Original article

Proximal migration of fibular malleolus during tibial lengthening despite syndesmotic screw fixation: A series of 22 cases


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ABSTRACT

Introduction: During tibial lengthening procedures, it is recommended to prevent fibular malleolus proximal migration using a distal tibiofibular syndesmotic screw, which is removed at 6 months. We have observed proximal migrations of the fibular malleolus despite placement of this syndesmotic screw.

Objective: The objective of this study was to demonstrate this migration and to study the influence of two factors that may favor its occurrence: positioning of the syndesmotic screw and union of the fibula at the time of removal.

Hypothesis: An unhealed fibula at the time the distal tibiofibular syndesmotic screw is removed and its tricortical position promote the proximal migration of the fibular malleolus.

Material and methods: This was a retrospective, single-center, analytical study that included 22 lengthening procedures in 18 patients from 5 to 17 years of age who had undergone tibial lengthening and presented a preoperative continuous fibula. The position of the fibular malleolus, union of the fibula, and the tri- or quadricortical position of the screw were assessed based on four successive x-rays.

Results: Tricortical positioning of the syndesmotic screw was significantly associated with proximal migration of the fibular malleolus during lengthening (P = 0.0248 < 0.05). However, there was no significant relation between an unhealed fibula and proximal migration of the fibular malleolus when the screw was removed (P = 0.164 > 0.05).

Discussion: Proximal migration of the fibular malleolus during lengthening is promoted by placing a non-quadricortical syndesmotic screw. Quadricortical positioning of the screw should be recommended. Migration of the fibular malleolus after ablation of the syndesmotic screw seems to be related to absence of fibular union but this series was too small to demonstrate this clearly.

Level of evidence: Level IV: Retrospective study.

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1. Introduction

Lengthening the tibia using the callotasis technique, initiated by Ilizarov [1], consists in allowing formation of bony tissue between two osteotomy edges subjected to progressive distraction [2,3]. This procedure is a source of mechanical complications [4–7]. Among these complications, proximal migration of the fibular malleolus during tibial lengthening was demonstrated by Saleh et al. [8], warranting placement of a tibiofibular syndesmotic screw before tibial lengthening [6,8]. The advantage is to preserve tibiofibular ratios because their modification can destabilize the tibiotaral joint. Proximal migration of the fibular malleolus is associated with valgus deformation of the ankle [4], a risk factor for tibiotalar osteoarthritis [9].

However, we have noted that the analysis of the radiological and clinical files seems to show, in certain patients, proximal migration of the fibular malleolus despite the presence of a syndesmotic screw. This migration, when it occurs during lengthening, could be related to ineffective syndesmosis, resulting from non-quadricortical positioning of the syndesmotic screw. On the other hand, when it occurs after ablation of the syndesmotic screw, the non-union of the fibula could be a promoting factor [4].

The objective of this study was therefore to demonstrate this proximal migration of the fibular malleolus and to study the relation between the two potential promoting factors: the positioning of the syndesmotic screw and union of the fibula at the time the syndesmotic screw is removed.

2. Materials and methods

We conducted a retrospective single-center study. The inclusion criteria were a tibial lengthening procedure in the Paediatric...
Orthopaedics department of the Timone University Hospital in Marseille, France, between February 2007 and July 2012, with a total of the syndesmotic screw and preoperative presence of a continuous fibula. Among the 27 lengthening procedures carried out, five were excluded because the x-rays could not be interpreted. Twenty-two lengthening procedures carried out in 18 patients (ten males and eight females; age, 5–17 years) were analyzed. The indication for lengthening was unequal limb length in 14 patients: 12 congenital causes, one tumoral cause, and one infectious cause. Four patients had bilateral lengthening for hypochondroplasia.

The mean age at the beginning of the lengthening procedure was 11.2 years (range, 5.6–16.8 years). The mean lengthening was 5 cm (range, 2–8.6 cm), and the lengthening relative to the initial size of the tibia was 23% (range, 11–44%). The healing index was a mean of 28.9 days/cm (range, 20.5–53 days/cm).

The surgical technique and post operative follow-up were identical for all the patients and were performed by the same operator.

### 2.1. Surgical technique

The first step was a stable and flexible intramedullary nailing of the tibia [10], following a descending trajectory. Distal tibiofibular syndesmosis was then done by placing a percutaneous cortical screw (diameter, 3.5 or 4.5 mm), 3 cm from the tibiotalar joint space and slightly ascending above and inside compared to the tibial mortise. Radioscopic guidance was used to ensure that the growth cartilage was not injured.

A circular external hexapodal fixator was placed in the cases of unilateral lengthening; a monolateral external fixator was used for cases of simultaneous bilateral lengthening.

A high-energy (using the oscillating saw) subperiosteal osteotomy of the middle third of the fibular diaphysis was performed through a lateral approach. A bone resection—mean thickness, 13 mm (range, 5–22 mm)—was associated. A low-energy subperiosteal osteotomy (using a drill and an osteotome according to the postage-stamp technique), of the middle third of the tibial diaphysis was performed through a medial approach. The level of the osteotomy depended on how much lengthening was planned and on whether or not an axial deformation needed correction during the lengthening procedure.

### 2.2. Lengthening protocol and follow-up

The lengthening procedure began after a mean of 7-day latency period with a speed of 0.5 mm twice a day, until the length desired was obtained.

The syndesmotic screw and the external fixator were removed under general anesthesia, after the tibia had healed, judged based on the criteria proposed by Fischgrund et al. [11]: presence of three corticals with a thickness greater than 2 mm on AP and lateral x-rays. The systematic follow-up included a periodical clinical and radiographic examination: post operative, after 1 month, 3 months, before the material was removed, after material ablation, and at 1 year.

