DEGLOVING INJURIES: PATTERNS, TREATMENT AND EARLY COMPLICATIONS AMONG PATIENTS AT A TEACHING HOSPITAL IN WESTERN KENYA

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ABSTRACT

Background: Degloving injuries result from avulsion of extensive portion of skin and subcutaneous tissue from the underlying fascia, muscles and tendons. They commonly occur in orthopaedic surgery with accompanied blood loss, concomitant injuries and contamination.
Objective: To determine the pattern, treatment, and early complications of degloving injuries.
Methods: A prospective study among 48 patients admitted with degloving injuries at Moi Teaching and Referral Hospital-Kenya between 1st December 2016 and 30th November 2017. The diagnosis was made through physical examination and ultrasonography followed by photo-documentation while demographic and injury history were recorded in a questionnaire. Fisher's exact test of association between pattern of injury and complications was conducted.
Results: Median age was 26 (IQR: 18.5, 42.5) years with male to female ratio of 1.5:1. Most (75%) of the injuries were from road traffic accidents commonly (n=23) affecting the lower limbs. Open degloving injuries (n=44) either had single (n=29) or serial debridement (n=15) with the commonest definitive treatment being primary closure (n=22). Closed degloving injuries were either conservatively managed (n=2) or drained (n=2). Only 31.2% of the patients developed complications which statistically was significantly associated (p=0.002) with the patterns of degloving injury.
Conclusion: Open degloving injuries affecting the lower limbs were commonest and were mainly treated through primary closure. Early complications were associated with injury patterns and treatment modality. There is need to develop institutional protocols for the treatment of degloving injuries to reduce early complications

Key words: Degloving injuries, Patterns, Treatment and early complications

INTRODUCTION

Avulsion of soft tissue whereby an extensive portion of the skin and subcutaneous tissue detaches from the underlying fascia and muscles are known as degloving injuries (1). These injuries were reported from as early as 1938 as Wringer injuries of the hand (2). They were later referred to as avulsion injuries (3) irrespective of the nature of trauma in the event the skin and subcutaneous tissues were stripped "degloved" as a flap of the deeper tissue (4). These skin avulsion injuries occur when a shearing force is applied to a trapped limb (3). Historically, the most common cause of the degloving injuries then were laundry machines and patients sustained injures of their upper limbs (2–5). Currently, the most common cause of degloving injuries are motor vehicle accidents, falls, recreational and sports activity, and direct injuries from striking objects (6). The injury is produced by an extremely powerful shearing force applied to the part of the body affected. Degloving occurs in the plane where the attachment of the skin or subcutaneous tissue to the deeper structures is weakest (1). They are broadly classified into either open or closed degloving injuries (1). Open degloving injuries are further subdivided according to the Yan's Classification (7) as: Pattern 1 (purely degloving injury); Pattern 2 (degloving injury with the involvement of deep soft tissues) and Pattern 3 (degloving injury with long-bone fractures). According to the Arnez classification, these degloving injuries can also be classified into four patterns based on the extent of the tissue

injury as: abrasions/avulsions, non-circumferential degloving injuries, circumferential single plane injuries and circumferential multi-plane injuries (8).

Degloving injuries are more commonly observed in males due to a disproportionately higher burden of traumatic injuries (9). Although they may occur anywhere in the body, the main sites of degloving injuries are lower extremities, trunk, scalp, and face (1,10). The patterns, treatment modalities, and early complications of degloving injuries (within 30 days after definitive treatment) vary in different institutions and are influenced by various patient and institutional factors (11). These factors include the age of patients, mechanism of injury, location of the injury, early diagnosis, other systemic illnesses, and timing of treatment offered among others (10). Every year, Degloving injuries contribute to a sizable proportion (3%) of all patients admitted in the orthopaedics wards at Moi Teaching and Referral Hospital (MTRH) (12) . Treatment of these injuries are quite challenging, and the outcomes are sometimes unfavourable due to the severity of the injury, severe contamination, and massive blood loss. The pattern, treatment modalities, and complications of these injuries are not adequately documented locally. This study therefore aimed at determining the patterns, treatment modalities, and early complications of degloving injuries among patients being managed at the Moi Teaching and Referral Hospital (MTRH).

