THE USE OF ESMARCH EXSANGUINATION FOR THE TREATMENT OF EXTREMITY WOUND BURNS

Aballay A.M., Recio P., Slater H., Goldfarb I.W., Tolchin E., Papasavas P., Caushaj P.F.

Department of Surgery, The Western Pennsylvania Hospital Burn Trauma Unit, Clinical Campus, Temple University School of Medicine, Pittsburgh, Pennsylvania, USA

SUMMARY. Tourniquets are routinely used during the excising and grafting of burn wounds located on the limbs in order to decrease blood loss. It has been postulated that the exsanguination of extremities by using Esmarch bandages might further reduce blood loss. However, there are concerns about a decrease in graft quality when Esmarch bandages are applied. The purpose of this prospective, double-blinded randomized study was to compare Esmarch application in addition to tourniquet (exsanguinated extremities) with the application of tourniquet alone. Thirty-eight excisions of bilateral extremity wounds were performed. Both limbs were tangentially excised after tourniquet application with one limb randomly chosen for prior Esmarch exsanguination. Blood loss was estimated during this procedure. Graft take was assessed twice: on post-operative days 3 and 7. The burn surface area and total area grafted were equivalent in the extremities with Esmarch bandages when compared to the extremities without them. Total blood loss was less in the extremities where Esmarch was applied. Graft take was similar in the two groups. Statistical analysis was performed with a two-tailed paired T-test. It is concluded that the use of Esmarch exsanguination in addition to tourniquet further reduces blood loss without affecting the quality of the engraftment.

Introduction

Tangential excision and grafting of burn wounds result in considerable blood loss. This may lead to blood transfusions, which are associated with various risks. The quality of skin grafts when tourniquets are applied to the extremities has been evaluated in previous publications. Esmarch exsanguination is a technique which has proved to be effective in decreasing blood flow to the extremities. It is relatively simple and inexpensive, and is widely used in other surgical procedures.

Our initial experience with excising and grafting exsanguinated limbs occurred many years ago. There were incidences when the excision did not go deep enough and the grafts failed because they were placed on nonviable tissue. We then abandoned the exsanguination technique and began to use a tourniquet on an unexsanguinated limb to limit bleeding and to allow us to have a better sense of tissue viability during excision and grafting operations. The technique of excising and grafting an unexsanguinated limb was successful and as we gained experience we decided to again try the use of tourniquet and exsanguination of the limb with the use of an Esmarch elastic bandage.

As with any technique used during burn surgery that limits blood flow to the extremity, there are concerns about the adequacy of the depth of the excision, since the expected small vessel bleeding that is used as guidance is not present. This may lead to the placement of grafts on devitalized tissue and an unsuccessful engraftment.

With the purpose of limiting blood loss, we prospectively evaluated the application of Esmarch bandages on patients who presented with bilateral extremity burns. Our hypothesis is that Esmarch exsanguinations on extremity burn wounds further decrease blood loss without affecting the quality of the engraftment.

Methods

Thirty-eight consecutive patients with bilateral extremity burn wounds of the upper or lower extremity were included in the study. The execution of the study was approved by the Institutional Review Board.

At the time of the surgery, the extremities were randomized. One extremity was excised and grafted after the application of a tourniquet only. The other extremity underwent Esmarch exsanguination and then the application of a tourniquet.

The technique was performed in the following fashion. A tourniquet was placed on the proximal part of the extremity. Prior to application of the tourniquet, the extremity was wrapped at the tourniquet site with a soft gauze to prevent post-operative discomfort and skin bruising at the sites where the tourniquet might have pinched the unprotected skin.

The arm was then elevated to allow passive exsanguination, which occurs as the large veins are emptied into the more proximal circulation. Then a 5” Esmarch was
applied systematically from the distal part of the extremity (hand/foot) to the cuff.

The methodical application of the Esmarch required an assistant to hold the arm properly in the upright position.

Once the Esmarch was applied, the distal cuff was inflated to 250 mm Hg to complete the exsanguination of the extremity. The Esmarch was then unwrapped. At this point, the tangential excision of the extremities took place until uniform small vessel bleeding was obtained.

