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First do no harm: A patient-reported survey of split skin graft donor site morbidities following *thin* and *super-thin* graft harvest

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ABSTRACT

The split-thickness skin graft (STSG) donor site is the commonest used during burn surgery which has its own complications and as such the focus should be on minimizing it. Modifications to practice in our unit which we believe aid this include limiting the amount of STSG taken and the harvest of *super-thin* STSGs, with 0.003–0.005 in. (0.08–0.13 mm) being the commonest dermatome settings used. A patient-reported survey via a mobile phone link to a questionnaire was sent to 250 patients who had a STSG for an acute burn between 1st August 2020 and 31st July 2021. Patient demographics were collected from electronic records including the thickness of the FTSG taken when recorded. Patient responses were statistically analyzed and logistic regression with backwards elimination was performed to explore which contributing factors led to an improved experience of the donor site. Questionnaire responses were obtained from 107 patients (43%). These were between one and two and a half years after the injury. Concerning early donor site issues, itch was a problem for 52% of patients, pain was a problem for 48% of patients. Less common problems (fewer than 25% of patients) were leaking donor sites, wound breakdown, and over-granulation. Regarding long-term outcomes, increased, decreased or mixed pigmentation at the donor site was reported by 32% patients at the time of the survey. Hyper-vascular donor sites were reported by 24% patients. Raised or uneven feeling donor sites were reported by 19% patients, firm or stiff donor sites by 13% patients, and altered sensation by 10% patients. At the time of the survey, 70% responders reported their donor site looked "the same or about the same as my normal skin". Of these, 62 reported how long it took for this to happen, and it equates to a third looking normal at 6 months and half looking normal at a year. For the 32 patients who reported their donor site looking abnormal, 72% were "not bothered" by it. Patients with *super-thin* grafts (0.003–0.005 in.) were significantly more likely to have normal sensation, normal stiffness, and be less raised at their donor sites than those who had *thin* grafts (0.006–0.008 in.). This survey gives important information on patients' experiences of donor site morbidity that may form part

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of an informed consent process and allow tailored advice. Furthermore, it suggests that *super-thin* grafts may provide a superior donor site experience for patients.

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1. Introduction

An inevitable consequence of obtaining a split-thickness skin graft (STSG) is that we create an iatrogenic injury. This injury is widely accepted and can be an afterthought in the consent process, and not considered to be significant in the minds of the patient, their families and the clinical team both before and after surgery. The introduction of autologous cell-based therapies into the model of care from the 1990's was focused on dermal salvage in the wound bed such that less dermis was transferred with the STSG leading to thinner donor sites. In addition, the cell therapies allowed expansion of the area of the wound covered and so the donor site size could be reduced. Despite these strategies donor sites can present a significant burden in terms of short-term consequences such as pain, itch, or delayed healing, as well as long-term color, textural and sensitivity differences compared to normal skin. [1–3].

The primary aim of this study was to obtain a thorough understanding of patients' perspectives on the short- and long-term morbidities of their STSG donor sites to obtain accurate data for patient information and the consent process. The secondary aim was to examine factors that may contribute to the development of significant donor site morbidity to improve the patient experience and tailor advice for follow up to specific patient groups.

We hypothesized that gender, age, burn % total body surface area (% TBSA), estimated donor % TBSA, Fitzpatrick skin type and STSG harvest thickness may all impact on the patient experience during donor site healing, and may have an impact on long-term donor site outcomes.

2. Materials and methods

2.1. Study design

This was a cross-sectional study that used a questionnaire consisting of 23 questions to assess patients' experience of their donor site. It explored itch, pain, wound breakdown, over-granulation, color, thickness and sensation of scar, acceptability of anatomical location, and other challenges experienced as stated by respondents.

This study was carried out as part of a Quality Improvement activity with permission obtained from the Fiona Stanley Fremantle Hospital Governance Evidence Knowledge Outcomes (GEKO) board, GEKO number 47178.

