# Glycated hemoglobin as a predictive factor for postoperative outcome in controlled versus uncontrolled diabetic patients with ankle fractures

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**Background**
Ankle fracture in diabetic patients is a challenging condition owing to the inherent risk of complications with either operative or nonoperative treatment. However, operative treatment is considered the gold standard treatment for such cases. In this study, the hypothesis is that the glycated hemoglobin (HbA1c) could have a predictive value for postoperative outcomes and complications.
**Patients and methods**
A total of 34 diabetic patients with ankle fractures were included in this study. The patients are divided into two groups: the first group included patients with controlled diabetes (HbA1c<7) and the second group included patients with uncontrolled diabetes (HbA1c≥7). All patients were treated by standard open reduction and internal fixation.
**Results**
The complications rate was higher in the uncontrolled diabetes group (63.2%) than in the controlled diabetes group (26.6%). Preoperative HbA1c was higher in complicated patients than in uncomplicated patients ($P$=0.033), and postoperative HbA1c was also higher in complicated patients than in uncomplicated patients ($P$=0.031). The postoperative American Orthopedic Foot and Ankle Society (AOFAS) score was significantly higher in the controlled diabetes group than in the uncontrolled diabetes group ($P$=0.046).
**Conclusion**
The overall rate of complications was higher in the uncontrolled diabetes group (HbA1c≥7) than in the controlled diabetes group (HbA1c<7), with a statistically significant difference. These complications were mainly related to wound healing. Despite being statistically insignificant, poor radiological outcome was more common in the uncontrolled diabetes group. According to the postoperative AOFAS score, clinical outcome was more superior in the controlled diabetes group than in the uncontrolled diabetes group.

**Keywords:**
ankle fractures, diabetics, glycated haemoglobin, HbA1c, predictor, uncontrolled

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## Introduction

Ankle fracture is a very common orthopedic injury worldwide, with ~184 fractures per 100 000 people per year, and these numbers are rising because of increase in the popularity of high-level sports and over-aging population [1]. These fractures become challenging in high-risk people, especially diabetic patients. Moreover, diabetic patients tend to have other medical comorbidities, including peripheral vascular disease, coronary artery disease, neuropathy, and obesity. These comorbidities add more chances for complications with either conservative or surgical management [2,3]. These complications include wound healing problems, delayed union, nonunion, and Charcot arthropathy with the last two complications being strongly associated with diabetes [4]. Recently, it was found that the complication rate of nonoperative treatment was higher (75%) than surgically treated diabetic patients (12.5%). So, operative management for displaced ankle fracture in diabetic patient is considered the optimal treatment as the patient's general condition permits for surgery [5]. The challenge now for diabetic patients with ankle fracture is to determine the proper time, type of surgery, methods of fixation of ankle fractures, and postoperative rehabilitation protocol and to identify risk factors and predictive values for postoperative complications that can be managed to get the optimal anatomical and functional outcomes following surgical treatment of ankle fracture in diabetic patients. It is well known that diabetes causes its complications through hyperglycemic state, and one of the most predictable

values to detect long-term glycemic control is glycated hemoglobin (HbA1c). As per the American Diabetic Association, optimal glycemic control is achieved with HbA1c less than 7%, whereas HbA1c 7% or more is considered uncontrolled [6,7].

This study aims to compare the short-term results of standard open reduction and internal fixation of ankle fractures in noncomplicated diabetic patients between controlled and controlled patients and to determine the role of HbA1c as a predictive factor for the clinical outcome and the risk of complications of standard surgical treatment of ankle fractures in noncomplicated diabetic patients.

## Patients and methods

This randomized prospective controlled study was conducted after approval of the ethical committee and after having the consents from all patients; it included 34 adult diabetic patients with ankle fractures. All patients were treated in Helwan University hospitals during the period from November 2019 till November 2021. The sample size was calculated by a statistician. The age ranged between 26 and 68 years old, with a mean age of 50.03 years. BMI ranged between 21 and 43, with a mean BMI of 31.7. There were 14 (41.2%) females and 20 (58.8%) males. Regarding the fracture side, there were 15 (44%) cases with right ankle fractures and 19 (56%) cases with left ankle fractures. According to anatomical classifications, there were 11 (32.4%) cases with medial malleolus fracture, eight (23.5%) cases with lateral malleolus fracture, 12 (35.5%) cases with bimalleolar fracture, and three (8.8%) cases with trimalleolar fractures. All patients were classified into two groups: the first group with controlled diabetes (HbA1c<7) and the second with uncontrolled diabetes (HbA1c≥7). The first group included 15 (44%) patients, whereas the second group included 19 (56%) patients.

