

NONUNION OF LONG BONES IN BASRAH; EVALUATION AND MANAGEMENT

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Abstract

Nonunion of long bone fracture holds a big challenge for both the patient and the orthopedic surgeon. This study aimed to explore the possible causes and to evaluate the effectiveness of the treatment of nonunion in our region.

Eighty-four patients with established nonunion of long bones were enrolled. All patients with primary fracture underwent; conservative, immediate or delayed operative treatment. Evaluation of nonunion was done by; careful general & local clinical examination, general & specific laboratory investigation, and radiological assessment with special emphasis to classify as atrophic or non-atrophic types. According to treatment modalities of nonunion, the patients were divided into three groups: Conservative (for those who refuse surgery or unfit for anesthesia), early, and delayed operative treatments.

From the total 84 patients, 68 patients (81%) were males while 16 patients (19%) were females. Their age range was 13-77 years with a mean of 36.5 years. Five patients (6%) had co-morbidities including; diabetes, bronchial asthma, renal failure, hypertension. Cigarette smoking was not significant (p-value: 0.827). Tibia was the commonest bone involved in nonunion representing 46% (39 patients), followed by femur 36% (30 patients) and humerus 18% (15 patients). Forty-Five patients (54%) developed hypertrophic nonunion while 39 patients (46%) have atrophic nonunion. Non-union in this study was in seventeen cases (20.2%) due to single cause, while in fifty-five patients, (65.5%) due to two causes and the other twelve patients (14.3%) were due to combinations of three causes. Internal fixation with bone graft was performed for thirty patients (36%), external fixation with bone graft was applied to eighteen patients (21%), external fixation alone was done for 14 patients (17%), internal fixation alone was applied to 7 patient (8%), bone graft alone was done for 3 patients (4%), external and mini internal fixation with bone graft was done for 2 patients (2%). The mean time of follow up after definitive treatment for nonunion was 12.4 weeks. The majority of our patients (36 patients, 43%) were followed for 12-24weeks. The commonest bone that showed complete union in this study was femur (48%), tibia (30%), and humerus (22%).

In conclusion, the chief causes that stand behind nonunion of the long bones which we revealed by our successive clinical, radiological, labrotary and active operative judgments in this study were; infection, insecure fixation, comminution, and soft tissue interposition. Internal fixation with autogenous bone graft proved to be the vital step to dissolve the obstacle of nonunion.

Keywords: nonunion, bones, long, evaluation, treatment

Introduction

Nonunion is established when a minimum of 9 months has elapsed since the injury, and the fracture shows no visible progressive signs of healing for 3 months. This is not applicable to every fracture, so fracture of the long bones should not be considered as nonunion until at least 6 months had elapsed since the injury. On the contrary femoral neck

fracture can be labeled as nonunion after only 3 months since the injury. Nonunion classified into hypertrophic and atrophic, although exact cause of nonunion still unknown, but there are certain local and systemic factors that may contribute in its etiology. These are: open fracture, infection, segmental fracture especially middle fragments, comminuted fracture,

insecure fixation, insufficient time for immobilization, treatment by wrong open reduction, fracture distraction by plate and screw, and fracture of irradiated bone. Systemic factors are: Patient's metabolic and nutritional status, general health, activity level, and consuming tobacco or alcohol. Nonunion may presented by pain, disability, and deformity¹.

Patients and Methods

This prospective study was carried out in Basrah Teaching Hospital. Eighty-four patients with established nonunion of femur, tibia, and humerus were enrolled to evaluate the effectiveness of treatment and to study the possible causes. Detailed history was taken from each patient regarding the initial fracture: the exact time of trauma and the mechanism of fracture. Examination involved: site of fracture, its pattern, associated bone loss, soft tissue status, grading, and associated neurovascular injuries. All patients with primary fracture underwent: conservative, immediate or delayed operative treatment. Evaluation of nonunion was done by careful general and local clinical examination, general and specific laboratory and radiological investigations with special emphasis to classify nonunion to atrophic or non-atrophic

type. Detailed medical history was done including chronic illness, drug history and smoking. To find out the possible causative agents of nonunion, we classified patients into 3 main groups: Group one, which may attributed to one cause, group two, due to 2 main causes, and group three, combination of three main causes. According to the treatment modalities of nonunion, the patients were divided in three groups: Conservative, early, and delayed operative treatment such as fixation either internal or external with or without bone graft. Follow-up time ranged from three to nine months; group one, those extended from 1-12 weeks, group two, those extended from 13-24 weeks and group three, those extended from 25-36 weeks. Data were analyzed using SPSS version 10. The results were statistically significant at $P < 0.05$.

