

## TUMESCENT INFILTRATION OF LIDOCAINE AND ADRENALINE FOR BURN SURGERY

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**SUMMARY.** Tumescent infiltration is a widely used type of regional anaesthesia for cutaneous surgery. This technique makes it possible to administer high doses of lidocaine and adrenaline within the safety limits, leading to reduction in pain and bleeding during the operation. In this study, tumescent infiltration of lidocaine and adrenaline was used in routine procedures of burn surgery such as escharectomy, debridement, tangential excision, and skin grafting. In 17 patients with scald and flame burns, tumescent infiltration was performed prior to surgical procedures under either general anaesthesia or intravenous sedation. After 15 minutes, escharectomy, debridement of necrotic tissues, tangential excision of the burned skin, removal of the granulation tissue, and harvesting of the skin graft were performed. No complications occurred. All vital signs remained within safety limits during the operations. Haemorrhage was minimal and the operations were thus performed easily and rapidly. During removal of granulation tissue, very little blood loss occurred so that both the excision of granulation tissue and skin grafting were accomplished rapidly because of the minimal need of severe haemostasis. The duration of surgery was considerably reduced. No haematoma or bruising developed after surgery. No blood transfusions were required as the decline in haematocrit levels was not more than 3%. Post-operative analgesia was excellent for the first 8 h, eliminating the need of additional measures. Tumescent infiltration of adrenaline and lidocaine is a simple, effective and safe technique which facilitates anaesthesia in large areas of the burned body surface and leads to less bleeding and easy surgical dissection and hydrodissection, allowing fast, easy and painless burn surgery.

**Keywords:** tumescent, burn, lidocaine, anaesthesia, sedation

### Introduction

The tumescent technique involves the injection of large volumes of dilute local anaesthetic such as lidocaine or bupivacaine, with or without adrenaline solution, into subcutaneous fat, obtaining swelling and firmness (tumescent) of the surgical area and also creating regional anaesthesia of the skin and subcutaneous tissue that allows cutaneous surgery without pain. In particular, in cutaneous surgery, this procedure has some specific advantages, e.g. anaesthetization of large areas of body surface, low incidence of bleeding, and prolonged post-operative analgesia. It also facilitates surgical dissection and reduces post-operative swelling and bruising.<sup>1,2</sup> Tumescent infiltration, which recently has gained widespread popularity, may therefore be considered a useful tool for local anaesthesia in cutaneous surgery, e.g. in liposuction, hair transplantation, excision of certain skin lesions, cervicofacial rhytidectomy, dermabrasion, and fat grafting.<sup>1-7</sup>

In this study, tumescent infiltration of lidocaine and adrenaline was used for routine burn surgery procedures,

including escharectomy, debridement, tangential excision, and skin grafting.

### Materials and methods

This study included 17 patients, eleven with scald burns and six with flame burns. The youngest patient was seven years old and the oldest patient was 41. Nine patients were under the age 15. The median age was 18,4 yr. Eleven patients were female and six male. The patients were admitted to our hospital 1 to 19 days after their injury and there were thus various burn wound patterns, depending on the time of injury - each one required a specific surgical approach (*Figs. 1a, 2a, 3a*). The initial examination revealed superficial burns in six of the patients, and it seemed feasible to allow the wounds to achieve spontaneous epithelialization. In the other 11 patients the skin was severely damaged and required surgery, such as escharectomy, debridement, tangential excision, and skin grafting more than once until healing was accomplished. The total body surface area (TBSA) burned ranged from

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**Fig. 1a** - Full-thickness burn eschar, the result of a road accident, during delivery of tumescent solution via a fine cannula. The tumescent solution administered under the necrosis facilitated elevation of the eschar with an action similar to that of hydrodissection.



**Fig. 1b** - View of wound immediately after excision of eschar. Note the bloodless surgical area, which permitted rapid completion of the operation (less than 10 min).



**Fig. 2a** - View of lower extremity skin necrosis due to scald burn. Note the significant pallor around the margins of the wound after tumescent infiltration caused by adrenaline's vasoconstrictor action.



