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Original Article

Outcomes and complications of diabetic burn injuries: a single center experience

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Abstract: Introduction: Comorbid conditions may adversely affect burn outcomes. Burn injuries remain one of the most prevalent injuries presenting to emergency departments. The current study compares the outcomes of burn injuries in diabetic and non-diabetic patients. Methods: A retrospective review of 705 burn patients admitted to the burn unit was performed. All adult patients (18 years old and above) who were admitted to the burn unit were included. The study compared the complications and outcomes of the diabetic and non-diabetic burn patient. Results: Patient were divided into diabetic (14%) and non-diabetic groups (86%). Diabetic burn patients were more likely to be older with a mean age of 58.7 years compared to 33.6 years in non-diabetic group (P=0.000). Inhalation injury was found in 3% of diabetic group compared to 14% of non-diabetic group (P=0.009). Diabetic patients were more likely to have associated medical comorbidities especially hypertension. Overall mortality rate was 13% and overall length of stay (LOS) was 28.4 days with no significant differences between groups. Conclusion: Older age, hypertension and contact burns are significantly associated with DM in burn patients. No increased risk of burn-related infections, mortality and LOS were observed in the DM group.

Keywords: Burn injury, diabetes mellitus, inhalation injury, outcome, complications

Introduction

Diabetes mellitus (DM) is a major health problem and considered one of the leading causes of mortality globally. According to the World Health Organization, Saudi Arabia has the 7th highest prevalence of DM globally [1-3]. Diabetic patients have altered microcirculation and impaired immune system causing a weak inflammatory response and delayed wound healing [4].

DM is considered a poor risk factor for trauma patient outcomes, including burn injuries [5]. It has been identified as the most important independent risk factor causing poor outcomes after a burn injury [6]. Mortality in diabetic burn patients has been investigated in many studies [7-12]. Due to several other factors including prolonged hospital stay, diabetic burn patients have a higher rate of infection compared to non-diabetic burn patients [13]. Sepsis, burn wound cellulitis and urinary tract infections are more prevalent in diabetic burn patients, however, these complications were reduced with optimal control of blood glucose level [14, 15]. Acute kidney injury (AKI), acute respiratory distress syndrome (ARDS), and septic shock are major consequences of burn injury and known to have high mortality rates (30-77%) in general population [16, 17]. Whether co-existing DM would worsen these outcomes remains unclear.

The current study evaluates risks and outcomes of burn-related complications in diabetic patients in comparison to non-diabetic burn patients at a single burn center.

Table 1. Demographic and clinical variables

Variable		Diabetic Group	Non-Diabetic group	*p*-value
Age (mean ± SD)		58.73 ± 13.99	33.64 ± 12.98	0.000
Gender	Male (n, %)	60 (60.6%)	427 (70.57%)	0.319
	Female (n, %)	39 (39.4%)	179 (29.43%)	
Total Body Surface Area percentage (TBSA%)		14.17 ± 18.94	28.31 ± 26.77	0.436
Hemoglobin A1C level		9 ± 2.2		
Body Mass Index (BMI)		22.03 ± 14.90	18.4 ± 13.95	0.677
Length of Stay (LOS)		21.90 ± 30.46	29.44 ± 39.28	0.069
Inhalation injury		3 (3%)	85 (14%)	0.009
Mortality		9 (9%)	83 (13.71%)	0.207
Therapy prior to admission		26 (26.26%)	165 (27.27%)	0.841
Ventilation Yes /No		14 (14.14%)	188 (31%)	0.661
Inotrope Yes/No		12 (12.12%)	115 (19%)	0.616
Smoking history		9 (9%)	39 (6.44%)	0.331
History of escharotomy/fasciotomy		8 (8.08%)	146 (24.13%)	0.760

Methods

Study settings

This is a retrospective study was conducted at the burn unit of King Abdulaziz Medical City (KAMC), Riyadh, Saudi Arabia. KAMC is a tertiary-care level I trauma center with a bed capacity of 1,501. The burn unit at KAMC is one of the largest burn units in the Middle East with an average 100-140 annual admissions of adult burn injuries. Institutional Review Board (IRP) was obtained prior to the start of this study from King Abdullah International Medical Research Center (KAIMRC) with IRB number RC17/295/R. Due to the retrospective nature of this study, the informed consent letters have been waived according to IRB of KAIMRC recommendations.

