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Epidemiology of Delayed Union of Long Bones

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Abstract

Aim: To study the epidemiology of delayed union of long bones.

Introduction: In India, the availability of fracture healing therapies to the general public is limited. The infrastructure of the health system in India, involving both public and private sector does not provide adequate opportunity for rural and low-income inhabitants to access the needed care. Due to these reasons, majority of the global burden of injuries are borne by low and middle-income countries.

Material and methods: Patients getting admitted in AVBRH hospital above the age of 18 years of either sex with radiological features of delayed union. Study was a prospective, case control observational type carried out in a rural health setup at AVBRH. It comprised of 153 patients out of which 43 patients had delayed union of a long bone, 53 patients had non-union. These patients were compared with 57 patients that had postoperative fracture union which were included as a control group who had the same risk factors for delayed union.

Results: Aging, female gender, comminuted and segmental fractures, higher grades of soft tissue injury, smoking, and infection were found to be independent risk factors for delayed union in long bone fractures. Among the risk factors, smoking and infection can be controlled to decrease the prevalence of delayed union.

Conclusion: It is necessary that we create awareness about the importance of primary treatment like immobilization and wound debridement, as patients should reach as early as possible. Patient's relative's moral support is necessary in order to get early hospitalization so as to reduce the risk of delayed union among patients and so that appropriate modality of treatment (surgical and conservative) with use of bone regeneration substitutes such as bone grafting and PRP can be done to promote faster healing keeping infection in control.

Keywords: Fracture; Healing therapies; Long bones; Injuries; Bone grafting

Introduction

Injuries are predicted to become the leading cause of disability over the next few decades eventually rising to the level of a substantial global burden in which musculosketal injuries play a major part [1-6]. In India, the availability of fracture healing therapies to the general public is limited. The infrastructure of the health system in India, involving both public and private sector does not provide adequate opportunity for rural and low-income inhabitants to access the needed care. Due to these reasons, majority of the global burden of injuries are borne by low and middle-income countries.

One of the complications that occur due to fractures is delayed union. Delayed union, by definition, is present when an adequate period of time has elapsed since the initial injury without achieving bone union. The fact that a bone is delayed in its union does not mean that it will become a non-union. Non-union is one of the end results of a delayed union, and the differentiation between the two is sometimes difficult to make [7].

Incidence of Delayed union or non-union of fractures occurs in 5% to 10% of long-bone fractures. Early recognition of delayed or non-union improves outcomes and prevents further anxiety and disability for the patient. Non-union of the long bones fractures is a serious complication prolonging patient morbidity, time lost from work, and economic hardship.

Classically the stated reasons for delayed union are problems such as inadequate reduction, inadequate immobilization, distraction, loss of blood supply, and infection [8]. It has many other causes including bone or soft tissue loss, soft tissue interposition, poor blood supply, infection, pathological fracture, poor splintage or fixation, and fracture distraction. Risk factors include NSAIDs, smoking, Cigarette Smoking, infection, deficiency, thyroid imbalance, hyperparathyroidism (primary hyperparathyroidism presenting as delayed fracture union), and occult infection.

The development of systems for early fracture stabilization advanced drastically. However, it is a poor strategy to focus solely on restoration of mechanical integrity. It should be coupled with an optimization of the environment for bone healing. It is obvious that this can be achieved with a clear understanding of the mechanism of reparative osteogenesis for only in this way can the real cause preventing

consolidation of the fracture first be determined and then be eliminated.

The aim of our study was to find out the causes of delayed union in long bones in our rural set up with patient inflow from different parts of the Vidharbh region, and the efficacy of different modalities of treatment.

Material and Methods

The study was a prospective, case-control observational type conducted from August 2014 to August 2016. The study was conducted on 153 patients admitted in AVBRH hospital above the age of 18 years of either sex. The patients were diagnosed cases of Delayed union and non-union of fractures of long bones where the fracture of the long bone had already been operated. The controls that were selected were patients aged 18 years and above who did not have a diagnosis of a fracture-healing complication (union present). Controls were matched to their cases and length of history in the database so that these characteristics could be evaluated as risk factors.

The study did not include patients with pathological fractures, patients with open fractures of Gustilo Andersons Classification Type IIIc and patients who were not willing for inclusion in the study

Based on a review of the medical literature, we chose to study socio-economic status, moral support (family), educational status, time between the injury and hospitalization, primary treatment received or not, and post-op immobilization (early/late) in cases of delayed union. The socio-economic status, moral support and educational status were assessed with help of Singh's socio economic emotional scale (SSEE) [8].

