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Original Article

Staged excisions of moderate-sized burns compared with total excision with immediate autograft: an evaluation of two strategies

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Abstract: Background: Different surgical techniques have evolved since excision and autografting became the treatment of choice for deep burns in the 1970s. The treatment plan at the Burn Center, Linköping University Hospital, Sweden, has shifted from single-stage excision and immediate autografting to staged excisions and temporary cover with xenografts before autografting. The aim of this study was to find out if the change in policy resulted in extended duration of hospital stay/total body surface area burned (LOS/TBSA%). Methods: Retrospective clinical cohort including surgically-managed patients with burns of 15%-60% TBSA% within each treatment group. The first had early full excisions of deep dermal and full thickness burns and immediate autografts (1997-98), excision and immediate autograft group) and the second had staged excisions before final autografts using xenografts for temporary cover (2010-11, staged excision group). Results: The study included 57 patients with deep dermal and full-thickness burns, 28 of whom had excision and immediate autografting, and 29 of whom had staged excisions with xenografting before final autografting. Adjusted (LOS/TBSA%) was close to 1, and did not differ between groups. Mean operating time for the staged excision group was shorter and the excised area/operation was smaller. The total operating time/TBSA% did not differ between groups. Conclusion: Staged excisions with temporary cover did not affect adjusted LOS/TBSA% or total operating time. Staged excisions may be thought to be more expensive because of the cost of covering the wound between stages, but this needs to be further investigated as do the factors that predict long term outcome.

Keywords: Burn surgery, xenografts, moderate sized burns

Introduction

In 1983 Engrav [1] described the efficacy of early excision and immediate autografting for burns compared with the widely-used conservative management plan that was popular at the time. Since then most western centers have followed these principles, but with somewhat different approaches. The use of xenografts for temporary cover before final autografting was introduced after introduction of early excision of burns [2]. The aim was to have a better-prepared wound bed to reduce the number of failures and the need for repeated excisions, so saving time, donor sites, and resources. There is, however, a lack of current evidence about which is the best approach for combining excisions, grafting, and the use of xenografts [3].

The total excision and immediate autografting of burns was first implemented at our center in the 1990s having been inspired by Janzekovic [4] and Herndon [5]. The plan was later updated to the technique proposed by Still [2], in which early, staged excision was introduced after the year 2000, with the use of xenografts as temporary substitutes before autografting. It was claimed that this allowed more precise demarcation of burned areas, optimized the condition of the wound bed, and so reduced the rate of failed grafts, which in turn led to a shorter duration of hospital stay [2]. However, we know of few if any recent comparisons of the two regimens.

Herndon [5], with many other authors [6-8], have used mortality as an outcome indicator for new management principles. However, it is of

Table 1. Descriptive data of patients

	Excision and autograft group (n = 28)	Staged excision group (n = 29)
Age (years)	31.5 (9.0-55.0)	47.0 (10.0-80.0)*
Age groups		
0-18	9	4
19-60	17	15
> 60	2	10
Male	21	22
Female	7	7

Age is presented as median (10-90 centiles), and n, *P = 0.02.

limited use today because mortality in modern burn care is so low [9-11]. Duration of hospital stay reflects the time that the wound takes to heal, and is considered to be a method of assessment of the efficiency and quality of the burn service [12]. In the USA in the 80s, the consensus was that burn centers should be able to maintain at or below 1 day/total body surface area% (TBSA%) burned. Almost a decade later, a review of outcomes of burns from the predecessor of the National Burn Repository (NBR) (The American Burn Association's Patient Registry) by Saffle showed that the goal was being achieved [12]. This was later refined [13].

The aim of the present study was therefore to find out if adjusted LOS/TBSA% is shorter when staged excisions of burns is used with temporary cover with xenografts until final autografting. We compared a previous period during which immediate, total excision and autografting was used, with the present technique of staged excision with temporary cover followed by final autografting. The hypothesis was that the up-to-date technique would be better.

