
The Use of Sheet Autografts to Cover Extensive Burns in Patients

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We previously have reported on the enhanced cosmetic and functional outcome with the use of sheet autografts. The recent goal has been to cover larger surface areas with sheet grafts, or for patients with larger burns, covering the hands and face with sheet grafts, if possible. To evaluate the use of sheet grafts in burns of more than 30% total body surface area (TBSA), the percentage covered with sheet and meshed autograft was reviewed in 105 patients admitted between January 1, 1990, and August 30, 1994. Results were that 18 patients (17%), with a mean of 44.3% TBSA burns, had all of their full-thickness wounds (mean, $36.5\% \pm 2.2\%$; range, 20% to 55.5%) covered with sheet grafts (Group 1). Seventeen patients (16%), with mean burn size of 64.3%, had their wounds (mean, $35.1\% \pm 4.4\%$; range, 15% to 79%) covered solely with mesh graft (Group 2). The lower percentage covered by mesh alone was skewed by the high mortality rate (53%) in this group. Seventy patients, $58.4\% \pm 19\%$ (range, 30% to 92%) TBSA burn, had their full-thickness wounds covered with a combination of mesh and sheet graft (Group 3). In Group 3, the mean percentage of TBSA covered by sheet grafts was $15.0\% \pm 1.4\%$ (range, 1% to 42.5%) and that covered by meshed grafts was $39.4\% \pm 2.6\%$ (range, 4% to 93%). Three quarters (73%) of patients in this group had sheet grafts placed on the face, whereas 63% had them placed on the hands. Extremities and the trunk were more often grafted with mesh graft. Sheet grafts were the sole coverage in patients with burns up to 55.5%. With even larger burns, sheet grafts were used to cover the face and hands. Because of its superior cosmetic and functional outcome, sheet autografting should be considered for covering moderately sized burns. Sheet autografting should be considered for more important cosmetic and functional areas, such as the face and hands, for massive burns. (*J Burn Care Rehabil* 1998;19:33-8)

Hypertrophic scars and contractures are two of the most debilitating consequences of burn injury. Early excision and grafting reduces the local inflammatory response and leads to less scarring¹; however, scarring remains a serious problem. Several factors related to grafting, such as the extent of meshing, the use of sheet grafts, and graft thickness, clearly influence cosmetic and functional outcome. Petry² demonstrated that grafting full-thickness wounds in rabbits with meshed split-thickness grafts led to greater contraction than sheet grafts. The same decrease in wound contraction was found in patients whose burns were covered with sheet grafts.³ In small burns,

the improvement in cosmetic and functional outcomes with the use of sheet autografts instead of meshed grafts has been reported previously.⁴ In that study, patients who were treated with sheet grafts required pressure garments for less time (9.2 months for sheet grafts versus 15.2 months for mesh grafts; $p < 0.001$ by Student's *t* test) and had better cosmetic outcomes based on a rating scale performed by judges blinded to the purpose of the study.

Many burn surgeons avoid using sheet grafts, except in small burns, for several reasons. The use of a larger donor site is one reason given for not using sheet grafts. The belief is that one should not trade a larger donor site scar for a more cosmetic skin graft. Excessive scarring leading to significant cosmetic abnormalities has not been observed, however, especially when the back or scalp is used as a donor site.⁵ Others state that mesh grafts are much easier to apply and have less tendency to develop subgraft hematomas.

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Table 1. Demographics of the entire patient population

N	105
Age (mos) Mean (range)	75.6 (1-201)
Sex (M/F)	71/29
% TBSA Mean $\pm$ SEM, (range)	56.9 $\pm$ 1.6 (30-92)
% Full-thickness Mean $\pm$ SEM, (range)	50.5 $\pm$ 1.6 (27-91)
Length of stay (days)	58.3 $\pm$ 3.5 (6-255)
% Mortality rate	22

Although sheet grafts take a little more effort, the operative time is not prolonged, and the frequency of hematomas is not increased when compared to 1:1 mesh.⁴ The cosmetic results from the extra effort have produced very satisfying cosmetic and functional results when compared with meshed skin grafts.

Because of the encouraging results, sheet grafts are used now for the sole coverage of patients with larger burns. Even with extensive burns, the philosophy has been to cover functionally and cosmetically important areas such as the hands and face when sheet grafts could not be used to cover the entire burn. To evaluate sheet grafts in patients with larger burns, a retrospective review of the use of sheet grafts in patients with burns of more than 30% total body surface (TBSA) was performed.

