

Evaluation of different surgical modalities of treatment for various types of nonunion in tibia

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Abstract

Introduction: Non-union is a problem faced by most of orthopaedic surgeons. Tibia is the commonest site of non-union in long bone fracture. Management of non-union has remained a constant challenge. As tibia is subcutaneously located and has less blood supply in its distal part complicates the management of non-union of tibia. Present study was designed to assess the utility of various available modalities of treatment for different types of non-union of tibia.

Material & Methods: 32 patients of non-union of tibia admitted in orthopaedic ward during the period of January 2013 to December 2015 were included in a prospective study. Detailed history, clinical examination conducted and diagnosis was confirmed after radiological examination. After that suitable plan of treatment was formulated and undertaken according to type of non-union.

Results: Results were excellent to good in 59.24%, satisfactory in 37% and poor in 3.7%.

Conclusion: Tibia is the commonest site of non-union in long bone fracture. Open reduction and internal fixation after freshening of bone ends and autologous bone grafting is the commonest mode of treatment in non-union Tibia management.

Keywords: Non-union, Tibia, Bone graft.

Introduction

Non-union is a problem faced by most of orthopaedic surgeons. Of all the fractures of long bones, incidence of non-union is 5 to 10%.^(1,2) Tibia is the common site of non-union in long bone fracture^(3,4) up to 62% followed by femur 23%, humerus 7%, FA 7%. Management of non-union has remained a constant challenge. As tibia is subcutaneously located and has less blood supply in its distal part complicates the management of non-union of tibia. The associated bone defect, shortening, deformity & infection complicates the management.⁽⁵⁾ Non-union is defined by FDA panel as "Non-union is established when a minimum of 9 months has elapsed since injury and the fracture shows no visible progressive sign of healing for 3 months, but the criteria cannot be applied to every fracture". Present day surgeon have come to realise that earlier and more aggressive treatment is warranted. Surgical intervention is usually indicated 3 to 5 months after surgery of fracture which fails to show progressive sign of healing on serial radiography.

Diagnostic criteria for non-union is abnormal mobility, absence of transmission of movement, continuous disability at the fracture site and loss of function of the part, specific radiological findings pertaining to various types of non-union and histological changes at fracture site suggestive of fibrous tissue.

Principal causes of non-union are intervening extensive gap (Gap non-union), loss of blood supply, ischemic damage to surrounding muscle, abnormal biomechanics, infection,⁽⁶⁾ extensive comminution, improperly applied fixation devices, individual bone susceptibility, insufficient immobilisation, iatrogenic

factors, interposition of soft tissue, immunological factors, instability and metabolic disturbances. Cigarette smoking is well documented to place the patient at higher risk of delayed healing or non-union.⁽⁷⁾

Treatment of non-union is a challenge. There are multiple options for treatment of non-union with equal risks and benefits. In general hypertrophic non-union often can be treated by stable fixation of fracture whereas atrophic non-union requires freshening and bone grafting. The requirements common to all successful techniques are good reduction, sufficient bone grafting and firm stabilisation of fracture. Various modalities of treatment for non-union tibia are autologous bone grafting,⁽⁸⁾ electrical stimulation, open reduction & fixation, percutaneous bone marrow injection and external ring fixator.

Material & Methods

Present study was a prospective study of 32 patients of non-union in tibia admitted in Dept. of orthopaedics of a tertiary care hospital.

Inclusion criteria: All the patients in whom tibia fractures showed no visible progressive signs of healing for 3 months were included in this study.

Exclusion criteria: Patients with pathological fracture due to osteomyelitis, primary or secondary tumour and patients with congenital pseudoarthrosis were excluded.

All patients were evaluated clinically with special attention was given to local skin condition & neurovascular involvement. Standard x-ray AP & lateral views were taken and evaluated. Patients were investigated completely for operative and anaesthetic purpose.

Pre-operative evaluation: Counselling of patient and relatives was done regarding plan of treatment, possible complication, prognosis & outcome. Consent for surgery and for research study was taken from patient. Patient were evaluated fully and mode of treatment planned.

Surgical procedure: We have treated non-union of tibia with following modalities of treatment, (Fig. 1,2)

1. Nail fixation with bone grafting for diaphyseal non-union tibia
2. Plate fixation with bone grafting for metaphyseal non-union tibia
3. External fixation for infective types of non-union tibia
4. Tibialisation of tibia for gap non-union tibia
5. Ring fixator for gap non-union tibia

All the procedures were carried out in sterile operating room, under full aseptic precaution. Spinal anaesthesia or regional block anaesthesia was given depending upon the procedure to be carried out. Patient was taken on operation table, painting and draping done including joints above and below for free movement. The standard incision and surgical technique were used and fracture non-union site was opened. Bone ends were cleared from soft tissue and callus refreshing of end done to get bleeding zone, medullary canal opened, reduction achieved. The selected implant was fixed with standard surgical technique and checked for stability. Corticocancellous bone grafts slices were taken from iliac crest and placed at non-union site. Incision closed in layers, dressing was done.

Post-operative management: Posterior slab were given wherever necessary. I.V antibiotics given for 5 days. I.M analgesics given for first 3 days.

