Egypt, J. Plast. Reconstr. Surg., Vol. 46, No. 2, April: 149-154, 2022

The Versatility of Usage of Hydrosurgical Debridement in Major Burns

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ABSTRACT

Background: Burn wound debridement is an important step in management of major burns. There are several techniques of burn wound debridement include surgical, enzymatic, mechanical and autolytic. Hydrosurgical system is an additional type of debridement that preserve viable tissues, create smooth wound bed and decrease bacterial load.

Objective: This study compared the hydrosurgical debridement and traditional surgical methods of debridement of major burns.

Patients and Methods: This study is a prospective and comparative that compared traditional surgical debridement versus hydrosurgical debridement of major burns. This study was conducted between December 2020 to December 2021 at 2 major burn centers in Egypt (Burn unit of Ain Shams University Hospital and Armed Forces Burn Center at El Helmia Armed Forces Hospital).

Twenty patients with mixed depth of major burns were divided into two groups. In group I (n=10) debridement done surgically by Watson knife. In group II (n=10) debridement done by hydrosurgical system. Both groups were compared regarding intraoperative blood loos, blood component transfusion, mean number of sessions, mean duration of each session, healing time, risk of infection and Vancover scar scale.

Results: The current study showed that, the estimated blood loss, healing time, blood component transfusion and risk of infection were lower in group II than group I.

Key Words: *VERSAJET® – Burn debridement – Burn excision – Wound bed.*

Disclosure: The authors didn't receive any funds or grants regarding this work and has no issue to declare.

INTRODUCTION

Burn injuries are the fourth most common traumatic injury and cause an estimated 265000 deaths worldwide [1]. Management of burn patients includes several steps starting from the incidence of injury and may be lasting for years. Wound debridement is an initial step in burn management [2]. It can be made by different methods like enzymatic, autolytic, mechanical, biological and osmotic debridement [3]. It aims to remove the necrotic tissue, reduce the bacterial load, and convert the burn to acute wound that can accept skin graft [4]. However, this procedure can be painful and nonselective because it may remove healthy tissue. So, hydrosurgical debridement is an innovative tool based on jet of water and on the Venturi effect resulting from it, which is capable of removing the necrotic tissue by suction [5]. Moreover, it is a more selective and less painful procedure with shorter healing time, better tissue contouring and less intraoperative bleeding [3].

PATIENTS AND METHODS

This study is a prospective and comparative conducted between December 2020 to December 2021 at 2 major burn centers in Egypt (Burn Unit of Ain Shams University Hospital and Armed Forces Burn Center at El Helmia Armed Forces Hospital).

Ethical considerations: Consent was obtained from all participants. This study was approved from the research ethics committee of Faculty of Medicine, Ain Shams University.

Inclusion criteria: In this study, adults of both sex (18-45) years were included. Also, the study include mixed pattern burn with total body surface area (TBSA) (20-30%) of any burn etiology.

Exclusion criteria: Patients less than 18 years and more than 45 years were not included in the study. TBSA less than 20% or more than 30 were also excluded. Also, we exclude patients with comorbid disease.

Surgical intervention:

As regard protocol of burn centers that study take place in, debridement not exceed 10% per session and also early excision was followed at 48h after burn injury. In both group, debridement occurred under general anesthesia.

Participants in the study were divided blindly as follows:

- Group One (n=10) Knife based tangential excision group: In this group, debridement occur tangentially by Watson knife till an adequate bleeding surface was ensured.
- Group Two (n=10) Hydrosugical debridement group: In this group, debridement occurred by hydrosurgical system. Firstly, the device was checked to be sure that all the device pieces are intact. Single use of hand piece was confirmed. Solution used through the jet of device was adrenaline and sterile 9% saline (1: 500.000).

The number of sessions that each patient need was measured in both group. The following parameters were calculated in each session and compared in the two groups; type of intervention (either excision only or excision plus STSG), Mean Hb (gm/dl), Duration of each session (min.), Estimated blood loss (mL), Blood component transfusion, and vital data.

Coverage after debridement: When wound become ready, grafting occurred by using dermatome in both group. Grafts were meshed by mesher and (1.5: 1) fixation by staplers in all patients included in the study.

Post-operative period was divided into 2 phases:

Phase I (Healing phase) from burn trauma till complete wound healing: All surgical interventions were documented and analyzed regarding mean post operation HB, blood component transfusion (either not require or require less than 2 units or more than 2 units). Also, wound bed was followed up especially for signs of improvement and infection.

Phase II (scar phase) after complete wound healing: Healing time of each patient was measured in days and documented .Scar quality was noticed and compared between both groups using Vancover scar scale **[6]**.