The rest of the surgical procedure was the same for both extremities: a synthetic film, Omiderm™ (ITG Medev), was applied to the excised areas and then sprayed with thrombin solution. Then epinephrine-soaked gauze (1:1000 concentration) was used to wrap the extremities, and pressure was applied over the wound. At this point, split-thickness skin grafts were harvested and meshed 1.5:1.

After applying pressure for 15 min to the excised surface, the gauze and Omiderm were removed. If bleeding was present it was controlled with further pressure or, rarely, electrocautery. The donor skin was grafted and dressings were applied. Two qualified observers estimated the blood loss (the attending surgeon present during the procedure and the staff anaesthesiologist). This method has been validated previously and is an acceptable tool to determine blood loss in burn wounds. The observers were blinded as regards which extremity had Esmarch bandages applied. Other parameters recorded were the area of extremity burn (percentage total body surface area [TBSA]) and cm² excised/grafted.

The quality of the skin graft and the percentage of graft take were assessed twice - first, at the time of the first dressing change by a senior staff surgeon (post-operative day 3), and then it was assessed again at the initial office follow-up or, if in the hospital, on post-operative day 7 (also by a senior staff surgeon). The observer was also blinded as to which extremity had Esmarch bandages applied during surgery. The primary endpoints evaluated were blood loss and quality of graft take. The statistical analysis was performed using a two-tailed paired t-test.

**Results**

Thirty-eight patients undergoing bilateral excision and grafting of the extremities were included in the study. The sex distribution was 32 males and 6 females. The mean age was 36.2 yr (range, 19 to 63). The TBSA percentage burned had a mean of 20% (SD, 9.4%; range, 8 to 34%).

The average tourniquet application time was 32 min. The upper extremities were more commonly affected (24 times for upper extremities versus 14 for lower extremities). Randomization resulted in twenty-six applications of Esmarch and tourniquet for the right extremity versus 12 for the left extremity. Of all the patients, only four required transfusions while in the operating room. These four patients had a TBSA greater than 20%.

On further analysis, the percentage of surface area burned on the extremities was found to be on average 6.1% (range, 3 to 8%) for the extremities with Esmarch and tourniquet versus 6.4% (range, 4 to 8%) for those with tourniquet alone. There was no significant difference between these results (Table I).

With regard to the area excised and grafted, this was on average 1202 cm² (range, 650 to 1450) for tourniquet alone versus 1168 cm² (range, 700 to 1550) for the combination of tourniquet and Esmarch. Again, there was no significant difference between these two.

The estimated blood loss had a mean of 70 cc per unit of area excised (range, 25 to 200) for patients in whom Esmarch exsanguination was performed, while the mean was 110 cc per unit of area excised (range, 70 to 250) for patients in whom only a tourniquet was applied. The difference between these two groups reached a significant level (Table I).

At the time of assessing graft take, no significant difference was found, either during the initial dressing change (97% graft take with Esmarch against 98% without it) or at the initial office visit (95% graft take with Esmarch versus 96% without Esmarch).

**Discussion and conclusion**

The findings are similar to those of previous studies. These showed that applying tourniquets to the extremities, in addition to thrombin and epinephrine, limited the amount of blood loss.

The main concern as regards the addition of Esmarch exsanguinations to tourniquets was that the limiting of blood flow to the extremity would minimize capillary bleeding, which is usually the objective sign used by surgeons to distinguish viable from nonviable tissue. Applying a skin graft over a nonviable area would lead to loss
of the skin graft.

There was no need for re-debridement or re-excision in any of the patients. It is important to point out that the extensive experience of the surgeons involved during these operations may have played a role in the good results obtained. We do not recommend the use of Esmarch by inexperienced surgeons, since inadequate excising can lead to poor-quality skin grafts.

Although a statistical significance was found with regard to blood loss between the two groups, the clinical significance of these findings remains to be established. For this purpose, a study comparing the need for blood transfusions after surgery in patients in whom Esmarch exsanguinations are used and in those in whom tourniquets are used alone would be important to assess the clinical impact of using this technique.


BIBLIOGRAPHY