**Fig. 2b** - Same wound after debridement of necrotic tissue, showing decreased bleeding and significant pallor of wound surface where epithelium or fibrotic tissue was present.

3 to 35% (average, 19% TBSA). Patients who had either heart or kidney disease were not included in the study.

Electrocardiography, respiratory rate, blood pressure, and urine output were monitored throughout the entire operation by an anaesthesiologist. The patients' vital signs and state of consciousness were closely monitored. Pre- and post-operative haematocrit levels were measured in all patients in order to have an objective determination of blood loss during the surgical intervention - if it decreased by more than 28%, a blood transfusion was considered. The tumescent saline solution, consisting of lidocaine 0.05% and 1:1,000,000 epinephrine, was prepared in the

operating room just before the intervention. Pre-operatively, all patients necessarily received i.v. a prophylactic antibiotic (a first-generation cephalosporin) in order to prevent bacteraemia during the operation. The solution was heated to 37 °C, and a 3-mm incision was made in healthy skin adjacent to the burned area. A multiport infiltration cannula 2 mm in diameter was introduced into the subcutaneous fat under the wounds and donor sites for skin grafting. The injection was performed with a 50-ml syringe (*Fig. 1*) and the operation started after a delay of 15 min.

Escharectomy, debridement of the necrotic tissues, tan-



**Fig. 3a** - View of lower extremity skin defect after excision of the granulation tissue. Note the minimal bleeding from the burn wound and the skin graft donor site.



**Fig. 3b** - View of wound with skin graft.

genital excision of the burned skin, removal of granulation tissue, and harvesting of the skin graft were performed easily and rapidly with less bleeding than is usually the case (*Figs. 1b, 2b, 3b*). In patients with over 20% TBSA burned, surgical excisions were however performed only partially, while in patients with less than 20% complete excision was performed. This technique is not suitable for the fingers, toes, or penis. The maximum dose of lidocaine we used was 7 mg/kg; the amount of solution injected ranged from 200 to 1450 ml (mean amount, 345 ml). All but four patients were operated on under general anaesthesia. Three patients received ketamine anaesthesia and one underwent surgery with only i.v. sedation by fentanyl and midazolam.

An assessment was made in each case of intra-opera-

tive findings related to anaesthesia and bleeding, surgical advantages such as ease of dissection, and post-operative findings, such as the reduction of pain and of the requirement of blood transfusions and of patient care.

## Results

No complications occurred during the operations. All vital signs remained within safe limits. In selected patients with a smaller burned surface area, burns involving only layers of skin without extending to deeper structures such as bone or cartilage, non-infected burn wounds, and burns located on the trunk, back, abdomen, and the extremities, the tumescent infiltration technique proved to be suitable for performing surgical procedures under sedation without any need of general anaesthesia. Detailed data about the patients, surgery, and medications are presented in *Table I*.

**Table I** - Detailed information about patients, surgery, and medications administered

	Number	Range	Mean
Patients	17		
Age (yr)	-	7-41	18.4
Male	6		
Female	11		
Children	9		
Adult	8		
Type of burn			
Flame burns	6		
Scalds	11		
Operation time (min)		10-48	21
TBSA burned (percentage)		3-35	19
Volume of fluid (ml)		200-1450	345

Haemorrhage during the operations was minimal so that they were easy to perform. In particular, during the removal of granulation tissue, very little blood loss occurred so that excision of granulation tissue and skin grafting could both be completed rapidly because less haemostasis was needed (*Figs. 2b, 3b*).

Hydrodissection is an important method made possible by tumescent infiltration during surgery. It facilitates eschar separation without any bleeding (*Fig. 1b*). No haematomas or bruising developed after surgery. Any bruising caused by this technique can be assessed clearly around the skin graft donor sites and on the healthy skin of wound margins, but may be difficult to observe under an open wound.

As the difference between pre-operative and post-

operative haematocrit levels was no more than 3% and considering that haematocrit levels did not drop below 28%, blood transfusion was not used. Post-operative analgesia, especially in the first 8 h, was so satisfactory that no analgesic was required.