Statistical analysis:

The quantitative data were presented as mean, standard deviations and ranges when parametric and median, inter-quartile range (IQR) when data found non-parametric. Also qualitative variables were presented as number and percentages. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the *p*-value was considered significant as the following: $p>0.05$: Non significant. $p<0.05$: Significant. $p<0.01$: Highly significant.

RESULTS

This study shows that there was no statistically significant difference found between group I and group II regarding age, sex, smoking and residence of the studied patients with *p*-value=0.190, 0.606, 1.000 and 0.639 respectively. There was no statistical difference between both groups regarding mode of burn and mean HB post-operative. Also, the study shows that there was no statistically significant difference found between group I and group II regarding depth of burn as the majority of burn included was mixed pattern. These data regarding demographic data and clinical data on admission was declared in the Table (1).

The study declared that there is significant reduction in the mean intraoperative time in hydrosurgical debridement group than knife based debridement group in first, second, third and more than third session by about 12.2min, 16.3min, 12.11min, 43.33min respectively (Fig. 1).

The study declared that there is significant reduction in the estimated blood loss in hydrosurgical debridement group than knife based debridement group in first, second, third and more than third session by about 98ml, 114.5ml, 147ml, 466.67ml respectively (Fig. 2).

As regarding blood transfusion, the study shows that in the first session only 10% of hydrosurgical group need blood transfusion however 60% of knife-based group need blood transfusion. In the second session, 10% of group II required blood transfusion and 60% of group I. In third session, blood transfusion was required to 17% of group II and 78% of group I. Patients that were proceeded to more than three sessions were only in knife based group with 100% required blood transfusion (Fig. 3).

In our study, the mean number of sessions in group I was higher than group II with *p*-value 0.002. During healing phase, the risk of infection was found higher in group I than group II with *p*-value 0.006. Healing time was measured in days and there was short healing time in group II than group I with *p*-value 0.008. Scar characteristic was measured according the Vancover scar scale which was lower as total scale in hydrosurgical group than knife based group. This data was illustrated in Table (2).

The following figure shows an example of group I and group II before and after healing (Fig. 4).

Table (1): Comparison between knife based surgical debridement group (group I) and hydrosurgical debridement group (group II) regarding demographic data and clinical data on admission.

	Group I No.=10	Group II No.=10	Test value	*p*-value	Sig.
Demographic data:					
Age (years):					
Mean ± SD	25.70±3.27	29.50±8.20	–1.362•	0.190	NS
Range	20-31	18-43			
Sex:					
Females	3 (30.0%)	2 (20.0%)	0.267*	0.606	NS
Males	7 (70.0%)	8 (80.0%)			
Smoking:					
No	6 (60.0%)	6 (60.0%)	0.000*	1.000	NS
Yes	4 (40.0%)	4 (40.0%)			
Residence:					
Rural	6 (60.0%)	7 (70.0%)	0.220*	0.639	NS
Urban	4 (40.0%)	3 (30.0%)			
Clinical data on admission:					
Depth:					
Mode of burn:					
Others	2 (20.0%)	1 (10.0%)	3.619*	0.164	NS
Flame	8 (80.0%)	6 (60.0%)			
Scald	0 (0.0%)	3 (30.0%)			
Suspected inhalational injury:					
Yes	3 (30.0%)	2 (20.0%)	0.267*	0.606	NS
No	7 (70.0%)	8 (80.0%)			
Extent (TBSA %):					
Mean ± SD	24.60±4.40	24.90±4.33	–0.154•	0.880	NS
Range	20-30	20-30			
Superficial dermal (%):					
Mean ± SD	10.50±5.23	11.70±6.20	–0.468	0.646	NS
Range	5-20	3-20			
Deep dermal (%):					
Mean ± SD	12.20±5.27	11.60±7.69	0.204	0.841	NS
Range	7-20	4-25			
Full thickness (%):					
Median (IQR)	1.90±1.20	1.60±1.07	0.590	0.563	NS
Range	0-3	0-3			
Mixed pattern:					
SD + DD:					
Mean ± SD	21.50±4.53	22.40±4.55	–0.443•	0.663	NS
Range	16-28	15-28			
DD + FT:					
Mean±SD	14.70±4.79	13.20±8.07	0.506•	0.619	NS
Range	10-22	5-27			
Mean Hb (gm/dl):					
Overall	14.40±1.05	14.85±1.25	–0.873•	0.394	NS
Males	14.78±0.99	14.94±1.37	0.242•	0.813	NS
Females	13.50±0.50	14.50±0.71	1.897•	0.154	NS

p-value >0.05: Non significant.
p-value <0.05: Significant.
p-value <0.01: Highly significant.