### Inclusion criteria

The following were the inclusion criteria:

(1) Adult diabetic patients between 18 and 70 years old.
(2) Recent closed malleolar fractures within 2 weeks following trauma.
(3) Noncomplicated diabetic patients (with no peripheral neuropathy, peripheral vascular disease, established Charcot arthropathy, or diabetic nephropathy).

### Exclusion criteria

The following were the inclusion criteria:

(1) Patients with age more than 70 years old and less than 18 years.
(2) Complicated diabetic patients (manifested by peripheral neuropathy, peripheral vascular disease, established Charcot arthropathy, and diabetic nephropathy).
(3) Past history of ipsilateral or contralateral lower limb amputation at any level.
(4) Leg ulcers (recent or healed).
(5) Ankle fractures more than 2 weeks after trauma.
(6) Poor soft tissue covering the ankle: open fractures, massive soft tissue injury, or blisters at the time of presentations.

All patients are selected from the emergency department. They were carefully examined generally and locally, and the provisional diagnosis was confirmed by conventional radiograph and computed tomograph. Primary reduction of the fracture and support with below-knee slab were done. All patients were admitted to the hospital for proper preoperative investigations and optimization of the blood sugar status with the cooperation of a diabetologist (within 7–10 days from initial trauma). According to the level of HbA1c, patients were divided into two groups: the first group had controlled diabetes (HbA1c<7) and the second group had uncontrolled diabetes (HbA1c ≥7). All patients were exposed to the American Orthopedic Foot and Ankle Society (AOFAS)-hind-foot score for functional assessment preoperatively. Before surgical intervention, all patients were counseled regarding the indications for surgery, surgical steps, the expected outcomes, and possible complications (up to amputation). Time interval between trauma and time of surgery ranged from 1 to 10 days, with a median of 3 days.

### Surgical technique

Standard open reduction and internal fixation were used for all fractures:

Lateral malleolus: direct lateral approach was used, and internal fixation was done using one-third tubular or small dynamic compression plates.

Medial malleolus: anteromedial approach was used for proper visualization of the joint to facilitate reduction. Internal fixation was done using lag screws or tension band wiring according to the fragment size and fracture configuration.

Posterior malleolus: posterolateral approach was used, and internal fixation was done using 3.5-mm partially threaded screws or one-third tubular plate according to the fragment size.

Syndesmotic injury: the syndesmotic stability was checked intraoperatively using 'hook test.' Unstable joints were reduced using a large reduction clamp, and internal fixation was done using 3.5-mm cortical screws.

Reduction was confirmed by image intensifier and then a well-padded below-knee slab was applied for each ankle.

Patients were followed for a period ranged from 6 to 24 months, with a mean of 12.32 months. Postoperatively, standard radiograph was done (anteroposterior, lateral, and Mortise views). Patients were discharged the second day of surgery. Anticoagulant was started 12 h after surgery (enoxaparin, 40 mg subcutaneous injection once daily for 10 days). Antihyperglycemic drug dose was adjusted by the diabetologist. Sutures were removed after 2–3 weeks, with a mean of 2.35 weeks. All cases were immobilized in below-knee slab with strict no weight bearing for the first 4 weeks postoperatively. Then, the slab was removed, and patients were advised to start passive and active ankle range of motion with strict no weight bearing for the next 2 weeks. Fracture union was checked clinically and radiologically every 2 weeks. Partial weight bearing with crutches was started 6–12 weeks postoperatively, with a mean of 7.24 weeks. With axillary crutches aid, full weight bearing (with no ankle support) was allowed after complete union 8–24 weeks postoperatively, with a mean of 12.24 weeks.

