Distraction Osteogenesis in Old Fracture Neck of Femur – A Case Report

Faisal M.,[1] Sami A.L.,[2] Rabee,[3] S.M. Awais[4]

Address for Correspondence: *Dr. Faisal Masood (Assistant professor), Department of Orthopedic & Spinal Surgery Unit I, King Edward Medical University, Mayo Hospital Lahore*

Distraction osteogenesis popularized by Ilizarov has been the only solution in most of bone defect nonunions but this has never been worked in old fracture neck of femur with resorbed neck. We applied this principle in a young child with old fracture neck of femur with resorbed neck. We applied across hip external fixator and gradual distraction was started. Resorbed neck was completely formed in 06 months and patient regained his normal leg length and mobility and escaped major surgery.

Back Ground

Femoral neck fractures in children are exceedingly rare, accounting for less than 1% of all pediatric fractures.[1] In comparison, the prevalence of fractures of the hip in children is less than 1% of that in adults. Therefore, most orthopedic surgeons will treat only a few such fractures in their lifetime.[2]

Although hip fractures in children can generally be expected to heal, their importance lies in the frequency and severity of complications, including AVN, coxa vara, premature physeal closure, limb length discrepancy and occasionally nonunion. Nonunion is very rare in children.[3] Because the hip is developing in the growing child, deformities can progress with age. Even nonunions can proceed to deformity and limping gait.[4,5] Traditionally nonunion in this area are treated with valgifying osteotomy, pediatric DHS/screws with or without bone grafting.[12-14] This procedure is not effective in cases where there is greater proximal migration of proximal femur as was in our case.[9,10] We decided to apply across hip external fixator to bring this proximally migrated femur downwards and observe the effect of distraction on osteogenesis in this potentially notorious area.

Fracture healing is a complex process that requires the recruitment of appropriate cell (fibroblasts, macrophages, chondroblasts, osteoblasts, osteoclasts) and the subsequent expression of the appropriate genes (those that control matrix production and organization, growth factors, transcription factors) at the right time and in the right anatomical location.[5,6] A fracture initiates a sequence of inflammation, repair, and remodeling that can restore the injured bone to its original state within a few months if each stage of this complex interdependent cascade proceeds undisturbed.[6] Clinical union occurs when progressively increasing stiffness and strength provided by the mineralization process makes the fracture site stable and pain free. Roentgenographic union is present when plain roentgenograms show bone trabeculae or cortical bone crossing the fracture site. Radioisotope studies have shown increased activity in fracture sites long after painless function has been restored and roentgenographic union is present, indicating that the remodeling process continues for years.[7]

Einhorn described four distinct healing responses, characterizing them by location: bone marrow, cortex, periosteum, and external soft tissues.[15] He suggested that perhaps the most important response in fracture healing is that of the periosteum, where committed osteoprogenitor cells and uncommitted, undifferentiated mesenchymal cells contribute to the process by a recapitulation of embryonic intramembranous ossification and endochondral bone formation.[5] The periosteal response has been shown to be rapid and capable of bridging gaps as large as half the diameter of the bone; it is enhanced by motion and inhibited by rigid fixation. The external soft tissue response also depends heavily on mechanical factors and may be depressed by rigid immobilization and thus distraction exerts a provocative impulse on periosteal response for osteogenesis. This response involves rapid cellular activity and the development of early bridging callus that stabilizes the fracture fragments. The type of tissue formed evolves through endochondral ossification in which undifferentiated mesenchymal cells are recruited, attach, proliferate, and eventually differentiate into cartilage-forming cells.[07]

According to Paley et al., most nonunions can be treated with restoration of alignment, followed by compression.[16] Some nonunions may require additional cortical osteotomy and either internal bone transport or overall lengthening to obtain the original bone length. This was popularized by the extensive work of Ilizarov who made the concept of distraction osteogenesis.[9,17] But this exercise has never been attempted in fractures of neck of femur (old fractures or non-unions). In children it seems working as relatively thick periosteum can lead to bone regeneration but in adults it might not be applicable because of thin or deficient periosteum in this area.[5] This was the reason we selected pediatric neck of femur fractures.

Case History

Our pt was a 12 years boy who was brought by the parents with limping gait, which gradually developed after he had a fall from height sustaining injury to his left hip area about 04 years back. After fall initially he was treated by local bone settlers with wooden splints. He started walking about

02- 03 months of splintage but was associated with pain and limping gait. The pain settled gradually but limp increased with time. At the time of examination, there was 04 cm shortening in the supratrochaenteric area of left femur with disturbed Bryant's triangle. He had a limping gait of waddling type with positive trendlenberg test for left side. Left hip ROM was Ok except decreased abduction. Systemic examination was unremarkable.

Radiological Assessment

X-rays of Pelvis with both hips, showing old fracture neck of femur with varus angulation and significant proximal migration of greater trochaenter. Femoral head seemed viable and was confirmed by bone scan.