Study population

The study included all adult burn patients (above 18 years of age) admitted to the burn unit for a period of 16 years, from 1 January 2000 to 31 December 2016. The main groups are the diabetic and non-diabetic burn patients. The diabetic group included all patients who already diagnosed with diabetes mellitus during admission or on sugar lowering medication and/or insulin. Patients with incomplete and inconsistent data were excluded.

Data collection and analysis

Demographical data, age, gender and body mass index (BMI) were collected. Clinical variables, preexisting comorbidities, prior treatment, type and extent of burn, length of stay (LOS), inhalation injury, need for escharotomy/fasciotomy, complications and mortality were retrieved from medical records.

Excel sheet was used for data entry and IBM Statistical Package for the Social Sciences version 21 (SPSS v.21) was used for data management and analysis. Descriptive statistics were performed to describe the demographic variables. A T-test and Chi-square was used to analyze numerical and categorical data, respectively. A *p*-value of <0.05 was considered significant with a confidence interval of 95% and a 5% margin of error. A step-wise regression test was done to identify significant variables.

Results

A total of 705 burn patients were included with 14.0% (n=99) diagnosed with DM. Patients were classified in two groups: diabetic group and non-diabetic group. **Table 1** compares the demographics, treatment prior to admission, body mass index (BMI), total body surface area (TBSA), length of stay (LOS), smoking, inhalation injury, ventilation or inotrope support, and necessity for escharotomy/fasciotomy. Diabetic burn patients were more likely to be older with a mean age of 58.7 years (SD ± 13.9, *p*-value <0.0001; Odds ratio 1.07 and 95% CI). The diabetic group has an average Hgb A1C 9 ± 2.2. Inhalation injury was found in 14% of the non-DM group (n=85, *p*-value =0.009) com-

Table 2. Proportions of comorbidities in the diabetic and non-diabetic groups

Comorbidities	Diabetic Group (n, %)	Non-Diabetic group (n, %)	*p*-value
Chronic pulmonary disease	5 (5%)	26 (4.29%)	0.732
Congestive heart failure	6 (6.06%)	4 (0.66%)	0.836
Renal disease	12 (12.12%)	5 (0.82%)	0.413
Hypertension	64 (64.64%)	22 (3.63%)	0.000
Liver disease	5 (5.05%)	5 (0.82%)	0.227
Cardiovascular disease	6 (6.06%)	2 (0.33%)	0.694
Peripheral vascular disease	3 (3.03%)	0 (0%)	0.999
Hypothyroidism	6 (6.06%)	9 (1.48%)	0.736
Malignancy	1 (1.01%)	3 (0.49%)	0.527
Myocardial Infarction	11 (11.11%)	4 (0.66%)	0.620
Neurological disease	3 (3.03%)	16 (2.64%)	0.824
Psychiatric disease	3 (3.03%)	15 (2.47%)	0.745

Table 3. Burn types within the comparison groups

Burn Type	Diabetic Group (n, %)	Non-Diabetic group (n, %)	*p*-value
Chemical	10 (10.10%)	71 (11.73%)	0.380
Scald	22 (22.2%)	79 (13.09%)	0.064
Blast	1 (1.01%)	3 (0.49%)	0.764
Electrical	1 (1.01%)	36 (5.95%)	0.390
Flame	48 (48.5%)	381 (62.97%)	0.261
Contact	14 (14.14%)	14 (2.31%)	0.036
Friction	3 (3.03%)	21 (3.47%)	0.444
Total	99	605	

pared to 3% of the diabetic group (OR .14, 95% CI). The overall mortality rate was 13.04% (n=92) and the overall LOS was (28.38 ± 38.24 days) with no statistically significant difference between both groups. The DM group tended to have a higher BMI, but this was not statistically significant.