With each visit to the orthopedic clinic, the patients were reviewed by the diabetologist for proper glycemic control. Three months postoperatively, HbA1c as checked to evaluate the glycemic control during the first short postoperative period.

#### Case presentation 1

A 65-year-old male patient with right isolated fracture of medial malleolus (Fig. 1). Preoperative HbA1c was 8. Preoperative AOFAS score was 30, and postoperative AOFAS score was 76. This patient showed delayed union, which was established at 9 months postoperatively (Figs 2, 3).

#### Case presentation 2

A 43-year-old male patient with right lateral malleolus fracture (Fig. 4). Preoperative HbA1c was 8.4. Preoperative AOFAS score was 13 and postoperative AOFAS score was 55. This patient showed complex regional pain syndrome and skin irritation. Implant was removed 1 year postoperatively, and the symptoms improved (Figs 5 and 6).

## Results

This study was conducted on 34 diabetic patients with ankle fractures. There were 14 (41.2%) females and 20 (58.8%) males, with the age ranged between 26 and 68 years. The demographic and characteristic data of the patients included in the study are shown in Table 1.

**Figure 1**


Isolated medial malleolus fracture.

**Figure 2**


Fracture was fixed with a tension band. Delayed healing at 6 months postoperatively.

In Table 2, a comparison between the group of controlled diabetes and the group of uncontrolled diabetes showed no significance regarding the time of staples removal and starting partial and full weight bearing.

**Figure 3**

Complete union at 9 months postoperatively.

The rate of postoperative complications is shown in Table 3. Some patients had more than one complication.

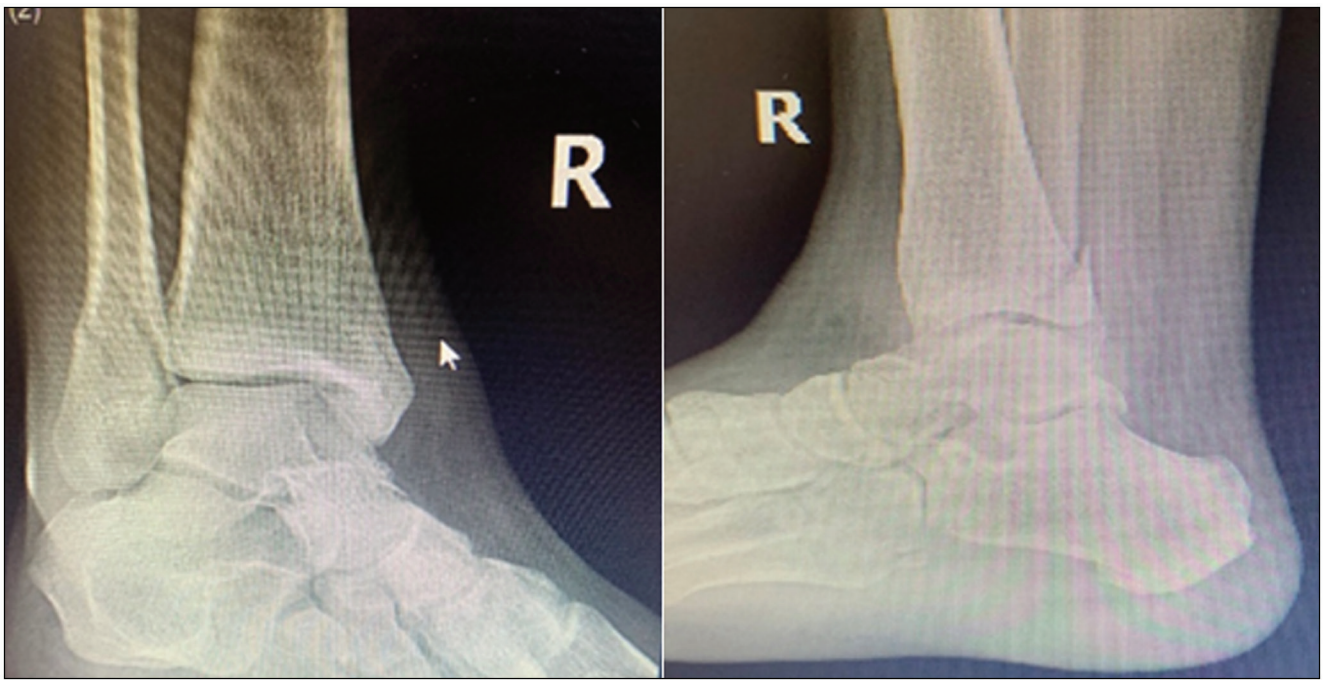
In Table 4, there was a statistically significant improvement in the postoperative AOFAS score in controlled diabetes group more than in the uncontrolled group.

