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## Assessing the outcomes of treatment of infected long bone nonunion fracture with distraction osteogenesis using the linear rail system

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### Abstract

**Background:** The treatment of bone gap due to an infected nonunion and open infected fracture is very interesting and controversial topic in orthopedics due to factors such as poor vascularity of surrounding tissue. Distraction osteogenesis is a method of producing unlimited quantities of living bone directly from a special osteotomy site. This study was performed to assess the role of bone transport by rail fixator (Pitkar, India) in treatment of bone gap in long bones due to infected long bones nonunion fracture.

**Methods:** Patients folders were perused, proforma formed and data collected partly from the folder and partly filled by the enrollee. Information as regards biodata, clinicoradiological characteristics, Outcome of management were taken. Patient also filled the quality of life questionnaire. Data analyzed using SPSS version 23 and represented as charts and tables.

Variables were compared and conclusions drawn.

**Results:** 85.7% were males. M:F ratio 6:1. Ages 32-40 were the most operated (50%). Limb lengthening was done in 53.6% while bone transport in 39.3%. the tibia was the bone most operated in 85.7% of cases. Most distractions were less than 7cm (50%).

Pin tract infection was the most common problem found in 5 out of the 28enrollees, most had no problems. Limb length discrepancy was found in 7.1%.

There were associations found between complication and aim of surgery and also with length gained.

**Conclusion:** The linear rail system is vasatile in the treatment of infected long bone nonunion fractures with excellent result, little complications and a very satisfactory quality of life.

**Keywords:** Infected nonunion, long bone fractures, linear rail system, quality of life, distraction osteogenesis

### Introduction

The treatment of bone gap due to an infected nonunion and open infected fracture is very interesting and controversial topic in orthopedics due to factors such as poor vascularity of surrounding tissue, deformity of joints, limb length discrepancy and scarring of skin due to previous surgeries <sup>[1]</sup>. Distraction osteogenesis is a method of producing unlimited quantities of living bone directly from a special osteotomy site by controlled mechanical distraction which bridges the gap and rapidly remodels to a normal macrostructure for the local bone capable of bearing load <sup>[2]</sup>.

Infected nonunion of the long bones is usually associated with deformity, bone loss, persistent infection at the fracture site, and severe adverse effects on health-related quality of life <sup>[3]</sup>.

In 1951, Professor Gavril Abramovich Ilizarov from Kurgan in Russia developed circular external fixators for the management of long bone fractures and deformities in children but later found useful in the management of limb length inequalities by way of lengthening the bone.

It is said that living tissues subjected to slow steady traction becomes metabolically activated in both the biosynthetic and proliferative cellular pathways: this is referred to as the law of tension-stress.

The successful results achieved by Ilizarov ring fixator bears a testimony to the success of this system. But due to many complications such as persistent pain, deformity of joints and discomfort caused by Ilizarov ring fixator, inspired the development of rail fixator. This study was performed to assess the role of bone transport by rail fixator (Pitkar, India) in treatment

of bone gap in long bones due to open infected fracture and infected nonunion. 1 Correction of limb length discrepancies (LLD) is a time consuming, challenging and highly rewarding procedure as such requires patience and full co-operation of the patient as well as the family<sup>[4]</sup>.

This study sets to assess the ability of the linear rail system in treating infected major limb nonunion fracture that may warrant significant bone resection that are a nightmare to the surgeon, the patient and the patients relations as well. Its sets to do this via both clinical and radiological evidences such as infection control, gap covered, x-ray evidence of union, length gained and regenerate consolidation and post removal of device to assess the quality of life of patients who had the device.

Throughout the world, trauma is a leading cause of death and disability for all age groups except persons older than 60 years and is one of the top three causes of death for persons between 5 and 44 years<sup>[5]</sup>.

Limb salvage techniques are the main stay in current management of large bone defects and limb shortening in infected non unions warranting bone resection to aid management<sup>[6]</sup>.

The mean age of limb lengthening varies between 30-35yrs as most writers noted<sup>[7, 8, 9, 10]</sup>.

It is also found out that Males undergo distraction osteogenesis far more frequent than Female<sup>[11]</sup>.

