stimulating the proprioceptive foot receptors allowing active inversion of the foot [19] thus allowing normal subtalar joint motion but blocking excessive pronation and its resulting sequelae; it is a minimally invasive technique that does not distort the normal anatomy of the foot. However, the indication for this procedure remains controversial in the surgical community [20–24].

The purpose of this study was to evaluate our results with the stop screw method inserted with a minimal invasive technique in the treatment of flexible flatfoot in children.

2. Materials and methods

2.1. Patients

Between 1999 and 2007 we treated 21 juvenile flexible flat feet in 18 patients by a stop screw; 3 patients had bilateral surgery. The mean follow-up was 2.7 years (6 months–7 years). 5 patients were females and 13 were males. The age at time of surgery ranged between 8 and 14 years (mean: 11.9 years). We did not treat patients with pathologic ligamentous laxity.

2.2. Surgical technique

Surgical treatment is performed under general anaesthesia. A tourniquet is applied proximally to the lower limbs. Patients are placed in a supine position with the foot internally rotated. A 2-cm incision is made under the skin lines on the lateral aspect of the sinus tarsi (Fig. 1). Soft tissue dissection is performed bluntly. Then under radiographic control a guide wire is inserted vertically in the calcaneus from superior to inferior opposite to the sinus tarsi after reduction of the subtalar eversion (Fig. 2A and B), followed by drilling with a 3.2 mm drill bit and then insertion of a 6.5-mm cancellous screw with a length of 30–35 mm as a calcaneal-stop screw so that the screw head impinges against the lateral aspect of the talus preventing eversion at the subtalar joint (Fig. 3A–C).

Concomitant lengthening of the gastrocnemius (intramuscular according to Baumann) was carried out in five patients as an associated procedure: this was performed, if dorsiflexion in the neutral position after screw implantation was not possible at least to 5–10°.

Postoperatively the patients were allowed to walk with full weight bearing as soon as possible; in those patients in which gastrocnemius lengthening was performed we applied a walker in neutral position for 2–4 weeks. We recommended a supporting insole for 2–3 months as well as strengthening exercises for the tibialis posterior muscle.

2.3. Methods of evaluation

The diagnosis of functional flexible flatfoot was established by clinical and radiographic examination. Clinical diagnosis was based on increased valgus position at rest and during tiptoe standing test as well as restriction of dorsiflexion of the ankle joint in neutral varus/valgus position. ROM measurements were taken before surgery and at time of follow-up. This included plantar flexion, dorsiflexion, supination and pronation. The heel valgus angle at rest and in the tiptoe position was also documented before surgery and at time of follow-up.

Surgery was only indicated when these findings were coming together with subjective limitations of daily activities (e.g. pain and fatigue).

The podogram was assessed using four categories (Fig. 4) [25].

The amount of correction was considered by measuring the minimum width of the midfoot and comparing this to the maximum width of the forefoot (Fig. 5). Normal correction was considered, if the minimum width of the midfoot (B–B’) was ranging from 30% to 50% of the maximum width of the forefoot.
Overcorrection was defined, if the width of the midfoot was less than 30% of the width of the forefoot [25].

Standard lateral and AP X-rays were made before surgery and at time of follow-up. The line of angulation at the level of the talonavicular joint, which represents the continuity of the diaphyseal axis of the first metatarsal with the talar axis (Meary’s line), was measured in all cases.

2.4. Statistical analysis

Pre- and postoperative data were compared and statistically analysed with the Student t-test and the chi-square test \( (p < 0.001) \).

3. Results

Only two of our patients experienced subjective limitations in activities of daily life at time of follow-up; there was no objective reason for this. However, preoperatively all patients complained of discomfort to such an extent that surgery was indicated.

No significant differences were found between preoperative and postoperative plantar flexion, pronation and supination. However, dorsiflexion in neutral position showed a significant increase from \( 6.7 \pm 4.9^\circ \) to \( 15.6 \pm 3.9^\circ \).

The mean heel valgus angle at rest decreased significantly from \( 12.2 \pm 4.4^\circ \) preoperatively to \( 5.2 \pm 3.2^\circ \) at time of follow-up. The heel valgus correction during tiptoe standing increased significantly from \( 2.1 \pm 5.2^\circ \) before surgery to \( 6.9 \pm 3.9^\circ \) at follow-up.

