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Original Article

Hemoglobin Changes After Debridement in Burn Patients

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Abstract

Background: Sharp surgical debridement is important for burn injuries, but it causes blood loss and hemoglobin decline. The patient might require blood transfusion.

Objective: The primary aim was to quantify hemoglobin change after debridement in burn patients. Secondary aim was to estimate the effect of independent variables on hemoglobin change.

Methods: This prospective cohort study with 41 burn patients was on hemoglobin changes after debridement in a single hospital. The independent variables were debridement percentage, total body surface area, blood transfusion, age and gender.

Results: Median hemoglobin change was -1.60 g/dl (IQR -2.05 to -1.15) and blood transfusion occurred in 19.5% of procedures. Multiple linear regression analysis identified the percentage of debridement as the only independent predictor of hemoglobin change. Total Body Surface Area and age were not statistically significant predictors. Greater debridement was associated with greater hemoglobin decline.

Conclusions: Hemoglobin change depends on the amount of debridement.

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1. Introduction:

Burn injuries have complex pathophysiological changes, such as fluid shifts, inflammation, decreased erythropoiesis, infection and anemia. Early capillary permeability causes hemoconcentration, later catabolism and hemodilution cause hemoglobin (Hb) decline [1–4]. Sharp surgical debridement removes burn necrotic tissue, but it leads to hemoglobin decline. We may need blood transfusion, but blood transfusion practices are different between hospitals and blood transfusion thresholds are not clear [5]. International guidelines use patient blood management

(PBM) in order to standardize blood transfusion practice [6]. Most studies worked on tumescence, adrenalin, tranexamic acid (TXA) and enzymatic debridement [7–13], but few studies measured hemoglobin change (Δ Hb) after debridement in burn patients. Local studies support this complex condition and we need a better perioperative care: low hemoglobin has higher mortality in burn [14], amniotic membrane dressings improved wound care [15] and frequent Methicillin-resistant *Staphylococcus aureus* (MRSA) infection [16] and complex reconstructive procedures [17]. In perioperative care, no data describe hemoglobin change (Δ Hb) after

debridement in burn patients and identify related factors of this change. The aim of this study is to measure hemoglobin change after debridement, and to identify the relation of hemoglobin change (Δ Hb) with TBSA (Total Body Surface Area), debridement %, age, gender (male or female) and blood transfusion.

2. Materials and Methods:

Design and Setting

This prospective observational cohort study was in Sulaimani Hospital for Burn, Reconstructive and Plastic Surgery / Emergency. The hospital serves 2 million people.

Participants and Surgical Procedure

Surgical operations were between 3 December 2024 and 22 April 2025. Inclusion criteria were: first debridement, deep second or third-degree burns, requiring operative debridement, Hb measurements were 24 hours before and after procedure. Exclusion criteria were: unrelated bleeding, anticoagulants or hematologic disease. Written informed consent was signed by patients or their legal guardians. All 41 patients were anonymized and analyzed. We did not calculate the sample size; this exploratory study was to examine effect sizes for future multicenter studies. Topical adrenalin (1:1,000,000) was used in all procedures. We had normal vital signs and normal urine output (standard intraoperative care). Blood transfusion decisions were by intraoperative assessment of blood loss. Hemoglobin measured 24 hours before and

after operation; in all measurements, variation was ≤ 1 hour.

Statistical Analysis and Variables

We used descriptive statistics, group comparisons (Mann–Whitney U test, Fisher's exact test, Wilcoxon signed-rank test), correlation and regression analyses as needed for Hb change. Significance was two sided $p < 0.05$. Data were analyzed by SPSS v25. Effect sizes were by odds ratio with 95% confidence intervals, rank-biserial r for Mann-Whitney U test, Pearson (r), Spearman (ρ) coefficients, standardized coefficients (β), R^2 and adjusted R^2 . The same laboratory analyzer (Swelab Alfa) was used for all Hb assays according to institutional laboratory plans and quality controls.

Primary outcome was hemoglobin change. Other variables were: debridement (%) and TBSA (Total Body Surface Area) were estimated by using Lund and Browder chart. blood transfusion, age and gender (male or female).