MATERIALS AND METHODS

This study was conducted at the MTRH in Western Kenya. The facility is in Eldoret Town- Uasin Gishu County. The study adopted a prospective descriptive study design where 48 patients diagnosed with a degloved skin greater than one-fourth of the circumference of the affected body parts and those admitted with closed degloving injuries at the study site between 1st December 2016 and 30th November 2017 were enrolled into the study. Patients who had already developed complications after definitive treatment in peripheral facilities were excluded from the study.

Open degloving injuries were diagnosed through physical examination while closed degloving injuries were through physical examination and confirmed using ultrasonography. An informed consent was administered by a trained research assistant who also administered a questionnaire to collect the patients' sociodemographic and history of injury data. Clinical data was obtained during the course of treatment through medical chart reviews. The clinical data included cause and mechanism of injury, time from injury to hospital, whether debridement and skin grafting were done, location and classification of the injury, treatment, complications and the duration of hospitalization. At the time of wound exposure and assessment, degloving injury classification was done using both the Yan's and Arnez classification criteria; and adequate photo-documentations of degloving injuries were done using a digital camera from at least two different views with adequate focus. The main modalities for management of degloving injuries conducted at MTRH were debridement (within six hours from the time of arrival to the accidents and emergency department) followed by skin grafting once the wound was found suitable for grafting. Debridement was either done singly or serially depending on the level of wound contamination. Although other techniques such as local and free flaps could be done to manage degloving injuries, these are currently not offered routinely at the study site due to the few number of plastic surgeons available. The early complications during treatment were documented from the time of injury to 30 days after definitive treatment. Patients who were discharged earlier than 30 days were followed up in the outpatient clinic. The data collected was entered into a Microsoft Access database, coded, cleaned and exported to STATA/MP version 13 statistical analysis software. The categorical variables such as sex, education level and causes of injuries were summarized as frequencies and the corresponding percentages. While numerical variables such as age, time to surgery, and hospitalization period were summarized as median and corresponding interquartile range. Inferential statistical analysis was conducted using Pearson's Chi-Square and Fisher's exact tests to test the association between the presence of complications and various treatment modalities at 95% confidence interval. Mann Whitney U test was used to compare the median length of stay among those who developed complications with those who did not develop complications. Furthermore, Mann Whitney U test compared the average time taken from injury to debridement among those who developed complications and those who did not. The results were presented in the form of charts and tables.

This study received ethical clearance from the Institutional Research and Ethics Committee (IREC) of Moi University School of Medicine and MTRH (Approval Number: FAN/IREC/1686). Informed consent was obtained from patients older than 18 years of age while assents and parental

consent was obtained for those younger than 18 years. Patients' privacy and confidentiality was maintained by de-identifying patient data and storing their information in password secured databases accessible to only study staff. Patients were further informed that the findings of this study will be published in a peer reviewed scientific journal to inform degloving injuries management modalities.

RESULTS

The mean age was 30.5 (±17.2) years; median age was 26 (IQR: 18.5, 42.5) years with a male to female ratio of 1.5:1. More than four fifths (83.33%) of the patients were aged 16 years or more with a range of 4-70 years. Nearly half (47.92%) of those enrolled had secondary level of education or above (Table 1).

Table 1

Socio-demographic characteristics of the patients

	Category	No. (%)
Age (years) (n=48)	<16	8 (16.67)
	16-60	36 (75.00)
	>60	4 (8.33)
Gender (n=48)	Female	19 (39.58)
	Male	29 (60.42)
Education level (n=48)	None	3 (6.25)
	Primary	22 (45.83)
	Secondary	22 (45.83)
	Higher education	1 (2.09)

This study found 48 patients with degloving injuries out of a total of 1185 orthopaedic patients over the one-year period. This resulted in a degloving injuries prevalence of 4.05% at the Moi Teaching and Referral Hospital in Eldoret-Kenya. These degloving injuries (Figure 1) were stratified based on aetiology, where more than three-quarters (77.09%; n=37) occurred because of road traffic accidents while the rest were work-related. Specifically, nearly half (43.75%) of all the reported injuries were as a result of motorcycle accidents followed by motor-vehicle accidents (31.25%). Farm accidents (14.58%) and industrial accidents (8.33%) were identified as work-related injuries while bicycle accidents were the least prevalent at 2.09%.