More distractions are done for tibia than any other major limb long bone<sup>[6, 12]</sup>.

Patients had the linear rail device removed earlier in metaphyseal osteotomies than diaphyseal. On the other hand, Aronso *et al.* in his article "Mechanical force as predictors of healing during tibial lengthening by distraction osteogenesis" found the opposite<sup>[13]</sup>.

Thirty to thirty six months was noted by most writers to be the average follow up period in bone lengthening even thou a lot depends on the length targeted<sup>[14, 15]</sup>.

Mean external fixator time can be as long as between 13-15 months by some writers<sup>[6, 14, 16, 17]</sup>.

Concerning distraction osteogenesis, most writers found an average length of between 6-7cm.<sup>[1, 7, 12, 18]</sup> Hubert *et al.* found it lower<sup>[19]</sup>.

Complications that occur during distraction osteogenesis can be divided into three: Minor as those that does not require surgery to correct, major as those that requires another surgery to correct while true complications as those that remain unresolved at the end of surgery. The most common complication noted by most writers is pin tract infection<sup>[20, 14, 21]</sup>. Hantes and colleagues in their study on "complications in limb lengthening procedures: a review of 49 cases" found out that the incidence and severity of complications after limb lengthening procedures are significantly influence by the relative lengthening of the bone<sup>[22]</sup>.

Wang H. and friends in their article" Quality of life and complications at different stages of bone transport infected nonunion of the tibia" noted that most patient underwent about 2.9 operations on an average<sup>[3]</sup>.

## Methodology

This study is a retrospective study carried out at The Potters Specialist hospital Jos Nigeria between January 2018 and December 2020.

The operation register was perused for patients who had their infected long bone fracture managed with adequate debridement and a linear rail system applied to aid distraction osteogenesis. Patients 20yrs and above that came with severe wound infection

for which thorough debridement meant resection of a segment of bone, those with chronic osteomyelitis warranting bone resection, patients with severe soft tissue loss exposing a significant amount of bone that cannot have bone cover and those with abinitio significant bone loss were included in the study. Those excluded include the multiply injured, elderly patients who have loss cognitive function, psychiatric patients, those who refuse consent, those whose bone gab was less or equal to 2 cm, patients with previous ankylosis and those with other co morbidity that will alter outcome. Twenty eight patients who met the inclusion criteria and are not part of the exclusion criteria were enrolled. A proforma was used to extract information partly from the patient and partly from the folder such as the biodata(age, sex, marital status, religion, address etc), clinical characteristics (Interval between injury and presentation, indications for the surgery, aim of surgery, additional surgeries done, limb operated etc) and clinical outcome(problems and complications, length gained). An x ray was used to ascertain union at fracture site, length gained and consolidation of regenerate about a month after the linear rail system was removed. Patient's quality of life afterward was assessed via a quality of life questionnaire administered after a month of removal of the device. The linear rail system was used to transport, lengthen, or both depending to avoid constantinian effect that may occur. The linear rail system was applied following the standard rule for application of an external device vis a vis LRS.

Data obtained was analyzed using SPSS version 23 and plotted into charts and tables. Variables were compared and the significance of their relationships ascertained.

Conclusions were then made.

## Results

In this study there were 28 enrollees.

Twenty four (85.7%) were males and 4(14.3%) females. Fig 1 Age group 31-40 years were 14(50%), those > 40years 10(35.7%) while those 20-30 were 4(14.3%).

Mean age was 38.43±8.81. Fig 2.

Of the 28 enrollees, 53.6% had limb lengthening, 39.3% had bone transport while 7.1% had both limb lengthening and bone transport. Fig 3.

Patients who had surgeries done on the leg were 85.7%, 10.7% had it done on the arms and 3.6% had their surgeries on the forearm. Fig 4.

Those that had distraction of less than 7cm were 14(50%), between 8cm and 14cm were 10(35.7%) while those who had theirs greater than 14cm were 4(14.3%). Fig 5.

Amongst problem encountered pin tract infection was found in 5 patients, wound breakdown in 3 patients, and drift docking in 2 patients. Eighteen (64.3%) had no problems. Fig 6.