Static quadriceps exercises for nearby joints started on 2nd day. Check dressing was done on 5th post-operative day and infection was ruled out. Oral antibiotics were given after 5th day of operation till the wound healing. Sutures were removed on 10th-12th post-operative day and cast was given wherever necessary. Patient was discharged with advise to come for follow up after 6 wks. Final evaluation was done at the last follow up, points were noted about clinical union, deformity, shortening movement of adjacent joints and complications. Results were graded as excellent, satisfactory, good and poor.

Results

Total of 32 cases of non-union of tibia reported in orthopaedics department were given suitable operative

treatment and followed up regularly for the period of 15 months. The age of patient ranged from 20 – 55 yrs., majority of patients 17(53.12%) were between age 30 – 40 yrs., average age of the patient was 38.58 yrs. There were 81.25% male as compared to 18.75% females. Most common mode of trauma in this series was vehicular accident in 20(62.5%) patients, followed by 7(21.87%) due to fall from height. Right extremity is involved in 19 patients (59.37%) while 13(40.62%) cases were of left side involvement. In this series 17(53.12%) patients were of closed fractures while remaining 15(46.87%) were of open fractures. Majority of cases were of mobile type of non-union 22(68.75%) and remaining were stiff non-union On the other hand roentgen graphically most of the cases were of hypertrophic non-union 22(68.75%) cases. (Table 1)

Table 1: Patients characteristics

Age group in years	Percentage
20 to 30	6(18.75%)
30 to 40	17(53.12%)
> 40	9(28.12%)
Mode of trauma	
--Vehicular accident	20(62.5%)
--Fall from height	7(21.87%)
--Other	5(15.62%)
Clinical Types	
--Mobile non-union	22(68.75%)
--Stiff non-union	10(31.25%)
Nature of Injury	
--Closed fracture	17(53.12%)
--Open fracture	15(46.87%)

Probable cause of non-union in this series was iatrogenic in 14(43.75%) patients followed by soft tissue interposition and unstable fracture. Modality of treatment in this study was Corticocancellous bone grafting with nail fixation in diaphyseal non-union 18(56.25%) patients. Metaphyseal type of non-union were treated with fixation with plating and bone grafting in 8(25%) patients. Ring fixator in 2(6.25%) cases of infective gap non-union and simple external fixator in 1(3.12%) patient of infective non-union were applied. Bone grafting alone in 2(6.25%) cases of atrophic type of non-union with in situ fixation. tibialisation of fibula in 1(3.12%) patient of gap non-union was done. (Table 2)

Table 2: Modality of Treatment

Modality	Type of Non-union	No. of Cases/ %
1. Corticocancellous bone grafting with fixation		26(81.25%)
a) Nail Fixation	Diaphyseal	18(56.25%)
b) Plate Fixation	Metaphyseal	08(25%)
2. Ring fixation	Infective/gap	02(6.25%)
3. Simple external fixation	Infective	01(3.12%)
4. Bone grafting alone	Atrophic with in situ fixation with distraction at fracture site(gap)	02(6.25%)
5. Tibialisation of fibula	Gap	01(3.12%)

Union was achieved in 30 patients out of 32 as 1 patient was persisting in a stage of non-union and 1 patient underwent above knee amputation, these 2 cases were excluded. Majority of cases 20(66.66%) were united in between 7 to 10 months. Average time of union for metaphyseal non-union was 7.56 months while for diaphyseal non-union mean time of union was 8.7months. 2(6.66%) cases required more than 10 months for union. Complication in this study were superficial infection in 2(6.66%) cases while deep infection in 1(3.33%). Adjacent joint stiffness was found in 6(20%) while shortening more than 2 centimetre were in 4(13.13%) cases. Other complications like persistence of non-union, amputation and nail in joint was found in each 1(3.33%) case. Follow up period in this study was 10 to 15 months in majority of cases 19(63.33%). Clinically excellent to good results were seen in 17(56.66%) patients, satisfactory in 11(36.66%) cases while 2(6.66%) had poor result. (Table 3)

Table 3: Union time, Number of patients with complication and follow up and Clinical results

Time Taken For Union	No. Of Cases /percentage
3 to 6 months	08(26.66%)
7 to 10 months	20(66.66%)
11 to 14 months	01(3.33%)
More than 14 months	01(3.33%)
Complications	
Complications	No. Of cases /Percentage
Infection----Superficial	02(6.66%)
Deep	01(3.33%)
Adjacent joint stiffness	6(20%)
Shortening more than 2cms	04(13.13%)
Persistence of non-union	01(3.33%)
Amputation	01(3.33%)
Nail in joint	01(3.33%)
Follow up of patients	
3 months to 9 months	11(36.66%)
10 months to 15 months	19(63.33%)
Clinical Results	
Excellent	09(30%)
Good	08(26.66%)
Satisfactory	11(36.66%)
Poor	02(6.66%)

Clinical results as per type of non-union we found excellent to good results in 75% cases in metaphyseal non-union while 64.78% cases shown excellent to good results in diaphyseal non-union. (Table 4)