Ethical approval: Ethical approval was by the Internal Ethics Committee (No. 25; 23 October 2024), and the Research Ethics Committee of the Sulaimani General Health Directorate (No. 21572). The study was in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration.

3. Results:

Introduction of Age, Gender, Hemoglobin Change (Δ Hb), TBSA and Debridement

Table 1. Comparison between transfused (n=8) and non-transfused (n=33) procedures

Variable	Total (n=41)	Non-Transfusion	Transfusion	P-value
Age (years)	23.0 [15.0, 39.0]	24.0 [14.5, 41.0]	19 [15.3, 25.5]	0.66
Male, n (%)	17 (41.5)	16 (48.5)	1 (12.5)	0.110*
Preoperative Hb	10.9 [10.6, 11.8]	11.0 [10.6, 12.1]	10.9 [10.5, 11.4]	0.71
TBSA	40.0 [20.5, 53.0]	35.0 [16.3, 54.5]	46.5 [42.3, 53.0]	0.165
Debridement	19.0 [10.5, 25.0]	18.0 [9.0, 25.0]	25.0 [20.3, 29.5]	0.24

* Fisher's Exact Test: 2 cells with expected count < 5 ; minimum expected count = 3.32.

All p-values are for Mann-Whitney U test except gender which is Fisher's Exact Test. TBSA = total body surface area; Q1 = 25th

percentile; Q3 = 75th percentile. We used median [Q1, Q3] for all of our continuous variables because our data were not normally

distributed (Shapiro-Wilk test). Comparisons had very small effect sizes for age (rank-biserial correlation $r = 0.10$, $p = 0.66$), preoperative Hb ($r = 0.09$, $p = 0.71$) and Δ Hb ($r = 0.11$, $p = 0.66$); TBSA had a small effect size but this was not statistically significant (r

$= 0.32$, $p = 0.165$). Odds ratio for gender (OR= 6.59; 95% CI: 0.73–59.68) was not statistically meaningful because confidence interval (CI) crossed unity (one). Hemoglobin Change (Δ Hb)

Table 2. Median and Interquartile Range (IQR).

Variable	Median	IQR (25th–75th Percentile) *
Preoperative Hemoglobin (g/dl)	10.90	(10.60 to 11.80)
Postoperative Hemoglobin (g/dl)	9.20	(8.90 to 10.65)
Hemoglobin Change (Δ Hb) (g/dl)	-1.60	(-2.05 to -1.15)

* IQR = Interquartile Range; Δ Hb from pre- and post-operative hemoglobin values.

Postoperative hemoglobin level decreased in all of the 41 patients. This difference was statistically significant (Wilcoxon signed-rank

test: $Z = -5.582$, $p < 0.001$). The effect size was huge ($r = 0.872$). Hemoglobin Change (Δ Hb) and Blood Transfusion

Table 3. Hemoglobin Change (Δ Hb) and Blood Transfusion.

Blood Transfusion	median [Q1 to Q3]	Mean \pm SD*
Yes (n= 8)	-1.75 [-2.03 to -1.18]	-1.70 \pm 0.69
No (n= 33)	-1.60 [-2.15 to -1.10]	-1.62 \pm 0.82

* Mean \pm Standard deviation.

This difference is not statistically significant (Mann-Whitney U Test: $U = 118.00$, $Z = -0.462$, $p = 0.663$; rank-biserial $r = 0.11$), and the effect size is very small (negligible).

Hemoglobin Change (Δ Hb) Without Blood Transfusion (Sensitivity Analyses)

After removing patients who have blood transfusion: hemoglobin change was -1.60 g/dl (IQR -2.15 to -1.10); preoperative hemoglobin level was (median: 11.0 g/dl [IQR 10.6–12.1]); postoperative hemoglobin level was (median: 9.5 g/dl [IQR 8.9–10.8]); Wilcoxon signed-rank test: $Z = -5.015$, $p < 0.001$, $r = 0.87$, $n = 33$. Results were similar to the full cohort. The difference was statistically significant, and the effect size was huge.