In Table 5, it shows a statistically significant difference between the rate of postoperative complications in the controlled diabetes group and the uncontrolled diabetes group, with more complications in the uncontrolled group.

Table 6 shows the distribution of the postoperative complications between the two groups. Despite that the major difference was related to superficial infection, delayed wound healing, and delayed healing, which was higher in the uncontrolled diabetes group; this difference was not statistically significant. On the contrary, there was no significant difference between the two groups in the rate of other postoperative complications. The only case of postoperative Charcot arthropathy was related to the controlled diabetes group.

Table 7 shows that there is a statically significant difference between patients without complications and patient with complications regarding preoperative and postoperative HbA1c, with *P* values of 0.033 and 0.031, respectively. Patients with complications had high level of HbA1c.

**Figure 4**




Fracture lateral malleolus.

**Figure 5**


Complete union 3 months postoperatively.

**Figure 6**


Hardware was removed 1 year postoperatively because of skin irritation.

Table 8 compares the postoperative AOFAS score between the complicated and uncomplicated patients. It shows that the postoperative AOFAS score was higher in uncomplicated patients than in complicated patients with a high statistical significance.

The study shows a statistically significant difference between age and rate of postoperative complications. The complicated group with postoperative complications had an older age range than the uncomplicated group, with *P* value of 0.030 (Table 9).

There was no significant difference regarding the type of diabetes in the studied groups, as 33 patients were of type 2 diabetes and only one patient was of type 1 diabetes; this case was in the controlled group, and the fracture showed complete union with no complications.

## Discussion

Ankle fractures represent ~9% of all fractures and this percentage increases with increase in the population activities and ages. The association of ankle fracture with diabetes mellitus (DM) presents a serious challenge for the health care providers who are responsible for helping the patients to regain their activities and life back with no or minimal complications. There is an agreement that the incidence of postoperative complications is higher in diabetic patients than in nondiabetic patients. So, it is important to determine the factors that predispose to postoperative complications in diabetic patients with ankle fractures.

This study aims to determine whether HbA1c level has a predictive value in surgical treatment outcomes and postoperative complications in diabetic patients with ankle fractures and to compare the incidence of postoperative complications and functional outcomes between a group of controlled diabetes and another group with uncontrolled diabetes.

This study was carried out on 34 diabetic patients with ankle fractures with 15 (44%) patients having controlled diabetes (HbA1c<7) and 19 (56%) patients having uncontrolled diabetes (HbA1c≥7). The age range was 26–68 years old, with a mean of 50.03. Regarding sex, there were 14 (41.2%) females and 20 (58.8%) males. BMI range was 21–43, with a mean of 31.7. A total of 15 (44%) patients had right ankle fracture and 19 (56%) patients had left ankle fracture.

During the follow-up period, all patients were evaluated regarding the postoperative complications (including superficial wound infection, delayed wound healing, delayed union, nonunion, arthritis, and unplanned surgery for revision or hardware removal)

**Table 1 Demographic and characteristic data of the patients**

| | |
|---|---|
| Age | |
| Range | 26–68 years old |
| Mean ±SD | 50.03±2.61 |
| Sex | |
| Female | 14 (41.2) |
| Male | 20 (58.8) |
| BMI | |
| Range | 21–43 |
| Mean ±SD | 31.70±5.56 |
| Fracture side | |
| Right | 15 (44) |
| Left | 19 (56) |
| Comorbidities | |
| No | 22 (64.7) |
| Hypertension | 8 (23.5) |
| Cardiac | 1 (2.9) |
| Both | 3 (8.8) |
| Preoperative (HbA1c) | |
| Controlled group (<7%) | 15 (44) |
| Uncontrolled group (≥7%) | 19 (56) |

HbA1c, glycated hemoglobin.