Results

The gender of the total 84 patients was 68 males (81%) and 16 females (19%). Their age ranged from 13-77 years with a mean of 36.5 years. Most of our patients were in the age group of 30-39 years (28 patients, 33%), the lowest incidence was reported in the age group 70-79 years (2 patients, 2.4%) as shown in Fig.1.

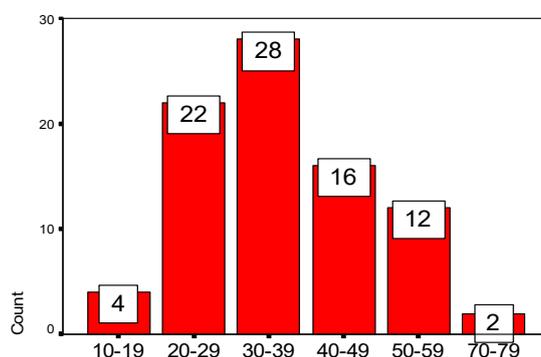


Figure 1: Age distribution.

Regarding the types of initial fractures, they were comminuted fracture in 49 patients (58%), followed by transverse fracture in 25 patients (30%), oblique

fracture in 9 patients (11%) and spiral in 1 patient (1%). Closed fractures were seen in 48 patients (57%) and open fractures in 36 patients (43%).

Mechanisms of initial fractures were: Road traffic accident in 48 patients (57%), bullet injury in 29 patients (34.5%) and fall on the ground in 7 patients (8.5%). The initial fractures in 21 patients (25%) were treated conservatively while 33 patients (39%) underwent internal or external fixation with or without bone graft, and thirty patients (36%) were treated by delayed operative method. Tibia was the commonest nonunion bone in 39 patients (46%), followed by femur 30 patients (36%) and 15 patients humerus (18%). Forty-Five out of 84 patients developed

hypertrophic nonunion representing (54%) while the remaining 39 patients (46%) were atrophic nonunion. Only five patients (6%) have co-morbidities. Cigarette smoking was recorded in forty-three patients (51%) ranging from mild to heavy smoker while non-smoker were forty-one patients (49%), this was not significant p-value (0.827).

The cause, which stand behind nonunion was in seventeen patients (20%) one factor, while in fifty-five patients, (66%) was two causes and in twelve patients (14%) was combination of three-causes as shown in Table I.

Table I: Causes of nonunion.

No. of causes	Causes	No. of pt.	Percent.
One factor	Infection	8	9%
	Insecure fixation	6	7%
	Open fracture	3	4%
Total No.		17	20%
Two factors	Infection + open fracture	11	13%
	Infection + soft tissue interposition	10	12%
	Infection + insecure fixation	10	12%
	Infection + comminution	9	11%
	Infection + open fracture	8	10%
	Comminution + insecure fixation	7	8%
Total No.		55	66%
Three factors	Infection +open fracture +comminution	5	6%
	Insecure fixation + infection + soft tissue interposition	5	6%
	Infection + segmental fracture + insufficient time of immobilization	2	2%
Total No.		12	14%
Total		84	100%

Surgical treatment as a target role for getting complete recovery from nonunion was done in 60 patients (71%) while 9 patients (11%) was treated conservatively and 15 patients (18%) were treated by delayed operative management. For most patients in whom operative treatment was chosen as definitive option for treatment of nonunion, internal fixation with bone

graft was performed in thirty patients (36%), external fixation with bone graft in eighteen patients (21%), external fixation alone in 14 patients (17%), internal fixation alone in 7 (8%), bone graft alone in 3 (4%) external and internal fixation with bone graft in 2 (2%), and finally external and internal fixation in one patient (1%) as shown in Fig.2.