Therefore, hemoglobin change (Δ Hb) was independent of blood transfusion. Pearson correlation analysis showed a significant moderate negative association ($r = -0.433$, $p = 0.012$) between size of debridement and hemoglobin change (Δ Hb). Assumptions for parametric correlation were evaluated. Data were normally distributed (Shapiro-Wilk tests: $p > 0.05$). Linearity and homoscedasticity (no funnel shape or fanning) were visually confirmed (Figure 1). The greater debridement leads to a greater decline of postoperative hemoglobin level. These findings were similar to non-parametric analysis (Spearman's $\rho = -0.427$, $p = 0.013$).

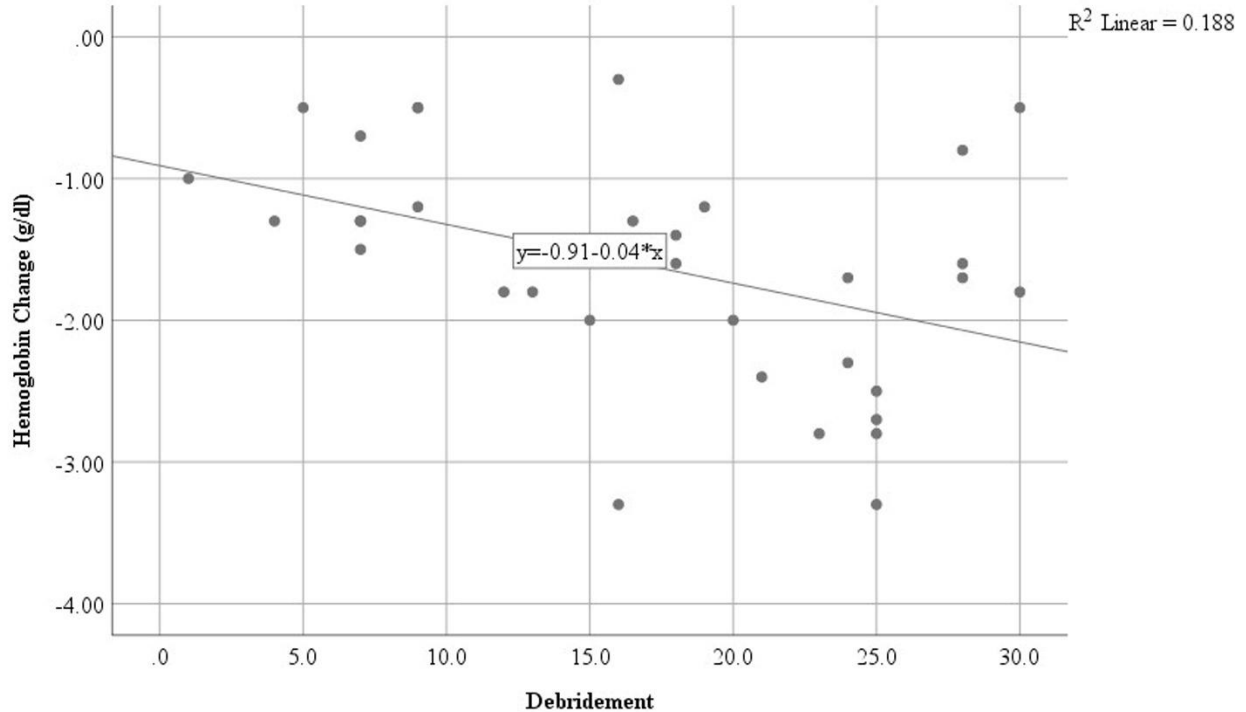


Figure 1. Scatter diagram shows relationship between percentage of debridement and hemoglobin change (Δ Hb). According to coefficient of determination ($R^2 = 0.188$), debridement accounts for 19% of variance in hemoglobin change (Δ Hb). N = 33.

Regression Analysis: Factors Linked to Hemoglobin Change (Δ Hb) After Debridement

Multiple linear regression analysis of predictors of hemoglobin change (Δ Hb) after sharp surgical debridement (n = 41) was statistically significant, with 20% of the variance explained (adjusted coefficient of determination [adjusted R^2] = 0.20; $F(3, 37) = 4.38$, $p = 0.010$).