2.2. Questionnaire design

The questionnaire was developed with input from the multidisciplinary team, including surgeons, nurses, physiotherapists and occupational therapists. Initial paper-based questionnaires were explored in cognitive interviews with patients to refine language, check included questions for coverage, and add further questions to address other important factors. Two rounds of further testing were then performed and revisions carried out until saturation of new ideas and suggestions was reached.

2.3. Additional data collection

Demographic information was collected from the electronic Burns Information Management System (BIMS), and operative information from the Theatre Management System. Data included patient age, gender, Fitzpatrick skin type, days from burn to questionnaire completion, days from burn to STSG harvest, %TBSA burn, thickness of STSG harvest, number of STSG harvests, anatomical location of STSG harvest. The %TBSA size of the donor site was retrospectively estimated by the researcher based on the techniques used to reconstruct the wound, and descriptions from the operative note of harvest sites.

2.4. Patient inclusion and questionnaire distribution

Participants were included if they had an operation that included STSG harvested in the course of treatment for an acute burn between 1st August 2020 and 31st July 2021 at the State Adult Burns Unit (SABU), based in the Fiona Stanley Hospital in Perth, Western Australia. Patients were excluded if they were not having treatment for an acute burn or had no mobile phone number recorded. Data was collected in December 2022.

A link to the questionnaire was sent via a text message using Twilio customer engagement platform to the patient's mobile phone number. The questionnaire was completed by the patient via mobile smartphone using REDCap, a secure web application for building and managing online surveys. Two further rounds of reminder texts were sent to non-responders before it was assumed the patient did not wish to participate in the survey. The questionnaire is provided in the Supplementary Materials.

2.5. Treatment

Patients were treated according to the unit standards, with topical silver dressings used for a minimum of 48 h from the time of burn to prevent infection and careful oedema control at the burn wound by elevation and compression. Wounds are surgically debrided from day two post burn onwards, aiming for maximal dermal preservation by using a combination of sharp tangential excision and a rotatory dermabrader, to an end point of fine punctate bleeding dermis. Limbs are debrided under tourniquet where appropriate, but this is released to ensure dermal bleeding before the application of

topical 1 in 100000 epinephrine-soaked gauze. Very rarely is the burn wound pre-infiltrated prior to debridement. Excision edges are carefully "blended" using the dermabrader and ReCell autologous epidermal cell suspension (™ Avita Medical, Valencia, USA) is routinely used in combination with 1:1.5 meshed STSG, which aids with this blending of both pigment and color in the interstices of the mesh pattern.[4,5].

Super-thin (0.004–0.005 in.) skin grafts are preferred, harvested using a Zimmer air driven dermatome and chlorhexidine skin preparation as a lubricant and no pre-infiltration of the donor site, but careful hair removal with electrical clippers. Grafts are harvested usually by one of seven consultants, one fellow, two registrars or resident medical officer. Our registrars rotate every four months and are trained form the start of their rotation to harvest *super-thin* grafts. Following harvest, the skin is transferred immediately to a carrier board using non-toothed forceps and saline in a syringe, or by placing the board directly onto the graft in situ before lifting the graft off with the board. On the carrier board it is carefully manipulated using non tooth forceps and with saline prior to being meshed 1:1.5 through a Zimmer mesher. The scrub nurses are trained in the careful manipulation to avoid tears in the graft, so it does not prolong the procedure at all. Occasionally, a graft may be taken too thin and it has holes in, in which case the guard is opened slightly, or the operator increases the angle and presses firmly for the next harvest. After three large harvests, a new blade is frequently attached. Following meshing, the skin is spread on the board using saline in a syringe and the board is used to apply the skin to the wound bed. If necessary we cut the board with heavy scissors to facilitate this. Alternatively, if a sheet graft is being used, it is transferred onto paraffin dressing rather than a board, and this is used to subsequently transfer the graft to the recipient site following fenestration. The graft is secured using tissue glue or dissolving sutures or staples and dressed, usually with paraffin dressing and betadine-soaked gauze, dry gauze and outer bandages.

