

## Epidemiology and operative management of non-union in long bones

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### Abstract

**Introduction:** Non-union is a serious complication of fracture. Management of non-union has remained a constant challenge. The associated bone defect, shortening, deformity and infection complicate the management. Present study was designed to assess the utility of various available modalities of treatment for non-union in long bones.

**Material and Methods:** 59 patients of non-union of long bones admitted in orthopaedic ward during the period of January 2009 to 2011 were included in a prospective study. Maximum patients 25 (45.45%) were having non-union of tibia followed by femur seen in 12 (21.81%). Detailed history, clinical and radiological examination was conducted. Diagnosis was confirmed and suitable plan of treatment was formulated and undertaken.

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

**Conclusion:** Incidence of non-union is increasing gradually. Two commonest bones involved are tibia and femur. Open reduction and internal fixation after freshening of bone ends and autologous bone grafting is the commonest mode of treatment in non-union management.

**Keywords:** Non-union, Long bones, Epidemiology.

### Introduction

Non-union is a serious complication of fracture. Management of non-union has remained a constant challenge. The associated bone defect, shortening, deformity and infection complicate the management.<sup>(1)</sup> Major injuries are no longer confined to the battlefield of 20<sup>th</sup> century. 21<sup>st</sup> century has seen a rapid upsurge in modes of transportation, industrialization and mechanical farming result in increase in incidence of accident many folds. High energy trauma producing severe bone and soft tissue damage and advanced in trauma care have resulted in increased survivors among severely injured patients. This is thought to correlate increase incidence of delayed and non-union of fracture long bones.<sup>(2)</sup>

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 signs of healing for 3 months. But the criteria cannot be applied to every fracture. Rather than being limited by a definition of non-union that involves a set of time frame, 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 signs of healing on serial radiography.

Diagnostic criteria for non-union is abnormal mobility, absence of transmitted movements, continuous disability at the fracture site with 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, ischemia/ damage to surrounding muscle, abnormal biomechanics, infection,<sup>(3)</sup> 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.<sup>(4)</sup>

Non-union is classified by Judet and Judet and Muller et al. Weber- cech classification is one most widely used for non-union into hypertrophic, atrophic and normotrophic.<sup>(5)</sup> Of all the fractures of long bones, incidence of non-union is 5 to 10%.<sup>(6,7)</sup> Tibia is the common site of non-union in long bone fracture<sup>(8,9)</sup> up to 62%, followed by femur 23%, humerus 7%, and forearm 7%.

**Principle of treatment:** Treatment of non-union is a challenge. In general, treatment of non-union increases in complexity as the component of non-union (infection, deformity, shortening, bone defect) increases. There are multiple options for treatment of non-union with equal risks and benefits. The simplest and easily tolerated method shall be chosen. Generally the method chosen should leave as many other methods as possible. Operations for non-union are relatively extensive and should be recommended only after non-union has been demonstrated clinically and radiologically and when union is impossible without change in treatment. In general hypertrophic non-union often can be treated by stable fixation of fracture, whereas atrophic non-union requires refreshing and bone grafting. The requirement common to all successful techniques are good technique of reduction,

sufficient bone grafting and firm stabilisation of fracture.

Various modalities of treatment for non-union are autologous bone grafting,<sup>(10)</sup> electrical stimulation, open reduction and fixation, percutaneous bone marrow injection and external ring fixator. This study highlights the incidence and types of non-union and different modalities of management of non-union in long bones.

### Material and Methods

Present study is a prospective study of 59 patients of non-union in long bones, admitted in department of orthopaedics of a tertiary care hospital.

**Inclusion criteria:** The entire patient in whom long bone 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 and neurovascular involvement. Standard X-ray's; anteroposterior and 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 and outcome. Consent for surgery and for research study was taken from patient. Patients were evaluated fully and mode of treatment planned.

**Surgical procedure:-**We have treated non-union of long bones with following modalities of treatment.

1. Nail fixation with bone grafting in 26 cases.
2. Plate fixation with bone grafting in 17 cases.
3. Ring fixator in 5 cases.
4. Simple external fixator in 2 cases.
5. Bone grafting alone in 2 cases.
6. Tibialisation of tibia in 1 case.