Fig. A: *Across hip NA Fixator applied.*

Surgical Technique

We applied across hip external fixator (Naseer Awais) with four horizontal schanz screws incorporated into iliac bone through a transverse pin clamp and three schanz screws with a vertical pin clamp. The fixator was applied in a close manner under image intensifier. NA fixator is meant for controlled distraction, which was started at the rate of 02 mm/ day. Periodic radiological assessment was carried throughout the course of treatment. Successful distraction was seen initially with no subluxation of hip and viable femoral head. Pin tract care was carried out. At about 04 wks adequate distraction was achieved with restoration of neck shaft angle and radiological signs of osteogenesis in the resorbed neck area. Distraction was stopped when required length was achieved (50 days). Fixator was removed at about 04 months when adequate new bone was visible and hip spica was applied letting the bone to be mature enough to start wt. bearing at about 06 months. Patient eventually had full wt. bearing and equal length of both legs and physiotherapy was started. Pt is now independent walker without any limp, stiffness and leg length discrepancy. In this way we achieved full length and normal neck shaft angle and avoided major surgery and bone grafting.

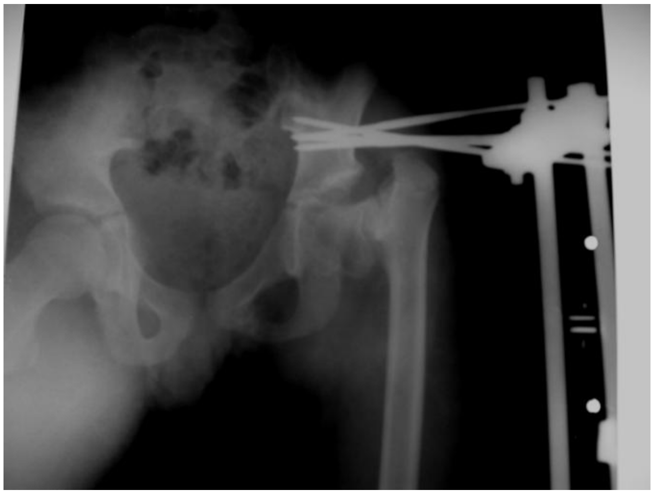

Fig. B: *Immediate Post Op X-rays.*

Fig. C: *06 Wks radiograph showing distracted proximal femur. Left Greater trochaenter at the level of opposite GT with flecks of bone in the neck area.*

Fig. D: *04 months post op X-ray showing adequate neck formation with normal restoration of neck Shaft angle. Fixator was removed at this stage and hip spica was applied.*

Fig. E: *With hip spica.*

Fig. F: *Radiograph in spica showing maintenance of position.*

Discussion

The distraction histeogenesis is a technique for generating both bone and soft tissue through application of tension to the tissue under carefully controlled conditions.[5-7] This is accomplished by slow distraction (approximately 1 mm/ day), divided into small increments (usually every 6 hours) by using an external fixator that is rigid to bending and

Fig. G: *After spica removal at 06 moths with completely formed neck & normal Neck shaft angle.*

Fig. H: *After spica removal with no leg length discrepancy.*

torsion stress but allows axial micromotion.[16] The method is used in the treatment of fractures, nonunions, osteomyelitis, deformities, bone loss, and congenital abnormalities. This method differs from other techniques for reconstruction of bone and soft tissue in that it is minimally invasive and extremely versatile; it generates tissue (it does not simply stretch it).[20,21]

In 1951 Ilizarov discovered that normal tissue could be generated under carefully applied tension; he termed this phenomenon the tension-stress effect. The tension-stress effect on the bone causes neovascularity, increased metabolic and biosynthetic activity, and orderly cellular proliferation in a similar but not identical manner to normal endochondral ossification at the physis. The tension-stress effect on the bone causes a bipolar fibrous interzone, which matures in an orderly fashion.[16]

The ability of tissue to grow linearly under conditions of tension applies not only to bone but also to soft tissue. Muscle, nerves, skin, and blood vessels are generated, not stretched, in response to tension; their cellular components proliferate in the direction of the applied tension.

The second use of this method can be to treat deformities or malunions without free tissue transfer and additional grafting.[22]

The main factor in children, which made this technique successful in this vulnerable and notorious area, is periosteum, which is relatively thicker as compared to adults in which it is almost absent in this area. This periosteum under suitable tension was stimulated to regenerate the lost bone and successful restoration of anatomical neck shaft angle.[5,12-14,16,17]

Conclusion

Distraction osteogenesis is a technique evolved for bone loss non-union but it had never been tried in old Fx NOF with proximal migration of proximal femur and loss of normal neck shaft angle. There are no publications on such experience before. We achieved anatomical reduction and bone formation avoiding extensive surgery (osteotomy and or bone grafting). This experience hopefully will prove a better solution for such a complicated nonunion.

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