Patient that had limb length discrepancy out of the 28 enrollees were 2(7.1%), those with fracture regenerate and joint contractures were 1(3.6%) each and 24(85.7%) of them had nil complications. Fig 7.

There was significant association between complication and aim of surgery ( $\chi^2=15.170$ , p-value= 0.019). No association was noted between problems and aim of surgery ( $\chi^2=9.734$ , p-value= 0.136). A similar finding was obtained between good quality of life and aim of surgery ( $\chi^2=2.158$ , p-value=0.340). Table 1.

There was significant association between complication and length gained ( $\chi^2=13.100$ , p-value= 0.041). No association was noted between problems and length gained ( $\chi^2=7.660$ , p-value= 0.264). A similar finding was obtained between good quality of life and length gained ( $\chi^2=0.686$ , p-value=0.710). Table 2.

Regarding quality of life most patients (42.9%) rated it as good and the other 21.4% very good and when asked about the satisfaction their current health 50% said they were satisfied and another 21.4% were very satisfied. Table 3.

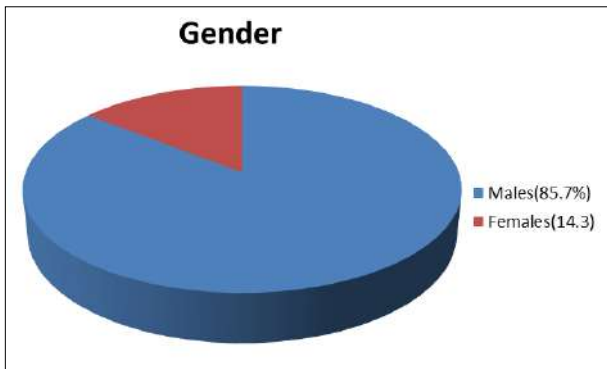


