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Original research article

An outcome assessment of infected non-union of Tibia using Limb Reconstruction system (LRS)

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Abstract

Background: Due to increasing number of high-energy traumatic events, the incidence of complex and compound fractures are also in the rise. Such fractures are often exposed to various environmental contaminants, inadequate debridement and sometimes erroneous decision making leading to cases of infected non unions. Eradication of infection in such cases and achieving union may sometimes pose serious challenge to orthopaedic surgeons. Presence of comminution, bone gap or deformity can seriously complicate the situation. No definite surgical technique has been found to be full proof in dealing with these infected nonunion cases.

Aim: The aim of the present study was to evaluate the functional and radiological outcome of Limb Reconstruction system (LRS) in infected nonunion of Tibia.

Materials and Methods: This prospective observational study was carried out in the Department of Orthopaedics, Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India, for 1 year. We analysed 30 patients with infected non-union of tibial diaphysis treated by using the LRS after resection of infected and sclerotic bone at the fracture ends and doing bone transport from either end of tibia during this study period. Preoperative and monthly follow up post operative X-ray of the affected leg with AP and lateral view including knee and ankle joint were obtained and analysed till the completion of one year postoperatively.

Results: The mean age 44.7yrs (25-60yrs), male: female ratio 2:1, average follow-up period 52.5 weeks, average bone resected 7.5 cm (4-14 cm), average duration of bone transport 10.7 weeks (5-19 weeks), an average union time of bone ends 10.9 weeks (8.8-11.9 weeks), average duration of consolidation of regenerate 38.2 weeks (32-42 weeks)of the patients. Bony results and functional results were assessed according to ASAMI Score. Bony results excellent – 73.33%, good-13.33%, fair – 6.67% and poor – 6.67%. Functional results were excellent – 53.33%, good- 23.33%, fair – 16.67% and poor – 6.67%. Out of 30 patient, 2 patient developed severe equinus deformity at ankle joint and 2 patient had limb length discrepancy >3.5 cm. 7 patient had superficial pin tract infection. **Conclusion:** LRS fixator is an excellent tool for management of infected non unions which is easy to apply, comfortable for the patient with minimum complications and predictable as well as reproducible outcomes.

Keywords: Infected Bone, Nonunion, Bone transport, Limb lengthening, LRS, Fixator

Introduction

Tibia being the most common fractured long bone[1] with recorded incidence of 17–21 per 100000 population, represents 2% of all fracture and 36.7% of all long bone fractures in adults.[2] Epidemiological studies have shown that open fracture comprises 23.5% of all tibial shaft fracture.[3] The common causes of fracture are road traffic accident (62.2%), falls(18.7%), sports(7.4%) and direct blows(8.3%).[1] The lack of the muscular covering over anteromedial aspect of the tibia and poor blood supply predispose open tibial fractures to certain complications. They present with a 10–20 fold increased risk of developing infection than open fracture in any other anatomical areas[4] and a nonunion rate as high as 28% has been reported in the literature.[5] Incidences of complex open injuries of the limbs are on the rise owing to the increased number of high energy vehicular accidents in recent times, which subsequently giving rise to more cases of infected non-unions.[6] Infected non-union of long bones are not only a source of functional disability but also can lead to economic and social hardship. Infected non-union has classically been defined as a state of non-union of fracture for at least six months with persistent infection at the fracture site. Infected non-union can result from various aetiologies, commonest being, open fractures, previous surgical procedures or as sequelae to osteomyelitis of bone. Infected non-unions have been the menace for Orthopaedic surgeons since decades, because of factors, i.e. a) previous surgeries would have resulted in cicatrisation of the soft tissue with an avascular environment around the fracture site, b) chronic discharging sinus suggestive of pus collection and possible presence of sequestrum, c) necrosis of fracture ends near the non-union site up to variable lengths, due to thrombosis of vascular channels of the bones, d) prolonged immobilization, multiple surgeries with fibrosis of the muscles resulting in stiffness of adjacent joints, e) the microorganism may have developed resistance to multiple antibiotics, f) occurrence of limb length discrepancy and deformities, and g) variable degree of soft tissue loss or defects requiring multiple sessions of plastic surgical reconstructions.[7,8] Various researchers over the years have used many different approaches to deal with these complex problems. But, it has not been possible to address all the problems mentioned above by using any single technique. Therefore attempts are often made to follow a technique which can minimise the total number of additional surgical procedures, apart from being able to achieve union and controlling infection. External fixation devices which are compatible with "distraction osteogenesis" and gradual correction of deformities are gaining popularity in recent times in the management of infected nonunions.[9,10] Limb reconstruction system (LRS) is such an external fixation device which has shown great promise in such cases. The aim of the present study was to evaluate the functional and radiological outcome of Limb Reconstruction system (LRS) in infected nonunion of Tibia.