All the procedures were carried out in sterile operating room, under full aseptic precautions. Spinal anaesthesia or regional block anaesthesia was given

depending upon the procedure to be carried out. Patients were taken on operation table, painting and draping done including joints above and below for free movement. The standard incision and surgical techniques 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 and reduction achieved. The selected implants were fixed with standard surgical technique and checked for stability. Corticocancellous bone graft slices were taken from iliac crest and placed at non-union site. Incisions were closed in layers and dressing was done.

**Post-operative management:** Posterior slabs were given wherever necessary, intravenous antibiotics were given for 5 days and intramuscular analgesics were given for first 3 days. Static quadriceps exercises for nearby joints were started on 2<sup>nd</sup> day. Check dressings were done on 5<sup>th</sup> post-operative day and infections were ruled out. Oral antibiotics were given after 5<sup>th</sup> day of operation till the wound healing. Sutures were removed on 10<sup>th</sup> to 12<sup>th</sup> post-operative day and casts were given wherever necessary.

Patients were discharged with advice to come for follow up after 6 weeks. 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

Epidemiology of fracture in this study showed that, as compare to total number of admission in orthopaedics department, traumatic work load is more than cold cases indicating increase in incidence of traumatic operations. The overall incidence of non-union in this study in relation to orthopaedics work is 0.70%. But after analysing data, it was observed that, non-union has increased from 0.55% to 0.8% during this study (Table 1). The average non-unions in relation to traumatic operative orthopaedics workload were found to be 1.87% in this study.

**Table 1: Epidemiology of fracture non-union**

Year	Total No. Admission	Total No. of Operations	Operations on trauma cases	Operations on cold cases
2009	3268	1584	1270(80.17%)	314(19.82%)
2010	3450	1640	1300(79.268%)	340(20.73%)
Upto Jun 2011	1702	648	572(88.27%)	76(11.728%)
Incidence of non-union in relation of orthopaedic indoor work				
Year	Total no. of Admission	Total no. of Non-union	Percentage	
2009	3268	18	0.550%	
2010	3450	29	0.840%	
Upto Jun 2011	1702	12	0.705%	
Total	8420	59	0.70%	

Total 59 cases of non-union reported in orthopaedics department of which 4 cases were lost in follow up after initial diagnosis, remaining 55 cases were given suitable operative treatment and followed up regularly. The age of the patients ranged from 16 to 70 years. Majority of patients 26 (47.27%) were between age 21 to 40 years with average age 41.58 years. There were 74.35% males as compared to 24.45% females with M: F ratio of 2.93:1. Most common mode of trauma in this series was vehicular accident in 28(50.9%) patients, followed by 17(30.9%) due to fall from height. Maximum patients 25(45.45%) were having non-union of tibia followed by femur seen in 12 (21.81%) patients. Right extremity was involved in 28 patients (50.90%), while 27 cases were of left side involvement. In this series 60% patients were of closed fractures while remaining 40% were of open fractures. Majority of cases were of mobile type of non-union 35(61.30%) and remaining were of type stiff non-union. Roentgen graphically, most of the cases were of hypertrophic non-union 32(58.17%) cases. (Table 2)

**Table 2: Patients characteristics**

Age group in years	Percentage
<20	3(5.45%)
20 to 40	26(47.27%)
40 to 60	15(27.27%)
>60	11(20%)
Mode of trauma	
--Vehicular accident	28(50.9%)
--Fall from height	17(30.9%)
--Assault or direct trauma	10(18.18%)
Clinical Types	
--Mobile non-union	35(61.30%)
--Stiff non-union	20(36.70%)
Nature of Injury	
--Closed fracture	33(60%)
--Open fracture	22(40%)

Probable cause of non-union in this series were iatrogenic in 19 (34.54%) patients followed by soft tissue interposition and unstable fracture. Most common modality of treatment in this study was fixation with nail plus corticocancellous bone grafting applied in 26(50.90%) patients, while fixation with plate plus bone grafting in 17(30.90%) cases. Ring fixator application in 5(9.09%) patients, simple external fixator in 2(3.63%) patients, bone grafting alone in 2(3.63%) and tibialisation of fibula in 1(1.18%) patients were other modalities of treatment used in this study (Table 3).