*: Chi-square test.
•: Independent *t*-test.
≠: Mann-Whitney test

SD: Superficial dermal.
DD: Deep dermal.
FT: Full thickness.

Table (2): Comparison between group I and group II regarding mean number of sessions, data of healing phase and scar phase.

	Group I	Group II	Test value	*p*-value	Sig.
No. of session:					
Mean ± SD	3.20±0.63	2.20±0.63	3.536	0.002	HS
Range	2-4	1-3			
Healing phase:					
Infection:	3 (30.0%)	9 (90.0%)	7.500*	0.006	HS
No	7 (70.0%)	1 (10.0%)			
Yes					
Scar phase:					
Healing time (days):					
Mean ± SD	54.10±6.06	43.90±8.90	2.995•	0.008	HS
Range	40-60	33-58			
Total Vancover score:					
Mean ± SD	10.60±0.52	5.50±1.18	12.534•	0.000	HS
Range	10-11	3-7			

p-value >0.05: Non significant.
p-value <0.05: Significant.
p-value <0.01: Highly significant.

*: Chi-square test.
•: Independent *t*-test.

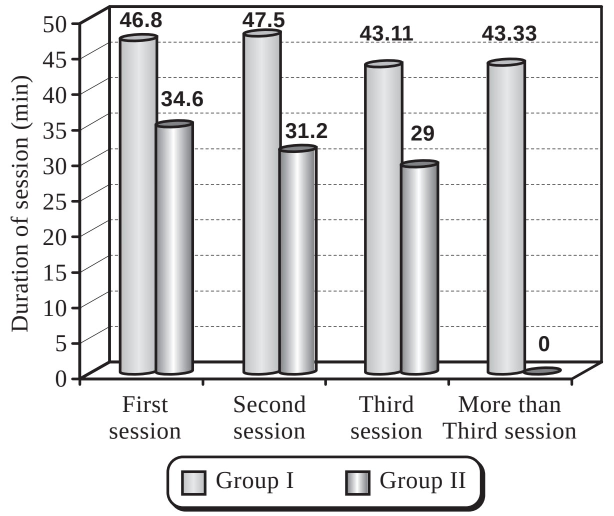


Fig. (1): Comparison between group I (knife based debridement) and group II (Hydrosurgical debridement) regarding duration of sessions.

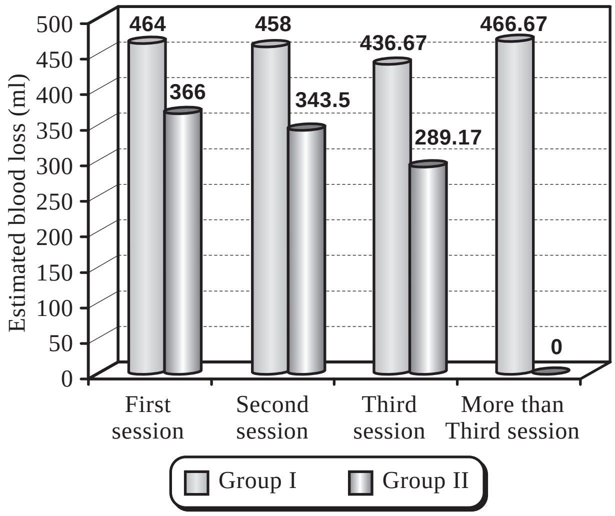


Fig. (2): Comparison between group I (knife based debridement) and group II (Hydrosurgical debridement) regarding estimated blood loss in each session

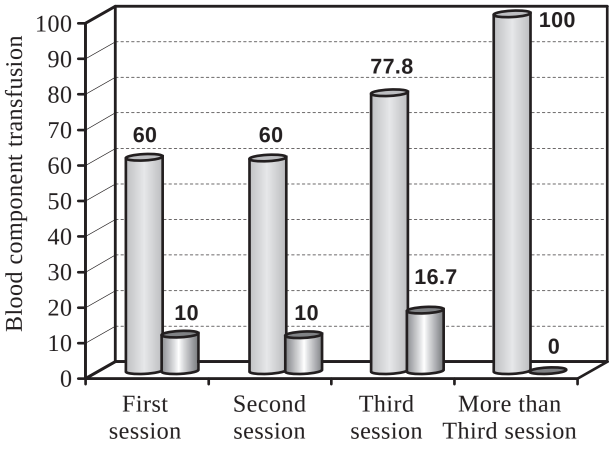
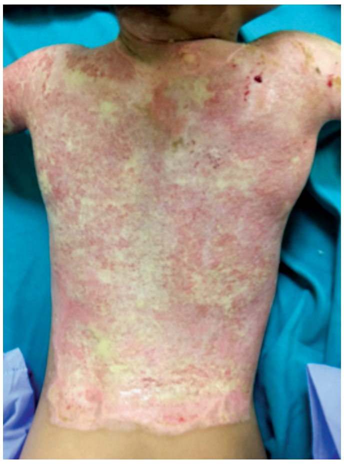
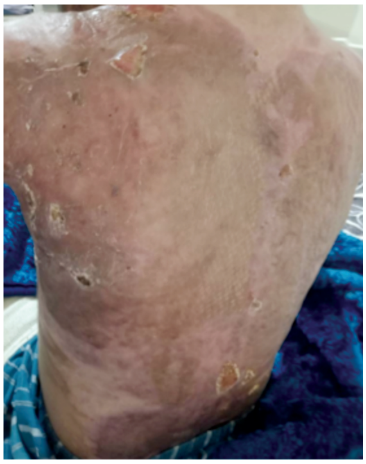