Fig 1: Distribution by gender

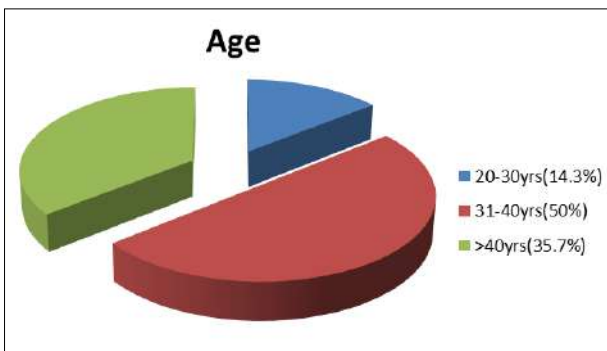


Fig 2: Distribution by age

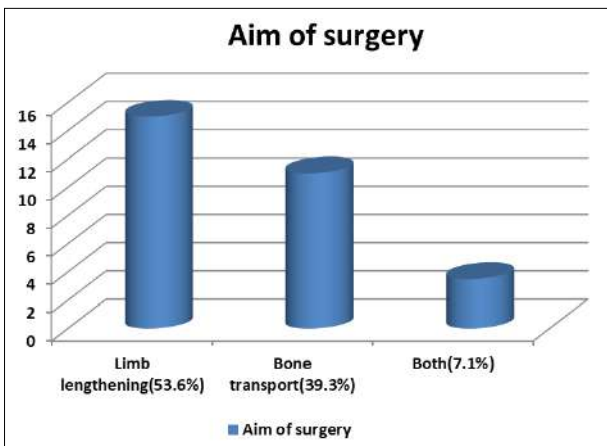


Fig 3: Distribution by aim of surgery

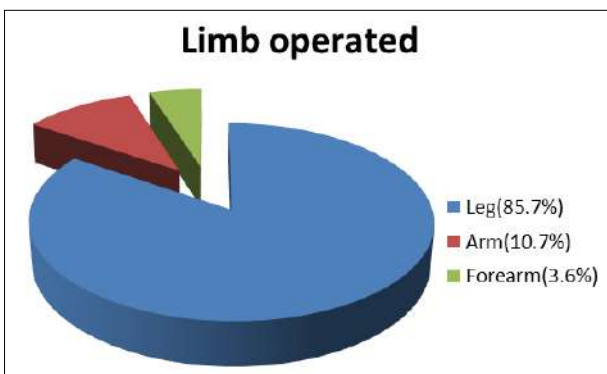


Fig 4: Distribution by limb operated

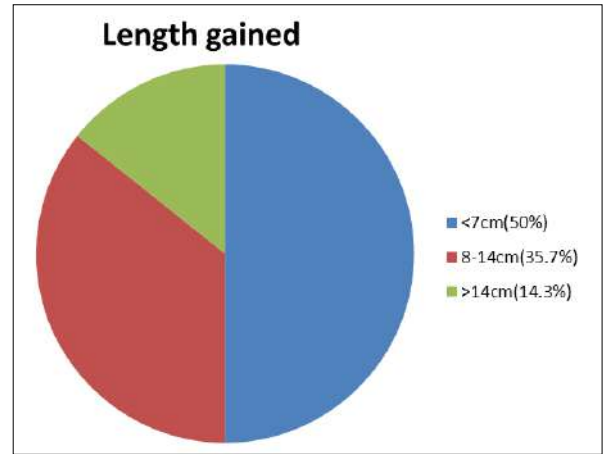


Fig 5: Distribution by length gained

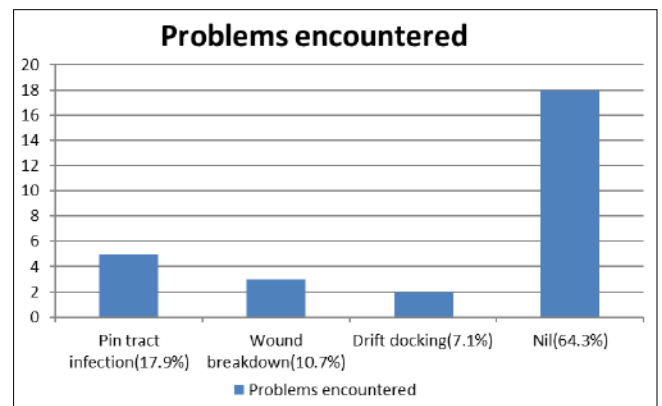


Fig 6: Distribution by problems encountered

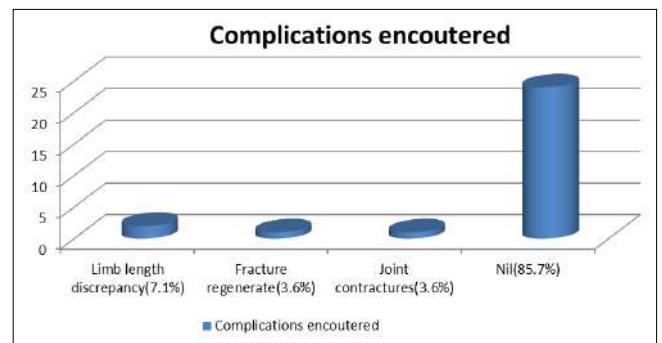


Fig 7: Distribution by complications encountered

Table 1: Association between variables and aim of surgery (n= 28)

Variables	Aim of surgery			$\chi^2$	P-value
	Limb lengthening	Bone transport	Both		
<b>Complication</b>					
Limb length discrepancy	1(6.7)	1(9.1)	0(0.0)	15.170	0.019
Fracture regenerate	0(0.0)	0(0.0)	1(50.0)		
Joint contractures	0(0.0)	1(9.1)	0(0.0)		
Nil	14(93.3)	9(81.8)	1(50.0)		
<b>Problems</b>					
Pin tract infection	0(0.0)	4(36.4)	1(50.0)	9.734	0.136
Wound breakdown	1(6.7)	2(18.2)	0(0.0)		
Drift docking	1(6.7)	1(9.1)	0(0.0)		
Nil	13(86.7)	4(36.4)	1(50.0)		
<b>Quality of life</b>					
Good	7(46.7)	5(45.5)	2(100.0)	2.158	0.340
Poor	8(53.3)	6(54.5)	0(0.0)		