**Table 3 Percentage of complications in all studied patients**

| Complications | Total *N*=34 [*n* (%)] |
|---|---|
| No complications | 18 (52.9) |
| Complications | 16 (47.1) |
| Superficial infection | 4 (11.8) |
| Delayed wound healing | 2 (5.9) |
| Delayed union | 5 (14.7) |
| Nonunion | 1 (2.9) |
| Charcot arthropathy | 1 (2.9) |
| Unplanned reoperation | 4 (11.8) |
| Arthritis | 7 (20.6) |
| Other complications | 2 (5.9) |

**Table 2 A comparison of time of staple removal and partial and full weight bearing between controlled diabetes group and uncontrolled diabetes group**

| | Controlled DM (*N*=16) | Uncontrolled DM (*N*=19) | Test value | *P* value | Significance |
|---|---|---|---|---|---|
| Staple removal (weeks) | | | | | |
| Range | 2–3 | 2–3 | −0.919 | 0.365 | NS |
| Mean ±SD | 2.27±0.46 | 2.42±0.51 | | | |
| Start PWB (weeks) | | | | | |
| Range | 6–12 | 6–10 | −1.660 | 0.107 | NS |
| Mean ±SD | 6.80±1.66 | 7.58±1.07 | | | |
| FWB (weeks) | | | | | |
| Range | 8–24 | 8–24 | −1.567 | 0.127 | NS |
| Mean ±SD | 10.93±3.99 | 13.26±4.53 | | | |

DM, diabetes mellitus; FWB, full weight bearing; PWB, partial weight bearing.

and functional outcome using the AOFAS-Hind-foot score. The complication rate in this study was 47.1% of all studied patients, with 26.7% in the controlled diabetes group and 63.2% in the uncontrolled diabetes group. With a statistically significant increase in complications rate in the uncontrolled DM group, with

**Table 4 Comparison between postoperative AOFAS score in controlled diabetes group and in uncontrolled diabetes group**

| | Controlled (*N*=15) | Uncontrolled (*N*=19) | Test value | *P* value | Significance |
|---|---|---|---|---|---|
| AOFAS postoperative | | | | | |
| Median (IQR) | 87 (74–97) | 84 (76–85) | −1.68219 | 0.046 | S |
| Range | 55–100 | 55–90 | | | |

AOFAS, American Orthopedic Foot and Ankle Society.

**Table 5 Comparison of the rate of postoperative complications between controlled diabetes group and uncontrolled diabetes group**

| | Controlled DM (*N*=5) | Uncontrolled DM (*N*=19) | Test value | *P* value | Significance |
|---|---|---|---|---|---|
| Rate of complications | 4 (26.6) | 12 (63.2) | 4.480 | 0.034 | S |

DM, diabetes mellitus.

**Table 6 Distribution of postoperative complications between controlled diabetes group and uncontrolled diabetes group**

| Complications | Controlled (*N*=15) | Uncontrolled (*N*=19) | Test value | *P* value | Significance |
|---|---|---|---|---|---|
| Type of complications | | | | | |
| Superficial infection | 0 | 4 (21.1) | F | 0.113 | NS |
| Delayed wound healing | 0 | 2 (10.5) | F | 0.492 | NS |
| Delayed union | 0 | 5 (26.3) | F | 0.053 | NS |
| Non union | 1 (6.7) | 0 | F | 0.441 | NS |
| Charcot arthropathy | 1 (6.7) | 0 | F | 0.441 | NS |
| Reoperation | 2 (13.3) | 2 (10.5) | 0.064 | 0.801 | NS |
| Arthritis | 3 (20.0) | 4 (21.1) | 0.006 | 0.940 | NS |
| Other complications | 0 | 2 (10.5) | F | 0.492 | NS |

**Table 7 Comparison between patients with postoperative complications and patients with no postoperative complications regarding preoperative and postoperative glycated hemoglobin level**

| HbA1c | Without complications (*N*=18) | With complications (*N*=16) | Test value | *P* value | Significance |
|---|---|---|---|---|---|
| Pre | | | | | |
| Mean ±SD | 7.44±1.07 | 8.39±1.40 | −2.234 | 0.033 | S |
| Range | 6.6–10.4 | 6.6–11.2 | | | |
| Post | | | | | |
| Mean ±SD | 7.38±0.89 | 8.13±1.03 | −2.261 | 0.031 | S |
| Range | 6.7–9.9 | 6.9–10.1 | | | |

HbA1c, glycated hemoglobin.

