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FUNCTIONAL OUTCOME OF FRACTURE HEALING IN DIABETIC VERSUS NON-DIABETIC PATIENTS.

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ABSTRACT

Background:
Fracture healing is a complex biological process influenced by several systemic factors, including metabolic disorders such as diabetes mellitus. Diabetes has been associated with impaired bone metabolism, delayed fracture healing, and increased risk of postoperative complications. Understanding the impact of diabetes on fracture healing and functional recovery is important for optimizing patient management and improving treatment outcomes.

Objective: To evaluate and compare the functional outcome of fracture healing in diabetic versus non-diabetic patients.

Methods: This comparative observational study was conducted in the Department of Orthopaedics at a tertiary care hospital. A total of 100 patients with fractures were included and divided into two groups: diabetic patients (n = 50) and non-diabetic patients (n = 50). Demographic details, fracture characteristics, healing time, complications, and functional outcomes were recorded. Fracture healing was assessed clinically and radiologically during follow-up. Functional outcomes were evaluated based on mobility, pain, and ability to perform daily activities. Statistical analysis was performed using the independent Student's t-test for continuous variables and the Chi-square test for categorical variables, with a p-value <0.05 considered statistically significant.

Results: The mean age of patients in the diabetic group was 56.4 ± 10.2 years, while in the non-diabetic group it was 52.3 ± 11.3 years, with no significant difference between groups (p = 0.07). The mean fracture healing time was significantly longer in diabetic patients (18.6 ± 4.2 weeks) compared with non-diabetic patients (15.3 ± 3.8 weeks) (p = 0.001). Complications such as delayed union, infection, and nonunion were more common among diabetic patients (p = 0.04). Functional outcomes were better in the non-diabetic group, with a higher proportion of excellent outcomes and fewer poor outcomes (p = 0.03).

Conclusion: Diabetes mellitus adversely affects fracture healing and functional recovery. Diabetic patients demonstrated prolonged healing time, higher complication rates, and poorer functional outcomes compared with non-diabetic patients. Careful monitoring, strict glycemic control, and appropriate rehabilitation may help improve outcomes in diabetic patients with fractures.

Keywords: Diabetes mellitus; Fracture healing; Functional outcome; Delayed union; Orthopedic fractures

INTRODUCTION

Fracture healing is a complex and highly coordinated biological process that involves sequential phases of inflammation, cellular proliferation, angiogenesis, callus formation, and bone remodeling. Successful bone repair depends on several factors, including adequate blood supply, mechanical stability, and a balanced metabolic environment. Systemic diseases can significantly influence this process, and among them, diabetes mellitus has emerged as one of the most important metabolic disorders affecting bone regeneration and recovery following fractures [1].

Diabetes mellitus (DM) is a chronic metabolic disease characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin resistance, or a combination of both. The global burden of diabetes has increased dramatically over the past few decades. It was estimated that approximately 171 million individuals worldwide were living with diabetes in the year 2000, and this number is expected to rise to about 366 million by 2030 [2]. The prevalence of diabetes is particularly high in developing countries such as India, where rapid urbanization, lifestyle changes, and genetic susceptibility have contributed to the increasing incidence of the disease. This rising prevalence has important implications for orthopedic practice, as diabetes significantly affects bone metabolism and musculoskeletal health.

Patients with diabetes are more susceptible to several musculoskeletal complications, including osteoporosis, increased fracture risk, delayed fracture healing, and impaired functional recovery. Several studies have demonstrated that individuals with diabetes have a significantly higher risk of fractures compared with non-diabetic individuals [3–5]. In addition, the risk of fragility fractures tends to increase with longer duration of diabetes and poor glycaemic control [6].

Hyperglycemia negatively influences bone metabolism through multiple mechanisms, including reduced osteoblastic activity, increased osteoclastic bone resorption, impaired collagen synthesis, and decreased angiogenesis. Additionally, diabetes is associated with microvascular and macrovascular complications that may compromise blood supply to the fracture site, thereby delaying the healing process [7]. The presence of diabetic neuropathy, peripheral vascular disease, and impaired immune function may further increase the risk of infection, delayed union, and nonunion following fractures [8].

Experimental and clinical studies have demonstrated that diabetes alters several biological mechanisms involved in bone repair. Persistent hyperglycemia disrupts cellular processes responsible for bone turnover and regeneration. In diabetic models, reduced bone formation, vascular impairment, and increased bone marrow adiposity have been observed, all of which compromise bone quality and structural integrity [9]. Furthermore, circulating factors present in patients with type 2 diabetes may impair osteoblast maturation and differentiation [10]. These changes collectively impair callus formation, reduce bone mineral density at the fracture site, and prolong the overall fracture healing time compared with non-diabetic individuals.