Materials and Methods

This prospective observational study was carried out in the Department of Orthopaedics, Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India, for 1 year. after taking the approval of the protocol review committee and institutional ethics committee.

Methodology

We analysed 30 patients with infected non-union of tibial diaphysis treated by using the LRS after resection of infected and sclerotic bone at the fracture ends and doing bone transport from either end of tibia during this study period. Preoperative and monthly follow up post operative X-ray of the affected leg with AP and lateral view including knee and ankle joint were obtained and analysed till the completion of one year postoperatively. Preoperative X-rays were used to assess the length of resection of the infected and sclerosed bone. In the first stage thorough debridement of wound was done. Infected and fibrotic tissue was completely

excised. Any implant Nail/Plate was removed. Infected bone was excised till the bleeding ends appear (paprika sign). Any sinus tract, if present was excised. Medullary canal was opened; end was reamed with flexible reamers. Length of excised fragrant was measured and antibiotic spacer with appropriate antibiotic was put in place to fill gap. LRS was applied medially or antero-medially with three clamps. Wound was closed either primarily or flap cover was done in the same setting. Patients had been allowed ambulation with protected weight bearing and ROM exercise of the knee and the ankle joint was started on the very next day. Systemic antibiotic were continued for 4-6 weeks. After 4-6 weeks time,when infection got controlled and parameters like TLC, DLC, CRP, ESR came down to the normal level, the second stage surgery, in the form of antibiotic spacer removal and corticotomy at one suitable end of tibial metaphysic was done. A compression distraction device (CD device) was applied. Again patients were allowed protected weight bearing and ROM exercise of the knee and the ankle joint was started on the very next day. Distraction osteogenesis at the corticotomy site was started after 10 days, at the rate of 1 mm / day in 4 steps to fill the gap. Patients had been followed once monthly and X-ray was obtained to assess growth and maturation of the bony regenerate and range of movements at the ankle and the knee joints. After complete restoration of excised bone by the new regenerate, LRS was left in place till full consolidation of the bone regenerate. The union at the fracture ends was achieved by the compression at bony ends using CD device.

Results

Results of 30 patients were assessed (n=30), mean age 44.7yrs (25-60yrs), male: female ratio 2:1, average follow-up period 52.5 weeks, average bone resected 7.5 cm (4-14 cm), average duration of bone transport 10.7 weeks (5-19 weeks), an average union time of bone ends 10.9 weeks (8.8-11.9 weeks), average duration of consolidation of regenerate 38.2 weeks (32-42 weeks).Bony results and functional results were assessed according to ASAMI Score.

Bony results excellent – 73.33%, good-13.33%, fair – 6.67% and poor – 6.67%. Functional results were excellent – 53.33%, good- 23.33%, fair – 16.67% and poor – 6.67%. Out of 30 patient, 2 patient developed severe equinus deformity at ankle joint and 2 patient had limb lengthdiscrepancy >3.5 cm. 7 patient had superficial pin tract infection.