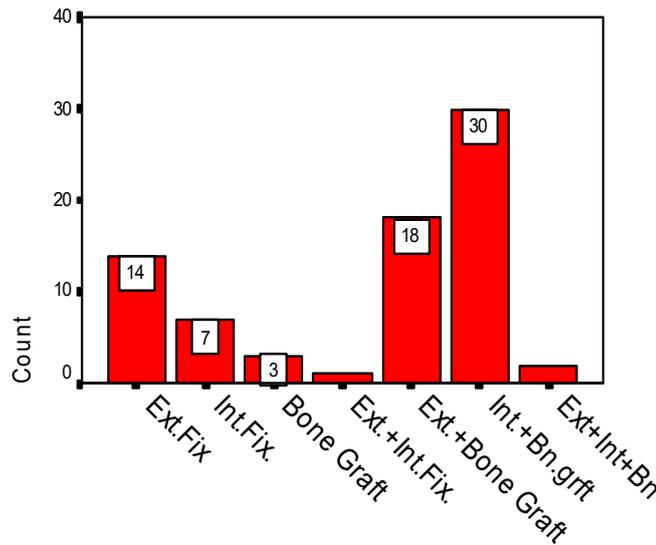


Figure 2: Operative treatment for nonunion.

The mean time of follow up after definitive treatment was 12.4 weeks with highest incidence (43%) in those extended from 12-24weeks, while 11% ranged from 25-36 weeks and 36% for only 1-12weeks. The optimal golden target in this study was to achieve union

using different ways of management. We obtained 32% union rate compared with 68% failure rate. The common bones united in this study were; femur in 48% of the cases, tibia in 30% patients, and humerus in 22% cases, as demonstrated in Figure 3.

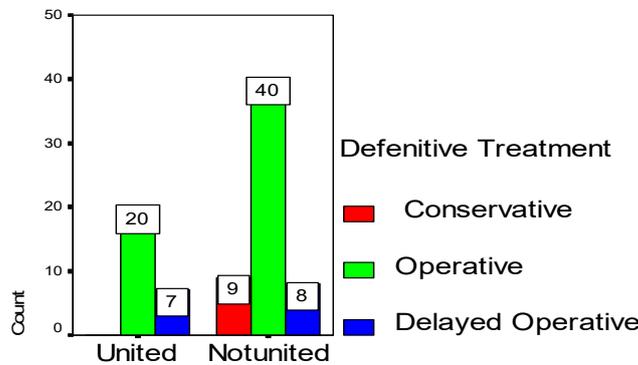


Figure 3: The outcome of nonunion.

Discussion

Nonunion age & gender distribution: In this study, nonunion was noticed mainly in the age group 30-39 year (33%), next to this was the age group 20-29 years (28%) while its lowest incidence was in the age group 70-79 (2%), this may be related to the small number of old patients who sustained fracture compared to young people who participate in everyday life activities. The mean age was 36.5 years old, which differs from

many studies²⁻⁴. The mean age at the start of treatment was 46.7 years, but goes with Bumbaširević⁵ were the mean age was 30.4 years.

Gender distribution: It's quite common to find nonunion in males more than females, which was documented strongly in this series by 81% males compared by 19% females out of 84 patients, this may be related to female's life style with all its restricted association as compared to

males in our culture. This was supported by the study of Joon-Woo kim³ (18 patients, 13 men and 5 women), ŁukaszSzelerski⁴ in which there was 102 patients (76 men and 26 women), and Bumbaširević⁵ (29 males and 1 female), this is may be explained by the life style in our society as women activities outside home is greatly restricted.

Fracture pattern: The most common fracture pattern presented in this study was comminuted fracture which was verified in 49 patients (57%), followed by transverse fracture in 25 patients (30%), then oblique fracture in 9 patients (11%) and spiral in one patient (1%), this was related mainly to the severity of the injurious mechanism. These results are supported by the study of Karladani AH⁶ were he recorded 52 comminuted fractures out of 104 tibial shaft fractures and against the study by Cognet JM⁷ were spiral fracture was the most common type presented.

