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Evaluation frequency and related factors of nonunion long bone fractures in traumatic patients of Tabriz Imam Reza Hospital

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A B S T R A C T

Blows to the bone, which leads to disruption of the continuity of the bone blade told fractures. In the treatment of bone fractures, there were surgical and non-surgical procedures, which ultimately can lead to the welding broken parts. But sometimes complications such as nonunion can complicate bone fractures union. Many factors can cause to create it. In this study, we're going to evaluate frequency of and nonunion in long bone fractures and its related factors of in traumatic patients. And based on the current findings try to discover abnormal process in order to fix it. The study is a descriptive-analytical study that examined all trauma patients years with non-union long bone fractures that were admitted in Imam Reza Hospital of Tabriz. All patients Information with long bone fractures that are complicated by nonunion was recorded in specials form. The collected data in the special form were analyzed by spss16 software. In this study (100 patients), 86 patients were male (86%) and 14 patients (14%) were female and rate of the nonunion was significantly ($P < 0.05$) high in males. The mean patient age was 37.4 years, the youngest patient was 3 years old and the oldest one was 78 years old. 34% of people had direct trauma and 66% had indirect trauma. And significantly ($P < 0.05$) nonunion frequency in close fractures, transverse fracture, vehicle accidents, Tibia and femur fracture, was high. The most common causes of non-union in our patients were infections and anemia. In the distance of time until the non-union fractures, the mean interval was12.51months, the minimum period was 6 months and maximum period was 84 months. In conclusion, non-union are common in tibia and femur fractures. And a variety of factors including male gender, older age, open fracture, infection, and lack of adequate blood flow, systemic diseases and anemia is effective in non-union of long bone fracture.

Introduction

Any impact on bones that disrupts the continuity of bone sheets is called bone fracture. Causes of fracture are different and include direct or indirect trauma, abrupt muscle contraction, mild and repeated impacts, mild impacts on osteoporotic bones, or background pathologies. The causes of almost all fractures, with or without background pathologies, are direct and indirect traumas (1).

There are different surgical and nonsurgical methods for the treatment of bone fractures. These treatments may finally lead to the union of fractured segments. However, some of the bone-uniting treatments are accompanied by side effects, which result in several problems (1).

Considering the increasing prevalence of vehicle accidents, facture of femoral bones and long bones in general is among the most common forms of fracture seen in the trauma emergency wards. Since the femur is the longest bone in human body and is among the bones bearing weights, fracture of this bone leads to long-term morbidity and severe disability (2).

Every year, more than two million cases of long bone fractures are treated in the United States. Almost 5% suffer from nonunion and many patients experience delayed union.
Aggressive treatment procedures have reduced the figures for acute bone fractures. Labor and economic losses caused by nonunion are considerable with these types of fractures and therefore call for innovative treatment methods (3).

The treatment of this fracture includes different medical and surgical methods (4). The plating and intramedullary nail techniques are more popular than the other methods while the other methods are used for some certain cases.

In recent years the closed interlocking intramedullary nail method has been used as the method for the treatment of such fractures (2, 4). The incidence of complications with this method is also lower than the plating method (5-12).

The possibility of tibia fractures nonunion increases, if it is accompanied by injury and crushing of soft tissues or if it follows a high-energy trauma and causes extensive crunching (13). On the other hand, some treatment methods that lead to higher damages in soft tissues increase the chances of nonunion due to the disruption of blood circulation in the bone (14). External installation of the fixator is also another cause of tibia nonunion (15). Hence, more recent textbooks recommend the less aggressive tibia surgery procedure (i.e. the closed interlocking intramedullary nail), in which there is no need to open the fracture and drain the hematoma (16). Tibia fracture nonunion largely disturbs the daily lives of patients and may keep them away from work and money making for a long time. On the other hand, the mental conditions resulted from the chronic disease shall not be overlooked (17).

Considering the aforementioned problems, in recent years numerous studies have been conducted on the side effects of bone fractures and attempts have been made to address the causes. One of the major problems caused by the complications of fracture is the nonunion of bone fractures, which is observed after treatment. FDA defines nonunion as follows:

1) At least in a 9-months period after the fracturing, no progress is seen in terms of the union of fractured bones within 3 months.

