Outcomes of Ankle Fractures Fixation in Controlled Versus Uncontrolled Diabetic Patients

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Abstract

Objective: To identify the role of preoperative HbA1c as a predictive value of clinical outcomes as well as for the risk of complications following surgical treatment of diabetic ankle fractures.

Methods: This study was carried on 34 patients, all were well known diabetic patients with 15 patients (44%) were had controlled diabetes (HbA1c<7%) and 19 patients (56%) were had uncontrolled diabetes (HbA1c≥7%). with a mean age of 50.03 years old and BMI with mean of 31.7.

Results: The complications rate was 47.1% of all studied cases. Complication rate among controlled DM group was 26.7% and complication rate for uncontrolled DM was 63.2%.

Conclusion: There was statistically significant increase in complications rate in uncontrolled DM group with high HbA1c ≥ 7%. There was positive correlation between rate of all complications and level of HbA1c, mainly complications related to wound problems, as surgical site infection and delayed wound healing. There was positive correlation between age and rate of complications. there was negative correlation between level of HbA1c and functional improvement.

Keywords: *Ankle fracture, Diabetes, HbA1c.*

INTRODUCTION

Ankle fracture is a very common orthopaedic injury worldwide with approximately 187 fractures per 100, 000 people per year and those numbers are rising because of increasing the popularity of high-level sports and an over-aging population. Those fractures become challenging in high-risk people specially diabetic patients, who are predisposed for many complications following ankle fracturs that may prevent them from return to their pre-fracture life. 1

With recent studies it was found that patients with displaced ankle fractures have unacceptable high complication rate when managed non¬operatively. The complication rate of non-operative treatment was 75% compared to 12.5% with surgically treated diabetic patients. So recently, operative management for displaced ankle fracture in diabetic patient is the optimum treatment as the patient general condition permits for surgery.2

Uncontrolled diabetes and chronic hyperglycemia had a 3.8 times higher risk of overall complications, 3.4 times higher for non-infection complications (malunion, nonunion, or Charcot arthropathy), and 5-times higher for infection complications. So tight glycemic control during peri¬operative period is mandatory to avoid and decrease rate of post¬operative complications.1

The challenge now for diabetic patient with ankle fracture is to determine the proper time, type of surgery, methods of fixation of ankle fractures and post-operative rehabilitation protocol, and to identify risk factors and predictive values for post-operative complications that can be managed to get the most optimum anatomical and functional outcomes following surgical treatment of ankle fracture in diabetic patients. 3

AIM OF THE WORK

Aim of the study was to identify the role of preoperative HbA1c as a predictive value of clinical outcomes represented by union and functional improvement, as well as for the risk of complications following surgical treatment of diabetic ankle fractures.

PATIENTS AND METHODS

The work was done at Helwan University hospitals. Study design; cohort study.

Ethical Committee Approval: Following Department Research Committee approval and Research Ethics approval.

The study was carried on adult diabetic patients who were submitted for ORIF for ankle fracture. Inclusion criteria were, Adult diabetic patients between 18-70 years old, recent closed malleolar fractures within 2 weeks following trauma and non-complicated diabetic patients. And exclusion criteria were age of more than 70 years old or less than 18 years old, complicated diabetic patient manifested clinically, past history of ipsilateral or contralateral lower limb amputation, leg ulcer either recent or past history of leg ulcer, old neglected ankle fractures more than two weeks, massive soft tissue injury and open fractures and subcutaneous bullae at time of presentation.

The study was carried on 34 patients, all were well known diabetic patients categorized into 2 groups. Group of controlled DM,15 patients (44%) were had HbA1c <7%. And group of uncontrolled DM, 19 patients (56%) were had HbA1c ⩾7%. with age ranged from 26 to 68 years old with a mean age of 50.03 years old. and their BMI ranged from 21- 43 with a mean BMI of 31.7. And they were 14 female (41.2%) and 20 male (58.8%). There were 11 (32.4%) cases with medial malleolus fracture, 8 (23.5%) cases with lateral malleolus fracture, 12 cases (35.3%) with bimalleolar fracture and 3 (8.8%) cases with trimalleolar fracture. With follow up period ranged 6-24 months with mean of 12.32 months.