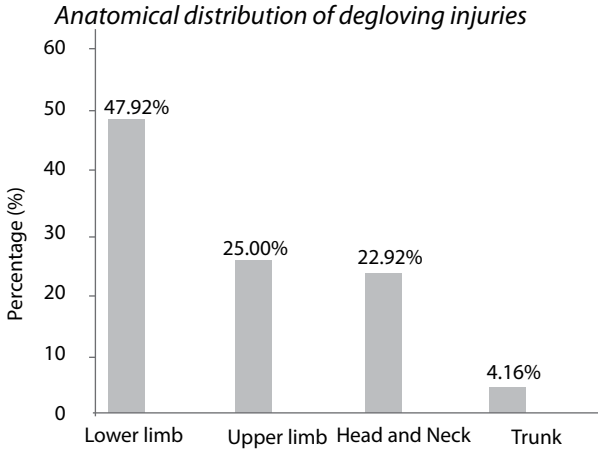
Figure 1

Degloving injury of the right thigh

Most (72.92%) degloving injuries occurred on the extremities with majority (47.92%) being lower limb injuries followed by (25%) those on the upper limb (Figure 2).

Figure 2

Anatomical distribution of degloving injuries



Most of the patients delayed arriving in the hospital for management with less than one-third (31.25%; n=15) arriving in under 12 hours (Table 2).

Majority of the patients (91.67%; n=44) had open degloving injuries which got either single (n=29) or serial debridement (n=15). The definitive management for these open degloving injuries was primary closure that was done to half (50%; n=22) followed by split-thickness skin grafting (22.7%; n=10), full-thickness skin grafting (15.9%;

Table 2

Time between injury and arrival to the hospital

Variable	Category	Frequency
Time between injuryto arrival at the hospital	<12 hours	15 (31.25)
	12 – 23 hours 59 minutes	15 (31.25)
	24 – 47 hours 59 minutes	14 (29.17)
	≥ 48 hours	4 (8.33)

n=7) and muscle flap (11.4%; n=5). The remaining patients (n=4) had closed degloving injuries which were either conservatively managed (50%; n=2) or drained (50%; n=2).

When the injuries were subtyped (Arnez Classification), the most frequent were non-circumferential degloving injuries accounting for over half (59.09%) of those reported (Table 3).

Table 3

Distribution of degloving injuries by status and subtypes

Variable	Category	No. (%)
Status	Closed	4 (8.33)
	Open	44 (91.67)
Subtype	Non-circumferential degloving	26 (59.09)
	Circumferential multiple plane	7 (15.91)
	Abrasions/avulsion	6 (13.64)
	Circumferential single plane	5 (11.36)

The open degloving injuries were further classified as per the Yan's classification where, pure degloving injuries (Pattern 1) accounted for 45.45% (n=20) of all the injuries reported. This was followed by those affecting deep tissues (pattern 2) at 36.36% (n=16) with the least occurring being degloving injuries with an associated bone fracture at the site of injury (pattern 3) at 18.19% (n=8).

Most patients with pattern 1 (60%; n=12) and Pattern 2 (37.5%; n=6) injuries had a single debridement and primary closure while those with patterns 3 mainly (37.5%; n=3) received single debridement and muscle flap (Table 4). Most patients who underwent muscle flap as their definitive treatment had to undergo serial debridement prior to the definitive treatment.

Table 4

Surgical management of open degloving Injuries based on Yan's classification patterns

Management	Pattern			
	1	2	3	Total
Serial debridement/FTSG	0	2	1	3
Serial debridement/muscle flap	0	1	3	4
Serial debridement/primary closure	2	1	1	4
Serial debridement/STSG	3	1	0	4
Single debridement/FTSG	0	2	2	4
Single debridement/muscle flap	0	0	1	1
Single debridement/primary closure	12	6	0	18
Single debridement/STSG	3	3	0	6
Total	20	16	8	44

Legend: FTSG = Full Thickness Skin Graft, STSC = Split Thickness Skin Graft

Following the various management options offered based on the nature of degloving injury, 31.3% (n=15) of all the patients developed early complications. When these complications were classified by pattern (using Yan's Classification criteria), 62.5% (n=5) of those with pattern 3 had early complications compared to the 8.3% (n=2) of those who presented with pattern 1 degloving injury, a difference that was found to be statistically significant (p=0.002) as shown on Table 5.