Diabetes also induces systemic changes that can adversely affect tissue repair. Increased blood viscosity and microvascular dysfunction may reduce tissue perfusion and cause localized hypoxia. Such conditions impair inflammatory responses and delay wound healing. Consequently, diabetic patients are at greater risk of postoperative complications, including infection, delayed union, malunion, and nonunion following fracture treatment [11–13].

Functional recovery after fracture healing is an important outcome parameter in orthopedic practice. It reflects the patient's ability to regain mobility, return to daily activities, and maintain an acceptable quality of life. Functional outcomes are commonly assessed using parameters such as range of motion, pain scores, walking ability, and standardized functional assessment scales. However, systemic diseases such as diabetes may adversely affect these outcomes by influencing tissue healing, rehabilitation potential, and overall recovery.

The incidence of fractures continues to increase globally due to factors such as aging populations, road traffic accidents, and lifestyle changes. Among elderly individuals, hip fractures represent a

major cause of disability and loss of independence worldwide, and the number of hip fractures is expected to increase substantially in the coming decades [14–16]. Diabetes has been shown to increase fracture risk and is also associated with higher rates of complications and poorer clinical outcomes following fracture repair [17].However, the available evidence regarding the influence of diabetes on fracture healing and functional recovery remains limited and sometimes inconsistent. Some studies have reported poorer rehabilitation outcomes and prolonged recovery in diabetic patients, whereas others have observed comparable outcomes between diabetic and non-diabetic individuals following fracture treatment [18–20].Given the increasing prevalence of diabetes and its potential impact on musculoskeletal health, it is important to understand how diabetes affects fracture healing and functional outcomes. Identifying differences in healing patterns and recovery between diabetic and non-diabetic patients may help clinicians anticipate complications, optimize treatment strategies, and improve postoperative rehabilitation protocols.

Therefore, the present study was conducted to evaluate and compare the functional outcome of fracture healing in diabetic versus non-diabetic patients. The study aimed to assess whether diabetes significantly influences fracture healing time, complication rates, and functional recovery following fracture management.

MATERIALS AND METHODS

Study Design and Setting

This hospital-based comparative observational study was conducted in the Department of Orthopaedics at a tertiary care center. The study included patients presenting with fractures who were admitted to the orthopedic department and underwent appropriate fracture management. A total of 100 patients were enrolled in the study and were divided into two groups based on diabetic status.

- **Group A:** Diabetic patients with fractures (n = 50)
- **Group B:** Non-diabetic patients with fractures (n = 50)

Patients were selected using predefined inclusion and exclusion criteria.

Inclusion Criteria

Patients meeting the following criteria were included in the study:

- Patients aged 18 years and above
- Patients diagnosed with fractures requiring treatment
- Patients willing to participate and provide informed consent
- Patients with a confirmed diagnosis of diabetes mellitus (for the diabetic group)

Exclusion Criteria

The following patients were excluded from the study:

- Patients with pathological fractures
- Patients with polytrauma or multiple fractures affecting functional assessment
- Patients with severe systemic illnesses affecting bone healing
- Patients with previous fractures in the same limb
- Patients unwilling to participate in the study

Diagnosis of Diabetes Mellitus

Patients were classified as diabetic based on a documented history of diabetes mellitus, current treatment with antidiabetic medications, or laboratory findings consistent with diabetes according to standard diagnostic criteria.

Fracture Management

All patients received appropriate fracture management based on the type and location of the fracture. Treatment modalities included conservative management such as immobilization with casts

or splints, as well as surgical interventions such as internal fixation when indicated. Postoperative care and rehabilitation protocols were implemented according to standard orthopedic guidelines.

Data Collection

Demographic and clinical data were collected using a structured proforma. The following variables were recorded:

- Age and gender
- Type and site of fracture
- Mechanism of injury
- Presence or absence of diabetes mellitus
- Mode of fracture treatment
- Complications during the healing period

Patients were followed up at regular intervals to assess fracture healing and functional recovery.

Assessment of Fracture Healing

Fracture healing was assessed clinically and radiologically during follow-up visits. Clinical indicators included absence of pain at the fracture site, restoration of limb function, and ability to bear weight where applicable. Radiological healing was evaluated through follow-up radiographs demonstrating callus formation and cortical continuity.

Functional Outcome Assessment

Functional outcomes were evaluated during follow-up using standardized clinical parameters such as pain, range of motion, ability to perform daily activities, and mobility status. The functional recovery of patients was compared between diabetic and non-diabetic groups to determine the influence of diabetes mellitus on fracture healing outcomes.