In the preoperative podographic study 11 feet were graded as type 4, 8 as type 3, and 2 feet as type 2 podogram. While at the time of follow-up, 17 feet showed a normal podogram, 2 were graded as type 1, and 2 feet were graded as type 2.

The mean value of talonavicular angulation (Meary’s line) was \( 162 \pm 8.9^\circ \) before surgery and \( 174 \pm 5.8^\circ \) at time of follow-up; this difference was also statistically significant (Fig. 6A and B).

Removal of the screw was performed 2–3 years after implantation, but not before growth arrest of the foot (approximately 12 years in females, and 14 years of age in male patients). There were no complications encountered in this series.

4. Discussion

Flexible flatfoot is a common condition with a reported incidence of 5% in children and adults [26,27]. The associated factors and clinical significance of flexible flatfoot have been shown to produce...
children who have difficulty with increased physical activity, and show dynamic functional changes of the lower extremities [28]. Numerous treatment options have been advocated, but there is no clear algorithm to ensure adequate correction and resolve the patient’s symptoms.

Ideally, the deformity should be corrected in young children, before it becomes fixed and adaptive osseous changes have occurred. The operative technique should not interfere with subsequent growth of the foot [13].

Arthroereisis procedures are designed to limit subtalar joint motion and to improve the weightbearing position of the foot by placing a motion-blocking implant into the sinus tarsi. The first surgeon who described this technique was Dr. Recadero Alvarez, however he never published his technique. Although previous reports have stated good results, these articles were usually case studies or follow-up reports [29–31]. It shifts the load from the joints of the medial column back towards the lateral column, decreases the moments at the talonavicular and medial cuneiform-navicular joints and decreases the forces on the medial extensions of the long plantar ligament and plantar apponeurosis resulting in more normal distribution of load throughout the foot [1].

Satisfactory results were obtained in all except for two patients representing 10% of the studied group who experienced subjective limitations of their daily life. These results are similar to that of Giannini et al. [30] who noted significant radiographic and subjective improvement in a 4-year follow-up study of 21 adolescent patients. They used a bioabsorbable implant of PLLA.

There was a significant clinical improvement in the heel valgus angle at rest and during tiptoe standing, in the podographic grading and in the postoperative range of dorsiflexion in neutral position. Similar results were obtained by Giannini et al. [30] and Carranza et al. [25] in their studies about subtalar arthrothesis in flexible flatfoot. Radiologically there was significant improvement of the talonavicular angulation (Meary’s line) like other similar studies reported in the literature [19,25,30].

Our surgical technique in subtalar arthroereisis is simple small lateral incision at the sinus tarsi like that described by Giannini et al. [30] and Carranza et al. [25] but with vertical not horizontal insertion of the implant (screw), and less invasive than the combined medial and lateral approaches described by Viladot [32] who in addition operate upon the anterior and posterior tibial tendons.

Concomitant gastrocnemius lengthening was needed in 5 feet of this series representing 23.8%, while Carranza et al. [25] reported a significant number of flat feet (66%) required surgery to stretch a retracted Achilles tendon. According to our data we cannot explain this difference.

There is much controversy regarding the optimal age to perform the operation [33,34], we obtained our results in the age group ranging from 8 to 14 years with a mean of 11.9 years. Carranza et al. [25] believed that the optimal age to perform this operation is 12 years to avoid the development of cavovarus deformity in those feet that was operated at a very early age as reported by Viladot [32].

There were no complications encountered in this series, as by this technique we avoid the complications that may develop due to insertion of spacers, metal or bioabsorbable screws transversely in the sinus tarsi as granuloma formation, displacement of the implant, biomaterial failure and staining of the tissues, implant irritation and sinus tarsi pain, and other problems related to proper sizing and configuration of the implants used [25,35,36].

We can conclude that subtalar arthrothesis is relatively simple, effective, minimally invasive procedure in treating flexible flatfoot in pediatric age.
Conflict of interest statement

No author or author's institution has a financial or other relationship with other people or organizations that may inappropriately influence the author's work.

References