Femoral deformity correction and lengthening on nail with monorail external fixator : A case report

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Abstract

Limb length discrepancy (LLD) is quite common. Lower limb shortening is one of the causes of limb length discrepancy. The common treatment that is used is the llizarov technique for bone lengthening. The new technique uses an intramedullary nail with a monoplanar external fixator. Using this technique, bone lengthening duration in patients can be reduced and knee joint mobility can be improved without jeopardizing bone regeneration. We report a case of a 27-year-old gentleman who had right femur shortening from childhood and was referred to us for corrective deformity. He underwent bone lengthening on the nail which lenghthens and equalizes the leg while avoiding stiffness and reduces joint mobility which leads to good patient satisfaction outcome. The use of the external fixator with intramedullary nailing to lengthen the femur is one method that can reduce patient burden mentally and physically. However although it has many advantages we must watch out for the complications during the regular visits to ensure good outcome.

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Introduction

Limb length discrepancy (LLD) is quite common with about 23% of the general population having LLD of about 1cm or more.1 In a study by Guitchet et al, they found that the prevalence of people with LLD requiring corrective device is approximately 1 in 1000. Lower limb shortening is one of the causes for limb length discrepancy. It can be due to fracture complications or congenital defects which will lead to pelvic tilt and secondary scoliosis and in the long-term, could lead to osteoarthritis of the hip, knee and spine.

llizarov is a common technique for bone lengthening. This technique uses systems of rings and anchored using Kirschner wires in tension followed by osteotomy of bone and gradual distraction.

The llizarov method requires the patient to tolerate the long lengthening period which usually presents with complications such as pin site infection and reduced joint mobility. Therefore, considerable physiotherapy is required to prevent permanent joint stiffness, which relies on extreme patient compliance. As a result, the long use of the fixator is not tolerated in most patients.[2] Hence newer techniques have been developed to reduce the complications of the external fixator. One of the new techniques uses an intramedullary nail with a monoplanar external fixator. Using this technique, the bone lengthening duration in the patient can be reduced and knee joint mobility can be improved without jeopardizing bone regeneration.

Case report

A 27-year-old gentleman presented to our clinic with limb length discrepancy due to right short femur. He fell from one floor height at the age of 8 years and sustained trauma to the right lower limb but no fracture was detected. He did not have any symptoms but he started noticing limb shortening when he was 15 years old. He was using his right foot support to minimize the limp. Apart from that, he did not complain of having knee or hip pain yet. Examination revealed shortening of 5 cm in the femoral component of the right lower limb only with full range of movements at the knee and hip joints. There was no abnormality in the spine. Measurement of shortening was confirmed by computed tomography scanogram. After consultation, the patient agreed for femur lengthening procedure using locked intramedullary nailing (Smith and Nephew) and external fixator (Limb reconstruction system; LRS).

Surgical technique

The patient was put in supine position on a radiolucent table. He was given spinal anaesthesia after all the preoperative checklist was done. The patient was cleaned using povidone from the upper pelvis to the tip

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of the right toes, then draped fully in a sterile condition. Initial x-ray was done to check the initial position of the femur. Preoperatively it was concluded from the x-ray that there was shortening of 35mm on right femur with valgus deformity. The anatomical lateral distal femoral angle (aLDFA) was about 76 degrees which was less compared to normal aLDFA of 80 degrees when compared to the left femur. Then two Hydroxyappatite (HA)-coated Shanz pins were inserted respectively at the lateral part of the femur proximally and distally. The placement of the Shanz pins was made slightly near to the anterior cortex and perpendicular to the anatomical axis of the femur penetrating two cortices in order to allow subsequent passage of the nail. This was followed by femoral osteotomy which was performed at the diaphyseal and metaphyseal junction which was about 10 cm from the knee joint. The osteotomy itself was performed using a semi-circumferential bone drilling technique with a 3.5-mm drill bit on the lateral, posterior and anterior part of the cortex and completed by osteotomizing the medial cortex using an osteotome.

The valgus deformity of the right femur created two different anatomical axes proximal and distal to the deformity site. These two axes intersected at a crossing point known as Centre of Rotational axis or CORA. This point was located 10 cm proximal to the joint line and the osteotomy of the femur was performed at this point. We placed the shantz pins perpendicular to these two anatomical axes and once the osteotomy was completed, we were able to correct the valgus deformity of the distal femur by distracting the osteotomy site like an open wedge method and making sure that the shantz pins were parallel to each other proximally and distally. This can be seen from Figures 1B and 1C where osteotomy is done at the CORA and valgus deformity was corrected. This was followed by stabilizing the position of the pins with a monorail bar so that the correction of the valgus was maintained.

The retrograde nail was introduced subsequently and the reaming of the canal was continued until size 11 and nail size 10 was introduced into the canal. The nail was locked at the distal part of the femur and the proximal part was not locked in order to allow the lengthening process to work. This can be seen from Figure 1A where the nail has been inserted and monorail inserted in situ. Post operatively, the patient was started with iv cefuroxime 1.5 gm 8 hourly during hospitalization. Intraoperative flexion was able to be achieved up to 90 degrees. Post operatively pain was controlled. Patient was allowed to go home on day 3 post operatively and was seen back at the clinic 10 days after discharge. During the time the patient was instructed not to distract the external fixator. During this latency period, the patient was only allowed to do daily wound dressing and no other complications were noted.