Mechanism of fracture: The commonest causative mechanism for fracture in this study was road traffic accident in 48 patients (57%), followed by bullet injury in 25 patients (30%) and one patient fall from height. In spite of severity of injuries which caused nonunion, but still closed fracture had high incidence than open fracture, this may be due to changing closed to open fracture by surgical intervention. Closed fracture was recorded to be 57% and open fracture 43% this is supported by the study of Karladani AH⁶ as he recorded 22 open fracture out of 104 patients with tibial shaft fracture, Malik MH⁸ recorded 30 open fractures out of 214 long bone fractures, and Nabil A. Ebraheim⁹ of the 169 nonunion reviewed, 133 (78.7%) were closed fractures and 36 (21.3%) with open fractures.

Nonunion and bone involved: Tibia was the most common bone involved in nonunion in this study seen in 39 patients (46%), femur 30 patients (36%), and humerus 15 patients (18%), this may be

related to the peculiar character of tibia regarding its anatomical position. Results were not similar to the study by Malik MH⁸ who recorded 122 femurs, 75 tibial fractures and 17 humeri and also does not correlate with Arsalan H¹⁰ who estimated 12 femoral fractures and 10 tibial fractures.

Types of nonunion: In this study, patients with established nonunion from other orthopedic surgeons who were treated by different surgical modalities mainly by changing closed to open fractures, there were 45 patients (54%) developed hypertrophic nonunion while the remaining 39 patients (46 %) had atrophic nonunion, this may be explained according to the type of fixation used for the patients. These results goes with the study by Markus Rupp¹¹ as 162 participants in the study, 99 patients (61.1%) suffered from a hypertrophic nonunion, while 63 patients (38.9%) had an atrophic nonunion.

Nonunion and chronic disease: Diabetic patients come on the top of the list of those who developed nonunion, 5 patients (6%), they were on oral hypoglycemic drugs with poor dietary control. Most of them had high fasting blood sugar, this contributes in their intolerance to operation and all of them end up with nonunion, this was statically significant. There were; one patient asthmatic, one anemic and one with chronic renal failure, all of them were still set with nonunion due to local and systemic effects of the disease.

Smoking and nonunion: In this series we recorded 43 patients (51%) as cigarette smoker compared with 41 patients (49%) non-smokers, 57 patients ended with nonunion 31 were smokers, while among those 27 who achieved union, 15 of them were nonsmokers and the remaining 12 patient were smokers, this is reinforced by Jacques Hernigou¹² who suggested solid association between smoking and delayed bone healing, and Dinah¹³ who advice to stop smoking one week before

surgery which interfere with process of coagulation and fibrinogen level.

Causes of nonunion: The causes that stand behind nonunion had been studied systematically to find out the possible correlation between nonunion of the long bone and its causative agents, as we had classified the causes into 3 main groups: Group I: The cause is one factor (17 patients, 20%). The possible causes were insecure fixation 8/17, then infection 6/17, and open fracture in 3/17 patients (4%). Group II: This is consisting of 2 likely main causes: this was the biggest group represented 55 patients (66%). It is classified into infection and open fracture 11/55 patients, infection and insecure fixation 10/55 patients, insecure fixation and soft tissue interposition 10/55 patients, and infection and comminution 9/55 patients, infection and open fracture 8/55 (10%), and comminution and insecure fixation 7/55 (8%). Group III: Consists of combination of three potential causes represented by 14% (12 patients) here the main collection was infection, open fracture, and comminution 5/12 (6%), also insecure fixation+infection+soft tissue interposition 5/12 (6%) and the last was combination of infection+segmental fracture+insufficient time for immobilization 2/12 (2%). So we can identify that the main factors which stand behind nonunion of the long bones in this study which were infection, insecure fixation, comminution, and soft tissue interposition. This does not go with the study by Milind Madhav Chaudhary¹⁴, who blamed recalcitrant infection, complex deformities, sclerotic bone ends, large bone gaps, shortening, and joint stiffness. But goes with study by Mills¹⁵ were a total of 31% of patients had a single attributable cause, 55% had two causes, 14% had three causes and 1% had all the four.

