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Complications in Leg Lengthening over an Intra medullary Nail : Review of 25 procedures in 20 patients

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Abstract : We have performed leg lengthening in 10 femoral and 15 tibial segments over an intra medullary nail in 20 patients to decrease external fixation time, and to reduce the risk to malalignment or refracture. Bilateral tibial lengthening was performed in 5 cases for familial short stature. The median lengthening achieved was 4.9(3 10) cm, and the median external fixation time was 148(76 390) days, with a Healing Index of 30.2 days/cm. The procedure was accompanied by a few complications common to lengthening, most of which were effectively managed during the treatment period. We found axial deviation in 3 lengthened segments, but no refracture was encountered in the entire series. Intrămedullary nail infection occurred in 3 cases, each managed by nail removal, fixator reassembly and treatment of infection. We concluded that this method was superior to the conventional lengthening using an external fixator, allowing early rehabilitation, reducing axial deviation and minimizing the risk to refracture. However, the risk to deep intramedullaryinfection necessitated care throughout the treatment period.

Introduction

Limb length discrepancy is a common problem, and many methods have been described to achieve correction, After the introduction of the Ilizarov method of equalizing the extremities, leg lengthening by distraction osteogenesis has been widely used in both children and adults especially in patients with congenital disturbance in growth, or in whom the growth of one limb has been disturbed by trauma or disease, and in those who have an unusually short stature. Leg lengthening by distraction osteogenesis involves two phases. The first phase is the distraction phase, and the second is the consolidation phase. The consolidation phase is usually two to four times longer than the distraction phase[7].

Patients often tolerate poorly the period of consolidation : complications can be many, and early removal of the external fixator may be disastrous. In order to reduce the external fixation time and reduce the risk to consequent complications, many authors have employed a procedure of limb lengthening over an intramedullary nail[2][8][14]. Complications such as

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Table 1. Patient Data

Case	A	B	C	D	E	F	G	H	I
1	F	26	tibia	R	1	138.5	240	8.3	28.9
			tibia	L				8.3	
2	M	27	tibia	L	2	4	138	4.2	32.8
3	M	20	tibia	R	1	151	300	10	29.4
			tibia	L				10	
4	F	17	femur	L	3	4.8	116	S	23.2
5	M	15	femur	L	3	3	92	3.2	28.7
6	F	18	tibia	R	1	148	105	S	21
			tibia	L				S	
7	M	27	tibia	R	4	3	144	3	48
8	F	18	tibia	R	1	150	120	5.5	21.8
			tibia	L				5.5	
9	M	33	femur	L	3	6	390	6	65
10	M	20	femur	L	3	7	192	6	32
11	M	19	femur	R	5	3.2	82	3.5	23.4
12	M	35	femur	R	3	S	99	S	19.8
13	M	21	tibia	L	6	150	150	3	50
14	F	28	tibia	R	1	147	122	4.5	27.1
			tibia	L				4.5	
15	M	34	femur	R	5	3	125	3	41.6
16	M	18	femur	L	5	4.5	103	4.6	22.3
17	M	14	femur	L	2	4	134	S	26.8
18	F	14	femur	L	3	7	155	7.5	20.6
19	F	31	tibia	L	4	4	109	3.8	28.6
20	M	37	tibia	L	4	3	76	3	25.3

A Sex : M, male ; F, female
B Age(years)
C Bone : t, tibia ; f, femur
D Side : R, right ; L, left
E Etiology : 1 familial short stature, 2 postop infection, 3 postop trauma, 4 residual poliomyelitis, 5 Legg Calve Perthes' disease sequelae, 6 short stature due to rickets
F Total height(cm)for short stature patients and leg length discrepancy(cm)in others
G Duration of external fixator(days)
H Lengthening achieved(cm)
I Healing Index(days/cm).

axial deviation or fracture are common when limb lengthening is achieved by external fixator and these can considerably increase the duration of treatment and morbidity. With the additional use of an intramedullary nail, these complications can be effectively minimized. Here report our experience in femoral and tibial lengthening using an intramedullary nail.