**Table 2:** Association between variables and length gained (n = 28)

Variables				$\chi^2$	p-value
	≤7 cm	8-14 cm	>14 cm		
<b>Complication</b>					
Limb length discrepancy	1(7.1)	1(10.0)	0(0.0)	13.100	0.041
Fracture regenerate	0(0.0)	0(0.0)	1(25.0)		
Joint contractures	0(0.0)	0(0.0)	1(25.0)		
Nil	13(92.9)	9(90.0)	2(50.0)		
<b>Problems</b>					
Pin tract infection	2(14.3)	1(10.0)	2(50.0)	7.660	0.264
Wound breakdown	0(0.0)	2(20.0)	1(25.0)		
Drift docking	1(7.1)	1(10.0)	0(0.0)		
Nil	11(78.6)	6(60.0)	1(25.0)		
<b>Quality of life</b>					
Good	6(42.9)	6(60.0)	2(50.0)	0.686	0.710
Poor	8(57.1)	4(40.0)	2(50.0)		

**Table 3:** Rating/satisfaction with quality of life and health satisfaction

	Frequency (n=28)	Percentage	$\chi^2$	p-value
<b>How would you rate your quality of life?</b>				
Poor	4	14.3	5.143	0.162
Neither very poor nor poor	6	21.4		
Good	12	42.9		
Very good	6	21.4		
<b>How satisfied are you with your health?</b>				
Dissatisfied	5	17.9	10.000	0.019
Neither very dissatisfied nor dissatisfied	3	10.7		
Satisfied	14	50.0		
Very satisfied	6	21.4		

## Discussion

Infected long bone nonunion fracture are not only difficult to manage but they often a times come with other association for which in most cases will warrant bone resection and subsequent gap management to be able to achieve good union and maintain limb lengths equal in the long run improve quality of life. The linear rail system uses the Ilizarov technique to either compress or distract bones together giving an additional advantage satisfactory union.

We studied 28 patients in retrospect to see how the linear rail has helped redefined their lives most of which are males 24 as against 4 women giving a ratio of about 6:1. [11] This is in line with most finding of trauma related articles and reason not far from the fact that men are more involve in outdoor sourcing for food in an attempt to keep the house stable. They are also in most conflict situations responsible to protect their wives, children and their territorial integrity as such more exposed to having injuries.

Age groups 31-40yrs were 50% of the enrollees and another 35.7% by those >40yrs. This is not too far from the fact that they are the normal working age group and as they try to make ends meet for their respective families fractures are inevitably high [7, 8, 9, 10].

The leg (tibia) was operated in 85.7% of cases making it the most operated. **Error! Bookmark not defined.** [Error! Bookmark not defined.], This can be explained by the fact that the tibia is more subcutaneous than any of the long bones and once injured has a high risk of being open and even when closed its more distal to the heart than most other long bones making its blood supply a little bit more compromised and unable to cope with infection. Majority of the patients had bone distractions less than 7 cm. this could be explained by the fact that there is a preexisting paradigm that puts the maximum uni-focal lengthening at 7 cm. **Error! Bookmark not defined.** [12, 18],

Although most of the patients (85.7%) had no problems amongst

those with some problems pin tract infection was the most common (17.9%) even though most do well with pin tract care and antibiotics where indicated. **Error! Bookmark not defined. Error! Bookmark not defined. Error! Bookmark not defined.** On the same vain 85.7% of the enrollees had no complications while in those with complications limb length discrepancies was the most noticed and that was in 7.1%.

Regarding quality of life most patients (42.9%) rated it as good and the other 21.4% very good and when asked about the satisfaction their current health 50% said they were satisfied and another 21.4% were very satisfied. **Error! Bookmark not defined.**

Comparing variables significant association was found between complications and aim of surgery, similar was noted between complications and length gained.

## Conclusion

The linear rail system is a viable tool in the orthopedic surgeons hand when it comes to management of infected long bone nonunion fractures using the Ilizarov technique with little or no problem or complication and with a satisfactory quality of life thereafter.

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