Table 1: demographic profile of the patients

Profile	Results
Mean age	44.7yrs
M:F	2:1
Average bone gap (after infected bone resection)	7.5cm
Average duration of bone transport	10.7 wks
Average union time	10.9 wks
Average duration of consolidation of regenerate	38.2 wks

Table 2: Bony outcome according to ASAMI score

Bony Outcome	No of Patient	Percentage
Excellent	22	73.33%
Good	4	13.33%
Fair	2	6.67%
Poor	2	6.67%

Table 3: functional outcome according to ASAMI score

Functional Outcome	No of Patient	Percentage
Excellent	16	53.33%
Good	7	23.33%
Fair	5	16.67%
Poor	2	6.67%

Fig. 1: Infected Non-union with implant failure

Fig. 2: Regenerate consolidation with bone endsunion

Fig 3. Removal of LRS with application PTB

Fig. 4: Tibial interlocking nail in situ

Fig. 5: Removal of LRS and regenerate consolidation with boneends union

Discussion

Fractures of the tibia are one of the commonest injuries especially with the rise in vehicular accidents. The large subcutaneous anteromedial surface predisposes to open fractures and often leads to a bone gap devoid of soft tissue cover. Soft tissue damage and periosteal stripping are common in high velocity and open injuries, and this can compromise the vascularity of the tissues around the fracture. Infection of the wound, deformity, limb shortening and non-union are all known complications of fracture of the tibia. They often lead to a bone gap which may further increase on debridement of the infected or necrotic bone. In the musculoskeletal system, the biomechanical environment plays a key role in repairing, maintaining, and remodelling of bone to meet its functional demands. Fracture non-union is a chronic condition associated with pain, functional and psychosocial disability. Stability, vascularisation and good rehabilitation are required for successful union of tibia fractures. Thus the management of tibia nonunion revolves around attempts at satisfactorily restoring the above-mentioned factors to bring about an adequate union for physical and psychological rehabilitation of the patient. Different methods of treatment have been recommended for the management of infected gap non-union. One of these methods is the "Conventional" or classic method. This method focuses on eliminating the existing infection and drainage from the bone thereby facilitating the healing process. This is achieved by sequential debridement of all the infected and nonviable tissues. This line of management mandates the use of prolonged antibiotic therapy, bypass bone grafting and long-term orthotic support. The process of healing in these cases takes place by secondary intention. The protracted time is taken in this procedure usually results in stiffness of adjacent joints. The second method is the "active" method in which attempts are made at obtaining early bony union and the period of convalescence is reduced to a minimum owing to which the motion in adjacent joints is preserved. In this method, the restoration of bony continuity gains priority over the treatment of underlying infection.

Management of infected non-union is aimed to control the infection and to promote union at the fracture site with a proper alignment of the fracture fragments along with the maintenance of normal length and restoration of movements at the adjacent joints and getting a fully functional and painless limb. The segment of infected bone was resected till the bleeding ends appear (paprika sign).[11] Distraction osteogenesis was done at the rate of 1 mm / day in 4 steps to fill the gap.[12] It took around 4 weeks to 17 weeks depending upon the length of excised bone.[13] In our Study treatment of infected non-union of tibia 93.33% patient showed successful Union in 8 to 12weeks period which is comparable to other studies Garcia-Climbrelo et al,[14] Gajbhiye AI et al.[15] and Patil S et al.[16] In majority of the patients range of motion was not much impaired. Average follow-up was for the 18 months ranging from 12 to 24 months study is comparable to Ajmera A et.al.[17] Mean bone transport was 3 to 12 cm comparable to the other studies like Donnan L.T et al.[18] and Sen et al.[19] Mean duration of LRS application was 52.5 weeks. In this study 2 patient had severe equines deformity at ankle joint as the patient did not comply with the ROM exercise. 2 patient developed shortening of limb > 3.5 cm as he discontinued bone transport because of severe pain. 1 case developed loosening of the pin in which we had to re adjust the frame and change the pin. LRS is easy to handle and apply in comparison to ilizarov fixator, though that is also equally good to achieve union in infected non- union cases but LRS is compatible, light weighted simple design and short learning curve to apply. Wound care is easy and permits early mobilisation and rehabilitation. It provides more stability because of the tapered pins. Axial compression can be achieved at the fracture site by using the compression-distraction device.

Conclusion

LRS fixator is an excellent tool for management of infected non unions which is easy to apply, comfortable for the patient with minimum complications and predictable as well as reproducible outcomes.

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