Table 5

Occurrence of early complications based on Pattern using Yan's classification criteria

Pattern	Early complications		P-value
	Yes	No	
1	2 (8.3%)	22 (91.7%)	0.002f
2	8 (50.0%)	8 (50.0%)	
3	5 (62.5%)	3 (37.5%)	

f Fishers Exact test

These early complications included local wound infection (40%), haemorrhage (26.7%), graft failure (20%) and primary flap necrosis at 13.3% (Figure 3).

When complications were compared to treatment modalities, there was a statistically significant association (p=0.043) between patients who had serial debridement and developing early complications (Table 7).

Figure 3

Early complications of degloving injuries

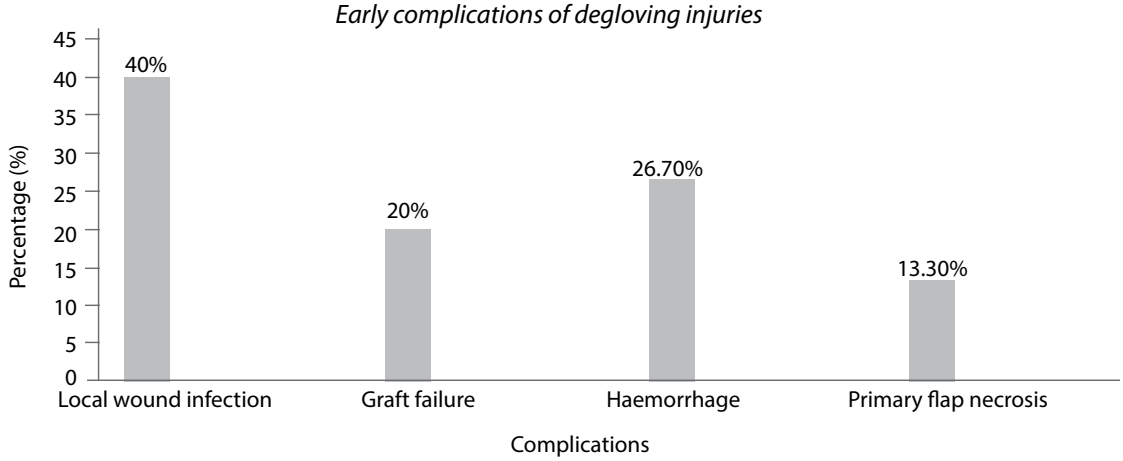


Table 7

Association between treatment modalities and complications

Treatment	Complication		P-value
	No (n=33)	Yes (n=15)	
Single debridement	22 (75.9%)	7 (24.1%)	0.189c
Serial debridement	7 (46.7%)	8 (53.3%)	0.043f
Primary closure	17 (77.4%)	5 (22.6%)	0.241c
FTSG	4 (57.1%)	3 (42.9%)	0.662f
FTSG	6 (60%)	4 (40%)	0.703f
Muscle flap	2 (66.7 %)	3 (33.3%)	0.307f
Antibiotics	2 (100%)	0 (0%)	-
Drainage	2 (100%)	0 (0%)	-

f Fishers Exact test; c Chi-Square test

DISCUSSION

The mean age of patients was 30.5 (±17.2) years and this matched the findings from a study conducted in Uganda (9) where the reported mean age was 28.8 years. Similar mean age results were reported in Qatar at 30.5 years (10) and Shanghai – China at 32.4 years (7). However, a relatively higher mean age was reported at the third military hospital of China where the mean age of those enrolled was 35.7 years (13). The reason for this deviance in mean age could be attributed to the difference in the age range of the two target populations at 16-70 years in the current study and 16- 65 years in China (13). Another mean age and age-range trend difference was reported in Istanbul, Turkey (6) where patients enrolled had a mean age of 16 years with an age range of 6-33 years.