Each patient in this study was carefully assessed clinically by taking a detailed medical history and adequate clinical examination. General examination includes vital signs, (BMI) and examination of both lower limb for bilateral lower limb oedema, distal pulsation (dorsalis pedis) both sides. Examination of both lower limb for ulcers, old scar for ulcers, amputation and manifestation of complicated diabetes. With local examination for the affected limb for tenderness, deformity, limitation of movement. Skin condition including skin ulcers, open fractures or skin compromised by oedema or subcutaneous bullae. All patients had standard x ray ankle three views. CT ankle was done for patients with suspected trimalleolar fracture.

All patients had laboratory evaluation for HbA1c at time of presentation for group categorization, kidney function to detect diabetic nephropathy and other preoperative laboratory tests including random blood sugar,

CBC, PT, PTT, INR.3 ECG and chest X ray. For functional evaluation, the American Orthopedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score scale was used in this study.22 After preoperative evaluation, anticoagulant was started and was held 12 hours before surgery. All the patients received a prophylactic broad-spectrum antibiotic (cefazoline 1000mg 12 hours before surgery & another dose cefazoline1000mg during induction of anesthesia).

Control of blood glucose level: Under supervision and management of endocrinologist, glycaemic state was controlled to keep fasting glucose less than 140 mg/dl and random glucose levels lower than 180 mg/dl according to American Diabetes Association (ADA). Diabetic medications were modified in case with poor control according to fasting and random blood sugar. 3

During inpatient period, oral medications was held on the day of surgery, basal-bolus regimen of long-acting insulin was given preoperatively the morning of the surgery, combined with supplemental short-acting SC insulin (sliding scale) when blood glucose is >180 mg/d according to capillary glucose level tested every 6 hours and premeal when patient resume oral feeding. 2 For insulin-treated patients they were given two thirds of their usual dose of long-acting insulin preoperatively the morning of the surgery. And return to their usual dose after oral intake was resumed with supplemental short-acting SC insulin (sliding scale) was given when blood glucose is >180 mg/d according to capillary glucose level tested every 6 hours. During perioperative stage blood glucose level was kept above 70 mg/d.

RESULTS

This study was conducted on 34 diabetic patients admitted to Helwan University hospitals in the period from November 2019 till November 2021 for open reeuction and internal fixation for unstable ankle fracture. They were 14 females (41.2%) and 20 males (58.8%) with age ranged from 26-68 years with mean ± SD of (50.03 ± 12.61). Study was carried on between two groups first group of 15 patients (44%) were had controlled diabetes (HbA1c<7%) and second group 19 patients (56%) were had uncontrolled diabetes (HbA1c≥7%) Table (1,2). The complications rate was 47.1% of all studied cases. Complication rate among controlled DM group was 26.7% and complication rate for uncontrolled DM was 63.2%. with statistically significance of P-value 0.034. Table (3)

The study shows that the major differences between the two groups were among complications related to wound healing as superficial infection, delayed wound healing which were more with uncontrolled DM group Table (4). While other types of complications were almost near the same rate between the two groups. With no major complications were occurred in both groups. There was positive correlation between high level of HbA1c and overall complication rate and it shows statistically significance with P-value of 0.033.Table (5) Also, the study shows also positive correlation between age and rate of complications with P-value of 0.030. With complication rate increase with increased age. With no statistically significant regarding gender or BMI. Table (6).

Table (1): Demographic and characteristics data of the studied patients.

		Total no. = 34
Age	Mean ± SD	50.03 ± 12.61
	Range	26 – 68
Gender	Female	14 (41.2%)
	Male	20 (58.8%)
BMI	Mean ± SD	31.70 ± 5.56
	Range	21 – 43
Fracture Side	Right	15 (44 %)
	Left	19 (56%)

Co-morbidities	No	22 (64.7%)
	Hypertension	8 (23.5%)
	Cardiac	1 (2.9%)
	Both	3 (8.8%)
Preoperative (HBA1c)	Controlled < (7 %)	15 (44%)
	Uncontrolled ≥ (7%)	19 (56 %)

Table (2): Comparison between controlled DM and uncontrolled DM groups regarding demographic and clinical parameters. That show no statistically significance difference between the groups.