After harvest, 1 in 100000 epinephrine-soaked gauze is applied to the donor site. If the donor site is appropriately small, this is followed by intradermal infiltration with 0.25% bupivacaine and 1 in 400000 epinephrine. ReCell™ is frequently applied to the donor site as well as the wound bed, although its use on the donor site was not consistent, and nor was it routinely or reliably recorded at this time. Operation note templates have now been introduced to record its use on the donor site. Standard donor site dressing is alginate dressing, gauze and Fixomull® (BSN Medical) adhesive dressing or crepe bandage, although other donor site dressings are used on occasion. The donor dressings usually remain in place for at least a week. Recipient sites are checked between two and seven days after surgery, and pressure garments, massage and silicone are commenced as soon as possible after grafting, but usually within the first two weeks.

2.6. Statistical analysis

Descriptive statistics assessed the characteristics of the sample population. Categorical data, such as gender and Fitzpatrick skin type was presented as numbers and percentages. Age of patient, days from injury to questionnaire completion, days from injury to STSG harvest, %TBSA burn size, and estimated %TBSA donor size were collected as continuous variables, presented as mean (plus standard deviation) or median (plus interquartile range) as appropriate. Harvest thickness was collated as a binary variable with thicknesses of 0.003–0.005 in. (3/1000–5/1000 in.; 0.08–0.13 mm) classified as *super-thin* grafts and 0.006–0.008 in. (6/1000–8/1000 in.; 0.15–0.20 mm) classified as *thin* harvests. In the case of repeated harvests or different settings the thickest harvest was recorded. The respondent and non-respondent group were compared using these descriptive variables with Wilcoxon rank sum tests or proportion tests.

Univariate and multivariate logistic regression with backwards elimination was performed to explore which contributing factors were associated with the patients' experiences of their donor sites. Initial models contained covariates gender, age, %TBSA (for both donor and burn) Fitzpatrick type, and harvest thicknesses. Binary outcomes that assessed sensations in donor sites were analysed for pain, itch and altered sensation compared to normal (less sensitive, more sensitive, itchy or painful). Binary outcomes that assessed scar characteristics were analysed for scar height (feeling raised, indented or uneven compared to normal skin), and scar stiffness/firmness.

Current satisfaction of donor site scar was assessed by asking whether it bothered the patient "not at all", "a little" or "a lot", and whether they consider the donor site now looks like, or nearly like, normal skin. Results are presented as tables and graphs. REDCap data was extracted via Microsoft Excel and further statistical analysis was performed using Stata 17.0 (StataCorp LLC, 2021). Statistical significance was taken at an alpha level of 5%, with 95% confidence intervals reported.

3. Results

The number of patients coded on the theatre management system as having "SSG or split skin graft or synthetic skin graft" during the timeframe was 266. Patients were excluded if they did not have a recorded mobile phone number [13] or if they had died [2], leaving a total of 250 potential participants.

3.1. Surgical technique for all patients

The operation notes of the entire cohort of 250 patients revealed the thigh was the commonest site for donor site harvest according to the surgical team, accounting for 200 (80%) cases. Where recorded this was from the lateral (n = 47), posterior (n = 45), posterolateral (n = 32) or circumferential (n = 22). Other donor sites included the arm and forearm (n = 26), back (n = 5), buttock (n = 4) or calf (n = 2). It was not recorded in 13 patients.

The thickness of STSG harvest was recorded in the operation note of 179 patients. Overall, 152 (85%) of patients had *super-thin* harvests (0.003 – 0.005 in.) and 27 patients (15%) had *thin* harvests (0.006 – 0.008 in.). See Fig. 1.