Most (75%) of the patients' degloving injuries were as a result of road traffic (motor vehicle and motorcycle accidents). Similar high aetiological findings were reported in both Uganda and Qatar at 84% (10) and 75% (9) respectively. This high prevalence of degloving injuries resulting from motor vehicle and motorcycle accidents could be attributed to an increase in the use of motorcycle as a means of public transport in western Kenya (14).

Nearly all (91.7%) of the degloving injuries reported in this study were open. This matched findings in Qatar (10) where nearly four-fifths (79.8%) of the enrolled patients had open degloving injuries. When the degloving injuries were classified based on the anatomical site of occurrence, this study reports that majority of them (47.92%) occurred on the lower limbs. Although the highest proportion reported in this study, this proportion of degloving injuries occurring on the lower limbs is half that reported in Brazil at 95.7% (5). Higher proportions of degloving injuries occurring on the lower limbs as seen in this study were also reported in Pakistan at 72% (15).

Open degloving injuries are best treated within the first eight hours from the time of injury (13). This study reports that it took an average of 19 hours from the time of injury to debridement and approximately five days to grafting. This could be attributed to late presentation to the hospital and high workload at the study setting's accidents and emergency (casualty) department and theatre. These extensive open degloving injuries can be problematic for reconstructive surgeons due to the complexity of the injury further interfering with their treatment and closure. Because of this complexity, they may require serial debridement and dressing, with the eventual placement of skin graft (6,9,10,13,16). However, other studies have reported that the immediate use of the degloved skin as a full-thickness skin-graft gives the most satisfactory coverage to the denuded areas (17,18). The grafting methods used for closure of degloving injuries in clinical practice vary. The techniques have been refined in the primary treatment of open degloving injuries with satisfactory results. In a follow-up Taiwanese study (19), multiple stabbing over the skin graft were performed to allow fluid drainage when the defatted skin was repositioned. The fixation of the skin graft to the underlying bed with multiple staples was advocated to provide adequate stability. The full-thickness skin graft with such a pattern of perforation healed well and produced a satisfactory cosmetic appearance (17-20).

Early complications associated with degloving injuries management were observed in nearly one-third (n=15) of the patients. These complications were predominant among those with open degloving injuries, whereby nearly half (40%) of them had local wound infection. The other complications reported were skin graft failure (20%), haemorrhage (26.7%), and flap necrosis (13.3%). The overall early degloving injury management complications in this study are lower than those reported in a study conducted in Brazil at 62% (5). This could be attributed to better patient management and education which reduces complication rates. In Uganda (9), 29.41% of degloving injuries resulted in haemorrhagic shock while in Doha-Qatar, the infection rate reported was 3.9% (10). Occurrence of early management complications statistically was significantly associated with the pattern of degloving injuries (p=0.002). Most (62.5%) of those with pattern 3 degloving injuries had complications reported in a Chinese study (7) where patterns 1 and 2 had better treatment outcomes. Age was found to have limited influence on the occurrence of early complications following the management of degloving injuries just like other previously reported studies (6,7,10).

CONCLUSIONS

This study reports that a great proportion of patients with degloving injuries were young and male. The commonest anatomical site for degloving injuries was the lower limb. Road traffic accident was the major causative factor for the degloving injuries reported in this study; with the commonest pattern of degloving injuries being pattern 2 and non-circumferential

degloving injuries. The commonest management techniques for open degloving injuries at MTRH were debridement, primary closure, skin grafting, and muscle flap; while closed degloving injuries were managed either conservatively or through surgical drainage. It took approximately 19 hours from the time of injury to debridement and 5 days for grafting. The common early management complications for degloving injuries were local wound infection, graft failure, primary flap necrosis, and haemorrhage which were statistically associated with the pattern of degloving injury.

RECOMMENDATIONS

This study recommends that young male individuals should be empowered on the risks of degloving injuries and the applicable prevention and safety measures to help reduce their likelihood of being injured. Furthermore, the management of degloving injuries should be multidisciplinary and more studies should be conducted at different healthcare facilities to corroborate this study's findings.

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