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Case Report

Use of double-row monolateral Trauma-Fix unibar lengthener for femur lengthening in patients with leg length discrepancy

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ABSTRACT

We report the case of a patient in whom the use of monolateral double-row Trauma-Fix lengthener was successful for femur lengthening after initial difficulty in lengthening by using the single-row lengthener.
Problem and case report: A girl 12 years of age presented with a leg-length discrepancy (LLD) of 8 cm and left genu valgum deformity due to a trauma-induced left distal femur physial lesion during her infancy. The patient's weight and height were 38 kg and 148 cm, respectively, and the mechanical axis was 16 degrees of valgus at the time of operation. The lengthening procedure was initiated on postoperative day 7 after the initial correction of the genu valgum deformity. However, no distraction was observed at the osteotomy site, and a convergent angulation deformity developed at the pin-clamp joint.
Method and outcome: This problem was resolved successfully with the addition of another row of the Trauma-Fix lengthening device, which was linked via the previously applied pins. A final lengthening of 7.5 cm was achieved in 3 months by using the double-row lengthener without pin tract infection or breakage. The monolateral frame of the Trauma-Fix lengthener was removed in the 11th postoperative month after a solid union of the femur was achieved. The postoperative mechanical axis of the knee was 4 degrees varus. The monolateral double-row lengthener device that showed high efficiency and improved the strength of the ball joints were used along the single-row lengthener, and it may serve as a good alternative for augmentation of insufficient ball joints during limb lengthening.

1. Introduction

Leg length discrepancy (LLD) is a problem worldwide, but its prevalence varies in different populations. Various studies have reported that LLD occurs in 23%–70% in the general population and 40% in health running athletes.[1–3] Few patients with LLD need correction, and the treatment approaches range from a relatively simple and widely used shoe-lift therapy to complex surgical interventions in patients who meet the clinical criteria.[4] At present, the guiding principles for LLD treatment are as follows: (1) LLD of <2 cm, either no treatment or a shoe-lift therapy is administered; (2) LLD of 2–6 cm, an epiphysiodesis or shortening procedure is considered; (3) LLD of 6–15 cm, a lengthening procedure may be performed; and (4) LLD of 15–20 cm or more, a staged lengthening may be performed.

The history of surgical lengthening procedure can be traced back to a century ago when the famous Italian surgeon, Codivilla, applied a lengthening procedure in distraction osteogenesis, consisting of three steps: osteotomy, lengthening, and, finally, solid consolidation.[5] In the 1940s, Gavril Abramovich Ilizarov first performed clinical lengthening; the Ilizarov technique remains one of the most popular and frequently used approaches for the treatment of patients with LLD. [6,7] The current standard approach for lengthening generally includes external and internal devices (nailing system).[8] The best known and most widely used lengthening devices are monolateral external fixators, such as Orthofix,[9] and traditional circular external fixators, such as the Ilizarov ring fixator and the Taylor Spatial Frame (TSF).[10]

We encountered with case of patient, in whom treatment by femur distraction using the monolateral single-row Trauma-Fix unibar lengthener failed owing to the instability of the ball-joint link between the lengthener to pins fixed at the femur and a bending angular deformity occurred at the links during distraction of the unibar lengthener. Therefore, we considered that the Uni-bar Lengthening Device, (U5; Uni-bar system, Trauma-Fix, Taipei, Taiwan) was not sufficiently rigid to distract the tight soft tissue and to maintain the fixation position in this case. Here, we

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describe our clinical experience with the use of a novel double-row lengthening device in a monolateral frame for the treatment of patients with LLD.

2. Case report

2.1. History and problem

A 12-year-old girl presented with an LLD of 8 cm and left genu valgum with mechanical axis of valgus at 16 degrees that was caused by a trauma-induced, left-distal femur physial lesion during her infancy. The previous episode led to partial physial arrest of a peripheral type at the lateral femoral condyle of the left knee. Her body weight and height were 38 kg and 148 cm, respectively. The initial surgical plan was left femur lengthening with osteotomy at the distal femur and right distal femoral physial stapling at the same time. We performed osteotomy and corrected the genu valgum at her left femur; the entire procedure was performed under the C-arm guidance. The monolateral external lengthening device (TraumaFix, Uni-bar System) was subsequently applied to the femur and was fixed with three proximal and three distal half pins. The right distal femoral physial stapling was performed smoothly to cause growth arrest.

Postoperatively, the pin tracts were disinfected with 75% alcohol during hospitalization. Distraction was started on the 7th postoperative day; however, no distraction effects were observed at the osteotomy site under the lengthening device (Fig. 1). In addition, a convergent bending deformity developed at the ball joint of pin and clamp over the distraction rod, but no lengthening was observed at the bony site of the osteotomy site. This problem was thought to be due to the weakness of the ball joint that was composed of a half pin and pin clamp of the unibar lengthener. To resolve the weakness of the ball joint of the single-row lengthener, another row of the distraction rod was applied with the same previously used pins, at the operation room under general anesthesia. The concept of a second lengthener connecting with half pins was just similar to double rods applied during external fixation to enhance stability. After the double-row lengthener was set up, distraction lengthening progressed smoothly and continued as planned (Fig. 2).