Treatment of primary fractures: In this series, initial treatment which were done by other orthopedic surgeons (the first surgeon who treated those patients) were:

Conservative group: Those patients were subjected to conservative procedure in form of casting, skin or skeletal traction, this method representing 25% (21 patients). **Operative group:** those patients who underwent operative interference like frequent session of wound excision, with essential procedure as external or internal fixation with or without bone graft was estimated to be 39% (33 patients). **Delayed Operative group:** this group consists of patients who had conservative treatments to start with then changed to operative treatment represented 36% (30 patients).

As we notice from the above figures, the main bulk was surgical interference which may precede the misery of fracture nonunion by changing the closed fracture to open one which reflect the rush decision for treatment of fracture. This is supported by study of Healy WL¹⁶ who exposed his patients to both conservative and operative treatment of 26 humeral shaft fracture, but does not go with studies by Court-Brown-C-M¹⁷ in a review study of 459 patients, tibial fracture nonunion treated operatively (primary reamed nailing and Nabil A. Ebraheim⁹ of the 169 cases reviewed, the initial treatment was ORIF with plating in 108 (63.9%), IMN in 24 (14.2%), external fixation in 13 (7.7%) and unknown in 20 (11.8%). The remaining four initial treatments included one instance of multiple Steinmann pins, one allograft, one plate and cast and one non operative. So our option for choosing both operative and conservative methods based on patient condition, surgical skills, confidence, operative facilities and our general situations.

Definitive treatment of Nonunion: In this study the ideal target was to achieve union in the non-united fracture of the long bone, this was performed by either operative treatment like internal fixation and autogenous bone graft from ileum or tibia, this was done in thirty patients(36%). External fixation and bone

graft was performed in eighteen patients (21%). External fixation alone in fourteen patients (17%). Internal fixation alone in seven patients (8%). Conservative treatment was applied in 9 patients (11%) (Since either refusal for surgical interference or existence of comorbidities which made them inoperable). Delayed operative treatment was performed in 15 patients (18%), so we can distinguish 89% of our patients treated by operative and delayed operative, with just 11% conservative decisions. Here we can touch the big hope of our orthopedic surgeons and their huge desire to get from the sadness of nonunion by achieving this large number of surgical interference while those who treated conservatively either unfit for general anesthesia because of medical precautions or they refuse the operation. This does not go with study by Shih CH¹⁸ who treated 121 cases of femoral neck fracture by Knowles pins, study by Rijnberg WJ¹⁹ where he used fresh autogenous iliac bone graft for 48 tibia. In Nabil A. Ebraheim⁹ study, out of the 169 nonunions, the specific initial treatments were dynamic condylar screws in 21 (12.4%), anterograde nailing in 18 (10.7%), angled blade plates in 16 (9.47%), retrograde nailing in six (3.55%), and locking compression plates in five (2.96%). In addition, 30 (17.8%) received bone grafts during the initial treatment.

Follow up time: Group 1: extended from 1-12 weeks (3 months) was included 36% (30 patients). Group 2: from 13-24 week (3-6 months) was included 43% (36 patients). Group 3: those extending from

25-36 week (6-9 months) included 11% (9 patients). Mean time of follow up was 12.4 week, so from these figures above we can recognize that the period of follow up in the group 1 not enough to regard the chance of treatment well established to decide this treatment option not successful (according to the definition of nonunion), so this group needs further follow up time, especially if we look to the follow up time in other studies like Bumbaširević⁵. Bony union was achieved at the tibial docking sites after a mean of 4.5 months in 29 patients (97%), Yin, P²⁰. The mean follow up after removal of the apparatus was 23.12 months (14-46 months), Shi CH¹⁸ 32 months, Rijnberg WJ¹⁹ 6-29 months.

Conclusion:

The causes that stand behind nonunion of the long bone in this study were; infection, insecure fixation, comminution, and soft tissue interposition. Internal fixation with autogenous bone graft proved to be the vital step to solve the obstacle of nonunion. The wisdom of clever orthopedic surgeon who recognizes the fracture that should require interference conservatively or operatively from the start is important step to prevent nonunion.

In order to accomplish union we advise to have healthy viable bone ends, plentiful bone graft, with faultless suitable rigid fixation.

The main complications which façade in this study were failure to complete union and recurrence of infection in addition to psychosomatic upset of the patients because of dissatisfaction.

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