

## ORIGINAL ARTICLE

## Wound Healing in Diabetic Patients

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## ABSTRACT

**Introduction:** Diabetes mellitus (DM) is a very common disease that results from the body's inability to maintain blood glucose level within normal limits. Blood glucose levels are either too high or too low. One study shows that up-to 30% people with DM experience skin problems. If blood sugar levels are well controlled, the rate of wound healing and developing a severe infection is significantly less. Regarding management of wound in diabetic patients, keep wounds dry with meticulous dressing, limb elevation, protect the surgical fixation in splint or braces for an extended period of time and patient education to keep in touch wither consultant and promptly report any unusual discomfort, pain, wound discharge, soaking of dressing and systemic symptoms.

**Objectives:** the objective of this study is to identify the risk of wound infection and rate of healing in diabetic patient.

**Materials and Methods:** The study was conducted at orthopedic department of Gulab Devi hospital. It was a Cross sectional study. The data was collected from September 2021 to February 2022. Non-Probability purposive sampling technique was used. The data was collected from indoor of Gulab Devi Chest Hospital Lahore and informed consent was taken from all the patients. The target populations were those who have diabetes mellitus and treated in orthopedic ward at Gulab Devi hospital Lahore. Diabetic patients enrolled in the presented study n=60.

**Results:** our patient population was 28 to 55 year old with mean age 40years. 83% were in 35 to 40 age group. Wound problems were frequently encountered in patients with uncontrolled diabetes and 50% (n=30) of these patients had at least one wound complication after operation. And 71% (n=43) patients had increased pain and delayed recovery of their surgical wounds. When it comes to the relationship between bone health and diabetes, 63% (n=38) patients had history of previous bone fracture and 61% (n=37) patients had deformity of bone. Due to diabetic neuropathy 68% (n=41) patient were weight bearing on fracture site without concern. And the risk of diabetes include slow wound healing 75%.

**Practical implication;** we aim to raise awareness among treating surgeons and physicians of patients presenting with diabetes and planning to undergo surgical intervention. Meticulous wound care and strict control of blood sugar levels are paramount to successful outcome.

**Conclusion:** Diabetes mellitus is a systemic disease associated with uncontrolled blood sugar levels with systemic manifestations. Our study has proved an association of high wound complication with DM patients. Strict diabetic control as well as extra vigilance and meticulous techniques are needed to prevent complications in this group of patients.

**Keywords:** Diabetes mellitus, infected wound, diabetes complications, wound healing

## INTRODUCTION

Diabetes mellitus (DM) is a very common disease that results from the body's inability to maintain blood glucose level within normal limits. Blood glucose levels are either too high or too low. One study shows that up to 30% people with DM experience skin problems. If blood sugar levels are well controlled, the rate of wound healing and developing a severe infection is significantly less<sup>1, 2</sup>. According to the Centers for Disease Control (CDC), a high percentage of diabetic patients experience complications after orthopedic surgery caused by infected wounds, in literature search various studies have reported an infection rate between 1.4% to 18.8%<sup>3-5</sup>.

Diabetes mellitus itself is not considered a risk factor for fracture. But dealing with orthopedic conditions in diabetic patients represents a difficult task for the orthopedic surgeons. Diabetes mellitus is known to have an adverse effect on fracture and wound healing resulting in a high rate of fracture and skin complications. Risk is high in both traumatic injury to the patients and elective surgery. To achieve timely healing with minimum complications in these patients with DM, various protocols and treatment modalities have been suggested. Previous accepted surgical techniques have been supplemented with modalities to encourage biological environment for wound and bone healing in diabetic patients<sup>6</sup>.

Even without an infection after surgery, slow fracture healing can be have a devastating impact on a person's routine life and work. Once DM has been diagnosed, one has to maintain their blood glucose levels within the scientifically accepted range to avoid long terms risks and issues associated with this disease process<sup>7</sup>. This should be regularly monitored through lab tests and a healthy life style is imperative in disease control.

Diabetic neuropathy is well researched phenomenon. Uncontrolled DM will lead to damage to the small vessels and

nerves leading to gloves and stocking distribution of neuropathy in the hands and feet. This combination of uncontrolled DM and neuropathy will lead to delayed wound healing and infection. The infection will eventually spread because these patents have compromised immunity. Spread of infection could be local or generalized like a sepsis and can be life-threatening<sup>8</sup>.