All patients had their preoperative full-length radiographs of the affected limb for assessment of the level and type of fracture non-union, plane of deformity, bone quality and presence of sequestrum. All patients were optimized preoperatively for the proposed operation. Physiotherapy within comfort with specific reference to joint mobilization and edema control was attempted in all patients. Culture swabs from draining sinuses and open wounds were carried out in all patients and appropriate antibiotic therapy was initiated. This was repeated whenever necessary throughout the duration of treatment or follow up.

Postoperatively all patients will have their radiographs for assessment of the status of union. Follow up x-rays were done. Patient's history of mobilization partial weight bearing, within comfort by a trained physiotherapist. Patients when discharged had follow up in the fracture clinics at monthly intervals for assessment of fracture union.

The average duration of delayed union and time of referral to our center was 3 months or more. The site of delayed union was identified. The initial diagnosis was based on Gustilo's classification. Patients with extensive bone loss at the time of initial injury was considered. Patient's debridement and internal fixation device (Intra-medullary nail or Plate Osteosynthesis and screw fixation) and, external fixation followed by plaster immobilization, as definitive treatment will be considered. The co morbidities were Diabetes, Hypertension, Asthma, thyroid disorders, History of smoking and alcohol consumption and treatment for psychiatric disorders.

Statistical analysis was done by using descriptive and inferential statistics using Chi-square test and software used in the analysis were SPSS 17.0 version and Graph Pad Prism 5.0 version and $p<0.05$ is considered as level of significance.

Results

In correlation with Singh's socio-economic emotional scale score(SSEE) and delayed union we found 29(18.95%) patients were under delayed union between score of 6 to 9, 35(22.88%) were under non-union with >9 score, in control group patients with union 57(37.25%) of patients were added, this study was significant correlation with help of chi-square test resulting p value (2χ-value)=0.0001 (109.28).

Score	United	Delayed	Non-union	2χ-value
<6	51(33.33%)	3(1.96%)	3(1.96%)	109.28, p=0.0001, S
6 to 9	6(3.92%)	11(7.19%)	15(9.80%)	
>9	0(0%)	29(18.95%)	35(22.88%)	
Total	57(37.25%)	43(28.10%)	53(34.64%)	

Table 1: Correlation of Singh's socio-economic emotional scale score (SSEE) with type of union.

Time between injury to hospital	United	Delayed	Non-union	2χ-value
0-5 days	57(37.25%)	25(16.34%)	40(26.14%)	29.03, p=0.0001, S
6-10 days	0(0%)	7(4.58%)	7(4.58%)	
11-20 days	0(0%)	4(2.61%)	3(1.96%)	
21-30 days	0(0%)	2(1.31%)	1(0.65%)	
>30 days	0(0%)	5(3.27%)	2(1.31%)	
Total	57(37.25%)	43(28.10%)	53(34.64%)	

Table 2: Correlation of time between injury to hospital with type of union.

In our study, out of 43 patients maximum number of patients came within 0-5 days of trauma 25(16.34%) patients were under delayed union, 40(26.14%) patients were under non-union and 57(37.25%)were under union, this gave us significant with help of chi-square test resulting p value(χ-value)=0.0001(29.03).

Primary Treatment	United	Delayed	Non-union	χ^2-value
Yes	52(33.99%)	5(3.27%)	9(5.88%)	85.93, p=0.0001, S
Not	5(3.27%)	38(24.84%)	44(28.76%)	
Total	57(37.25%)	43(28.10%)	53(34.64%)	

Table 3: Correlation of primary treatment received or not with type of union.

In our study, we found 38(24.84%)with delayed union and 44(28.76%) with nonunion had history of no primary treatment received just after trauma and in control group we had 52(33.99%) patients with union who received primary treatment, this correlation

was found to be significant with help of chi-square test resulting with p value=0.0001(85.93).

Post-op Mobilization	United	Delayed	Non-union	2ϰ-value
Early	6(3.92%)	28(18.30%)	38(24.84%)	49.07, p=0.0001, S
Late	51(33.33%)	15(9.80%)	15(9.80%)	
Total	57(37.25%)	43(28.10%)	53(34.64%)	

Table 4: Correlation of post-op mobilization with type of union.

Correlation with post op mobilization and delayed union, 28(18.30%) patients of delayed union and 38(24.84%) patients were under nonunion had history of early mobilization, 51(33.33%) patients of control group had history of late mobilization after post-operative management, the study had significant p value(χ^2-value)=0.0001 (49.07) with help of chi-square test.

Discussion

Correlation of Singh's socio-economic emotional scale score (SSEE) with delayed union

In Singh's socio-economic emotional scale score (SSEE) the parameters of modified socio economic status, literacy level and emotional support [9] were measured in our study according to which we found 29(18.95%) patients were under delayed union, between score of 6 to 9, this correlation was significant with p value(χ^2-value)=0.0001 (109.28) according to chi-square test (Table 1).