METHODS

Study protocol. Pediatric patients with burns equal to or greater than 30% TBSA, who were admitted between January 1, 1990, and August 30, 1994, were included in the retrospective study. Burn diagrams from the time of admission and operative diagrams of grafted areas were reviewed. Demographic data including the age, percentage of TBSA burn, percentage of full-thickness burn, length of stay, and mortality rate were recorded. Operative diagrams indicating which anatomic areas receiving grafts were used for determination of the areas covered with sheet grafts or mesh grafts, or both. An estimate of graft loss was made by documenting areas that required re-grafting.

Patients were placed into one of three groups: Group 1—patients treated with sheet grafts only; Group 2—patients treated with mesh grafts only; and Group 3—patients treated with a combination of sheet and mesh grafts. The extent of graft coverage was determined with each group. A statistical analysis comparing the three groups was not performed because the purpose of the study was to demonstrate the capability of covering large burn wounds with sheet grafts. Patients treated with meshed grafts or the combination of sheet

and meshed grafts had larger burns that prohibited the sole use of sheet grafts.

Grafting protocol. At our institution, the burn wound usually is handled with staged procedures.⁶ For the first stage (excision stage), the burn wound is excised tangentially down to viable tissue (usually fat). The wound site is usually treated with subeschar Pitkin solution, consisting of lactated Ringier's solution containing 2 ml of 1:1000 epinephrine. The Pitkin is injected with a roller pump device that drives the fluid through an 18 gauge spinal needle. The Pitkin solution gives a uniform surface for excision, and the epinephrine decreases blood loss. Tourniquets are routinely used for excising extremities. The tourniquet is left inflated until completion of the excision and after placement of gauze dressings and elastic dressings. Except for damage to major vessels, little attention is paid to bleeding. For areas that are not amenable to the use of tourniquets, major bleeding sites are controlled with cautery, and the dressing is applied and held in place with elastic dressings, or stretchy cloth (spandex) is stapled over the dressing as a quick stent.

The second stage (grafting stage) is performed on the day after excision. The dressings from the previous day are removed and bleeding is controlled. Usually, bleeding subsides rapidly, with only larger vessels requiring cautery or ligation. The donor site is prepared by injection of subcutaneous Pitkin solution to give a firm surface for harvest. The Padgett electric dermatome (Padgett Instruments, Inc.) is used, harvesting split-thickness grafts at approximately 12 to 15/1000 of an inch for donor sites that will not have to be reharvested in the near future. Thinner grafts are used for patients with extensive burns that will require donor site reharvest. Grafts are held in place with staples and then covered with fine mesh gauze and saline-soaked gauze. Elastic dressings or a spandex stent are used to keep the dressings in place. Face grafts are left open, covered with bacitracin, and frequently checked for hematomas.

After surgery, grafts are irrigated with antimicrobial solutions every 2 hours. Strict bed rest for the patient is used with most large grafts. Sheet grafts are checked on day 1 after surgery. Smaller children are given subanesthetic doses of ketamine (2 to 4 mg/kg) intravenously or intramuscularly during the dressing changes. Routine sedation is used for older patients. Any collection of blood or serum under the graft is removed by making a nick in the graft and expressing the fluid. Occasionally, large hematomas are removed by lifting one side of the graft, removing

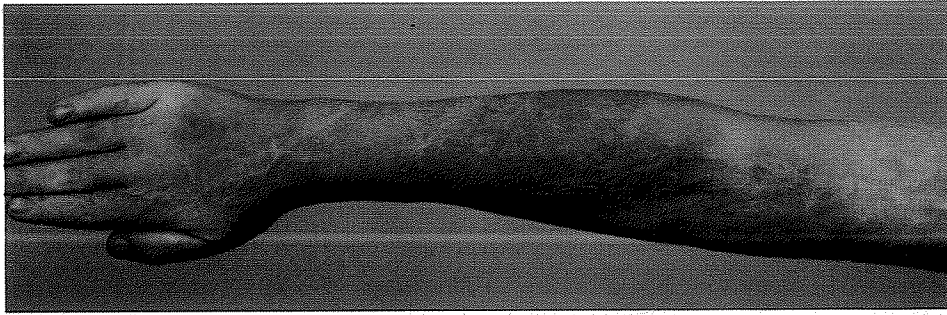


Figure 1. Sheet grafts on hand and forearm 2 years after placement on boy with burns to upper extremities, chest, and neck. Cosmetic appearance and function excellent.



