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Functional And Radiological Outcome Of Complex Non-Union Of Long Bones Treated By Monorail External Fixator – Prospective And Retrospective Study

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Abstract

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Introduction

Non Union Refers To A State In Which Healing Process Comes To A Halt Judged By Clinical And X Ray Evidence Beyond The Stipulated Period Of Healing For A Particular Bone And Fracture Pattern Due To Mechanical Or Biological Failure.

Non-union is a late complication of fracture and can occur when there is too much movement at fracture site (hypertrophic non-union), there is poor blood supply at fracture site (atrophic non-union), there is presence of infection (infective non-union) or when the two ends of fracture are not apposed (gap non- union).

Risk factors		
Related to person	Related to fracture	Related to treatment
➢ **Old age** ➢ **Poor nutritional status** ➢ **Nicotine and alcohol consumption** ➢ **Metabolic disturbances like hyperparathyroidism** ➢ **Can be associated with disorders like NF1**	➢ Related to fracture site ➢ Soft tissue interposition ➢ Bone loss ➢ Infection ➢ Poor blood supply ➢ Damage of surrounding soft tissue	➢ Inadequate reduction ➢ Insufficient mobilization ➢ Improper fixation

Complex non-union constituting infective non-union, gap non-union, and limb-length discrepancy secondary to bone loss needs specialized planning and assessment. Getting union along with correction of limb-length discrepancy is a challenging job for the orthopaedic surgeon. It needs a comprehensive approach for the management of these types of non-union, with simultaneous management of both non-union and bone gap. Most often, segmental bone defects are managed by transplantation of vascularized

or non-vascularized autogenous bone, allograft bone transplantation, or segment transport5. However, problems with vascularized bone grafts include donor site morbidity6, possibility of necrosis due to anastomotic complications7, long remodelling time, and high fracture rate8

Internal fixation along with bone grafting can be done in aseptic non-union without bone gap. In cases of infective non-union, in which bone gap is created surgically after thorough debridement, and in cases with traumatic bone gap, bone transport based on principle of distraction osteogenesis is an effective way of getting union and functional limb without limb-length discrepancy.

Bone transport using external fixators alone, as first introduced by Ilizarov, needs long-term management with external fixators9. Monorail external fixation works on the principle of distraction osteogenesis and is commonly used as effective treatment option for complex non-union of long bones. Monorail external fixator is an established mode of treatment10.

Aims And Objectives

Aim

The aim of this study is to evaluate the functional & radiological outcome in patients with non-union of long bone fracture who were treated with monorail external fixator

Primary Objective

To evaluate the functional & radiological outcome in patients with non-union of long bone fracture who were treated with monorail external fixator in terms of objective scores

Secondary Objective

To observe the complications of monorail external fixator

Methodology

Place of study-Department of Orthopaedics,Dr S N Medical college and associated hospitals, jodhpur

After ethical committee approval and patients consent

Inclusion criterion-Age 18 to 60 years

All complex non-union of long bones (tibia and femur) Patients who are ready to follow up for at least 9 months

Exclusion criterion-Pregnant females

Non-union resulting from metabolic and congenital causes

Age less than 18 years and more than 60 years

Patient medically unfit or unwilling for surgery

For study purpose, sample size was 22 subjects.

Twenty two patients (17 males and 5 females) with complex non union of tibia underwent thorough debridement and resection of non viable bone followed by bone transport to fill the gap and then lengthening (8 patients) or acute docking & lengthening (14 patients) by the use of rail fixator. The average time to union, bone gap filled, lengthening achieved, treatment index were measured. The bone and functional outcome assessment was done by ASAMI score. The complications were classified according to Paley's classification.

IlizarovBone Score follow up

Excellent: Union, no infection, deformity < 7 degree, limb length discrepancy < 2.5 cm

Good : Union + any two of the following: absence of infection, < 7 degree deformity and limb length inequality of < 2.5 cm

Fair Union + only one of the following: absence of infection, deformity < 7 degree and limb length inequality < 2.5 cm

Poor: Non union/re-fracture/union + infection + deformity > 7 degree + limb length inequality > 2.5cm

Ilizarov Functional Score Follow Up

Excellent: Active, no limp, minimum stiffness (loss of < 15 degree knee extension/ < 15 degree dorsiflexion of ankle), no reflex sympathetic dystrophy(RSD), insignificant pain.

Good : Active, with one or two of the following: limp, stiffness, RSD a, significant pain.

Fair Active, with 3 or all of the following: limp, stiffness, RSD a, significant pain.

poor Inactive (unemployment or inability to perform daily activities because of injury

failure Amputation.

Statistics

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All statistical analyses was performed by using Microsoft Excel 2007 and IBM SPSS software package (SPSS Inc. Chicago, IL, USA) version 22. All data was summarized as mean ± SD for continuous variables and as numbers and percentages for categorical variables. Student's T test for independent samples was used to compare two groups for data with normal distribution. Chi square test with Yates continuity correction was used for comparison of qualitative data. A $p<0.05$ was considered as statistically significant.

Table 1 Infected non-union types (jain et al.7 and non-union classification as per paley et al.8)

Infected non-union grading Number of patients (%)	
A1-Quiescent infection with defect <4cm	6(27.3)
A2-Quiescent infection with defect >4cm	4(18.1)
B1-Actively discharging sinus with defect <4cm	7(31.8)
B2-Actively discharging sinus with defect >4cm	5(22.7)
Classification of non-union of tibia (Paley et al.8)	
Type A- Non-unions with bone loss of <1cm	
A1-Lax/mobile non-union	0
A2-Stiff/non-mobile deformity	A2- 1 With no 0
fixed deformity	A2- 2 With 0
Type B – Non-unions with bone loss of >1cm	
B1- Bony defect, no shortening	4(18.2)
B2- Shortening, no bony defect	5(22.7)
B3- Bony defect and shortening	13(59.1)

Table2 Association for the study and Application of the Methods of Ilizarov (ASAMI) scoring system and number of patients in each group.

