Sagittal Plane Deformity During Femoral Lengthening

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**abstract**

The purpose of this study was to determine the incidence and degree of sagittal plane deformity that occurs during limb lengthening of the femur. Twenty-one patients (25 limbs) were identified who underwent femoral lengthening. The limbs were lengthened a mean of 6.1 cm, and mean follow-up was 1.5 years. The immediate postoperative deformity in the sagittal plane was 8.3°; this deformity did not progress during lengthening (P<.05). Mean displacement in the sagittal plane was 3.1 mm.

Angular deformities, although typically small, can occur in the sagittal plane and may be accompanied by displacement. These deformities are usually present immediately postoperatively and typically do not worsen significantly with lengthening.

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Figure: Radiograph showing a right femur immediately after placement of the external fixator.

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Limb-lengthening procedures are commonly performed in children primarily to correct limb-length inequality caused by a variety of etiologies.\textsuperscript{1-4} Although these techniques are often successful at achieving their primary goal of limb-length equality and angular correction, complications are common.\textsuperscript{5-10} Complication rates vary depending on the underlying etiology, location of the limb lengthening, degree of lengthening, definition of complication, and experience of the medical team.\textsuperscript{1,11-14}

These data were extracted from a series of studies that addressed the multitude of complications that occur during limb lengthening. Typically, the studies addressed only residual deformity and did not attempt to define how or when the deformities occur, and none addressed angular deformities as they occur in the sagittal plane.\textsuperscript{15-21} Angular deformities typically have only been assessed in the coronal plane (Figures 1, 2).

This study focuses exclusively on the angular deformities that occur after femoral lengthening. The purpose of the study was to determine the incidence and degree of sagittal plane deformity that occurs during limb lengthening of the femur. We hypothesized that angular deformities are uncommon and occur primarily in the coronal plane with lengthening (ie, the deformities drift into varus as the laterally placed fixator lengths).

**MATERIALS AND METHODS**

After receiving Institutional Review Board approval, this retrospective study of patients who underwent femoral lengthening was conducted. Demographic data, diagnosis, procedure, and complications were extracted from patient charts. Lateral radiographs were assessed to determine the degree of angulation and displacement at the level of the corticotomy. Radiographs were assessed peroperatively and after lengthening, as well as at the latest follow-up (Figure 3).

A total of 21 patients (25 limbs) who met the study criteria were identified. The patient population included 10 women and 11 men, with 13 left and 12 right limbs involved. Diagnoses included proximal femoral focal deficiency (8 limbs), fibular hemimelia with associated short femur (3 limbs), and femoral hypoplasia (14 limbs). Mean patient age at the time of lengthening was 10.2 years (range, 4-19 years). Limbs were lengthened a mean of 6.1 cm (range, 3.5-9 cm), and the average time patients were in the fixators was 8.1 months (range, 4-13 months). Mean follow-up was 1.5 years postoperatively.

Limbs were lengthened with the use of a monolateral external fixator. The fixator was secured to the femur with 3 half pins above and below the corticotomy site. The fixator then was removed, the corticotomy was performed, and the fixator was reapplied. Hydroxyapatite pins were used. Lengthening was performed in the standard fashion, at the rate of 1 mm/day after an initial 7-day latency period.

Statistical analyses were performed using paired \( t \) tests. A \( P \) value <.05 was considered significant.

**RESULTS**

The initial (immediate postoperative) mean deformity in the sagittal plane was 8.3\(^\circ\) (range, 3\(^\circ\)-18\(^\circ\)). This deformity did not progress during lengthening, with mean sagittal deformity measurements of 6.8\(^\circ\) (range, 0\(^\circ\)-21\(^\circ\)) at follow-up (\(P<.05\)). Two patients had angular deformities >10\(^\circ\). Mean displacement measured in the sagittal plane (either anterior or posterior) was 3.1 mm (range, 0-22 mm).

The initial (immediate postoperative) mean deformity in the coronal plane was 9.6\(^\circ\) (range, 0\(^\circ\)-26\(^\circ\)). This deformity did not progress during lengthening, with mean coronal deformity measurements of 8.2\(^\circ\) (range, 0\(^\circ\)-26\(^\circ\)) at follow-up (\(P<.05\)). Six patients had angular deformities >10\(^\circ\). Mean displacement measured in the coronal plane (either anterior or posterior) was 4 mm (range, 0-18 mm).

Only 1 patient had a deformity >10\(^\circ\) in both planes. At follow-up, there were no clinical complaints related to the residual deformity.

**DISCUSSION**

Angular deformities, although typically small, can occur in the sagittal plane and may be accompanied by displacement. These deformities are usually present imme-

Figure 1: Radiograph showing a right femur immediately after placement of the external fixator. Figure 2: Radiograph showing a right femur at the end of limb lengthening prior to fixator removal. Figure 3: Diagram showing the technique used to measure the sagittal deformity of the femur. The midpoint of the angulation was found, and an angle representative of the deformity was created using intersecting lines.
diately postoperatively and typically do not worsen significantly with lengthening.

Clinically, there appears to be little limitation in function, but often the underlying condition, in this case congenital femoral deficiency, may have functional limitations that mask any small changes in function. Despite this, 20% of limbs had angular deformities; therefore, a fixator that would allow for multiplane correction during the lengthening would be beneficial in this population.

REFERENCES