Statistical Analysis

All collected data were entered into Microsoft Excel and analyzed using SPSS version 25. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The comparison between diabetic and non-diabetic groups was performed using appropriate statistical tests such as the Chi-square test for categorical variables and the independent Student's t-test for continuous variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Age Distribution of the Study Population

A total of 100 patients were included in the study, comprising 50 diabetic patients (Group A) and 50 non-diabetic patients (Group B). The mean age of patients in the diabetic group was 56.42 ± 10.18 years, while the mean age in the non-diabetic group was 52.36 ± 11.27 years. The median age was 57 years (IQR: 49–64) in the diabetic group and 51 years (IQR: 44–60) in the non-diabetic group. The age difference between the two groups was not statistically significant ($p = 0.07$) using the independent Student's t-test.

Sex Distribution of the Study Population

Among diabetic patients, 32 (64%) were males and 18 (36%) were females. In the non-diabetic group, 30 (60%) were males and 20 (40%) were females. There was no statistically significant difference in gender distribution between the two groups ($p = 0.68$) as assessed by the Chi-square test.

Mechanism of Injury

The most common mechanism of injury in both groups was road traffic accidents. In the diabetic group, 24 patients (48%) sustained fractures due to road traffic accidents, followed by fall from

standing height in 20 patients (40%) and other causes in 6 patients (12%). In the non-diabetic group, road traffic accidents accounted for 26 cases (52%), falls for 18 cases (36%), and other causes for 6 cases (12%). There was no statistically significant difference in the mechanism of injury between the groups (p = 0.81, Chi-square test).

Type of Fracture

Long bone fractures were the most common fractures observed in both groups. In the diabetic group, 22 patients (44%) had tibial fractures, 14 (28%) had femoral fractures, and 14 (28%) had fractures involving other bones. In the non-diabetic group, tibial fractures were seen in 20 patients (40%), femoral fractures in 16 patients (32%), and other fractures in 14 patients (28%). The difference between the two groups was not statistically significant (p = 0.72, Chi-square test).

Fracture Healing Time

The mean fracture healing time in the diabetic group was 18.6 ± 4.2 weeks compared with 15.3 ± 3.8 weeks in the non-diabetic group. The median healing time was 18 weeks (IQR: 16–22) in diabetic patients and 15 weeks (IQR: 13–18) in non-diabetic patients. The difference was statistically significant (p = 0.001) using the independent Student's t-test.

Complications during Fracture Healing

Complications were more frequently observed in the diabetic group. Delayed union occurred in 10 patients (20%) in the diabetic group compared with 4 patients (8%) in the non-diabetic group. Infection occurred in 6 diabetic patients (12%) and 2 non-diabetic patients (4%). Nonunion was seen in 4 diabetic patients (8%) and 1 non-diabetic patient (2%). The difference in complication rates between the groups was statistically significant (p = 0.04) using the Chi-square test.

Functional Outcome

Functional outcome was assessed at final follow-up. In the diabetic group, excellent outcomes were observed in 14 patients (28%), good in 20 patients (40%), fair in 10 patients (20%), and poor in 6 patients (12%). In the non-diabetic group, excellent outcomes were seen in 22 patients (44%), good in 20 patients (40%), fair in 6 patients (12%), and poor in 2 patients (4%). Functional outcomes were significantly better in the non-diabetic group compared with the diabetic group (p = 0.03) using the Chi-square test.

Table 1. Baseline Demographic Characteristics of the Study Population (n = 100)

Parameter	Diabetic (n = 50)	Non-Diabetic (n = 50)	p-value	Statistical Test
Age (years), Mean ± SD	56.4 ± 10.2	52.3 ± 11.3	0.07	Independent Student t-test
Median (IQR)	57 (49–64)	51 (44–60)		
Male, n (%)	32 (64%)	30 (60%)	0.68	Chi-square test
Female, n (%)	18 (36%)	20 (40%)		

Table 2. Fracture Healing Time and Complications in Diabetic and Non-Diabetic Patients

Parameter	Diabetic (n = 50)	Non-Diabetic (n = 50)	p-value	Statistical Test
Healing Time (weeks), Mean ± SD	18.6 ± 4.2	15.3 ± 3.8	0.001*	Independent Student t-test
Median (IQR)	18 (16–22)	15 (13–18)		
Delayed Union, n (%)	10 (20%)	4 (8%)	0.04*	Chi-square test
Infection, n (%)	6 (12%)	2 (4%)		
Nonunion, n (%)	4 (8%)	1 (2%)		

Table 3. Functional Outcome of Fracture Healing in Diabetic versus Non-Diabetic Patients

Functional Outcome	Diabetic (n = 50)	Non-Diabetic (n = 50)	p-value	Statistical Test
Excellent	14 (28%)	22 (44%)	0.03*	Chi-square test
Good	20 (40%)	20 (40%)		
Fair	10 (20%)	6 (12%)		
Poor	6 (12%)	2 (4%)		

DISCUSSION

In the present study, the mean age of patients in the diabetic group was 56.4 ± 10.2 years, whereas in the non-diabetic group the mean age was 52.3 ± 11.3 years, with no statistically significant difference between the groups (p = 0.07). This suggests that age distribution between diabetic and non-diabetic patients in our study population was comparable.