Methods

The study group included patients managed with either early full excision of burns and immediate autografting (excision and immediate autograft group) or staged excisions before final autografting using xenografts as temporary cover (staged excision group). To get clear differences in management plans and avoid overlap, patients were selected from the late 1990s (1997-98) and from more recent years 2010-11. All patients managed surgically with burns 15%-60% TBSA% within each period who needed excision of the burn were included. Patients who died were excluded from the analysis.

Apart from the difference in surgical technique, all patients were treated according to our standard protocol [14], with fluid management [15], early enteral nutrition, and laboratory assessment [16]. Ringer's acetate was used for fluid resuscitation in volumes according to the Parkland formula (4 ml × kg body weight × TBSA%), with adjustments for urine output [17].

On admission the severity of the burn was assessed by a surgeon whose clinical examination took account of the appearance, capillary refill, and sensory function of the burned areas, and data were recorded on a detailed Lund & Browder chart. The plastic surgeon was responsible for taking care of the burned wounds and an anesthetist took care of the general condition and nutritional state of the patient.

In the excision and immediate autograft group the patients were operated on within the first week after injury. Regardless of the TBSA%, the patient's burn was excised in one stage and an immediate meshed autograft was placed during the same session. If the graft failed the patient was re-operated on when a donor site was available. The autografts were taken down according to the protocol on day 5 after operation and the dressing changed three times per week.

In the staged excision group the burns were excised within the first week after injury. The excisions were done in stages with a maximum of 20% TBSA% taken per operation or a maximum of two hours' operating time. Burns were covered with a xenograft Ez-derm® (Molnlycke, Health Care AB, Gothenburg, Sweden), which were kept in place with biological glue (DERMABOND ADVANCED® Topical Skin Adhesive, Ethicon or Artiss® Baxter) or metal staples. The wounds were then covered with a nylon mesh, wrapped in normal sterile gauze, and elastic stockings or elastic bandages applied. The xenografts were inspected after two days, and lifted from the wound bed in case the burn had been deepened, in which case it was revised and either covered with a meshed autograft or a new xenograft to create a better wound bed. Autografts were taken down according to the protocol in the fifth postoperative day, and the dressing was changed three times per week.

Table 2. Description of the extension and depth of the burn

	Excision and immediate autograft group (n = 28)	Staged excision group (n = 29)	*P* value
TBSA%	28.3 (16.5-42.0)	26.0 (15.0-55.0)	0.69
Superficial and deep dermal BSA%	17.5 (1.5-35.0)	16.0 (1.0-33.3)	0.47
Full thickness burns%	5.5 (1.0-23.5)	14.0 (0.0-40.0)	0.57

Data are presented as median (10-90 centiles). TBSA% = percentage total body surface area burned. BSA% = percentage body surface area.

Table 3. Description of duration of hospital stay

	Excision and immediate autograft (n = 28)	Staged excision (n = 29)	*P* value
Duration of stay (days)	27.5 (14.0-57.0)	31.0 (16.0-76.0)	0.14
Duration of stay/TBSA%	1.0 (0.5-2.1)	1.1 (0.6-2.2)	0.18
Duration of stay/excised BSA%	1.2 (0.5-4.0)	1.7 (0.7-2.6)	0.30

Data are presented as median (10-90 centiles). TBSA% = percentage total body surface area burned. BSA% = percentage body surface area.

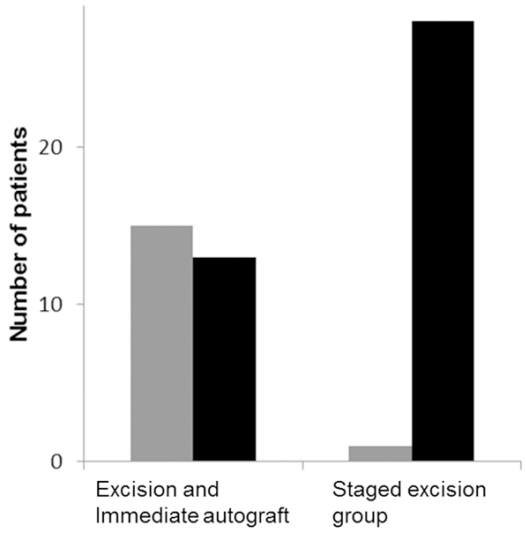

Figure 1. The distribution of patients according to number of operations in the two groups. Grey bars = patients who had one operation, black bars = patients who had two or more operations.