Regarding management of wound in diabetic patients, lot of research has been done. One study suggests a protocol to improve patient outcome by keep wound dry with meticulous dressing, limb elevation, protect the surgical fixation in splint or braces for an extended period of time and patient education to keep in touch wither consultant and promptly report any unusual discomfort, pain, wound discharge, soaking of dressing and systemic symptoms. Antibiotics regime will be incorporated in the theatre protocols as per local flora and sensitivity in liaison with microbiology department<sup>9</sup>.

Another study suggests frequent surgical wound assessments at regular intervals by a health care professional. Any skin sutures will be regularly reviewed by treating physician in this particular patient population and decision of removal will be made by doctor after making sure that skin margins have been healed and wound will not give way. Passive physiotherapy to be advised early in these patients and weight bearing status will be dictated by the operating surgeon in the light of latest x-rays and clinical evaluation. New concept of early mobilization and gradual weight-bearing in custom made fracture braces or boots should be considered for DM patients. Any delay in the healing process should be clearly recorded, documented and informed to the patient as well. Ole of professional physiotherapy is of significant importance in these patients and can be involved as soon possible within first six weeks<sup>10</sup>.

The aim of this study was to observe risk of infection in surgical wound of operative cases. All patients were admitted under care of two orthopedic surgeons and data was collected to look into infection.

Wound healing in diabetic patients is complicated by many factors and lot of research work has been. We conducted our study on local cohort to find out complications of wound healing and compare it with international standards. Very few studies before has looked at specific outcomes of wound healing in diabetic population.

**Objectives:** The objective of this study is to identify the risk of wound infection and rate of healing in diabetic patient.

**MATERIALS AND METHODS**

**Study Setting:** The study was conducted at orthopedic department of Gulab Devi hospital.

**Study Design:** It was a Cross sectional study.

**Study Timeline:** The data was collected from September 2021 to February 2022

**Sampling Technique:** Non-Probability purposive sampling technique was used. The data was collected from indoor of Gulab Devi Chest Hospital Lahore and informed consent was taken from all the patients. Population and sample size;

The target populations were those who have diabetes mellitus and treated in orthopedic ward at Gulab Devi hospital Lahore. Diabetic patients enrolled in the presented study n=60

**We use Cochran formula:**

$$n = \frac{Z^2 \cdot \frac{\alpha}{2} \cdot pq}{p^2}$$

Where, p=0.041, q=0.959, z<sup>2</sup>=3.841, p<sup>2</sup>=0.025

P= sample proportion.

N= Population size

z = level of confidence according to the standard normal distribution (for a level of confidence of 95%, z = 1.96.

**Inclusion Criteria**

- Those who willing to participate in this study
- Patients suffering from diabetes mellitus
- Patient with close fracture of long bone
- Patient who underwent surgery at Gulab Devi hospital

**Exclusion Criteria:**

- Nondiabetic patient
- outdoor patient

**Data collection procedure:** Data were collect through face to face interview, review of medical records using pretested structured questionnaire. Check the patient Blood sugar levels and make a chart. Check the bone fracture site, wound and healing progress.

**Data analysis:** Data was analyzed by SPSS 26 (SPSSA Inc. Chicago, USA).Quantitative data was summarized as mean, median, mode and standard deviation. Suitable statistical analysis was performed. The categorical value will be expressed in the form of frequency and percentages. Bar charts and pie charts was used to display the data. Appropriate statistical tools applied to analyze the data.

**Operational Definition: Diabetes Mellitus:** Diabetes mellitus is a systemic disease process characterized by uncontrolled blood glucose levels resulting from defects in insulin formation or insulin action or both or a disease in which the body's ability to produce or respond to the hormone insulin is impaired, resulting in abnormal metabolism of carbohydrates and elevated levels of glucose in the blood.

**Bone Fracture:** Break or any breach in the continuity of the bone is called fracture

**Wound Healing:** Wound healing is a natural ability of the skin to repair itself from damage. This damage could be a surgical incision or a traumatic wound. Wound healing can be primary, secondary or tertiary depending on the skin's health, wound severity and biological environment for healing.