2.2. Treatment and result

After the second row of distraction rods was applied, the lengthening progressed smoothly at a rate of 1 mm/day. At the culmination of treatment, a final length of 7.5 cm was achieved as planned, and the problem of LLD was corrected. A steady growth of the newly formed bone at the distraction gap was noticed during the follow-up. The monolateral external fixator of the Uni-Bar System was removed in the 11th postoperative month after a solid union of the bone and consolidation of the lengthening segment was achieved (Fig. 3).

The patient tolerated the monolateral double-row external fixation lengthener well during the 11-month treatment period and reported only a minimal level of inconvenience. Wound infection, pin breakage, or deformity problems were not observed. Radiography obtained 11 months after the operation showed resolution of the LLD with minimal angulation and rotation, with mechanical axis of varus of 4 degrees. A long leg brace was applied to maintain the knee joint in extension during the lengthening and consolidation stages. Gradual range of motion (ROMs) exercises were commenced immediately after the removal of the lengthening frame. At the last follow-up, the ROM of the hip and knee were both at flexion 0–135 degrees.

Fig. 1. Failure of initial distraction on the 7th postoperative day.

Fig. 2. Smooth progression of lengthening after another distraction rod was applied.

Fig. 3. Lengthener was removed and leg length discrepancy was resolved 11 months after the operation.

3. Discussion

Clinicians can choose among various approaches available for the treatment of patients with LLD, and the advantages and disadvantages of all the approaches are rather clear.[6,10,11] The Wagner Method, open lengthening following a mid-diaphyseal osteotomy, was popular due to its fast correction and effectiveness; however, it was associated with high rates of complications.[12] Today, the Ilizarov technique and concept of gradual distraction of 1.0 mm/day are most used.[13] Generally, the ring fixator provides strong stability and good results. Lengthening with a monolateral frame is usually the treatment of choice for the femur because it is not as cumbersome as the Ilizarov device.[14] However, the drawback of the monolateral frame is that it has inadequate rigidity and is not sufficiently strong to support a ball joint as a hinge to maintain the alignment. Currently, no previous studies have reported the use of the double-row lengthener. We propose that a double-row lengthener for the treatment of LLD is feasible and effective because it overcomes the mentioned drawbacks and thus results in a satisfactory clinical outcome. This idea derives from a previous experience with the Hoffman external fixation system. The double-row Hoffman external rod frames have proven to be stronger and involve fewer deformities as complications than single-row frames in the treatment of long-bone fractures.

The main problem of weakness during lengthening might result from the ball-joint hinge between the pin and clamp. Deformities involving various angulations of these joints have been reported during external fixation for both fracture and lengthening.[15,16] A double-row frame holds the pins rigidly and decreases the torque over the ball-joint hinge, thereby securing the solid fixation and providing effective stability. In the case of our patient, we used surgical methods that focused on the fixation stability of the double-row frame, which provided greater strength to achieve lengthening in the distraction phase. The subsequent consolidation phase started after the lengthening procedure was completed, and the extremity that was operated on was strongly fixed using this external fixation system.[11] According to the theory of structural mechanics, the rigidity of the frame (which maintained the proximal group of pins parallel to the distal group of pins and allowed the lengthening to proceed) relies on the rigidity of the pins over the bone and joint structure between the pins and pin-clamp device that links the pins with distraction lengthening rods. The application of the double-row lengthener in fact decreased the stress across the joint between pins and lengthening rod as compared with the traditional single lengthener that easily leads to failure because of its poor strength. However, further clinical studies and biomechanical experiments for measurements may

provide the quantification needed to design much stronger supports in terms of rigidity for use in this device.

Sangkaew[14] reported a simple technique of distraction osteogenesis in the femur that increased lengthening; this technique used a conventional AO/ASIF monolateral external fixator. This fixator was less bulky, had easier applications, and caused fewer pinhole wounds than the external circular fixator did. In the case of our patient, we applied the double-row monolateral external lengthening device that not only resolved the LLD but also corrected the genu valgum of 15 degrees after osteotomy. Therefore, double-row devices should also be considered an alternative for deformity correction, because they are strong and provide external fixation stability.[17,18]

After the completion of lengthening, bone consolidation can be achieved either by retention of the frame until a solid bone mass is formed or by replacement with a secondary internal fixator with interlocked nails. The former method only requires the simple removal of fixators after the treatment is completed. The latter method could achieve a more satisfying result and is thought to be more advantageous for the following reasons: a shorter treatment course, earlier rehabilitation, and prevention of a refracture.[19] Wu and colleagues reported a secondary internal nail fixation technique that shortens the treatment course and has high union (all 11 cases) and low complication rates (two patients with rigid equinus feet).

The limitations of external fixators include bulkiness, susceptibility to infection, and bothersome wound care. [20] In addition, secondary deformity, refracture, and prolonged recovery time for rehabilitation have been reported.[21–23] In the future, more cases and clinical applications with long-term follow-up will provide more information. Other limitations of double-row external fixators are yet to be accounted for, and the complete disclosure of new and alternative treatment approaches is crucial. The various treatment methods and techniques should be explored on a case-by-case basis.

The concepts of double-row lengtheners provide a simple, strong, and less-bulky device during the lengthening procedure. We had the experience of a successful clinical trial with satisfactory results in treating a patient with LLD.

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