Data analysis and statistics

Variables were retrieved retrospectively from the local database [14] and the following were used in the study: LOS/TBSA% and LOS/excised TBSA%, total excised body surface area%, excised body surface area% per operation, total operating time, number of operations, TBSA% full thickness burn (%), age, and sex.

Data are presented as median (10-90 centiles) unless otherwise stated. The significances of differences between the groups were assessed using the Mann-Whitney *U* or the chi square test, as appropriate. Probabilities of value less than 0.05 were accepted as significant.

Results

We studied 57 patients, 28 in the excision and immediate autograft group, and 29 in the staged excision group. Median TBSA% was 27 (17-52), age 38 years (10-72), and duration of stay 30 days (14-63). Forty-three patients (75%) were male. The median number of operations/patient was 2 (1-9), and the staged excision group was older than the other group (**Table 1**). There was no significant differences in extension or depth of burns between the groups (**Table 2**).

The adjusted LOS/TBSA% did not differ between the groups, being close to 1 in both (**Table 3**).

When the staged management strategy was used most of the patients were operated on several times (**Figure 1**). The median number of operations/patient was higher in the staged group, as was the delay before the first autograft. The number of autograft operations was also larger in the staged group. However, the mean operating time was shorter in the staged group, as was the excised area/operation (**Table 4**). Among the subgroups with multiple operations the excised body surface area%/operation was also smaller in the staged group (**Figure 2**), though the total operating time/TBSA% did not differ between groups.

Discussion

This is the first study to our knowledge in which two surgical strategies for excision and grafting

Table 4. Description of operation related variables

	Excision and immediate autograft (n = 28)	Staged excision group (n = 29)	*P* value
Day of first operation	1.0 (0.0-5.0)	2.0 (0.0-7.0)	0.13
No of operations	1.0 (1.0-4.0)	4.0 (2.0-9.0)	< 0.000
First autograft (day)	1.0 (0.0-5.0)	6.0 (2.0-17.0)	< 0.000
No of autografts	1.0 (1.0-4.0)	3.0 (1.0-6.0)	0.004
Total operating time (minutes)	343 (140-993)	436 (148-1324)	0.38
Mean operating time (minutes)	214 (140-383)	135 (77-195)	< 0.000
Excised BSA%/operation	21.5 (7.5-32.0)	10.0 (0.0-18.0)	< 0.000
Total operating time/TBSA%*	12.3 (6.0-24.2)	13.3 (6.0-45.8)	0.61
Number of surgeons/operation	2.0 (2.0-4.0)	2.2 (1.5-3.6)	0.20

Data are presented as median (10-90 centiles). BSA% = percentage body surface area. *Total operation time/TBSA%* = minutes/TBSA%.