The clinical and radiological files were reviewed by an observer other than the operator. The study of the clinical files allowed us to collect the necessary patient data (age, sex, pathology, side operated) and the chronology of the events related to the intervention (dates of the intervention and removal of the material). The study of the radiographic files allowed us to measure the position of the fibular malleolus, fibular union, and the positioning of the syndesmotic screw (tricortical or quadricortical) (Fig. 1a, b). This evaluation was conducted on four successive AP and lateral x-rays of the entire leg, taken according to a standardized protocol and at defined times: before the lengthening procedure (post operative x-ray), after lengthening, and before and after removal of the syndesmotic screw. In case of doubt on the position of the screw when analyzing the x-rays, this was confirmed by analyzing the surgical report.

The measurements were taken with a centimeter-scale ruler for the x-rays taken before 2008 and by computer using the Picture Archiving and Communication System (PACS) for x-rays taken starting in 2008.

### 2.3. Evaluation of fibular malleolus migration and fibular union

Measuring the position of the fibular malleolus consisted in calculating the distance between two parallel straight lines: one passing by the medial malleolar attachment, the other by the fibular malleolar attachment (Fig. 2). We labeled this distance as the distal tibiofibular index. This measurement method was described by Macnicol and Catto [12], and has since been used by several authors in children and adults [4,8]. Proximal migration of the fibular malleolus was defined by the difference between two successive measurements of this distance. The fibula was considered healed at the date of the first x-ray showing continuous osseous callous formation.

The statistical analyses were performed by an independent statistician using R software. To study the relation between a binary variable (tricortical or quadricortical screw, fibular union or non-union) and a quantitative variable (difference of distal tibiofibular indices), logistical regression was used.

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**Fig. 1.** a: tricortical position of the syndesmotic screw; b: quadricortical position of the syndesmotic screw.

**Fig. 2.** Distal tibiofibular index.
3. Results

During the lengthening period, proximal migration was observed in 15 cases (68%). The mean proximal migration of the fibular malleolus was 2.8 mm (range, 0–8 mm). In the five cases in which the migration was greater than 5 mm, the screw was tricortical (Table 1).

Upon removal of the syndesmotic screw, proximal migration was demonstrated in 17 cases (77%). The mean proximal migration of the fibular malleolus was 2.7 mm (range, 0–8 mm). In the five cases in which the migration was greater than 5 mm, the fibula was not healed.

Overall, during the period between the post operative x-ray and the x-ray taken after the material was removed, proximal migration of the fibular malleolus existed in 18 lengthening procedures, i.e., 82% of the cases. Proximal migration of the fibular malleolus was a mean of 4 mm (range, 0–13 mm) (Fig. 3).

Tricortical positioning of the syndesmotic screw was significantly associated with proximal migration of the fibular malleolus during lengthening (p = 0.0248 < 0.05). On the other hand, there was no significant relation between non-union of the fibula and proximal migration of the fibular malleolus at the time the syndesmotic screw was removed (p = 0.164 > 0.05).

4. Discussion

Tibial lengthening using external fixation requires paying particular attention to the fibula and the orientation of the distal tibiofibular joint. It has been shown that syndesmotic screw fixation of the distal tibiofibular joint limits proximal migration of the fibula [8].

This study demonstrates the possibility of proximal migration of the fibula despite the presence of a syndesmotic screw. This proximal migration is greater than 5 mm in more than 25% of the cases (6/22), thus making it a factor of valgus deformation of the distal tibiofibular joint, as shown by Park et al. [4].

In this same study, Park et al. found non-union of the fibula to be a factor promoting proximal migration of the fibular malleolus.
We hypothesized that upon removal of the syndesmotic screw, an unhealed fibula should have the same influence on the fibula position. This study did not demonstrate a statistical relation confirming this hypothesis. However, it can be noted that in five cases of migration greater than 5 mm, a fibula with non-union was found. On the contrary, when the fibular migration was less than 5 mm (17 cases), a fibula with non-union was found in only three cases. It can therefore be expected that there is probably a relation between these two factors but the statistical power of the present study was insufficient to show it. However, the frequency of proximal migrations of the fibular malleolus associated with an unhealed fibula found in this study leads us to believe that it is preferable to remove this screw when there is union of the fibula.

On the other hand, we were able to show that the tricortical positioning of the syndesmotic screw has less mechanical efficacy than a quadricortical screw and allows migration of the fibular malleolus. The choice of this position can be explained by the desire to prevent medial cutaneous lesions. However, no cutaneous lesions were noted when the screw was quadricortical.

As we have seen, the main limitation of this study is its small sample and its resulting lack of statistical power, making it impossible to conclude on one of the main objectives of the study. In addition, the absence of clinical significance of one of the main evaluation criteria, a radiological criterion, can be criticized. However, since the relation between proximal migration of the fibula as demonstrated on x-rays and ankle valgus has been shown [4], we do not find this to be a major obstacle. On the other hand, other factors may cause a valgus deformation of the ankle and thus, influence the height of the fibular malleolus, such as insufficiency of the medial (deltoid) collateral ligament [13,14], insufficiency of the posterior tibial muscle [14,15], and a posterior musculoaponeurotic chain that has become too short [14,16]. The latter, not studied herein, could create confounding bias.

In conclusion, it seems that quadricortical positioning of the syndesmotic screw should be recommended to prevent proximal migration of the fibular malleolus as much as possible. A fibula demonstrating bone union upon removal of the syndesmotic screw is probably another factor making it possible to minimize this migration but a complementary study would be necessary to prove this point.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References