As in our rural set up most of the patients of modified Prasad's socio-economic status were below class-III, literacy level of our population maximum had only primary education and no emotional support from the relatives.

A study performed in Saudi Arabia by stated that majority of those injured are in the prime of life thereby leading to loss of education and economic hardships due to long periods of recuperation with the rising cost of medical care there is increased economic burden on the patients [10].

In our study, it was seen that Emotional Support played an important role. It was found that maximum number of patents 23(15.03%) were under delayed union of Grade 4 i.e. "No emotional support", in the control group 37(24.18%) patients were under Grade 1-Full emotional support by the relatives was given and with chi-square test, p value(χ^2-value)=0.0001(70.09) was significant, stating that the emotional support has an effect over delayed union.

A similar study had 111 patients with hip fractures who were interviewed and examined before discharge from the hospital [11]. The functional status of surviving patients was assessed again 6 months later. Patients who had a greater number of social supports had more complete recovery of their pre-fracture level of function.

Felder-Puig Rosemarie et al. had done a study stating that it was necessary for adolescence age group with pathological fractures to deal with problems such as restricted mobility, catching up with school and areas of social wellbeing, their means of emotional support are from older age groups which are often preoccupied with work and daily activities [12].

The main reason being in our rural health care setting, elderly patients requiring surgical interventions are often denied it. The families are sceptical of the outcome, hence unwilling to bear the cost of such potential surgeries minimizing risk of delayed union/non-union, which lead to better functional outcome. These families are unaware of government sponsored schemes to lower hospital expenses-another reason being these patients are neglected.

In our study we found results has 20(13.07%) patients who were under delayed union had a literacy level of primary education and 36(23.53%) patients who were in the control group with union and literacy level of graduation, this was significant with chi-square p value(χ^2-value)=0.0001(82.68).

Kadakia et al. stated that Patients with lower educational levels did significantly worse on the questionnaire biased on post-operative care, than those with higher educational levels [13]. The results of the study highlight a lack of comprehension within this patient population and suggest that an increased focus on patient communication by orthopaedic providers may be necessary.

Tsahakis et al. performed One hundred forty-six patients were given only the standard discharge instructions, whereas 153 patients were also administered the additional information document. Patients who received the intervention were 1.3 times more likely to know which bone was fractured (P=0.007) and 1.1 times more likely to be able to correctly name the medication(s) they were prescribed for deep vein thrombosis prophylaxis (P=0.03) [14]. The intervention did not preferentially aid patients with lower education backgrounds.

Correlation of time between injury to hospital and delayed union

The relation with time of injury to the duration of hospitalization in present study was that, maximum number of patients came within duration of 0-5 days of trauma i.e. 25(16.34%) patients were under delayed union 40(26.14%) patients were under non-union, this gave us significant p value (χ^2-value) =0.0001(29.03) using chi-square test (Table 2).

This study shows a significant correlation between injury and time taken for the patient in hospitalization for treatment, as most of the patients are poor and do not receive any means of transport for hospitalization. Hence, they were delayed in receiving treatment such as pre-op immobilization, skeletal traction and antibiotics to prevent infection, therefore increasing the risk of delayed union.

Amir Matityahu et al. observed a significant inverse correlation between the in-hospital resources that were available and the interval from admission to surgery [15]. This increased the time duration for fracture healing and one was the causes of delayed union.

Fischer et al. observed that out of 43 patients who had a Type-IIIB open fracture of the tibial shaft were reviewed to determine the effect of early treatment of the soft-tissue injury on the rate of major complications results show that adequate debridement and early assessment of the soft-tissue defect are necessary so that appropriate soft-tissue coverage can be provided within the first one to two weeks with fewer complication [16].

Correlation of primary treatment received or not with delayed union

In present study 38(24.84%) with delayed union and 44(28.76%) with non-union had history of no primary treatment received just after trauma this correlation was found to be significant with p value (χ^2-value)=0.0001(85.93) with help of chi-square test (Table 3).

As most of the patients in our study had primary education as their literacy level the importance of first aid such splinting/wound covering with compression and other life saving protocols are not known to the most of the people present at the site of RTA/Fall. If primary treatment was given at the appropriate time, will prevent the risk of delayed union and other major complication, as this study was carried out in the rural setup of Wardha the only few tertiary centre with ambulances, which provide facilities of transportation for the patients hospitalization. These factors also further add to the risk of delayed union in long.

Gustilo et al. observed retrospectively on 673 open fractures of long bones (tibia and fibula, femur, radius and ulna, and humerus) treated, the infection rate was 12% from 1955 to 1960 and 5% from 1961 to 1968 these patients were devoid of initial primary treatment most of ended up in delayed fracture healing, this results were as similar to our study [17].

