MAD shift in limb lengthening over the anatomical axis, a retrospective analysis.

Akram Al Ramlawi, Michael Assayag, Philip Kraus McClure INTRODUCTION:

Recently, major advances in orthopedic surgery have transformed limb lengthening devices from the typical external fixator to a telescoping intramedullary lengthening nail (ILN). All ILNs possess the same characteristic of lengthening strictly over the anatomic axis of the bone, unlike external fixators that lengthen over either the mechanical or anatomical axes. Baumgart proposed the reverse planning method (RPM), which overcorrects the lateral shift with a distal osteotomy to counteract medialization of the femur during lengthening with an ILN. The hypothetical medialization is thought to be due to the elongation of the femur over its anatomical axis that is naturally in a slight valgus at the knee level as compared to the hip. This method aims to restore or maintain a normal mechanical axis and orientation of the joints compared to traditional strategies using external fixation. Our study explores the effect of ILNs on the alignment and mechanical axis of the lower limb.

METHODS:

We retrospectively evaluated records for 154 femoral antegrade ILNs (PRECICE, NuVasive, Inc.) inserted in 122 adult patients for limb lengthening. We excluded patients that underwent concomitant osteotomies or tibial lengthening, or who had malunion, non-union, mechanical failure, or revision surgery for any reason. Long-leg standing X-rays were taken preoperatively, at the end of lengthening, around 3 months postoperative, and at culmination of consolidation (approximately 6 months postoperative). Mechanical angle deviation (MAD) and anatomic mechanical angle (AMA) were assessed as primary outcomes at each X-ray time point for sequential comparison. The Predicted MAD was derived from the trigonometric formula (Predicted MAD = lengthening*sin(AMA))

RESULTS:

Preoperative MAD was 2.4mm medial (SD = 10.6), diminishing to 1.9mm (SD = 13.2) medial by the end of lengthening. Upon assessment at consolidation, average MAD had equilibrated back to 2.6mm medial. Our results showed a net shift of .18mm and an absolute shift of 3.4mm, whereas the net predicted MAD was -.7 and the absolute predicted shift was 5.6mm.

Mean preoperative AMA was 5.9 (maximum 9 and minimum 0.1, SD = 1.49). At the end of lengthening the average AMA had decreased to 4.8 (maximum 10.74 and minimum 0.1, SD = 1.4)

DISCUSSION AND CONCLUSION:

Our data indicated minimal to no impact on the mechanical axis or joint alignment of the lower limb after lengthening using a telescoping femoral ILN in a deformity-free femur. Study results showed that the femur typically realigned in a way that minimized mechanical deviation while preserving joint alignment. Further studies are needed to understand the types of forces and factors that lead to this phenomenon.