A greater percentage of debridement was independently associated with greater hemoglobin decline: each 1% increase predicted a 0.057 g/dl greater decline ($B = -0.057$, 95% CI: -0.095 to -0.020 ; $\beta = -0.63$; $p = 0.004$). TBSA ($p = 0.212$) and age ($p = 0.094$) were not statistically significant predictors (Table 4). None of multiple linear regression assumptions were violated: residuals were normally distributed (Shapiro-Wilk test: $p = 0.558$), homoscedastic and independent (Durbin-Watson = 2.184). Collinearity diagnostics indicated no serious multicollinearity (all VIF < 2.1). Influential outliers were not observed (maximum Cook's D = 0.20). The sample size was acceptable (n = 41).

Table 4. Multiple Linear Regression Predicting Hemoglobin Change (Δ Hb)

Predictor	B (95% CI)	β	p	VIF
(Constant)	-1.27 (-1.93 to -0.61)	—	<0.001	—
Age, per year	0.012 (-0.002 to 0.027)	0.25	0.094	1.04
TBSA, per 1%	0.010 (-0.006 to 0.025)	0.26	0.212	2.09
Debridement, per 1%	-0.057 (-0.095 to -0.020)	-0.63	0.004	2.08

Δ Hb refers to the change in hemoglobin concentration. B = unstandardized coefficient; β = standardized coefficient. VIF = variance inflation factor. P = p-value. N= 41.

4. Discussion:

Implications: Our median hemoglobin decline of -1.60 g/dl (IQR -2.05 to -1.15) after debridement is similar to Slabber et al.'s mean decline of -1.2 g/dl, which is within our interquartile range [18]. Statistically, percentage of debridement was the only independent factor of hemoglobin change ($B = -0.057$ g/dl per 1%, $p = 0.004$). TBSA and age

were not statistically significant. To our knowledge, this is one of the few studies specifically reporting quantitative Hb change after debridement in a Middle Eastern burn population, and this appears to be the first multiple linear regression analysis that could identify percentage of debridement as the only independent factor of hemoglobin change (Δ Hb). Preoperative hemoglobin level was

more than 10 g/dl (median 10.9 g/dl [IQR 10.6 to 11.8]); the difference between patients with and without blood transfusion was not statistically significant ($p = 0.71$). Therefore, the 19.5% blood transfusion rate might reflect the intraoperative estimation of blood loss.

Limitations: A single-center prospective cohort design with 41 patients decreases external validity (generalizability). Statistically, the small blood transfusion subgroup ($n=8$) decreases power for comparison. Variations in surgical wound care might affect outcomes [19]. Standardized intraoperative care (normal vital signs and urine output) minimized fluid-related confounding of hemoglobin change (ΔHb), and this is similar to PBM (patient blood management) program [20]. We did not have estimated blood loss (EBL). Time interval between preoperative and postoperative hemoglobin measurement might change results. We did not record preoperative hemoglobin threshold triggering blood transfusion (before our Hb measurement). Topical adrenalin (1:1,000,000) was used in all procedures, which might affect ΔHb uniformly.

Potential Impact: Debridement percentage predicts hemoglobin change. Using percentage of debridement, surgeons can expect blood loss preoperatively. Therefore, this study might improve perioperative care and support standardized PBM [20,21]. To support these findings, we need multicenter studies with larger sample sizes, e.g., the TRIBE (Transfusion Requirement in Burn Care Evaluation) [22].

5. Conclusion: Sharp surgical debridement of burn wounds is associated with a median hemoglobin change (ΔHb) of -1.60 g/dl (IQR -2.05 to -1.15). In this study, total body surface area (TBSA) and age were not statistically significant factors. The percentage of sharp surgical debridement was statistically the only independent factor associated with

hemoglobin change (ΔHb). These findings support procedure-specific perioperative planning.

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Conflict of interest: The authors declare that there are no conflicts of interest related to this work.

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