Patients and Methods

During the period from March 1996 to November 2000, 20 patients underwent a limb lengthening procedure, involving 25 segments (10 femoral and 15 tibial), using the Ilizarov distraction technique combined with intramedullary nailing. Bilateral tibial lengthening was done in 5 patients. There were 13 male and 7 female patients with an average age of 23.6 years(range 14 37 years). The cause for the leg length discrepancy was trauma in 6 patients, shortening due to Legg Calve Perthes' disease sequelae in 3, infection (septic hip and knee sequelae) in 2, and residual poliomyelitis in 3, familial short stature in 5, and short stature due to rickets in the other(Table 1). In addition to lengthening, corrective osteotomy for deformity was done in 5 patients, triple arthrodesis in 2, and pantalar arthrodesis in 1 patient. The median preoperative leg length discrepancy was 4.3 cm(range 3-7 cm)in 14 patients in whom only one limb segment was short. In the other 6 patients with short stature, the median preoperative height was 147.5 cm (range 138.5 151 cm).

At operation, first the insertion of a guide wire into the meduallary canal was accomplished, and antegrade reaming was done over the guide wire to a total of 1.5 mm greater than the diameter of the nail to be used. A split patellar tendon approach was used for centrali-

zation of the point of entry of the intramedullary nail. Proximal corticotomy was carefully done with the guide wire in place. After removing the guide wire, the nail was then inserted into the medullary canal up to the distal metaphysis, and was proximally locked with two interlocking screws. In the tibia, AO tibial and humeral nails were used, while in the femur, Russel Taylor nails were used. In one case of femoral lengthening, a rush pin was used as the patient had a very narrow medullary canal. After the Ilizarov wires and pins were positioned taking care to avoid contact with the IM nail. The Ilizarov rings were connected and the frame assembled. In all the tibial lengthening cases, fibular osteotomy was done at the mid lower third junction. Postoperatively, the foot was splinted in dorsiflexion. Physical therapy was started on the 2 nd day, and the patient was allowed crutch walking. After 7 10 days of rest, lengthening was started at 1 mm per day (0.25 mm every 6 hours). The length and quality of regenerate were assessed every week on X-ray, and the rate of lengthening was adjusted accordingly. Once the desired length was achieved distal locking screws were inserted into the intramedullary nail. At this time the ring fixator was modified or removed, and instead a monofixator was applied to facilitate rehabilitation and to provide additional support to the regenerate in the distraction gap. There after the patients were followed every month. At each follow up, serial radiographs were taken and when there was radiological evidence of consolidation, then the external fixator was removed. Also during the entire follow-up, development of any complication was noted and managed accordingly. Complications were recorded as problems, obstacles or true complications. Problems included difficulties that required no operative intervention and which were fully resolved by the end of the treatment, while obstacles were difficulties that required operative intervention, and true complications were those that remained unresolved at the end of the treatment period[17]. The median follow up period was 23 months(range 15 to 47 months).

Results

The median gain in length was 4.9 cm(range 3 to 10 cm). The median time for the external fixation was 148 days(76 to 390 days). The median Healing Index was 30.2 days/cm.

External fixation duration was prolonged in 8 cases. Of which, 5 received an additional procedure such as corrective osteotomy in the tibia or femur for correction of a preexisting deformity. In the other 3 patients, deep intramedullary nail infection dereleped, and the nail had to be removed. This resulted in an overall increase in external fixation time. In most cases, knee flexion during the lengthening period was decreased, but improved gradually during the consolidation phase and returned to the preoperative level after removal of the fixator.

Serial radiographs at each follow-up showed delay in consolidation in the anterior and/or lateral cortex of the regenerate in many distracted segments. However, all the lengthened segments became consolidated with time. There was no refracture in any case. However, there was malalignment in 3 segments, 2 were valgus, and 1 was varus, which persisted de spite periodic adjustment in the frame as well as distraction.