Functional result	Bone results	Numbers of patients (Bone result/ functional result)
Excellent	Union, no infection, deformity <7, limb length of <15 knee extension/ <15	Active, no limp, minimum stiffness (Loss 12/11

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	Discrepancy <25cm	dorsiflexion of ankle). No reflex sympathetic dystrophy, insignificant pain
Good	Union + any two of the following: No infection, deformity <7, limb length Discrepancy <2.5cm	Active with one or two of the following: limp, stiffness, RSD, significant pain. 5/5
Fair	Union + only one of the following: No infection, deformity <7, limb length Discrepancy <2.5cm	Active with three or all of the following: limp, stiffness, RSD, significant pain. 3/4
Poor	Non-union/refracture/union + infection + Deformity >7 + limb length discrepancy >2.5 Cm	Inactive (unemployment or inability to return to daily activities because of injury) 2/2
Failure		Amputation 2

Table 3 Total number of patients included in study 22

Fracture side		Right 15
		Left 7
Gender		Male 17
		Female 5
Mechanism of injury		Road traffic accident 18(81.8%)
		Fall from height 1(4.5%)
		Machinery injury 1(4.5)
Complex gap non union following chronic osteomyelitis 2		
Number patients with external fixator in situ 08(36.4%)		

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Number of patients with infected nail in situ
05(22.7%)

Number of patients with infected plate in situ
03(13.6%)

Number of patients who had prior plastic surgery
08(36.4%)

Number of patients with raised ESR
22

Number of patients with raised CRP
22

Mean number of previous surgery
02.43 (range 1-5)

Mean time from injury to presentation
1.8 years (range 6 months- 19 years)

Table 4 Details of treatment related result.

Treatment variables

Mean bone defect
4.7cm (range 2-9cm)

Mean shortening before treatment
4.38cm (0cm- 13.5cm)

Number of patients who underwent bone transport followed by lengthening (gradual closure of bone defect)
08

Number of patients who underwent acute docking and lengthening
14

Number of patients in whom bony union wad achieved
20

Number of patients who required fibulectomy
16

Mean lengthening achieved
4cm (0-9cm)

Mean shortening after treatment
1.5cm (range 0-4.5cm)

Mean treatment index
2.1 months per cm

Mean follow up
11.3 months (8.3-22 months)

Mean treatment duration
8.2 months (7-19 months)

Discussions

In our study 20 out of 22 patients developed union without any residual infection. As per ASAMI criteria bone results were excellent in 12 (54.5%), good in 5

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(22.7%), fair in 3 (13.6%) and poor in 2 (9.1%). Functional results were excellent in 10 (45.45%), good in 5 (22.72%), fair in 4 (18.18%). Our results were similar to those of other studies

Aktuglu et al.20 performed a review of the outcome of Ilizarov ring fixator in infected non union of tibia and evaluated results of 27 studies published between 2008 and 2018 that consisted of a total of 619 patients and found combined bone result (excellent þ good) to be 88.6% and functional result (excellent þ good) to be 82.6%.

Yin et14 al performed a review of 13 studies published between 1995 and 2013 which consisted of results of 303 patients of infected non union tibia and had combined (excellent þ good) bone result of 87% and functional result of 76%.

Bhardwaj et al.19 in their comparative study between role rail and Ilizarov ring fixator in infected non union of long bones had good to excellent functional result in 84% patients in rail fixator group while 64% in Ilizarov ring fixator group although both group had 100% bony union . So they recommended Ilizarov ring fixator to be used in highly comminuted fracture that too near to joints otherwise rail fixator was equally good and had was associated with lesser complication, more acceptable to the patient and easier to apply

Acute docking and lengthening was done in 14 patients whereas 8 patients had transport of middle segment and then lengthening was done to compensate for shortening.

El Rosasy24 recommended maximum acute shortening in leg depends on the level of fracture exceeding the limit led to vascular compromise as confirmed by Doppler ultrasound and buckling of soft tissue that prevented further shortening. These safe limits are 3 cm proximal third leg, 3e5 cm in middle third leg and upto 6 cm in distal third. We adhered to above limits and eight patients who had large bone defect after debridement had to undergo gradual distraction 5 of which had problems of delayed union at docking site. Two united with compression alone and PTB calliper was given for 8 weeks, while 1 had to undergo freshening of bone ends, and the rest 2 had to undergo freshening of bone ends along with iliac crest grafting to achieve union.

Harshwal et al.15 and Ajmera et al.16 in their study on 37 and 30 patients using rail fixator had to do bone grafting in 2 patients each.

Bhardwaj et al.19 had to inject bone marrow aspirate at the docking in two patient fixed with

Ilizarov and 4 patients treated by rail fixator to achieve union.

Limitations

The main limitation of our study is lack of control group and small patient sample size. Majority of patients being males (17 males in comparison to 5 females only), average age 31 years (range 16-55 years) that is more young patients were included, both these factors may have favourably skewed the results towards better side as females and elderly have lower immunity 28-30 and different inflammatory response due to different hormonal milieu in females.

Conclusions

In conclusion rail fixator is a promising implant for the management of complex non union of tibia. Its main advantages are lighter yet robust frame, greater patient satisfaction, learning curve short, less complication and it addresses both the shortening and deformity. Although less stable, being monoplaner constrct unlike Ilizarov yet it serves the purpose with equally satisfactory functional and radiological results.

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