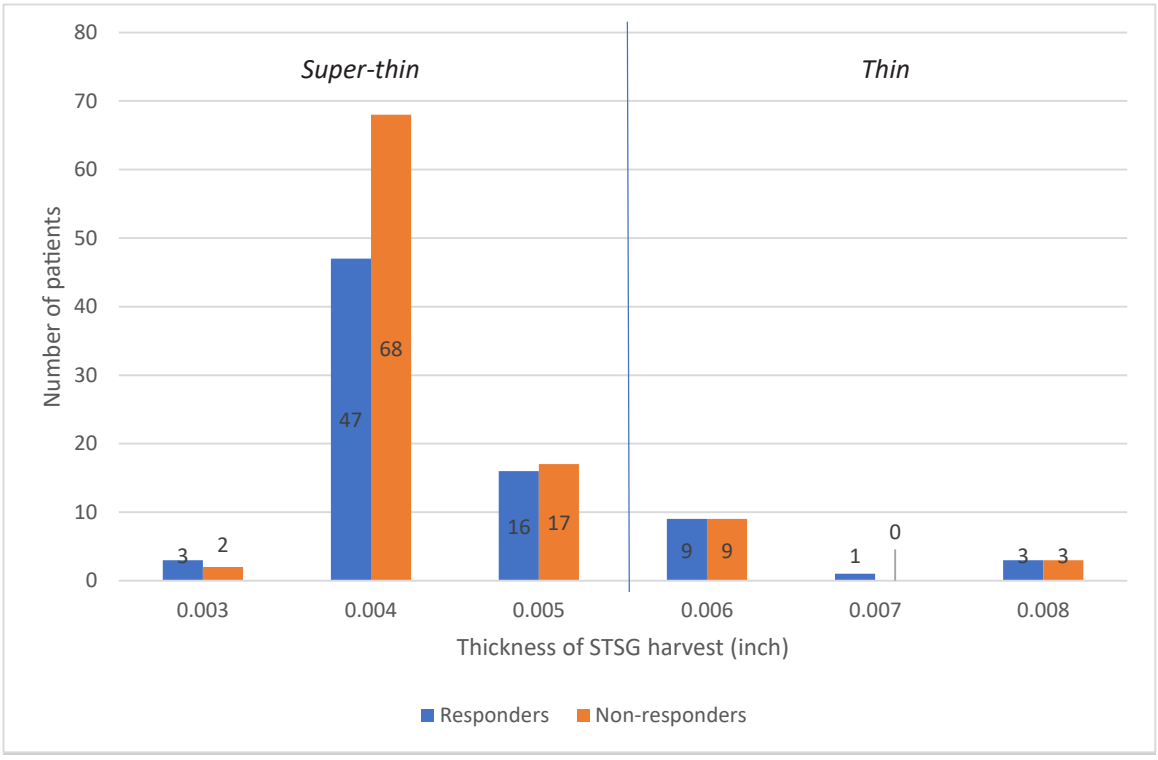

Fig. 1. Chart to show distribution of thickness of donor site harvest within the cohort of patients studied. These have been divided into *Super-thin* (0.003–0.005 in.) and *thin* (0.006–0.008 in.) harvests. No STSG were harvested on a thicker dermatome setting. For each thickness the number of responders versus non responders to the questionnaire has been represented by separate columns.

3.2. Patient characteristics and group comparison

From the 250 potential participants 107 (43%) responded to the questionnaire. Responders were comparable to non-responders for all variables except age, with responders (median age 45 years) being significantly older than non-responders (median age 36 years) (See Table 1). We found no significant difference in the proportion of patients who had *thin* or *super-thin* harvests between responders and non-responders ($p = 0.65$), see Fig. 1.

Median time from burn to STSG harvest was 5.4 days. The 34 patients who were grafted over 10 days after their initial burn were examined in further detail. Of these, 20 had late presentation to the burns unit; four were delayed due to treatment of medical or psychiatric comorbidities; three had delayed healing following expected conservative management; two had dermal substitute application prior to later STSG and one patient declined surgery for 13 days before requesting it.

3.3. Patient-reported donor site location and acceptability

When patients were asked "Where is/are your donor site(s)" the most frequent site reported was thigh (n = 63, 60.6%); buttocks (n = 29, 27.9%); arms/forearms (n = 13, 12.5%); abdomen (n = 6, 5.8%), calf (n = 5, 4.8%) back (n = 3, 2.9%). The question was not completed by three patients. Of note, the proportions of each donor site recorded by surgeons in the operation note were different, suggesting a difference between the surgeon and the patient in classification of anatomical areas (for example posterior thigh may be perceived as buttock by a patient).

When asked "Is there anywhere you would rather have had your donor site?", 99 patients (93.4%) said "no", and seven patients (6.6%) said "yes". Three had buttock donor sites, three had thigh donor sites and one had buttock and thigh donor site according to the patients. See Table 2 for details.