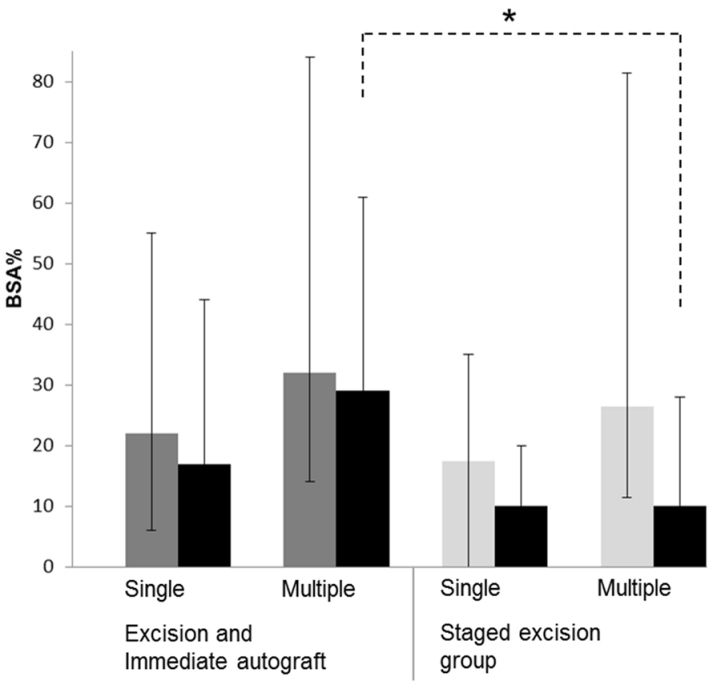

Figure 2. The difference in TBSA% (grey bars) and excised BSA% per operation (black bars) grouped by the patients who had one operation (single) or more (multiple) operations. Data are presented as median (10-90 centiles). *P < 0.001 between the excision and immediate autograft and the staged excision groups.

of moderate-sized burns have been compared. Both techniques are based on previously published work (early excision and autografting [1] and the staged approach as described by Still [2]). However, neither of these publications reported on both LOS/TBSA% and LOS/excised body surface area%.

The most important and surprising finding was that the staged excision technique did not, as we had thought, reduce the adjusted duration of stay as was anticipated based on the findings of the original publication by Still [5]. The number of repeat autografts, however, was (as anticipated) higher in the excision and immediate autograft group, which suggests a higher rate of failed grafts on a less than optimal wound bed. The gain using staged excision and grafting on an optimal wound bed did not, however, result in a corresponding reduced LOS/TBSA%, and the total operating time/TBSA% did not differ between groups though the extra cost of temporary covering material (xenografts) may reduce the cost-benefit of the latter technique. The only obvious gain of the staged procedure with temporary cover is the improvement in the working conditions of the operating staff as operating times are shorter.

As we have said previously, to our knowledge no comparison has been made between the effects of staged excision and temporary cover with the regular method of immediate excision and autografting. In the original publication by Still [5] (which advocated the technique) fewer stages were used in the control group during the first year. It may be claimed, therefore, that the support for this technique is weak. Another complicating factor is that a recent study by Engrav [13], which analyzed the surgical outcome, stated

that such an evaluation is more complex than previously thought because of the degree of heterogeneity usually seen among patients who require operation. In their paper the older dogma of 1 day LOS/TBSA% was questioned, as they found an extended duration of stay (about 2.5 days/TBSA%) among the patients being operated on. This was in contrast to those who were treated conservatively, whose duration of stay was close to 1.

Limitations of the study

This study has a number of important limitations. First, the number of cases in each group is limited and there are large differences between the groups despite the fact that they do not differ significantly. This we think is also a consequence of the slowly-changing epidemiology of burns in Sweden [18]. Secondly, the times compared are separated by several years. These times were chosen to make sure that the strategies were fully developed and implemented, and correspondingly significantly different. Thirdly, we did not make a comprehensive calculation of the costs and so the data are not conclusive, though we can be sure that the technique used during the second period is more expensive (increased cost of covering material) with no obvious advantages apart from the shorter operating time for each operation. Fourthly, an important point is the possibility of improving the LOS/TBSA% in the staged group by applying the first graft somewhat earlier. Fifthly, we did not assess any long-term follow-up data, such as quality of scar or any patient-reported outcome measure.

Strength of the investigation

The quality of the data may be claimed to be adequate as it is a case control study in one center after a distinct change in surgical policy, and the implementation time may be considered adequate as the change in policy was fully developed. Secondly, the data were prospectively recorded in a local registry. Thirdly, the uptake area for the study (a national unit) is relevant from a European perspective, and the techniques described are in accordance with published techniques. Finally, irrespective of the surgical technique used, the outcome data were favorable, in that LOS/TBSA% was below 2 as claimed by Engrave [13].

Conclusion

Contrary to our initial hypothesis, the excisions strategy in the staged group did not reduce the adjusted duration of stay. We also anticipated that the staged excisions and delayed autografting using temporary wound cover were more expensive. A way to shorten the adjusted duration of stay can by applying the first autograft earlier. The strength of these conclusions is, however, hampered by the limited number of observations made in this single center study. These findings suggest that further studies are warranted to examine the role of staged excision and delayed autografting using temporary wound cover.

Disclosure of conflict of interest

None.

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