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BURN

EFFECTIVENESS OF TUMESCENT IN REDUCING BLOOD LOSS IN TANGENTIAL EXCISION FOR ADULT BURN PATIENTS: A SYSTEMATIC REVIEW

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ABSTRACT

Introduction: T Tangential excision is a standard surgical approach for managing deep burns, yet it often results in considerable intraoperative blood loss. This can lead to increased transfusion needs and a higher risk of postoperative complications. Among the strategies developed to minimize bleeding, tumescent infiltration—using diluted vasoconstrictors such as epinephrine—has gained interest due to its affordability, simplicity, and applicability in resource-limited settings.
Method: This systematic review followed PRISMA 2020 guidelines. Literature searches were conducted in CENTRAL, MEDLINE (via PubMed), Scopus, and EBSCOhost. Included studies comprised randomized controlled trials, cohort studies, and case series assessing the impact of tumescent infiltration on intraoperative blood loss in adult patients undergoing tangential excision. Extracted data included study design, patient demographics, burn characteristics, surgical techniques, and outcomes related to blood loss and transfusion. Risk of bias was assessed using RoB 2.0 and ROBINS-I tools.
Results: Seven studies were included for qualitative synthesis, most of which were cohort designs involving patients with full-thickness burns covering 1–50% of Total Body Surface Area (TBSA). The use of tumescent infiltration—commonly employing epinephrine concentration between 1:500.000 until 1:2.000.000 dilution—consistently demonstrated reduced intraoperative blood loss compared to conventional techniques such as adrenaline-soaked gauze. The degree of blood loss reduction varied across studies, influenced by TBSA, unit used, surgical methods, and infiltration protocols.
Conclusion: Tumescent infiltration using epinephrine is an effective and safe method for reducing intraoperative bleeding in adult burn patients undergoing tangential excision even though there are differences in measurement of bleeding and tumescent concentration. Further multicenter cohort studies with standardized blood loss measurements are needed to confirm these findings and support wider adoption.

***Keywords**: Tumescent infiltration; Tangential excision; Burn surgery; Blood loss reduction*

Latar Belakang: Eksisi tangensial merupakan pendekatan bedah standar dalam tata laksana luka bakar dalam, namun prosedur ini kerap menimbulkan kehilangan darah intraoperatif yang signifikan. Kondisi tersebut dapat meningkatkan kebutuhan transfusi serta risiko komplikasi pascaoperasi. Di antara berbagai strategi untuk meminimalkan perdarahan, teknik infiltrasi tumesen dengan penggunaan vasokonstriktor terlarut seperti epinefrin semakin mendapat perhatian karena bersifat ekonomis, sederhana, dan dapat diaplikasikan pada fasilitas dengan sumber daya terbatas.
Metode: Tinjauan sistematis ini disusun sesuai pedoman PRISMA 2020. Penelusuran literatur dilakukan pada basis data CENTRAL, MEDLINE melalui PubMed, Scopus, dan EBSCOhost. Studi yang diikutsertakan meliputi uji klinis teracak, studi kohort, serta seri kasus yang mengevaluasi dampak infiltrasi tumesen terhadap kehilangan darah intraoperatif pada pasien dewasa yang menjalani eksisi tangensial. Data yang diekstraksi mencakup desain penelitian, karakteristik demografis pasien, karakteristik luka bakar, teknik pembedahan, serta luaran terkait kehilangan darah dan kebutuhan transfusi. Risiko bias dinilai menggunakan instrumen RoB 2.0 dan ROBINS-I.
Hasil: Sebanyak tujuh studi dimasukkan dalam sintesis kualitatif, sebagian besar merupakan studi kohort pada pasien dengan luka bakar derajat penuh yang melibatkan 1–50 persen Total Body Surface Area (TBSA). Penggunaan infiltrasi tumesen, umumnya dengan konsentrasi epinefrin antara 1:500.000 hingga 1:2.000.000, secara konsisten menunjukkan penurunan kehilangan darah intraoperatif dibandingkan teknik konvensional seperti penggunaan kasa yang direndam adrenalin. Besarnya reduksi perdarahan bervariasi antar studi, dipengaruhi oleh luas TBSA, satuan pengukuran yang digunakan, metode bedah, serta protokol infiltrasi.
Kesimpulan: Infiltrasi tumesen menggunakan epinefrin merupakan metode yang efektif dan aman untuk menurunkan perdarahan intraoperatif pada pasien dewasa dengan luka bakar yang menjalani eksisi tangensial,