**Table 3: Modality of Treatment and probable cause of non-union**

Modality	No. of Cases/ %
1. Corticocancellous bone grafting with fixation	45(81.81%)
a. Nail Fixation	26(50.90%)
b. Plate Fixation	17(30.90%)
2. Ring fixation	05(9.09%)
3. Simple external fixation	02(3.63%)
4. Bone grafting alone	02(3.63%)
5. Tibialisation of fibula	01(1.81%)
Probable Cause of Non-Union	
1. Iatrogenic	11(34.54%)
2. Soft tissue interposition	16(29.09%)
3. Unstable fracture	11(20%)
4. Wide displacement without any treatment	02(3.63%)
5. Gap non-union	07(12.72%)

Union was achieved in 50 out of 55 patients. 5 cases were excluded from study as 3 patients had less than 3 month follow up, 1 patient was persisting in a stage of non-union and 1 patient underwent above knee amputation. Majority of cases 36(72%) showed fracture union in between 3 to 6 months while 4(8%) cases required more than 14 months for fracture union. Complications in this study were superficial infection in 3(5.45%) cases, deep infection in 1(1.81%), adjacent joint stiffness in 10(18.18%), and shortening of limb more than 1 inch in 8 (14.54%) cases. Other complications like persistence of non-union, amputation and nail in joint was found in 1 (1.81%) case each. Follow up period in this study was 10 to 15 months in majority of cases 32(64%). Clinically excellent to good results were seen in 29(58%) patients, satisfactory in 19(38%) cases while 2 (4%) had poor result (Table 4).

**Table 4: 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	36(72%)
7 to 10 months	5(10%)
11 to 14 months	5(10%)
More than 14 months	4(8%)
Complications	
Complications	No. of cases /Percentage
Infection----Superficial	03(5.45%)
Deep	01(1.81%)
Adjacent joint stiffness	10(18.18%)
Shortening more than 2cms	08(14.54%)
Persistence of non-union	01(1.81%)
Amputation	01(1.81%)
Nail in joint	01(1.81%)
Follow Up in Patients	

Less than 3 months	3(6%)
3 months to 9 months	16(32%)
10 months to 15 months	32(64%)
Clinical Results	
Excellent	14(28%)
Good	15(30%)
Satisfactory	19(38%)
Poor	02(4%)

## Discussion

In our study, we studied 55 patients including 41 males and 14 females with age ranges from 16 to 70 years with follow up ranging from 3 to 15 months. Average age was 41.58 years. This is comparable to the observations of JOHNSON EE, SIMPSON LA (1995), where the average age was 40 years.<sup>(11)</sup>

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.<sup>(12)</sup> In our study most of the patient 28(50.9%) had fracture due to vehicular accident which indicate increased incidence of accident. There were 32 (58.17%) hypertrophic non-union and 23(41.83%) were atrophic types of non-union in our study while in the study by KOK-Long Pan, Shuker MH, et al (1994) there were 60% cases of atrophic and 40% cases were hypertrophic type of non-union.<sup>(13)</sup>

In our study, majority of cases 19 (34.54%) were having iatrogenic cause of non-union. Other causes we found were soft tissue interposition in 16 (29.09%) cases, unstable fracture in 11(20%) cases, gap non-union in 7 (12.72%) and wide displacement without treatment in 2 (3.63%) cases (Table 3). In our study, bone grafting was done in all patients of non-union treated with nail, plate and external fixator i.e. 45(81.81%) cases. Corticocancellous bone graft was taken from iliac crest. Dawson WJ, Mead MC (1986) treated 29 patients of tibial non-union with phemister bone grafting only.<sup>(14)</sup>

In our study most of cases 36(72%) were united within period of 6 months. This is comparable with the study of Wiss DA, Johnson DL et al (1992) were average of 7 months were required for union.<sup>(15)</sup> Main complications we found in our study were infection (9.62%), adjacent joint stiffness (18.18%). Clinically excellent to good results were seen in 29 (58%) cases and satisfactory in 19 (38%) cases. Two patients (4%) had poor results. Out of them, union could not be achieved in one patient and above knee amputation was done in one patient (Table 4).

Based on this study, it is concluded that incidence of non-union is increasing gradually. Epidemiological factors of host are fast and modern life. Epidemiological factors of agent are high velocity accidents with sever bone and soft tissue damage and epidemiological factors of environment are increasing operative management with neglect of soft tissue. All these factors seem to be important in causation of non-

union. Non-union is seen more commonly in young males with commonest bone involvement of tibia and femur. The two commonest causative factors noted are iatrogenic and soft tissue interposition.

Open reduction and internal fixation after freshening of bone ends with autologous bone grafting was the commonest modality of treatment. Proper initial treatment with proper selection of implant, more use of closed fixation and proper respect to soft tissues during surgery to avoid ischemia may help to prevent the increasing incidence of non-union.

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