2) When no union is observed in long bones at least 6 months after the injury (18).

Consequently, in spite of treatments used to treat the fracture, the fractured segments do not united in the required time and evident movements are seen between the fractured segments (pseudoarthrosis). Sometimes the fractured segments are connected through a relatively firm fibrous tissue and examinations reveal very minor yet painful movements at the site of fracture (fibrous-union). In any case, the fracture line is evident in radiographic images and bone sides yield to sclerosis. As a result, the healing does not occur within the time predicted for each fracture and challenges develop orthopedic surgeons to address the defects. However, the resulting problems and challenges can only be addressed with surgical approaches (1).

Finally, any factor that leads to a defect in the union of fractured bones can lead to nonunion. In order to treat such fractures, the fibrous tissue at the site of the fracture is removed with surgical procedures and the causes of the defects (disruption) are addressed. Then, the defect is repaired using bone grafts from the patient's body or chemicals that contribute to ossification (1).
This study was an attempt to examine the frequency of nonunion of long bones based on the causes of nonunion in traumatic patients. It was also tried to minimize the prevalence of this complication in patients so as to prevent this condition, reduce the incidence of one of the major current problems of orthopedic medicine, and finally play an important role in the treatment of such patients.

Materials and Methods

In a descriptive-analytical study in Department of Orthopedic of Tabriz University of Medical Sciences, the frequency and factors influencing long bones fracture nonunion in traumatic patients of Imam Reza Hospital in Tabriz were studied.

All of the traumatic patients, who were hospitalized in Emam Reza Hospital years for long bones fracture nonunion, were selected and included in the research.

It was an analytical-descriptive study that was carried out within 3 years on the inpatients of Imam Reza Hospital in Tabriz. The information on all of the patients suffering from long term fracture nonunion was incorporated into the research.

Statistical Analysis

The collected data were analyzed by SPSS-17 statistical software. The collected data were expressed as percentage and mean ± SD. Continuous (quantitative) variables were compared by Independent samples and Paired t test. Categorical (qualitative) variables were compared by contingency tables and Chi-square test or Fisher's exact test. P-value ≤ 0.05 was considered statistically significant.

Results and Discussion

In the present research, a total of 100 patients including 86 male (86%) and 14 female (14%) were studied. The prevalence of fracture nonunion was significantly higher in men ($P<0.05$).

The mean age of patients was 37.4 years, which fell in the 3-78 range. Of the patients under study, 6% were 20 years old (or younger), 26% were between 21-30 years old, 28% aged between 31 and 40 years old, 16% were between 41 and 50 years old, and 24% were over 50 years old.

The frequency of nonunion in patients of the 20 years old (or younger) group was significantly lower while this frequency was significantly higher in the 31-40 years age group.

Moreover, 34% of patients suffered from direct trauma, while 66% suffered from indirect trauma. The frequency of nonunion was significantly higher in patients with indirect trauma. 36% of patients had open fractures, while 64% had closed fractures. The frequency of nonunion was significantly higher in closed fracture cases.

48% of patients had transverse fractures, 12% had inclined fractures, 2% were suffering from spiral fractures, 28% were suffered from comminuted fractures, 8% had segmental fractures, and 2% had greenstick fractures. The rate of nonunion of greenstick fractures was significantly lower, while the rate of transverse fractures was significantly higher than others.

The fracture mechanism in 20%, 6%, and 74% of the patients was falling, remaining under wreckage, and vehicle accidents, respectively. The rate of fracture nonunion in patients who remained under wreckage was significantly lower while the rate of nonunion in car accidents was significantly higher.

Moreover, 33.8%, 24.7%, 5.2%, 28.6%, and 7.8% of patients were diagnosed with Tibia, Fibular, Ulnar, Femur, and Humerus fracture, respectively. The frequency of nonunion in patients with Ulnar fracture was significantly lower, while it was significantly higher in the case of tibia fracture.