Figure 2. Sheet grafts of chest, arms, and neck of same boy as in Figure 1.

the clot, and restapling the graft. The graft frequently can be saved if the clot is removed on day 1. On day 5, staples are removed and the patient is allowed to start therapy. Walking is started on day 5, except for grafts on the lower extremities, in which case walking is started on day 7. (Small lower leg grafts are occasionally treated with Unna's boots with immediate ambulation.) Pressure garments are usually fit 2 to 3 weeks after surgery.

Our philosophy for the treatment of very large burns is to excise expeditiously the entire burn wound (over 10 to 14 days). The first excision is started soon after burn shock. The hands, arms, and legs are usually the first site of grafting. Hands are covered with sheet grafts or at least a small mesh (with burns of more than 85% TBSA). Mesh

autograft is used on as much of the rest of the excised area as possible. Fresh allograft is then used to cover the remaining open areas. The rest of the full-thickness burns are excised and allografted in subsequent procedures over 2 weeks to eliminate the burn wound. Autograft is used to replace the allograft as donor sites heal. The postoperative care of mesh grafts is the same, except that the first dressing is performed on postoperative day 2.

RESULTS

A total of 105 patients, with a mean age of approximately 6 years, had their charts reviewed (Table 1). The mean burn size was 56.9% TBSA, and the mean full-thickness was 50.5%. For this study, full-

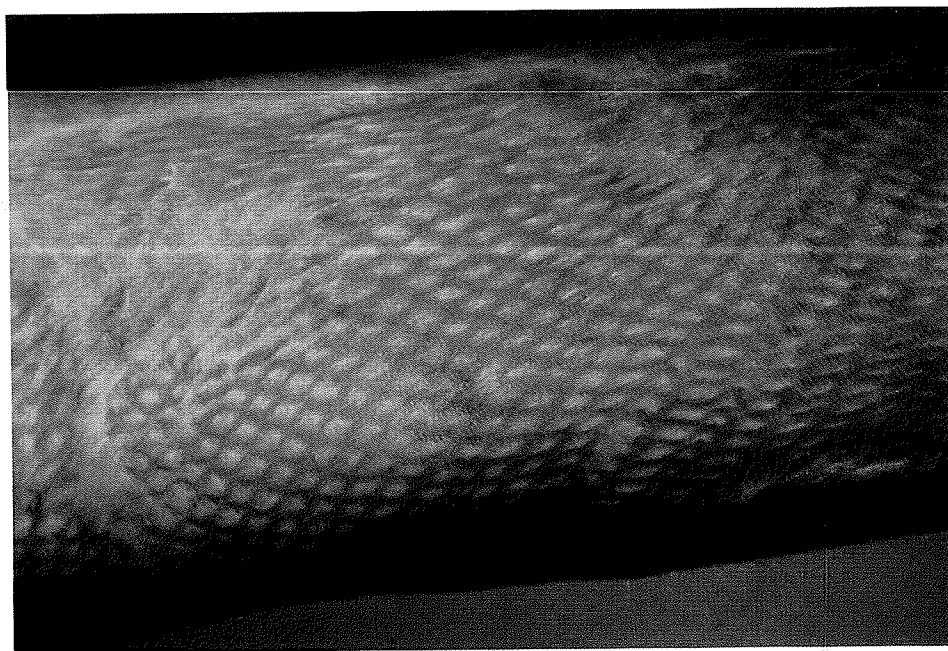


Figure 3. Forearm mesh graft visualized 2 years after placement reveals obvious mesh pattern.

Table 2. Burn size and percentage full-thickness (percentage grafted) of patients treated with sheet or mesh grafts, or both

	Group 1	Group 2	Group 3
	Sheet grafts	Mesh grafts	Sheet and mesh grafts
	18	17	70
% TBSA	44.3 $\pm$ 2.0 (34-63)	64.3 $\pm$ 4.3 (34.5-91)	58.4 $\pm$ 1.9 (30-92)
% Full-thickness	36.5 $\pm$ 2.2 (20-55.5)	35.1 $\pm$ 4.4 (15-79)	51.6 $\pm$ 1.9 (28-89)

Values shown as means $\pm$ SEM (range).

thickness burns were defined as burn areas that were grafted. The mean length of stay was 58 days, and there was a 22% mortality rate. Eighteen patients (17%) had their burns covered solely with sheet grafts (Group 1), whereas 17 patients (16%) had their burns covered using only mesh graft (Group 2). Seventy patients (67%) were covered using a combination of sheet and mesh grafts (Group 3) (Table 2). Less than five percent of either mesh graft or sheet graft required regrafting due to graft loss.