**RESULTS**

Our patient population was 28 to 55 year old with mean age 40years. 83% were in 35 to 40 age group. Table 1 Blood sugar level was an important contributory factor in diabetic wound management and 70% (n=42) patients had uncontrolled blood glucose levels of up-to 400mg/dl. While 25% (n=15) patients had good control between 130 to 150mg/dl. Remaining patients had fluctuating control. Figure 1. 37(61.67%) patients had family history of diabetes while a lesser 23(38.33%) did not had any family history.

Table 1: Descriptive Statistics of Age

N	60
Mean	40.68
Median	41.00
Mode	40 <sup>a</sup>
Std. Deviation	7.382
Minimum	28
Maximum	55

Descriptive analysis on the basis of age:

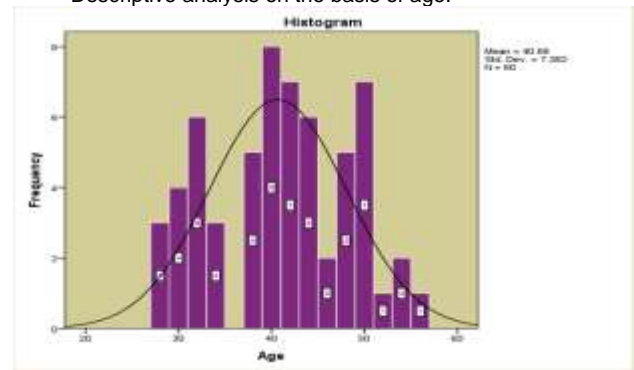


Fig. 1: Descriptive Statistics of Wound Problem after surgery

Wound problems were frequently encountered in patients with uncontrolled diabetes and 50% (n=30) of these patients had at least one wound complication after operation. And 71% (n=43) patients had increased pain and delayed recovery of their surgical wounds. Delayed recovery was associated with higher incidence of wound infection and 23% (n=13) patients had smelly wounds. Figure 2

**Have you had an operation with your wound problem**

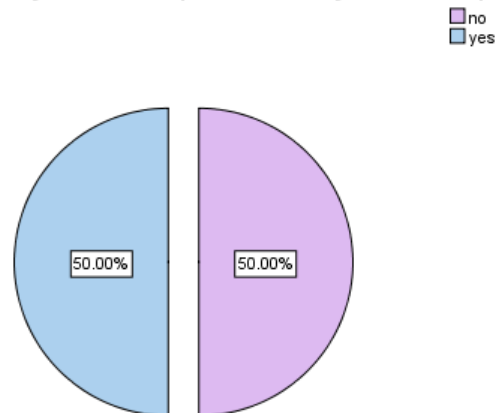


Figure 2: Descriptive statistics of Bone Fracture;

When it comes to the relationship between bone health and diabetes, 63% (n=38) patients had history of previous bone fracture and 61% (n=37) patients had deformity of bone Figure 3. Due to diabetic neuropathy 68% (n=41) patient were weight

bearing on fracture site without concern. These patients needed education and prolonged protection for appropriate healing of fracture.

Wound smell was also recorded during the healing process. Smell was not always associated with wound infection. Out of 60 patients 13(23%) patients had smelly wounds and 47(77%) patients had no smell. Figure 4

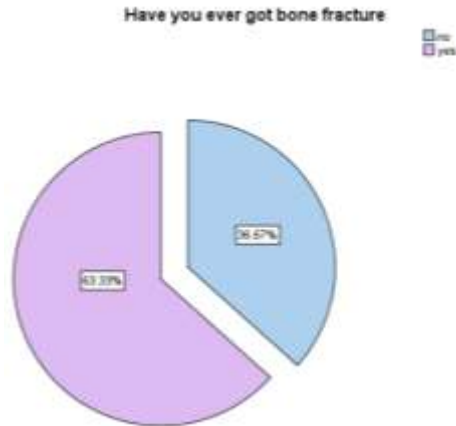


Fig 3:

Extra-articular manifestations of diabetes were also recorded and 42(70%) patients had blurring of vision, 49 (81%) patients had polyuria, 22(36.67%) patients feel body fatigue, 33(55%) patients had polydipsia. Out of 60 participants, majority 49 (61.67%) had dry and itchy skin. Table 2

Table 2: Extra Articular manifestations of Diabetes

No. of Patients	%age	Clinical Problem
42	70%	Blurring of vision
49	81%	Polyuria
22	37%	Body Fatigue
33	55%	Polydipsia
49	62%	Dry / Itchy Skin

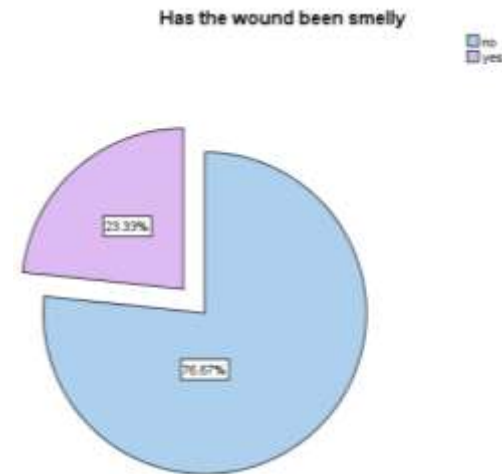


Fig-4:

Chi square test was performed to check association between pains and swelling on wound which shows that there is clear that there clear association between pain and swelling on wound site. Table 3

Table 3: Pain on wound \* Swelling of fracture site Crosstabulation

		Swelling of fracture site		Total	p value	Df	Value of alpha	Chi square value
		no	yes					
Pain on wound	No	12	5	17	0.041	1	0.05	0.225
	Yes	24	19	43				
Total		36	24	60				

Table 4: Chi Square test on wound smell, wound pain, fracture pain, fracture swelling and fracture movements.

Results	smelly wound	wound pain	fracture pain	fracture swelling	fracture movement	Row Totals
operative	18 (15.57) [0.38]	43 (33.36) [2.79]	25 (33.36) [2.09]	24 (33.36) [2.63]	39 (33.36) [0.95]	149
non operative	10 (12.43) [0.48]	17 (26.64) [3.49]	35 (26.64) [2.62]	36 (26.64) [3.29]	21 (26.64) [1.19]	119
Column Totals	28	60	60	60	60	268 (Grand Total)

We looked at additional findings in our study regarding wound and fracture in Diabetic vs non-diabetic patients. Wound smell was noted in 18 (30%) patients had smelly wounds when operated while some of the patients in the non-operative side also developed wound smell in 10 (6%) patients either from diabetic ulcer or traumatic wound. Patients with advance diabetes are usually suffering from neuropathy but it's a mixed pattern involvement and wounds are painful in most of the patients. Fracture swelling was also present in patients who didn't opt for surgery 36 (60%) patients and swelling takes longer to settle down. In continuation of same diabetic neuropathy, movements at fracture site are damaging and delayed the healing process. Diabetic patients are prone to develop Charcot joints and in our study population 21 (35%) patients doing unprotected movements at fracture site. While operative group was allowed to do rehab under supervision. We run a Chi square test on these criteria in operative vs non-operative group. The chi-square statistic is 19.9103. The p-value is .00052. The result is significant at p < .05.

**DISCUSSION**

Diabetes mellitus is a systemic disease process leading to uncontrolled blood glucose levels. Levels can be too high or too and both extremes are littered with complications. Blood glucose levels fluctuate because of abnormal breakdown of carbohydrates resulting from insulin deficiency or defect in insulin receptors<sup>11-13</sup>. In our study we included DM patients who underwent surgical intervention at our institute and among our patient population; male patients are in majority between the age group of 35 to 40. And there BSR levels have been recorded as high as 400mg/dL.

Diabetes mellitus has a genetic component and a positive family history poses a high risk of contracting the disease. Recently incidence of Diabetes has been on the rise among elderly population and this has been associated with environmental factors, sedentary life style, poor dietary choices and increase in stress in daily life. In our study 61.67% participants had family history of diabetes<sup>14,15</sup>.