**Table 8 Comparison of the postoperative AOFAS score between complicated and uncomplicated patients**

| AOFAS | Without complications (*N*=18) | With complications (*N*=16) | Test value | *P* value | Significance |
|---|---|---|---|---|---|
| Post | | | | | |
| Median (IQR) | 87 (84–97) | 75.5 (71–78.5) | 4.174 | 0.000 | HS |
| Range | 74–100 | 55–85 | | | |

AOFAS, American Orthopedic Foot and Ankle Society; IQR, interquartile range.

**Table 9 Comparison between complicated and uncomplicated groups regarding the effect of age, sex, and BMI**

| | Without complication (*N*=18) | With complication (*N*=16) | Test value | *P* value | Significance |
|---|---|---|---|---|---|
| Age | | | | | |
| Mean ±SD | 45.67±12.90 | 54.94±10.62 | −2.271 | 0.030 | S |
| Range | 26–69 | 39–70 | | | |
| Sex | | | | | |
| Female | 8 (44.4) | 6 (37.5) | 0.169 | 0.681 | NS |
| Male | 10 (55.6) | 10 (62.5) | | | |
| BMI | | | | | |
| Mean ±SD | 32.00±5.20 | 31.36±6.10 | 0.329 | 0.744 | NS |
| Range | 21–43 | 23–40 | | | |

a *P* value of 0.034, it was found that complications of delayed wound healing, superficial wound infection, and delayed union were more in the uncontrolled diabetes group, whereas other complications like arthritis and unplanned surgeries were almost equal in both groups. All cases of postoperative wound complications were treated with frequent dressing and antibiotics with no cases requiring readmission or surgical debridement.

Regarding radiological outcome for all studied patients, the overall poor radiological outcome rate was 17.6%, with five (14.7%) cases of delayed union and one (2.9%) case of nonunion. Regarding the distribution between the two studied groups, five (26.3%) cases of delayed union with no cases of nonunion were seen in the uncontrolled DM group, whereas in controlled DM, there was one (6.7%) case of nonunion. However, there was no statistically significant difference between the two studied groups, and there was no statistically significant correlation between poor radiological outcome and HbA1c level.

With no statistically significant difference between the two studied groups, four (11.8%) patients needed unplanned surgeries, representing two (10.5%) patients of the uncontrolled diabetes group and two (13.3%) patients of the controlled diabetes group. Moreover, there was no statistically significant correlation between the incidence of reoperation and HbA1c level.

There was only one (6.7%) case of Charcot arthropathy in the controlled diabetes group with no cases in the uncontrolled diabetes group, which was also statistically insignificant. All lateral malleolus fractures were fixed with one-third tubular or simple DCP plate (ordinary plate); they achieved a stable fixation with complete union with no case reported with Charcot arthropathy.

Among the studied 34 patients, there were seven (20.6%) cases of postoperative arthritis. Controlled diabetes group showed three (20%) cases, whereas the uncontrolled diabetes group showed four (2.1%) cases. There was no statistically significant difference between the two groups regarding the incidence of postoperative arthritis, and there was no statistically significant correlation between the incidence of arthritis and HbA1c level.

The AOFAS score was used to assess the functional outcome, and it was found that the mean difference was 67 points in the controlled diabetes group, whereas the mean difference was 60 points in the uncontrolled diabetes group. Hence, the functional outcome was superior in the controlled diabetes group.

With assessment of correlation between postoperative AOFAS score and other parameters, it was found that there was a statistically high significant negative correlation between age and postoperative AOFAS score, with a *P* value of 0.001; so, with increased age, there was less functional improvement among all studied patients.