Table: 4 Clinical results as per type of non-union

Clinical results	Type of non-union		
	Metaphyseal	Diaphyseal	Gap
excellent	4(50%)	6(35.29%)	
Good	2(25%)	5(29.49%)	
Satisfactory	2(25%)	6(35.29%)	3
Poor			2

Discussion

In this series we studied 32 patients including 26 males and 6 females with age ranges from 20 to 55 with an average age of 38.58. Follow up of this study was ranging from 6 months to 15 months. This is comparable to the observations of JOHNSON EE, SIMPSON LA (1995) where the average age was 40 years.⁽⁹⁾ In the study of McLAREN AC, BLOKKER MD (1989) on locked intramedullary fixation for metaphyseal non-union there were 14 patients, 12 were males and 2 were females.⁽¹⁰⁾ In this series most of the patient 20(62.5%) had fracture due to vehicular accident it indicate increase incident of accident. in the study there were 22(68.75%) hypertrophic non-union and 10(31.25%) were atrophic types of non-union while in the study by KOK-LONG PAN, SHUKER MH, et al (1994) on ten patients there were 60% cases of atrophic and 40% cases were hypertrophic.⁽¹¹⁾ In this study in majority 14(34.54%) cases were having iatrogenic cause of non-union. In our study bone grafting was done in all patients of nail, plate 26(81.25%). Corticocancellous bone graft were taken from iliac crest. DAWSON WJ, MEAD MC (1986) treated 29 patients of tibial non-union with phemister bone grafting only.⁽¹²⁾

In this study most of cases 20(66.66%) were united within period of 7 to 10 months this is comparable with the study of WISS DA, JOHNSON DL ET AL (1992) were average of 7 months were required for union.⁽¹³⁾ Main complication we found in this study were infection (9.99%), adjacent joint stiffness (20%). In this study clinically excellent to good results were seen in 17(56.66%) cases and satisfactory in 11(36.66%) cases. Two patient (3.33%) had poor result where union could not be achieved.

Based on this study it is concluded that, incidence of non-union is increasing gradually. Non-union is seen more commonly in young males, the commonest bone involved is tibia. The two commonest causative factors noted are iatrogenic and soft tissue interposition while open reduction and internal fixation after freshening of bone ends and autologous bone grafting is the commonest modality of treatment. Metaphyseal type of non-union is less common as compared to diaphyseal type and it takes less time for union. Infective and gap type of non-union takes more time for union and are associated with higher incidence of complications. Proper initial treatment with proper selection of

implant, more use of closed fixation, may help prevent the increasing incident of non-union.

References

1. Novicoff WM, Manaswi A, Hogan MV, Brubaker SM, Mihalko WM, Saleh KJ. Critical analysis of the evidence for current technologies in bone-healing and repair. *J Bone Joint Surg Am* 2008;90 Suppl 1:85-91.
2. ZuraR, Xion z, Einhorn T, et al. Epidemiology of fracture Non-union in 18 human, bones, *JAMASurg*:2016No.16;151(11):e1627754dol:10.1001/jamasurg.2016.2775;epub2016nov16.
3. Ellis H. The speed of healing after fracture of tibial shaft. *J. Bone joint surgery Br.* 1958;40-B(1):42-6.
4. Bauer GC, Edwards P, Widmart PH. Shaft fracture of tibia. Aetiology of poor results in a consecutive series of 173 fractures. *Acta chir scand* 1962;124:386-5.
5. Harshal RK, Sankhala SS, Jalan d, management of non-union of lower extremity long bone using monolateral external fixator-report of 37 cases. *Injury*, 2014mar;45(3):560-7.dol:10.1016/j.injury.2013.11.019.Epub 2013Nov27.
6. Mcqueen MM, Christie J, court – brown CM. Acute compartment syndrome in tibia diaphyseal fracture. *J bone joint surg Br*;1996 Jan;78(1):95-8.[medicine]
7. Schmitz MA, Finnigan M, Natrajan R, Effect of smoking on tibial shaft fracture healing. *Clin orthop* 1999 Aug 184-200:[medicine]
8. Phemister DB. Treatment of Un-united fracture by onlay bone graft without screw or the fixation and without breaking down of the fibrous union. *J. Bone Joint Surg.*1947;29A or B 946-60.
9. JOHNSON EE, SIMPSON LA, HELFET DL. Delayed intramedullary nailing after failed external fixator of tibia. *Injury Jan*: 1995;31-35.
10. McLAREN AC, BLOCKER CP. Locked intramedullary fixation for metaphyseal mal-union and non-union. *Clinic Orthop.* 1989; No-265:253-256.
11. Kok Long Pan, Shuker MH, M Ali Noor Ghani. Locked intramedullary nailing for complex non-union of the tibia. *Injury* 1994; Vol-25:655-657.
12. Dawson WJ, Mead MC, Sweeney HJ, Schafer MF. Onlay fibular bone grafting in treatment of tibial fracture non-union. *Clinic Orthop.* 1978; No.130:247-253.
13. Wiss DA, Johnson DL, Miao M. Compression plating for non-union after failed external fixation of open tibial fractures. *J Bone Joint Surg. (Am)* 1992;44-A,1279-1285.