Complications : There were difficulties encountered during the treatment period(Table

Table 2. Complications

Pin tract infection	9	6			Dressings+antibiotics
			3	0	Pin removal
Scanty callus (Ant./Lat. Cortex)	6	6	0	0	Filled spontaneously in time.
Delayed consolidation	1	1	0	0	Ext. fixator kept for longer duration and eventually united
Axial deviation valgus	3				Persisted despite periodic adjustment of frame and distraction.
		0	0	2	
varus		0	0	1	
Joint contractures	11	9	0		PT and after fixator removal, full ROM
Knee				2	PT and quadriceps plasty but stiffness persisted till end of treatment.
Ankle	5	2			Exercises
			1		Achilles' tendon lengthening
				2	10 20 degrees of equinus persisted
Peroneal nerve involvement	1	0	1	0	Nerve exploration and removal of offending wire
Intra medullary nail infection	3	0	0	3	IM nail removal, reassembly of external fixator & vigorous treatment for infection
Total	39	24	5	10	

2). These of these, 24 were problems, 5 were obstacles, and 10 were true complications. 9 cases developed pin tract infection, 6 of which were resolved by dressing and administration of antibiotics, while the other 3 cases were treated by change or removal of the offending wire. One case had delayed consolidation and was kept on a fixator for an extended period and was eventually united. Six cases had scanty or delayed calleus formation on the anterior or lateral aspects of the regenerate which filled spontaneously. There was mechanical axis deviation in 3 tibial lengthened segments, two went into valgus, and one into varus. In one patient with short stature in whom bilateral tibial lengthening of 10 cm was done in each side, varus angulation of 10 degrees was observed on the left side, and valgus angulation of 4 degrees on right side with a mechanical axis deviation of 2.5 cm. and 0.8 cm, respectively. However, at the last follow up, this patient had a full range of motion in both knees with mild restriction in dorsiflexion and eversion in the ankles and plantigrade feet, so our ultimate goal of lengthening was fully achieved. Joint contractures in the knee were seen in 11 cases. Nine were treated conservatively, and the range of motion of the knees was improved during the consolidation phase and was subsequently full after removal of the frame. Two knees, despite quadriceps plasty, eventually had partial ankylosis when seen at the last follow-up. Ankle equinus developed in 5. Two of these were treated non-operatively. Another one was treated with Achilles' tendon lengthening. One had persistent equinus deformity at the end of the treatment. In one case there was involvement of the common peroneal nerve because of entrapment by the wire. In this patient, exploration of the nerve was done, the offending wire

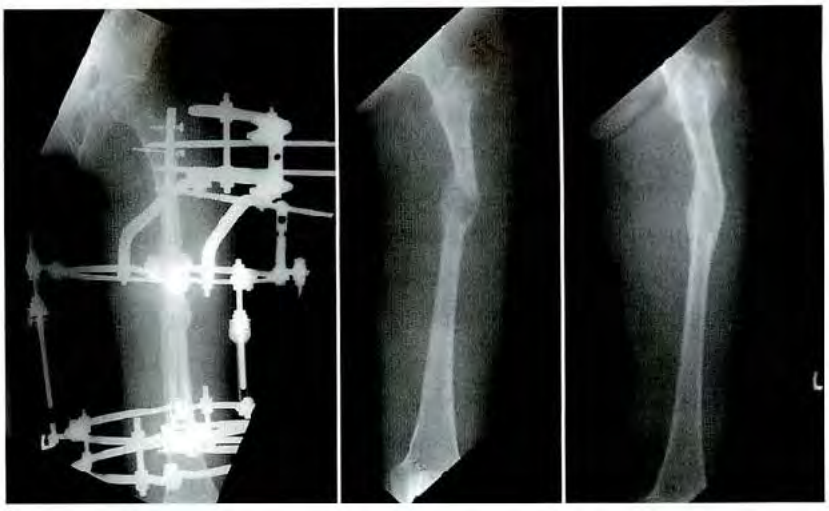

Fig. 1.
a : A patient with residual poliomyelitis underwent femoral lengthening over the humeral nail.
b : The intramedullary infection occurred during distraction, and the nail and external fixator were removed. There was visible callus formation at 3 cm of lengthening. A hip spica cast was applied.
c : Bone union was obtained with mild varus deformity at the lengthened region.

removed and another wire was inserted at a different site. Treatment with electric stimulation improved nerve function during the follow up and nerve function was completely restored by the end of the treatment. Three cases of intramedullary nail infection were encountered. One developed deep infection during the distraction phase(Fig. 1). In this patient, lengthening was abandoned half way, the intramedullary nail removed, and the infection treated vigorously while stabilizing the leg in the Ilizarov frame. In the other two cases, nail infection occurred during the late consolidation phase. In these, the intramedullary nail was removed, and infection eradicated while keeping the limbs in the Ilizarov apparatus.