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meskipun terdapat variasi dalam metode pengukuran perdarahan dan konsentrasi tumesen. Diperlukan studi kohort multisenter dengan standarisasi pengukuran kehilangan darah guna memperkuat temuan ini dan mendukung implementasi yang lebih luas.

Kata Kunci: *Infiltrasi tumesen; Eksisi tangensial; bedah luka bakar; Reduksi kehilangan darah.*

Conflicts of Interest Statement:
The authors listed in this manuscript declare the absence of any conflict of interest on the subject matter or materials discussed.

INTRODUCTION

Burn injuries are a persistent global health burden, with an estimated 8 million cases and over 100,000 deaths reported annually.[1] Mortality remains disproportionately high in developing countries, with Southeast Asia recording rates as high as 11.6 deaths per 100,000 population.[2] Effective burn care requires prompt and strategic management, particularly during the surgical debridement phase, where procedures like tangential excision are pivotal in removing devitalized tissue.[3] However, this surgical method is often associated with significant intraoperative hemorrhage, increasing transfusion requirements and potentially worsening patient outcomes. Blood loss during tangential excision can range widely and correlates with the extent of excised TBSA. Various strategies to mitigate bleeding include use of tourniquets, topical vasoconstrictors, electrocautery, and the more recently adopted tumescent infiltration technique.[4,5]

Tumescent infiltration involves subcutaneous injection of diluted vasoconstrictors, typically epinehphrine, in warmed saline, achieving vasoconstriction and tissue hydrodissection.[6,7] This low-cost, widely applicable technique has gained attention for its feasibility and efficacy. The objective of this study is to systematically evaluate the effectiveness of tumescent infiltration in reducing intraoperative blood loss during tangential excision in adult burn patients.

METHOD

Study Design and Search Strategy

A systematic review was conducted in 2025 at the Department of Surgery, Faculty of Medicine, Universitas Indonesia. The review followed PRISMA 2020 guidelines. Searches were performed on CENTRAL, MEDLINE (PubMed), Scopus, and EBSCOhost databases using combinations of keywords related to "burn injury", "tangential excision", "blood loss", and "tumescent infiltration".

Inclusion Criteria

Studies were included if they were clinical studies involving adult patients with thermal burns undergoing tangential excision in which tumescent infiltration was applied intraoperatively. Eligible study designs included randomized controlled trials (RCTs), non-randomized clinical studies, cohort studies, and case series. Studies were excluded if tumescent solution was administered only pre- or postoperatively, if the population consisted of pediatric, chemical, electrical, or inhalation burn cases, or if the studies did not report intraoperative blood loss as an outcome.

Study Selection and Data Extraction

Two independent reviewers screened titles, abstracts, and full texts. Extracted data included study design, demographics, burn characteristics, surgical technique, tumescent formulation, blood loss volume, transfusion need, and adverse effects.

Risk of Bias Assessment

Risk of bias in RCTs was assessed using Cochrane RoB 2.0, and ROBINS-I for non-randomized studiesd.