Similar findings have been reported in several previous studies evaluating fracture outcomes in diabetic patients. Norris et al. studied 5966 hip fracture cases and reported that the majority of fractures occurred in older individuals, particularly those above 50 years of age, indicating that fracture incidence increases with age in both diabetic and non-diabetic populations. This pattern is attributed to age-related bone loss and the increasing prevalence of diabetes in elderly populations. Furthermore, epidemiological studies have shown that aging combined with metabolic disorders such as diabetes significantly increases the risk of fractures and adverse outcomes[21].

In the present study, 64% of diabetic patients and 60% of non-diabetic patients were males, while females accounted for 36% and 40% of the two groups respectively. The difference in sex distribution was not statistically significant (p = 0.68).Similar male predominance in fracture cases has been reported in several orthopedic studies. This may be attributed to greater exposure to trauma, occupational hazards, and road traffic accidents among males. However, some epidemiological studies have suggested that fracture risk is higher in females, particularly post-menopausal women, due to osteoporosis and reduced bone mineral density. Nevertheless, diabetes has been shown to increase fracture risk in both sexes due to alterations in bone metabolism and microvascular changes affecting bone quality[22]. One of the key findings of our study was that fracture healing time was significantly prolonged in diabetic patients compared with non-diabetic patients. The mean healing time in diabetic patients was 18.6 ± 4.2 weeks, whereas in non-diabetic patients it was 15.3 ± 3.8 weeks, and this difference was statistically significant (p = 0.001).These findings are consistent with previous experimental and clinical studies demonstrating impaired fracture healing in diabetic individuals. Research has shown that diabetes disrupts bone metabolism and delays fracture repair due to hyperglycemia-induced cellular changes, reduced osteoblast function, and impaired angiogenesis. Studies indicate that fracture healing in diabetic patients may be prolonged by nearly 87% compared with non-diabetic individuals, reflecting significant impairment of bone repair mechanisms[23]. Furthermore, diabetic microvascular disease can reduce blood supply to the fracture site, impair inflammatory responses, and delay callus formation, thereby prolonging the healing process[24]. In the present study, complications were more common among diabetic patients. Delayed union occurred in 20% of diabetic patients compared with 8% of non-diabetic patients, while infection occurred in 12% of diabetic patients compared with 4% of non-diabetic patients. Nonunion was also more frequent in the diabetic group (8% vs 2%). Overall complication rates were significantly higher among diabetic patients (p = 0.04).These findings are supported by previous studies that have demonstrated a higher incidence of complications in diabetic patients following fractures. A systematic review evaluating lower-extremity fractures reported that diabetes significantly increases the risk of infection, malunion, nonunion, and reoperation after fracture treatment[25]. Similarly, clinical studies have shown that hyperglycemia impairs wound healing, increases susceptibility to infection, and disrupts bone regeneration processes, thereby increasing postoperative complications[26]. Functional outcome analysis in the present study showed that excellent outcomes were achieved in 28% of diabetic patients compared with 44% of non-diabetic patients, while poor outcomes were observed in 12% of diabetic patients compared with 4% of non-diabetic patients. The difference in functional outcome between the

groups was statistically significant (p = 0.03), indicating poorer functional recovery in diabetic patients.Several previous studies have evaluated the impact of diabetes on rehabilitation outcomes following fracture treatment. Reistetter et al. reported that diabetic patients often experience slower rehabilitation and poorer functional recovery following hip fracture surgery compared with non-diabetic patients. This may be related to associated comorbidities, reduced muscle strength, and impaired wound healing.However, other studies have reported contrasting findings. Mizrahi et al. found that functional outcomes after hip fracture rehabilitation were similar between diabetic and non-diabetic patients, suggesting that diabetes alone may not always adversely affect rehabilitation outcomes[20].

CONCLUSION

The present study demonstrated that diabetes mellitus adversely affects fracture healing and functional recovery. Diabetic patients showed significantly prolonged healing time and a higher incidence of complications such as delayed union, infection, and nonunion compared with non-diabetic patients. Functional outcomes were also poorer among diabetic patients, while non-diabetic patients achieved better recovery. These findings indicate that diabetes is an important risk factor influencing fracture healing. Strict glycemic control, careful monitoring, and appropriate rehabilitation are essential to improve outcomes in diabetic fracture patients.

LIMITATIONS OF THE STUDY

The present study had certain limitations. The sample size was relatively small with only 50 patients in each group, which may limit the generalizability of the findings. The study was conducted at a single tertiary care center, restricting applicability to other settings. The follow-up period was limited to fracture healing, and long-term functional outcomes were not assessed. Additionally, factors such as duration of diabetes, glycemic control, diabetic complications, and variations in fracture type and treatment were not analyzed separately.

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