Examination of the nonunion sites revealed that 36.2% suffered from tibia nonunion, 8.6% had fibular nonunion, 3.4% were suffering from radius nonunion, 36.2% were diagnosed with femur nonunion, 6.9% had Ulnar nonunion, and finally 8.6% were diagnosed with Humerus nonunion. The rate of nonunion was significantly lower in radius fractures, while it was significantly higher in patients with tibia and femur fractures.

Of all of the patients under study, 24.5%, 18.8%, 18%, 20%, and 18.8% were suffering from fracture site infection, displacement of fractured segments, lack of adequate bond between fractured segments, adjacency of fixation devices and metals, and anemia, respectively. No significant difference was observed in distribution of causes of nonunion in patients.

Investigations into the internal causes of nonunion (including biological and environmental factors) revealed that 30.8%, 23.1%, 19.2%, 3.8%, 3.8%, 6.4%, and 12.8% were caused by anemia, lack of pressure on fracture site, smoking, late manipulation of the fractured organ, hormonal factors, consumption of NSAIDs, and systemic diseases (such as diabetes). The nonunion cases caused by late manipulation of the fractured site and hormonal factors had the lowest frequency, while nonunion caused by anemia had the highest frequency ($P<0.05$).

Assessments of the interval between incidence of fracture and nonunion showed that the interval between the incidence and nonunion was 17.41 months, which fell in the 6-84 months range.

Using the modern treatment method, it is possible to treat most cases of fractured bone without any specific problem. After a fractured bone is treated, a new osseous tissue starts forming to connect the fractured segments.

However, some fractured bones do not recover even using the best surgical or nonsurgical method. In some cases, as a result of risk factors problems occur to the treatment and union of bones. When a bone does not heal it is called "bone nonunion". Moreover, "delayed bone union" is used to refer to a form of fracture that takes longer than usual to heal.

Fracture nonunion occurs when the bone lacks adequate stability or blood flow, or both. These conditions occur when the bone fractures as a result of a severe trauma such as a vehicle accident. In such cases, severe traumas usually cause problems to the flow of blood into the fractured bone.

Usually several factors increase the probability of fractured bones nonunion. Some of these factors include the following: use of tobacco or nicotine in any form; aging; severe anemia; diabetes; low vitamin D levels; hypothyroidism; under nourishment; infections; complex fractures; and intake of some specific drugs.

Orthopedic surgeons shall consider several factors involved in the nonunion of long bones. Currently, there is no unique method accepted by all and all of the available techniques are based on statistical findings. Many patients need 6 to 12 months of treatment and therefore they welcome any method that recovers the function of their disabled organ (19).

In our study, 100 patients (86 male and 14 female) were studied. The prevalence of nonunion was significantly higher in men.
The mean age of patients in our study was 37.4 years. The incidence of nonunion was significantly lower in patients aged 20 or lower while it was higher in the 31-40 years range.

In the study by Fong et al., the mean age of participants was 42 years while 69% of patients were male and 31% were female (20). In the research by Nwagbara, the mean age of patients was 39.7 years while 56.6% of patients were male and 43.3% were female. In addition, the prevalence of nonunion was higher in men aging between 42 and 53 years (21).

A comparison between the results of the aforementioned studies and our research showed that in all studies the prevalence of nonunion was higher among men aged over 40 years. This can be ascribed to the employment of men in difficult jobs and higher rate of driving among men.

In our study, 36% of patients suffered from open fractures and 64% had closed fractures. The rate of nonunion was also significantly higher among patients with closed fractures. Moreover, nonunion was more prevalence in transverse fractures.

Fong et al. reported that nonunion is most prevalence in closed fractures and transverse fractures (20). However, Lipinski and Wiley came to a contradictory conclusion and reported that nonunion of long bones is more common with open and segmented fractures (22). This finding might be a result of the frequency of the aforementioned fractures in the center under study and therefore achievement of a single uniform finding calls for more inclusive studies.

In our research, 20% of participants had fallen from a height, 6% went under rubble, and 74% experienced car accidents. Car accident was significantly the most common cause of bone fracture. In the research by Fong, falling from height was the most common cause of fracture while car accidents, accidents with pedestrians,

crushing, etc. were the most common mechanisms of fracture (20).