RESULTS

Study Selection

From 100 initial records, 22 duplicates were removed. After screening titles and abstracts, 10 articles were reviewed in full text, with 7 studies ultimately included for qualitative synthesis. (Figure 1)

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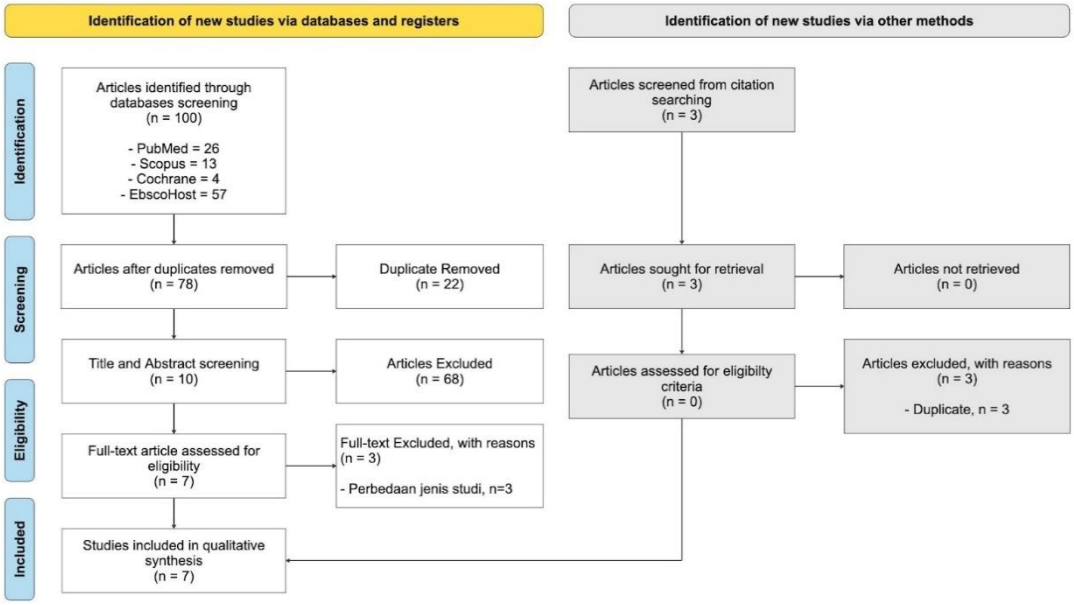

Figure 1. PRISMA flowchart

Study Characteristics

The included studies were mostly cohort designs involving full-thickness burns with TBSA from 1–50%. Tumescent infiltration used epinephrine in dilutions ranging from 1:500,000 to 1:2,000,000. Control groups varied from adrenaline-soaked gauze to standard excision methods. Infiltration protocols and blood loss measurement methods differed across studies (Table 1).

Effectiveness of Tumescent Infiltration

All included studies reported reduced intraoperative bleeding with tumescent infiltration. Gomez et al. reported a statistically significant decrease in transfusion volume (7.9±11.5 ml vs. 15.7±12.9 ml; p=0.031) compared to adrenaline gauze. Fujita et al. recorded a mean blood loss of 0.27±0.25 g/cm², while Robertson et al. found 0.37±0.2 cc/cm² using the tumescent technique. Cartotto et al. reported a blood loss of 123 ± 106 ml per % TBSA in the tumescent group

Table 1. Study Characteristic.

Author (Year)	Location	Study Design	Population	Age (Median; min–max / Mean ± SD)	Burn Depth	Burn Area (% TBSA)	Burn Type
Janezič et al. (1997)	Slovenia	Retrospective cohort	43	55 (15–82)	Mostly full thickness	1–20	Thermal
Gomez et al. (2001)	Canada	Retrospective cohort	30 (18) Traditional (n=15) Tumescent (n=15)	Intervention: 45 ± 19 Control: 49 ± 18	Full and partial thickness	30.2 ± 14.4	Thermal
Cartotto et al. (2000)	Canada	Retrospective cohort	35	59.7 ± 20.8 (35–82)	II–III	Intervention: 21% ± 15% Control: 19% ± 14%	N/A
Djurickovic et al. (2001)	United States	Prospective cohort	44 procedures	43 ± 18	N/A	9.8 ± 3.3	N/A
Fujita et al. (2008)	Japan	Prospective cohort	10	59.7 ± 20.8	N/A	18.9 ± 15.6 BSA	Thermal
Robertson et al. (2001)	United States	Prospective cohort	20	45 ± 10	Full thickness	33 ± 19	Thermal
Gumus, N (2011)	Türkiye	Prospective cohort	17 patients	7–41	Full thickness	3–35%	Thermal