Group 1. Sheet grafts were used as the sole cover for 18 patients with a mean burn size of 44% TBSA (range, 34% to 63%). The area covered with sheet graft (percentage of full-thickness) ranged between 20% and 55.5% TBSA (mean, 36.5%). Sheet grafts in this patient population resulted in excellent functional and cosmetic outcomes. An example of a patient covered with sheet grafts covering his arms, hands, chest, and neck (Figures 1 and 2) reveal excel-

lent functional and cosmetic outcomes at 2 years. The major cosmetic and functional problems with the sheet grafts are the seams. Despite the markings of the seams, the grafts lack the typical fishnet pattern seen after mesh grafting and are considered cosmetically superior.

Group 2. Mesh grafts were used as the sole graft coverage in 17 patients (16%). As expected, this group of patients had a much larger burn size (64%; range, 34.5% to 91% TBSA) (Table 2). The area covered with mesh graft is artificially low (35% TBSA) because this group had a high mortality rate (53%). Mesh grafts also were used to cover areas of lesser functional and cosmetic importance and areas that had questions of wound viability and increased chance of contamination. The mesh pattern always persisted, despite having an otherwise excellent graft take (Figure 3).

Group 3. Most of the patients with burns of more than 30% TBSA had wounds covered with a combi-

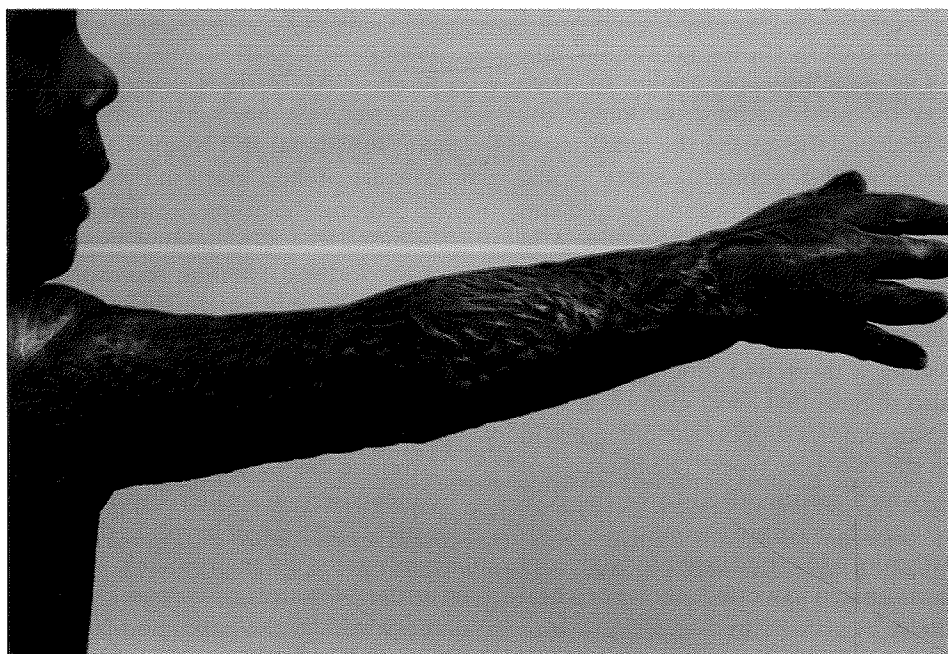


Figure 4. Two years after grafting, hand and lower face covered with sheet grafts (despite this girl sustaining 80% TBSA burns). Functional and cosmetic benefits obvious. Trunk and arm covered with 4:1 meshed autograft.

nation of sheet and mesh grafts. The philosophy is to cover the functionally and cosmetically important areas with sheet grafts, if possible, or at least use the smallest mesh. The face almost always was covered with sheet grafts, and the hands usually were covered with sheet grafts (Table 3). The trunk and extremities tended to be covered with a larger percentage of mesh grafts. For patients in this group, a mean of 15% of the burn was covered with sheet grafts, and a mean of 39.4% was covered with meshed grafts. Figure 4 shows the beneficial results of grafting in a child who survived a mostly full-thickness 80% TBSA burn. At 2 years, the lower face and hands, covered with sheet grafts, had excellent cosmetic and functional grafts. The arms and trunk were covered with 4:1 mesh. Despite the severity of the injury, there is a highly satisfactory outcome.