In our study, the highest rate of nonunion was observed in the tibia and femur (36.2%), which was followed by fibula and Humerus (8.6%), Ulnar (6.9%), and radius (3.4%). Nonunion rate was significantly higher in tibia and femur.

In a similar study, Nwagbara reported that the prevalence of nonunion among long bones is in the following order: Humerus, femur, tibia, Ulnar and radius. In this study, Humerus had the first place, which can be attributed to the higher number of Humerus fracture cases in the study center, postoperative care, and all of the factors involved in the nonunion of bones (21). On the other hand, Fong et al. emphasized that the rate of nonunion is higher in tibia fractures (20).

Arup K. et al. examined causes of nonunion of fibular fractures and concluded that anemia, failure to fix the fractured organ, disturbing the fracture site anatomy during surgery, concurrent fracture of tibia shaft, and fracture of the last one third of tibia shaft were among the most important causes of fibular fractures. It was also revealed that CT scan was an important means of confirming the diagnosis (23).

Hong fei-Shi et al. (2013) examined a therapeutic method for treatment of long bones fracture nonunion and concluded that various topical and systemic causes are involved in the development of this complication, some of which include metabolic disorders, drugs, smoking, alcohol abuse, infection, lack of adequate fixing, extent of fracture, lack of tolerance for post-operative weight, and patient's activity (24).
Antonova et al. (2013) conducted a study on the costs of tibia fracture nonunion and reported that patients who consumed strong opioids, corticosteroid, SSRI, and NSAIDs two years before hospitalization demonstrated a higher prevalence of nonunion. Moreover, the prevalence of nonunion was also higher in open fractures, infected fractures, placement of metal devices inside/near the bone, and open fixation (25).

Fong et al. reported that nonunion is associated with alcohol abuse, excessive tobacco use, systemic diseases (including diabetes), use of steroids, the fixation method, and tolerance for post-operative weight (20).

Hernigou et al. (2013) studied the effect of smoking on the delay in recovery from diaphyseal bone fracture and concluded that cigarette (tobacco) is a powerful factor leading to the nonunion of diaphyseal fractures in femur, Humerus, and tibia bones (26). Giannoudis et al. referred to smoking, lack of weight tolerance and the male gender as the causes of nonunion (27).

Lipinski and Wiley carried out a study, by which they concluded that long bone nonunion is common in the case of open, infectious and segmental fractures, and when anemia or lack of complete fixation are observed (22).

Burd et al. studied the effects of Indomethacin on nonunion of fractured long bones and stated that the risk of nonunion of long bones was significantly higher in patients receiving Indomethacin (28).

IC-Nwagbara examined the reasons for long bone fractures nonunion and reported that fracture site infection was one of the important factors contributing to nonunion. Moreover, according to their research, the prevalence of fracture nonunion is as

follows: Humerus, Femur, Tibia, Ulnar, and Radius. The relationship of nonunion with age and gender was not significant, but the prevalence of nonunion was higher among men in the 42-53 years range (21).

As seen, our results are almost similar to the results of the mentioned research. Therefore, it could be concluded that in long bone fractures, the tibia and femur bones are the most common sites of fracture. In addition, various factors such as male gender, high age, fracture site infection, anemia, systemic diseases, and lack of adequate blood supply are involved in nonunion of fractured long bones.

Suggestions

In the end, it shall be mentioned that in the present research the prevalence of nonunion was higher in the femur and tibia bones, but in some articles the prevalence of nonunion was higher in other bones. Moreover, some articles suggested that nonunion is higher in open factures, while some others suggested that nonunion is more prevalent in closed factures. Considering the disagreements in this regard, it is recommended to conduct more extensive studies simultaneously in several centers to obtain a consistent uniform result.

Furthermore, to prevent any problems it is recommended to consider the following points.

1. Paying attention to factors involved in this regard such as anemia (for example by taking measures to address anemia to prevent fracture nonunion)
2. Respect for traffic rules to prevent accidents
3. Performing sterilized surgeries and applying health regulations following operations
4. Recommending patients to stop smoking and avoiding uncontrolled prescription of steroids and NSAIDs

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