After fourteen days, the patient was instructed to distract the LRS 1 mm per day (0.25 mm every 6 hours). He was seen every 2 weeks to check for any complications that may arise. However, after two weeks, it was noted that the patient was unable to distract the LRS anymore. The difficulty was due to the inability to move the nail during the lengthening process because it was tightly inserted into the canal. As a result, we had to remove the nail temporarily to overcome the tightness and to allow the lengthening process to work. Hence the removal of nail was performed on day 28 post-operatively in which the patient was again instructed not to distract the LRS system and to start distracting 10 days after that. The distraction process worked well after day 10 and continued up to day 35. It was stopped on day 35 once the required amount of lengthening had been achieved. Once the length was achieved, the retrograde nail was inserted again and it was locked both distally and proximally before the LRS frame was removed. The patient was then instructed to ambulate with crutches while waiting for the consolidation process to complete. The range of motion exercises was started for the knee joints. Figure 2 shows post removal of the monorail external fixator and the lengthened femur shows callus formation all over the cortices indicating good bone union. Figures 3A and 3B show intraoperative and postoperative pictures regarding the advantage

of this technique whereby there was no restriction of joint mobility towards the knee. In figure 3C the joint orientation angle is important as we also corrected the valgus deformity that this patient had, hence restoring patient anatomical lateral distal femoral angle which was reduced preoperatively compared to the normal side. Thus apart from lengthening we also used this technique to correct the anatomical axis of the femur.

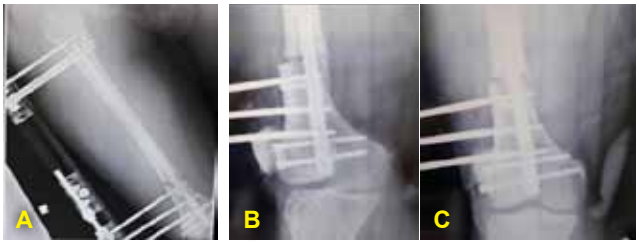

Figure 1. *A) Post-operative x-ray anterior posterior (AP) view showing correction of valgus deformity using LRS monorail external fixator with subsequent lengthening of the bone on nail B) lateral view of distal femur showing the osteotomy site and correction of valgus deformity*

Figure 2. *Showing x-ray of the femur after completion of lengthening process A) AP view showing bridging callus more on medial side B) lateral view showing good anterior and posterior cortical union C) bridging callus over medial side of the femur*

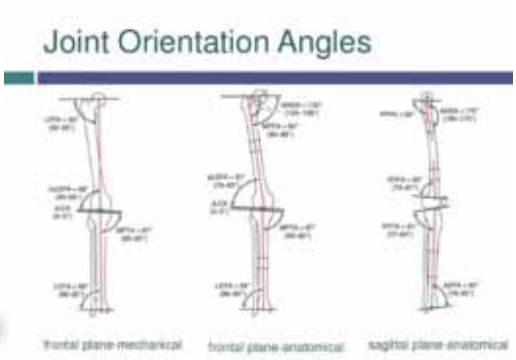

Figure 3. *A) intraop picture showing the locking of the proximal part of the nail with external fixator in situ B) post operative picture showing knee mobility C) showing diagram of joint orientation angles in which in this case the anatomical lateral distal femur angle was found to be less than 80 degrees making the distal femur in valgus position*

Discussion

Paley et al was the first one that introduced this method of lengthening of bone over the nail. [1] This method was introduced to fasten the healing and rehabilitation process of the patient. According to Paley *et al.* this method reduces the amount of time a patient needs to be on external fixator by one half. Apart from that, the radiographic consolidation index is also reduced significantly compared to the patient that is on Ilizarov method.

The standard method that is used for limb lengthening is the Ilizarov method. This method includes the use of rings and K wires to correct the deformity but the hardware needs to be kept for a long time during the consolidation phase and lengthening phase. This will put a psychological burden not only on patient but on the families as well. Apart from that the patient is also not encouraged for premature removal of the implant as it may lead to fracture and deformity.

In the Ilizarov method, the importance of preservation of endosteal blood supply is emphasized.[4] However, in this method reaming was done in order to insert the

nail which might jeopardize the endosteal blood supply. Patey *et al* in his study suggested to ream the canal at least 1.5 milimeters bigger than the intended size of the nail. According to his study, the reaming process does not prolong the time until the consolidation of new bone. This would mean that any damage to the medullary circulation during reaming is compensated by revascularization after reaming and the stability that is provided by the nail.[3]

There are many papers that support the advantage of bone lengthening using the intramedullary nail with an external fixator. In one study by Sun *et al.* in which they compared between bone lengthening of tibia using external fixator only and in combination with an intramedullary nail, they found out that the group that used external fixator with intramedullary nail produced better result with regard to bone healing time.[5]

Although there are many advantages of this technique it also comes with its own unique complication. In this case report there was one complication whereby the distraction was unable to proceed due to a tightly inserted nail. This may be due to the fact that initially we did not ream the canal 1.5 mm bigger than the intended size of the nail and that was why the nail was tightly inserted. However, after removal of the nail temporarily and reinsertion of the nail back into the femur after the canal was reamed up to 1.5mm bigger than the size of the nail, we managed to lengthen it back with no complication afterwards.

Conclusion

In this case report, the use of external fixator with intramedullary nailing to lengthen the femur is one method that can reduce the patient's burden mentally and physically. The long duration of time that is needed for the bone to lengthen and consolidate may jeopardize the knee mobility especially in a young active patient. Hence the use of this method will shorten the time and the patient can start performing joint exercises soon after removal of the external fixator while waiting for the bone to consolidate. However although it has many advantages we must watch out for the complication at regular visit so that a good outcome can be produced. A compliant patient is also needed so that patient will adhere to the instructions given by the doctor and physiotherapist.

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