		Controlled	**Uncontrolled**	**Test value**	**P-value**	**Sig.**
		No. = 15	**No. = 19**			
Age	Mean ± SD	48.73 ± 12.78	51.05 ± 12.73	-0.527•	0.602	NS
	Range	26 – 65	33 – 68			
Gender	Female	5 (33.3%)	9 (47.4%)	0.682*	0.409	NS
	Male	10 (66.7%)	10 (52.6%)			
BMI	Mean ± SD	32.44 ± 6.27	31.12 ± 5.03	0.684•	0.499	NS
	Range	21 – 43	23 – 40			
Side	Right	4 (26.7%)	11 (57.9%)	3.316*	0.069	NS
	Left	11 (73.3%)	8 (42.1%)			
Co-morbidities	No	9 (60.0%)	13 (68.4%)	F	0.746	NS
	Hypertension	4 (26.7%)	4 (21.1%)			
	Cardiac	0 (0.0%)	1 (5.3%)			
	Both	2 (13.3%)	1 (5.3%)			
Type of fracture	Bimalleolar	3 (20.0%)	9 (47.4%)	5.715	0.126	NS
	Trimalleolar	1 (6.7%)	2 (10.5%)			
	Lateral malleolus	3 (20.0%)	5 (26.3%)			
	Medial malleolus	8 (53.3%)	3 (15.8%)			
Time interval between trauma and surgery (days))	Median (IQR)	3 (2 – 5)	3 (2 – 7)	-0.386≠	0.700	NS
	Range	1 – 10	1 – 10			
Implant used For fixation	Screws	7 (46.7%)	9 (47.4%)	0.002*	0.968	NS
	Syndesmotic screw	4 (26.7%)	2 (10.5%)	1.503*	0.220	NS
	Plate	7 (46.7%)	15 (78.9%)	3.825*	0.051	NS
	Tension band	4 (26.7%)	4 (21.1%)	0.147*	0.702	NS

P-value > 0.05: Non significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant

*: Chi-square test; F: Fisher's Exact test; •: Independent t-test; ≠: Mann-Whitney test

Table (3): Comparison between patients with controlled DM and patient with uncontrolled DM regarding rate of post¬operative complications

	Controlled DM	Uncontrolled DM	Test value	P-value	Sig.
	No. = 15	No. = 19			
Rate of complications	4 (26.6%)	12 (63.2%)	4.480*	0.034	S

P-value > 0.05: Non significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant
*: Chi-square test; F: Fisher's Exact test

Table (4): Comparison between patients with controlled DM and patient with uncontrolled DM regarding distribution of post-operative complications.

Complication	Controlled DM	Uncontrolled DM
Superficial infection	**0 (0.0%)**	**4 (21.1%)**
Delayed wound healing	**0 (0.0%)**	**2 (10.5%)**
Delayed union	**0 (0.0%)**	**5 (26.3%)**
Non union	**1 (6.7%)**	**0 (0.0%)**
Charcot arthropathy	**1 (6.7%)**	**0 (0.0%)**
Unplanned re-operation	**2 (13.3%)**	**2 (10.5%)**
Arthritis	**3 (20.0%)**	**4 (21.1%)**
Other complications	**0 (0.0%)**	**2 (10.5%)**

Table (5): Comparison between patients without post¬operative complications and patients with complication regarding pre and post operative HBA1c.

HbA1c		Without complications No. = 18	With complications No. = 16	Test value	P-value	Sig.
Pre	Mean ± SD Range	7.44 ± 1.07 6.6 – 10.4	8.39 ± 1.40 6.6 – 11.2	-2.234•	0.033	S
Post	Mean ± SD Range	7.38 ± 0.89 6.7 – 9.9	8.13 ± 1.03 6.9 – 10.1	-2.261•	0.031	S

P-value > 0.05: Non significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant

•: Independent t-test

Table (6): Comparison between patients had post-operative complications and patients with no complications regarding age, gender and BMI

		Without complication	With complication	Test value	P-value	Sig.
		No. = 18	No. = 16			
Age	Mean ± SD Range	45.67 ± 12.90 26 – 65	54.94 ± 10.62 39 – 68	-2.271•	0.030	S
Gender	Female Male	8 (44.4%) 10 (55.6%)	6 (37.5%) 10 (62.5%)	0.169*	0.681	NS
BMI	Mean ± SD Range	32.00 ± 5.20 21 – 43	31.36 ± 6.10 23 – 40	0.329•	0.744	NS