In terms of co-morbidities, hypertension (64%, n=64) was found to be a significant risk factor in the DM group (*p*-value =0.000; OR 17, 95% CI). For other comorbidities, DM group had higher proportions in most conditions but the associations were not statistically significant (**Table 2**).

Regarding the type of burn, flame burn was the predominant type of burn in both groups (60.9%, n=429). The other burn types were similarly distributed in both groups (**Table 3**), with the exception of contact burn which was higher in the diabetic group.

Table 4 compares the complications between both groups. There was no significant association between DM and any specific complications. Acute kidney injury was seen in 10.8% with a mortlity rate of 68%. Respiratory complications such as ARDS (3.23%) and pnemonia (5.24%) had a high mortlity rate (90.3% and 54.1% respectively). Abdominal compartment syndrome had the highest mortality rate (100%) in contrast to gastrointestinal ulcer with no mortality. It must be noted the the frequency of abdominal compartment syndrome was very small in both groups. A higher proportion of pulmonary embolism occurred in the DM group but it was not statistically significant.

Discussion

The current study shows that diabetic burn patients may not be at high risk for burn-related infections as shown in previous studies. Although most diabetic patients had higher associated comorbidities (**Table 2**), they had less severe burn injuries compared to non-diabetic patients (**Table 1**). This is demonstrated by smaller surface area (14% vs. 28%) and less inhalation injury and ventilation (3% vs. 14%, and 14% vs. 31% respectively). The incidence of burn-related infections (burn wound sepsis, septic shock, pneumonia) were comparable in both groups. Previous reports showed that pre-existing DM in burn patients increases the probability of burn related infections [13], however, this was not confirmed in the current study as no difference was detected between both groups. One may argue that the severity of burn injury in diabetic patients are less compared to non-diabetic patients. This may play a role in reducing infectious complications, particularly lung-related complications. Despite this, septic shock is shown to be one of the leading causes of mortality among all burn patients (72%), with no difference between diabetic and non-diabetic patients.

DM has been considered as a predictor for poor outcomes in burn patients [5]. It has been

Table 4. Complications and mortality rate per complication

Complication	Diabetic Group (n, %)	Non-Diabetic group (n, %)	*p*-value	Mortality rate (n, %)
Acute kidney injury	14 (14%)	62 (10.24%)	0.245	52 (68.42%)
Deep vein thrombosis	3 (3.03%)	11 (1.81%)	0.422	1 (7.14%)
Pulmonary embolism	3 (3.03%)	6 (0.99%)	0.094	3 (33.33%)
Burn wound sepsis	19 (19.19%)	142 (23.47%)	0.351	45 (27.95%)
Septic shock	10 (10.10%)	83 (13.71%)	0.327	67 (72.04%)
Pneumonia	6 (6.06%)	31 (5.12%)	0.696	20 (54.05%)
Gastro-intestinal ulcer	2 (2.02%)	7 (1.15%)	0.477	0 (0%)
Abdominal compartment syndrome	1 (1.01%)	2 (0.33%)	0.335	3 (100%)
ARDS	1 (1.01%)	22 (3.63%)	0.174	21 (90.30%)
Others (amputation, pleural effusion, bedsore, UTI, etc.)	14	45		

associated with impairment in the inflammatory process and delay in wound healing stages [4]. Previous studies have shown that diabetic patients are prone to develop more complications after burn injuries with infections being the most prevalent, compared to non-diabetic patients [11, 13, 15]. Tight glycemic control using several measures such as early recognition, initiation of treatment, and following moderate insulin protocol were recommended with fewer complications and better outcome in management of burn injuries in diabetic and non-diabetic patients [18-20]. This would affect mortality rate rather than burn-related infections. This is supported by a previous article suggested early glycemic control within the first 3 days postburn in order to reduce mortality rate in diabetic and non-diabetic patients [19]. The burn-related infections are affected by multiple modifiable and un-modifiable factors other than DM which may lead to different outcomes. An independent study on diabetic burn patient with strict control on these factors could lead to more reliable results.