### **Discussion**

Tumescent anaesthesia is known as an easy and effective technique in cutaneous surgery. It is commonly used in liposuction, hair transplantation, scalp surgery, excision of skin lesions, cervicofacial rhytidectomy, dermabrasion, fat grafting, soft tissue reconstruction, and sentinel node biopsy of the axilla and groin. It has been used in various operations, e.g. mammoplasty, abdominoplasty, ambulatory phlebectomy, and flap surgery.<sup>1,4,6</sup> Although both the subcutaneous injection of dilute adrenaline and the tumescent infiltration of adrenaline alone has been widely utilized in burn surgery for the purpose of reducing intra-operative bleeding,<sup>8-11</sup> the use of tumescent infiltration with a combined solution of xylocaine and adrenaline in the surgical treatment of burns seems to be very limited and few studies report using the tumescent technique in burn surgery.<sup>1-7</sup> Apart from the bloodless area that is created, tumescent infiltration makes the surgery painless and easy for surgical dissection and also reduces post-operative swelling and bruising, which can facilitate burn surgery and the patient's post-operative follow-up. A large injection makes hydrodissection possible, provides an improved plane for dissection, and facilitates the rapid removal of necrotic tissue without bleeding in burn surgery. It has also been reported that lidocaine has an antibacterial effect which may be useful in burn wounds.<sup>12</sup>

Other effective alternatives for reducing bleeding following tangential excision, such as the application of adrenaline-soaked sponges, compression with an elastic bandage, and the use of tourniquets on extremities, are widely used in everyday burn surgery practice. However, although the application of adrenaline-soaked sponges causes vasoconstriction in the vessels, tumescent infiltration causes vasoconstriction prior to the excision, acting as a precaution against bleeding during surgery. The use of tourniquets on extremities is useful to prevent bleeding, but it is not suitable for use in other regions of the body and furthermore this technique results in significant rebound hyperaemia and bleeding after it is deflated.

Compression with an elastic bandage effectively reduces bleeding after surgery. In our own clinical practice, we have observed that before the use of the tumescent technique such patients needed blood transfusions much more than patients who are now given tumescent infiltration - patients with 10-15% or higher TBSA required a transfusion of at least one unit of blood to raise haematocrit levels after the surgical excision of wounds. Although

our study was not designed as a prospective comparative study, our past experience of burn surgery without the use of tumescent infiltration with xylocaine and adrenaline solution may offer a valid and objective comparison.

The tumescent technique has been clearly proved to be efficacious in reducing both intra- and post-operative bleeding, which is of vital importance in burn patients. Cardenas<sup>7</sup> presented the cases of 42 female patients treated with large-volume liposuction and extensive abdominoplasty after the use of tumescent infiltration. Although some extensive surgical procedures involving large areas were performed, only two patients required a transfusion after undergoing breast reduction in the same session. These results of limited blood loss after tumescent infiltration support our own experience of burn wound treatment. Bloodless surgical areas may however make it difficult in the tangential excision of burn wounds to distinguish necrotic tissue from vital skin because of the decreased punctate bleeding, resulting in unnecessarily deep excision of burned skin together with healthy tissue - but an experienced surgeon will overcome this problem without difficulty. While tumescent infiltration reduces post-operative bleeding, rebound hyperaemia may occur in some wounds, resulting in post-operative bleeding. The vasoconstrictor effect of adrenaline on subcutaneous tissue and the dressing over the wound limit any bleeding due to rebound hyperaemia through the effect by compression.

In a study of the surgical treatment of burns and post-burn sequelae in paediatric patients, Bussolin et al.<sup>13</sup> successfully utilized the tumescent infiltration of lidocaine and adrenaline under general anaesthesia, and then assessed the intra- and post-operative course, post-operative pain, and analgesic requirements. Also in this case the surgical advantages of this technique were clearly demonstrated, with bloodless, painless surgery allowing easy dissection. Their results were similar to ours but reflect outcomes related to children, with smaller burn wounds and post-burn sequelae.