versus 211 ± 166 ml in controls, alongside a

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reduced transfusion requirement (0.1 ± 0.3 units vs. 3.3 ± 3.1 units).

Janežič et al. noted a strong linear correlation between TBSA and blood loss ($R^2 = 0.57$; $p < 0.001$), reinforcing the efficacy of tumescent in minimizing bleeding. Gumus et al. also confirmed the technique's safety even in high TBSA cases using epinephrine-lidocaine mixtures. No significant cardiovascular side effects were observed. Differences in infiltration volume and administration technique also contributed to outcome variability, with doses ranging from 0.7 mL/kg/1% TBSA to over 1450 mL. Despite variation in blood loss assessment—ranging from visual estimates to hemoglobin-based formulas—all studies converged on the benefit of tumescent in blood conservation.

DISCUSSION

This systematic review demonstrates that tumescent infiltration using epinephrine significantly reduces intraoperative blood loss during tangential excision in adult burn patients. The technique's primary mechanism of action is localized vasoconstriction, which reduces capillary bleeding and improves visualization during excision. Infiltrated fluid also causes hydrodissection, allowing for easier separation of necrotic and viable tissue with reduced trauma.[8,9]

Studies included in this review employed different epinephrine concentrations, most commonly 1:1,000,000, and varied in administration volumes and techniques. Despite this heterogeneity, consistent findings were reported regarding reduced transfusion needs and intraoperative blood loss. Tumescent infiltration did not prolong operative time and in some cases was associated with shorter durations due to better surgical fields.[10,11]

Fujita et al. and Robertson et al. noted that the effective dose, time to onset of vasoconstriction (approximately 10–15 minutes post-injection), and infiltration depth all played important roles in maximizing the benefits of tumescent. Furthermore, Robertson et al. applied hemoglobin-based formulas to quantify blood loss, which yielded consistent and accurate estimates across procedures.[12]

Adverse effects were minimal. Janežič et al. observed only mild cardiovascular events, while Gumus et al. and Cartotto et al. found no clinically significant complications, even in patients with pre-existing cardiac conditions. The mixture of epinephrine and lidocaine also offered the advantage of prolonged postoperative analgesia.[13]

While some studies suggested tourniquets provided superior bleeding control in distal extremities, tumescent's flexibility makes it more suitable for anatomically sensitive areas such as the torso, neck, or buttocks. Moreover, cost-effectiveness and feasibility in rural or resource-constrained environments further elevate its clinical value.

This review is limited by the heterogeneity in study design, infiltration techniques, and outcome measurement tools. Standardized protocols for epinephrine concentration, injection volume, and blood loss measurement are necessary to enhance future research and enable meta-analytical comparisons. Nonetheless, this systematic review consolidates strong qualitative evidence supporting tumescent infiltration as a valuable technique in modern burn surgery.

CONCLUSION

Tumescent infiltration using diluted epinephrine is a safe and effective technique for minimizing blood loss during tangential excision in adult burn patients. Its simplicity, low cost, and adaptability make it particularly valuable in low-resource settings. Further high-quality studies are needed to establish standardized practice guidelines.

The included studies were mostly cohort designs involving full-thickness burns with TBSA from 1–50%. Tumescent infiltration used epinephrine in dilutions ranging from 1:500,000 to 1:2,000,000. Control groups varied from adrenaline-soaked gauze to standard excision methods. Infiltration protocols and blood loss measurement methods differed across studies.

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