Fig. (3): Comparison between group I (knife based debridement) and group II (Hydrosurgical debridement) regarding blood transfusion.

(A)  (B) 

A case of hydrosurgical debridement by VERSAJET®.

(C)  (D) 

A case of traditional debridement by Watson knife.

Fig. (4): (A) Mixed pattern burn in back. (B) Late follow-up, grafts were taken completely after debridement by VERSAJET® hydrosurgery device. (C) Mixed pattern bun in both lower limbs pre-operatively. (D) Late follow-up after debridement tangentially by Watson knife.

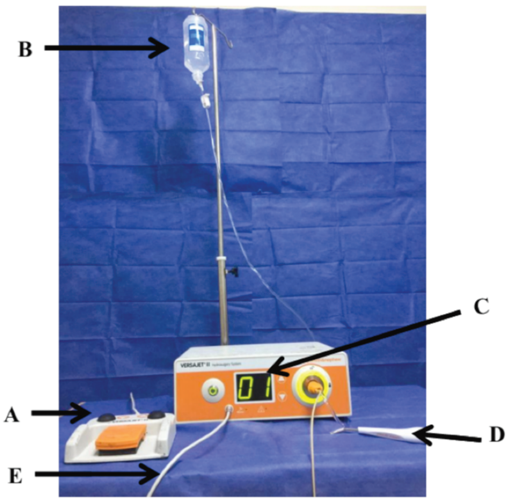


Fig. (5): VERSAJET® hydrosurgery device.

(A) Multifunction foot switch (surgical command of power up/down and jet on/off), (B) Adrenaline: Sterile 0.9% saline (1:500000), (C) LED window (clear view of power setting), (D) Handpiece (through it high velocity water flow), (E) Electricity source.

DISCUSSION

This study is comparative between the 2 groups revealed; highly significant decrease in number of sessions, duration of operation, and intra-operative blood loss and blood transfusion, in hydrosurgical debridement group compared to traditional debridement group. Which came in agreement with Hirokawa and his colleague **[7]** and Choi and his colleague **[8]**.

In this study we noticed a decrease in intraoperative blood loss due to the selectivity of hydrosurgery system to necrotic tissues only so the healthy tissues were spared during the hydrosurgical debridement in contrast to knife based technique.

Another advantage of hydrosurgical debridement is the shorter intraoperative time and this may be explained by the easiness to start and to use the device. Lower volume of blood loss and faster hemostasis in group II can be considered a reason for short intraoperative time than group I.

As regard healing time, this study between the 2 groups revealed; highly significant decrease in healing time, in hydrosurgical debridement group; compared to traditional debridement group ($p<$ 0.01). This result came in agreement with Yim and his colleague **[9]**, Bekara and his colleague **[10]** and Hirokawa and his colleague **[7]**.

Low risk of infection and short healing time of burned area of group II was explained by Hirokawa and his colleague **[7]** who reported that, the relatively early wound healing that followed hydrosurgical debridement was undoubtedly the result of the relatively shallow inflammatory cell infiltration, the relatively high vascular endothelial cell count and the relatively thin reactive fibrotic tissue that formed at the wound surface **[7]**.

Regarding healing time, our study does not supported by Bekara and his colleague **[10]**. They reported non significant shortening of wound healing time with hydrosurgery compared to traditional techniques **[10]**.

In another comparative study, Versajet® group showed higher incidence of graft taking than knife based group. Operative time of this study was insignificant **[11]**.

Limitations:

This study is limited by the small number of participant and needs to be applied on large scale.

Conclusion:

The current study showed that hydrosurgery system could represent an alternative to conventional surgical debridement in major burns. hydrosurgery system is better than knife based surgical debridement regarding estimated blood loss, duration of each session, healing time and risk of infection.

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