On reviewing the literature, we found many studies that have discussed the same subject. Liu and colleagues studied 21 diabetic patients with ankle fractures treated surgically. They divided them in two groups: controlled diabetes group (HbA1c<6.5) and uncontrolled diabetes group (HbA1c≥6.5). They found that the overall complication rate was 76.2% among all studied patients, where 88.9% in the uncontrolled diabetes group had postoperative complications, whereas 66.7% of the controlled diabetes group had postoperative complications. Regarding radiological outcome, 100% of uncontrolled diabetes group showed poor outcome (delayed union, nonunion, or malunion), whereas only 33% of the controlled diabetes group showed poor radiological outcome. Thus, HbA1c levels were inversely correlated to radiological union; high HbA1c levels were associated with lower rates of union, whereas low HbA1c levels were associated with higher rates of union. The percentage of revision was 55.6% in the uncontrolled diabetes group and only 5% in the controlled diabetes group; however, there was no correlation between HbA1c level and the revision rates. At 6-month follow-up, HbA1 c was inversely proportional to the AOFAS score as high HbA1c level was associated with poor AOFAS score, whereas low HbA1c was associated with high AOFAS score [8].

Lanzetti and colleagues in their study compared between diabetic and nondiabetic patients regarding the effect of diabetes and BMI on the complication rate in surgically treated adult patients with bimalleolar ankle fractures. The overall complication rate was 38.9% (35 cases), with 25 cases of wound complications, six cases of deep venous thrombosis, and four cases of pulmonary embolism. Of all complicated cases, 17.1% (six cases) were in the nondiabetic group and 82.9% (29 cases) in the diabetic group. All studied patients showed full union within 5 months. The have concluded that there is a significant correlation between diabetes and high BMI from one hand and the rate of wound complication on the other hand [9].

Hughes and colleagues studied 234 patients to evaluate the relation between HbA1c and bone healing in diabetic patients with ankle fractures, where 130 patients were treated surgically whereas 113 patients were treated conservatively. Overall bone healing

complication rate was 21% (51 patients), with 14.6% (19 patients) in the surgically treated group and 28.3% (two patients) in conservatively treated patients. In their final conclusion, they found that there is no correlation between HbA1c level and the rate of bone healing complications. However, they found that HbA1c had a predictive value regarding wound complications at the postoperative period in surgically treated group, with odds ratio of 1.26 [10].

Humphers and colleagues conducted their study on 322 diabetic patients to detect risk factors for predicting postoperative complications after foot and ankle surgeries. They concluded that HbA1c level can be considered a major risk factor for postoperative complications in diabetic patients after foot and ankle surgeries [11].

Despite having a sample that included all types of wound healing in diabetic patients, Christman and colleagues studied the correlation between HbA1c levels and wound healing in diabetic patients seen in John Hopkins Wound Clinic. Their study sample included 183 patients with a mean HbA1c of 8. The most common site of wounds in this group was the lower limb with 43.9% in leg or ankle and 41.2% in foot. They concluded that high level of HbA1c is associated with delayed wound healing [12].

In their retrospective study, Schmidt and colleagues studied 979 patients with ankle fractures treated surgically by standard open reduction and internal fixation. They aimed to study the effect of diabetes on the complication rate and postoperative functional outcome. The patients were divided into two groups: 131 (13.4%) patients with diabetes and 848 (84.6%) patients without diabetes. Patients with other comorbidities (obesity, neuropathy, renal disease, and cerebrovascular disease) represented 40.5% of the diabetic group and 23.8% of the nondiabetic group. They concluded that diabetes alone might not be a fundamental predictor of poor functional outcome. Diabetes was found to be a notable independent predictive factor for postoperative poor functional outcome and complications, when combined with other comorbidities [13].

## Conclusion

This study concluded that there was a statistically significant increase in complications rate in the uncontrolled DM group with high HbA1c≥7%. These complications were mainly related to wound problems, such as surgical site infection and delayed wound healing. The number of cases with poor radiological outcome was greater in the high HbA1c group than in the low HbA1c group, whereas unplanned reoperation and arthritis show almost near equal numbers. However, the difference between the two groups was statically insignificant.

Moreover, there was a negative correlation between age and improvement assessed by AOFAS score, with poor outcome with older age groups.

The limitation of this study is the relatively small sample size; however, we preferred to have a relatively small sample size than losing patients during follow-up.

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**Conflicts of interest**
There are no conflicts of interest.

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