Discussion

The concept of limb lengthening over an intramedullary nail in combination with an external fixator is not new. Bost and Larson[2] used an unlocked intramedullary rod in the femur for maintaining alignment during lengthening. To decrease the external fixation time, many authors have performed limb lengthening over an intramedullary nail[8,12,22]. Simpson et al.[19] used an external fixator and a locked intramedullary nail during lengthening the femur and tibia in an attempt to reduce the complication rate. To achieve lengthening, we chose to combine the use of an external fixator with an interlocking intramedullary nail to reduce the external fixation time, maintain alignment and to eliminate the risk to refracture. In our study, the external fixation time was 30.2 days/cm. This was somewhat longer than in other published series. Paley et al.[18], Manzotti et al.[15] and Simpson et al.[19] all reported an external fixation time of 20 days/cm. This increase in our series was primarily because five lengthened segments had simultaneous treatment of other associated problems including rotational and angular deformity or foot deformity. When comparing to the external fixation time of the previous studies where lengthening was done with an external fixator alone(52 days/cm. by Silberg et al.[22] and 51 days/cm by Paley et al.[17]), the time in our series was far shorter.

Radiological evidence of scanty callous formation at the distraction gap mostly on the anterior or lateral aspect was found in six segments and was possibly due to periosteal insult during corticotomy. So care should be exercised so as not to excessively stretch or strip the periosteum.

In our study, we found no case of refracture either during the lengthening phase or the consolidation phase. However, we experienced two cases of valgus and one case of varus deviation. Such complications are usually neglected. Lengthening produces significant forces on the soft tissues, and the various degrees of tension in the different muscle groups can cause marked axial deviation. The proximal femur tends to deviate into varus and procurvatum, while the distal femur angulates into valgus and procurvatum. The proximal tibia angulates into valgus and procurvatum, and the distal tibia into varus and procurvatum. These changes also tend to increase the risk to a fracture in the regenerate. Various authors have reported the incidence of a refracture and malunion after limb lengthening using an external fixator alone. Danziger et al.[3] in their series of 18 patients who underwent femoral lengthening using the Ilizarov method have reported refracture in as many as 39% of cases, while Eldrige and Bell[5] in their review of 571 cases of Ilizarov lengthening have reported a 3% incidence of a refracture. Aldigheri et al.[1] had a 6% refracture rate in unilateral callotasis using an Orthofix external fixator. De Bastiani et al.[4] found 5% with a refracture in their lengthening series. Faber et al[6] in their study of 24 femoral and 22 tibial lengthenings reported that the most frequent bone complication was axial deviation. They found 5 varus, 3 valgus, and 2 antecurvatum in femoral lengthening, while in tibial lengthening, they found valgus deformity in 5, varus in 2, and antecurvatum in 2. Tjernstrom et al.[23] reported 28 cases of angular deviation in 53 cases of limb lengthening using callous distraction. In our series of 25 lengthened segments over an intramedullary nail, we have been able to effectively reduce the incidence of malalignment and minimize the risk to a refracture which suggested this method was superior to conventional lengthening by an external fixator alone. These findings were consistent with previous studies.[13][18][19][22]

There remains concern about deep intramedullary infection. Although we adhered to the recommendations by Paley et al.[18] and Herzenberg and Paley[8], we still found intramedullary nail infection. Three patients developed nail infection, one during the lengthening phase, and two during the late consolidation phase. Kristainsen and Steen[12] reported intramedullary nail infection in one of nine cases, and Simpson et al.[19] found a 15% deep-infection rate. Additional care during placement of wires and pins in relation to the intramedullary nail and strict asepsis during distal locking of the nail are warranted.

We concluded that the combination of an external fixator and an intramedullary nail for limb lengthening effectively reduced the external fixation time, and minimized the risk to a refracture and malalignment, and facilitated early rehabilitation. This method was superior to conventional lengthening by an external fixator alone. The minor disadvantages included the more costly surgery, the additional operation for distal screw fixation, and finally the nail removal Caution should be exercised in the wire and pin placement in relation to the intramedullary nail to avoid infection.

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