The outcome of a burn injury is affected by many factors such as age, burn extent, burn type, presence of inhalation injury and the patients' comorbidities [12, 21-23]. Prior comorbidities increase mortality and morbidity rates in patients with burn injuries [15, 21, 24]. On this study, of all associated comorbidities, hypertension was found to be the most significant in diabetic patients compared to non-diabetic patients (64% vs. 3.6%; P=0.000). This is probably related to the higher age bracket in the diabetic group (58.7 vs. 33.6 years). Contact burn was found to be more prevalent in diabetic group compared to non-diabetics (14% vs. 2%). This may be attributable to the associated peripheral neuropathy seen in diabetic patients affecting patients' perception of painful stimuli and temperature, which makes them prone to burn injuries [13, 25].

Regarding burn-related complications, abdominal compartment syndrome, ARDS, septic shock, AKI and pneumonia were the leading causes of mortality in both groups. Multi organ dysfunction like AKI can develop in two periods: early within hours after the injury and late at 2-14 days after the injury [26]. Developing AKI early after admission could be attributed to hypo perfusion, reduced blood volume and under resuscitation. Sepsis is believed to be the leading cause of AKI in the late phase [22]. AKI is associated with a higher mortality rates as demonstrated in the current study and literature [27, 28]. Diabetic nephropathy is a well-known consequence of diabetic patients and may predispose them to further impairment of renal function after burn injury. One study showed a higher risk of renal failure in diabetic patients with lower extremities burns [29]. However, the incidence of AKI in both groups was comparable in this study.

Pneumonia is considered the leading cause of mortality in burn patients regardless of pre-existing DM [30]. Intensive glycemic control is shown to reduce the risk of pneumonia significantly [15]. Multiple factors predispose burn patients to ARDS after burn injury including inhalation injury and tobacco use [31]. The incidence of ARDS in the DM group was lower in our study (1%) compared to previous reports

(5.9% and 18.2%) [31, 32] which may be related to less severe burn injuries seen in our cohort. However, mortality rate increases significantly in presence of ARDS (**Table 4**).

The current study showed that DM did not have an increased risk of mortality; a finding that is similar to several reports [8, 10, 11, 33, 34]. LOS in diabetic burn patients remains controversial in the literature. Contact burn injuries of the feet were associated with higher LOS compared to other types of burns [13, 14, 35]. Despite less severe burn injuries seen in DM group in this study, a comparable LOS was noted in both groups.

Several limitations of this study should be noted. First, retrospective design carries the risk of selection bias. Data were collected from paper based medical records with several missing data; these records were excluded from the study. Second, small sample size, yet the proportion of diabetic patients were comparable to previous studies. Third, Hemoglobin a1c levels were not routinely performed for all patients and hence could not be included in our data. This is a potential area of future research as it would indicate proper glycemic control and its consequences on the outcomes. Lastly, majority of diabetic burn injuries were milder compared to non-diabetic patients as seen with lower inhalation injuries and less need for mechanical ventilation. This may impact the adverse outcomes has the injuries were comparable.

Conclusion

Older age, hypertension and contact burns are significantly associated with DM in burn patients. The risk of mortality and LOS were increased in the DM group compared to the non-diabetic group. DM has a minor role in determining the outcome of burn injuries despite being associated with more comorbidities and complications. There are some limitations due to the retrospective design of this study. Further research is required to investigate the effect of other comorbidities on the outcome of burn injuries in DM patients prospectively.

Disclosure of conflict of interest

None.

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