DISCUSSION

The development of the Tanner mesher was one of the great developments in burn care. Meshing of skin grafts allowed for a far greater ability to cover large areas of burn wounds and probably has been a significant contributor to improved burn survival. Although mesh grafts provide adequate coverage for burn wounds—and are often, in fact, lifesaving—they

Table 3. Mean percentage of TBSA covered with either sheet or mesh grafts on patients who were covered with a combination of sheet and mesh grafts

Anatomic distribution of grafts	Mesh	Sheet
Face	4	73
Hand	30	63
Upper extremity	67	44
Lower extremity	87	20
Trunk	81	37

have drawbacks. They lead to greater contracture of the wound as it heals, and they leave a pattern that is apparent for the patient's lifetime. The reasons for the persistent mesh pattern and the increase contracture are readily apparent. Two processes have to take place during the healing of a mesh graft. The normal adhesion, vascular ingrowth, and maturation phases of graft take occur only where the actual graft portion of the mesh adheres. Each interstice can be considered an individual wound that has to heal by secondary intent: by formation of an adequate granulation bed, contraction, and reepithelialization. The different forms of healing lead to different types of scar and thus lead to the permanent mesh pattern. The larger the mesh, the greater the wound that has to heal by

secondary intent. Deitch et al.⁷ demonstrated that the longer a wound stays open, the greater the tendency to scar. The same principle applies to mesh grafts. The larger the mesh pattern, the longer the wound takes to heal, and the greater the tendency to become hypertrophic and contract. Sheet grafts, which fully cover the wound, bring a more rapid end to the inflammatory phase, and lead to less scarring by allowing the wound to heal by a mechanism more closely related to primary closure. Clinical experience at our institution supports these findings; the previous results revealing a shortened time required for garment wear also suggest that sheet grafts heal with less scarring. In vitro studies support the difference in healing between the two graft types. The life cycle of myofibroblasts—which are theorized to be the cells responsible for contraction within a wound—is accelerated, and contracture is lessened in wounds covered with sheet grafts compared to wounds allowed to heal by secondary intent.⁸

The use of sheet grafts requires more vigilance in the operative and postoperative periods to ensure good results and to prevent graft loss. Attention to hemostasis usually minimizes postoperative hematomas. After surgery, early inspection of the sheet graft provides an opportunity to intervene if complications, such as accumulation of a hematoma, develop. If hematomas or seromas are evacuated by postoperative day 1 or 2, the graft will usually survive. The protocol is to check the graft on day 1. Hematomas lifting the entire graft have been evacuated on day 1 with excellent graft take. For face, neck, or chest grafts, the graft is usually left open and is frequently inspected for hematomas. The argument that sheet grafts require larger donor sites cannot be disputed, but no increase in donor site scarring has been noted, and there has not been a need for a greater number of procedures to cover sizeable areas. The improved functional and cosmetic outcomes for sheet grafts justify the extra effort of their application.

Clearly, not all patients can have their wounds covered solely with sheet grafts. To improve survival,

patients with burns larger than 50% TBSA usually need to have some or all of their wounds covered with mesh grafts. In these patients with extensive burns, however, one may want to consider covering important functional and cosmetic areas with sheet grafts. The use of sheet grafts in these areas does not appear to prolong the hospitalization of patients with severe burn injuries. The meshed areas are usually covered with clothing, whereas the exposed areas—the face and hands—are much more acceptable.

Previous work has shown that sheet grafts provide superior functional and cosmetic results for treating relatively small burns.⁴ This study demonstrates that sheet grafts may be used safely as the sole means of coverage on large burns—up to 55% TBSA. The benefits seen in smaller burns should be extended to patients with larger burns. In those patients for whom mesh grafts are unavoidable, sheet grafts should still be used for areas of cosmetic and functional importance such as the hands and face. The benefits seem worth the effort.

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