Diabetes mellitus if remains unchecked, leads to delayed wound healing and risk of infection. Diabetic neuropathy can lead

to skin breakdown and ulcer formation. These ulcers if operated upon or present near surgical wound, they pose an increased risk of infection and wound complications. If left under treated or uncontrolled, patient can end up having amputation. The pathophysiology of delayed wound healing in chronic hyperglycemic patients is a multifactorial process<sup>16</sup>. In our study 75% had face slow wound healing problem. Patients with DM also develop vascular disease leading to compromised circulation of extremities. This vascular disease process combined with neuropathy leads to compromised biological environment for wound healing. So there may be delayed healing or no healing at all<sup>17,18</sup>.

In a natural process of wound healing with normal body immunity, body begins the healing process of a surgical or traumatic wound through a series of physiological processes. First by preventing from infection then increasing the inflammatory mediators around the wound site and that's why initially the wound may be hyperemic and painful. This hyperemia is a positive sign of the body's physiological reaction to injury and healthy immune system. Treating physician must help this process by protecting the wound from external contamination and keep it dry. Moist environment is a bed for bacterial growth leading to infection. Infection will lead to painful wound, a sign which should be carefully evaluated especially in diabetic patients. In our study 71.67% had pain on wounds while 28.33% did not had painful wound<sup>19-21</sup>. Swelling around the wound is expected initially but if it is associated with un-usual pain or fail to subside over certain time period, infection must be ruled out<sup>22,23</sup>. In our study 40% patients had swelling on wounds while majority 60% did not had swelling on wounds.

Uncontrolled blood sugar levels can lead to body fatigue. In our study 36.7% had faced extreme fatigue. It could also be representing an overall poor health reserve of the patient, anemia of chronic disease and no routine for exercise. All these factors must be evaluated before an elective surgical intervention. For emergency these factors must be corrected promptly after the surgical procedure<sup>24</sup>.

Most common reason for uncontrolled DM is inadequate treatment, poor compliance and eventually it leads to the systemic side effects on musculoskeletal system, such charcot arthropathy of weight bearing joints, poor muscles health, neuropathy and arteriopathy leading to skin damage. In our study 65% did not move injured area freely due to weak muscles<sup>25</sup>.

We also recorded systemic complications of DM in our study population. DM can virtually affect any part of the body when left uncontrolled for longer duration of time. Systemic complications such as blurring of vision due to inflammation of optical lens. In our study 70% had blurring of vision. Diabetic retinopathy is also well documented pathology which could be temporary or permanent. This can lead to partial or complete blindness as well<sup>23, 24</sup>.

Polydipsia and polyuria are other two systemic side effects commonly reported among DM patients. Glucosuria is high level of sugar in urine which can lead to renal function compromise because kidneys have to filter out high glucose levels. DM also alter the carbohydrate metabolism in the body which leads to these systemic complications<sup>21, 26</sup>. Diabetic ketoacidosis is a dangerous escalation of uncontrolled blood sugar levels. Stress on the body such as surgery or infected wound deteriorate this insulin malfunction further and leads to a dangerous cascade of events which can result in acute renal injury, renal shut and eventually renal failure. These events if not controlled early lead to a very poor outcome and wound complications<sup>27</sup>.

Patients with DM have an overall abnormal body metabolism which lead to chronic changes on calcium and vitamin D levels as well. This leads to osteopenia and increased risk of fragility fractures. Bone remodeling cycle is also affected which results in reduced functions of osteoblasts and increased activity of osteoclasts and hence abnormal fracture healing response. Chronic renal disease associated with DM results in low levels of serum calcium. Joints in DM are affected through a different

pathway where loss of proprioception, loss of muscle tone, and abnormal pain response due to diabetic neuropathy and cartilage damage to high blood sugar levels leads to Charcot arthropathy which is an irreversible joint damage with poor outcomes<sup>28, 29 and 30</sup>.

## CONCLUSION

Diabetes mellitus is a systemic disease associated with uncontrolled blood sugar levels with systemic manifestations. Diabetic patients undergoing surgical intervention have a higher incidence of wound complications due to alteration of local as well as systemic response of body. Our study has proved an association of high wound complication with DM patients. Strict diabetic control as well as extra vigilance and meticulous techniques are needed to prevent complications in this group of patients.

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