P-value > 0.05: Non significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant

DISCUSSION

This study focused on functional outcomes, rate and types of complications between controlled DM patients and uncontrolled DM patients who were admitted for ORIF for ankle fracture. This study was carried on 34 patients with 15 patients for controlled DM group and 19 patients for uncontrolled DM group. The complication rate was 47.1% for all patient with complication rate among controlled DM group was 26.7% and uncontrolled DM group was 63.2%.

A similar study that show almost same results, was done by Jiayong Liu et al. They found that Overall post -operative complications rates were very high 76.2% of all patients. 88.9% of patients with uncontrolled DM had complications, and 66.7% of patients with controlled DM had complications. With infection and persistent swelling were the most common complications, both of which occurred in 38.1% of all patients. Infection rate was 55.6% with patients of uncontrolled DM and 25% in patients with controlled DM. Also they had overall high percentage of bone healing complications, 61.9% of all patients had poor bone healing (delayed union, non-union, or malunion). 100% of patients with an uncontrolled DM had poor radiological outcomes, while only 33.3% of patients for controlled DM group had poor radiological outcomes. Regarding functional improvement their study was agreed with current study results as they found that HbA1c levels were also inversely correlated to improvement in AOFAS at six-month, high HbA1c levels were associated with lower improvement in function scores, while low HbA1c levels were associated with higher improvement function scores. 4 Riccardo et al. who compared between two groups one diabetic and other was on-diabetic. They concluded that post operative complications among diabetic patient were mainly related to wound complications and superficial infection with as they noticed significance association between DM and wound complications after surgery for ankle fracture with (P -value = 0.03) and they noticed that most of patients with those complications had high HbA1c.5 Another study was done by Andrea et al. they focused on the relation between HbA1c level and wound healing in diabetic individuals seen at the Johns Hopkins Wound Clinic. Despite their study was different than current study regarding type of patients and aim of the study but their conclusions were very supportive to current study results regarding wound healing complications. Their study was conducted to 183 individuals with mean age was 61 years. The mean HbA1c was 8.0%. They noticed that wound-healing among individuals with lower HbA1c had faster healing. As the individual

with HbA1c of 5.6% had a wound-healing rate of 0.35 cm2 per day and the wound was completely resolved 64 days after initial presentation. The other individual with HbA1c of 11.1% had more badly clinical course and 727 days after initial presentation, the wound was not resolved. They concluded that elevated HbA1c was significant factor associated with delayed wound healing rate and this relationship was stronger for the wounds located on the foot. 6

Also Noahiro Shibuya et al. their retrospective study was aimed to evaluate the correlation between HbA1c level and bone healing. Their study was conducted in 177 diabetic patients with foot and ankle osseous procedures that require bone healing (arthrodesis, osteotomies and fractures). Mean age for all patients was 62.1 with mean BMI of 34, 2 and mean HbA1c of 7.2%. Focusing on those diabetic patients with fracture ankle there were only 4 bone healing complications (12.9%) occurred among 31 with open reductions and internal fixations of malleolar fractures. But there was no correlation or statistically significance between bone healing complications and changes in HbA1c. 7

Jessica Hughes et al. they discussed relation between HbA1c and bone healing in diabetic ankle fracture treated operatively and non-operatively. They noticed that 51 patients (21%) of all patients developed bone healing complications (non-union or malunion) 19 patients (14.6) of operatively managed group and 32 patients (28.3%) of nonoperatively managed group with no relation between HbA1c level and bone healing complications in either group. However, they found that HbA1c was a predictive value for wound complications at post-operative period in operatively managed group with odds ratio of 1.26.8

CONCLUSION

There was statistically significant increase in complications rate in uncontrolled DM group with high HbA1c $\geqslant$ 7%. There was positive correlation between rate of all complications and level of HbA1c, mainly complications related to wound problems, as surgical site infection and delayed wound healing. There was positive correlation between age and rate of complications. there was negative correlation between level of HbA1c and functional improvement.

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