With this technique, high-dose lidocaine up to 88 mg/kg can be administered within the safety limits without any signs of intoxication in liposuction patients.<sup>7,14,15</sup> Butterwick et al.<sup>14</sup> emphasized that lidocaine toxicity was directly correlated to plasma levels. Non-specific subjective symptoms of lidocaine toxicity occur between plasma levels 3.0 and 6.0 µg/ml, whereas objective signs, such as unconsciousness, seizures, coma, respiratory arrest, and cardiovascular depression, may occur between plasma levels 5.0 and 9.0 µg/ml. This last study documented the safety of a total lidocaine dose of 58,2 mg/kg with plasma levels of 0,5 µg/ml. The American Society of Dermatologic Surgery defines the maximum safe dose of lidocaine as 55 mg/kg.<sup>15</sup> In the present study, the maximum dose of lidocaine did not exceed 7 mg/kg in order to avoid its toxic effect, as lidocaine blood concentration was not measured.

In the medical literature a dose of lidocaine for the tumescent technique is recommended in liposuction surgery. We have not found any similar studies regarding lidocaine doses in burn surgery. In liposuction, retrieval of part of the injected solution is possible. However, in burn surgery, it is impossible to retrieve the solution except for the excised tissue containing some tumescent solution - the entire amount of lidocaine administered remains in the body and, at high doses, lidocaine intoxication can be seen. The safe dose of lidocaine 7 mg/kg was therefore preferred for

tumescent infiltration.

### Conclusion

Tumescent infiltration of adrenaline and lidocaine is a simple, effective and safe technique which not only simplifies anaesthesia in large areas of the burned body surface but also leads to decreased bleeding, easy surgical dissection and hydrodissection, and reduced bruising, thus making burn surgery rapid and easy.

**RÉSUMÉ. L'INFILTRATION TUMESCENTE DE LIDOCAÏNE ET ADRÉNALINE DANS LE TRAITEMENT CHIRURGICAL DES BRÛLURES.** L'infiltration tumescente est une méthode chirurgicale largement utilisée dans la chirurgie cutanée pour obtenir l'anesthésie régionale. Avec cette technique, il est possible d'administrer aux patients des doses élevées de lidocaïne et d'adrénaline, toujours dans les limites de la sécurité, et conséquemment de réduire la douleur et le saignement pendant l'opération. Dans cette étude, nous avons utilisé l'infiltration tumescente avant une intervention sous anesthésie générale ou sédation intraveineuse. Après 15 minutes, nous avons effectué l'escarrectomie, le débridement des tissus nécrosés, l'excision tangentielle de la peau brûlée, l'élimination des tissus morts et la récolte du tissu de granulation. Aucune complication n'est survenue. Tous les signes vitaux sont restés dans les limites de sécurité pendant les opérations. L'hémorragie était donc minime et les opérations ont été effectuées facilement et rapidement. Au cours de l'ablation du tissu de granulation, la perte de sang a été minime et l'excision du tissu de granulation et la greffe cutanée ont été effectuées rapidement en raison de la nécessité minimale d'une hémostase marquée - la durée de l'opération chirurgicale a été considérablement réduite. Après l'intervention chirurgicale, il n'y a eu aucun cas d'hématome ni d'ecchymose et aucune transfusion sanguine n'a été nécessaire puisque les niveaux de la réduction de l'hématocrite n'ont pas excédé le 3%. L'analgésie postopératoire a été excellente pour les 8 premières heures, ce qui a éliminé la nécessité de mesures supplémentaires. L'infiltration tumescente d'adrénaline et de lidocaïne est une technique simple, efficace et sûre qui permet l'anesthésie dans de grandes zones de la surface corporelle brûlée et cause une réduction du saignement, facilitant la dissection chirurgicale et l'hydrodissection et réduisant la tuméfaction et les ecchymoses postopératoires. Tout cela conduit à une opération chirurgicale facile, rapide et indolore.

**Mots-clés:** tumescent, brûlure, lidocaïne, anesthésie, sédation

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