Further studies recommended treatment for open wounds in joints with wide-spectrum systemic antibiotics, surgical debridement, irrigation of the joint and soft tissues, and primary closure should be done as early as possible was stated by Patzakis et al. [18].

In contrary Raman Mundi observed timely irrigation and debridement within six hours after injury has been established as the standard of care in the management of open tibial fractures, current evidence does not support such practice [19].

Correlation of post-op mobilization with delayed union

In present study, we found there was correlation with post op mobilization and delayed union, 28(18.30%) patients were found under delayed union and 38(24.84%) patients were under non-union had history of early mobilization, the study had significant p value(χ^2-value)=0.0001 (49.07) according to chi-square test (Table 4).

Most of the patients in tertiary health centres have history of early discharge due to unaffordability to stay in hospital for longer durations. These patients are unknowingly early mobilized soon after surgeries leading to the risk of delayed union. Thus patients should be properly council for immobilization for appropriate durations and avoid vigorous activities which in important in fracture healing.

Teo stated fracture is associated with slow healing and prolonged post-operative immobility [20]. Predominant fixation method was with an extramedullary device in 23 patients. 25 (75%) patients were placed on wheelchair mobilization or no weight bearing in early period. A large proportion of the patients required revision surgery and suffered implant failure. This results were as similar to our study (Figure 1).

A paper reviewed a series of thirty-four intercondylar fractures of the distal end of the humerus that were treated by open reduction over a ten-year period Jupiter et al. observed a mean follow-up complications included postoperative neuritis in five patients; three non-unions; and refracture, heterotopic bone, and deep sepsis in one patient each [21] (Figure 2).

Conclusions

Our thesis pointed out a significant correlation between emotional support (p-value (χ^2-value)=0.001(70.09)), literacy level (p-value (χ^2-value)=0.0001(82.68)) and Singh's Socio-Economic Index (p-value (χ^2-value)=0.0001 (109.28)) with delayed union.

Also in risk factors for delayed union we found primary treatment received or not (p-value (χ^2-value)=0.0001(85.93)), time between injury to hospitalization (p-value (χ^2-value)=0.0001(29.03)) and post-op mobilization (p value (χ^2-value)=0.0001 (49.07)) to be significant with parameters of trauma.

Clinical Significance

This study addressed an important gap in the literature: the lack of recent and broadly representative data on over all general condition, economic status and healthcare in the treatment of long bone fractures depending on the delayed union status.

Figure 1: Photograph showing operated case of compound grade II fracture proximal tibia.

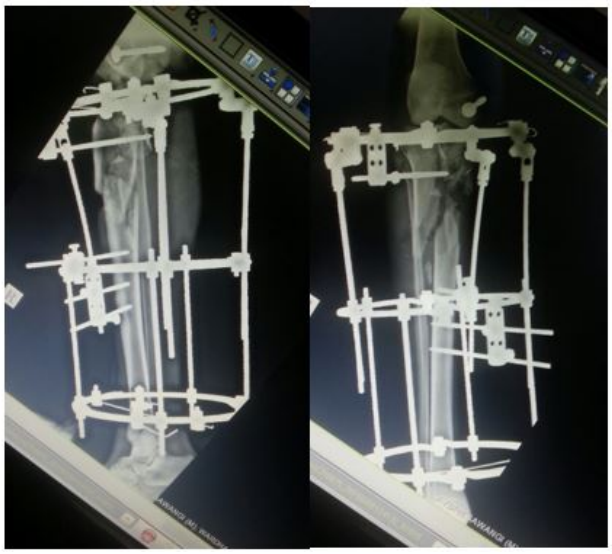

Figure 2: Radiograph X-ray showing operated case of compound grade II fracture proximal tibia.

Optimizing the results of fracture treatment requires a holistic view of patients and treatment. The nature of the patient determines the

priority targets for outcome, which differ widely between patients. The efficacy of treatment depends on the overall process of care and rehabilitation as well as the strategy adopted to achieve bone healing.

The information, which was concluded, can help to develop and promote preventive strategies, to inform the decision makers for resource allocation, to address issues relating to the health workforce, and to refine medical curricula. The majority of those injured worldwide have no access to an orthopaedic surgeon, and this is not likely to change in the foreseeable future, so strategies for teaching and training must educate and empower other health professionals to care for musculoskeletal injuries, where appropriate. While individuals, institutions, and societies from high-income societies may play an important role in partnering with colleagues and institutions in low and middle-income countries to develop and implement strategies to decrease the burden of injury, an exchange of information between and within providers from resource challenged environments will also be essential.

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