3.4. Patient-reported healing time

Patients were asked how long their donor site took to heal relative to their burn wound, as it was felt that asking a specific time frame would be subject to considerable recall bias this long after the event. Overall, 104 patients answered this question and 69 (65.7%) said the donor site healed "faster than my burn", 18 (17.1%) said it "took about the same amount of time as my burn", and seven patients (6.7%) thought it "healed slower than my burn". The remaining ten patients could not remember or had mixed healing.

Table 1 – Summary of demographic information for all patients, and divided into responders and non-responders. P-values demonstrate that the two groups are comparable in all areas except age, with responders being significantly older.

Median numbers reported for all groups	Total patients	Responders (%)	Non responders (%)	p-value
Number of patients	**250**	**107 (43%)**	**143 (57%)**	
Days since burn	616.5	641	591.6	0.229
range	392–817	453–817	392–815	
IQR	520–724	512–739	522–717	
Burn size % TBSA	2	2	1.5	0.224
range	0.1 – 55	0.1– 55	0–35	
IQR	0.6–4.4	0.6–5.0	0.6–4.0	
Donor %TBSA	0.5	0.5	0.5	0.392
range	0.01–22	0.01–22	0.01–15	
IQR	0.1–1.5	0.2–22	0.1–1.25	
Age of patient	40 years	45 years	36 years	**0.006** *
range	18–91	19–86	18–91	
IQR	28–53	31–55	28–50	
Male to female ratio	172:78	71:36:00	102:43	0.471
(%)	69%: 31%	66%: 34%	70%: 30%	
Days from burn to SSG harvest	5.4	5.1	5.5	0.355
range	1 – 48	1 – 25	1 – 48	
IQR	3.7–7.9	3.7–7.9	3.8–7.8	
Harvest depth recorded	179	79	100	
thin v super thin (n)	27 v 152	13 v 66	14 v 86	
% ratio	15%: 85%	16%: 84%	14%: 86%	0.649

Table 2 – Summary of patient free-text feedback for the seven patients who selected that they wished their donor site had been placed elsewhere on their body.

Patient	Patient age	Donor site (per patient)	Donor site (per op note)	Preferred donor site	Problems/reason for preference
1.	29 y	buttock	buttock	thigh	"every time I sat on the toilet it would stick to the seat it was uncomfortable to peel it off "
2.	33 y	buttock	posterior thigh	not sure	"awkward for going to toilet and uncomfortable"
3.	40 y	buttock	posterior thigh	arm or calf	"I would have been able to check, clean and change the area on my own"
4.	39 y	thigh	posterio-lateral thigh	buttocks	"scar could be hidden in underwear"
5.	38 y	thigh	posterio-lateral thigh	buttocks	"so the scar is hidden by shorts in summer"
6.	66 y	thigh	posterior thigh	calf	"convenience"
7.	18 y	thigh and buttock	not recorded	not sure	"somewhere where it would not have been such a bother, I couldn't sit comfortably because of it."

3.5. *Patient-reported symptoms during healing*

In order of frequency, the symptoms reported by patients as being a bit of a problem or a big problem were itch, pain, leaking dressings and wound breakdown (see Fig. 2.).

3.5.1. *Itch*

Of the 101 patients who answered this question, the commonest problem reported during healing was itch, which 43.6% and 7.9% of patients said was a bit of a problem or a big problem, with 48.5% reporting it as not a problem. We found small but significant increases in the odds of itch being reported in the donor site with increased %TBSA burn (OR 1.08, $p = 0.042$, 95% CI 1.003, 1.15) and younger age (OR 1.06, $p < 0.000$, 95% CI 1.03, 1.1).

3.5.2. *Pain*

Of the 102 patients who answered this question, pain was a bit of a problem or a big problem for 36.3% and 11.2% of patients respectively, meaning 52.0% reported not a problem. Regression analysis showed that as %TBSA burn increased, a small but significant increase in donor-site pain was reported (OR 1.12, $p = 0.019$, 95% CI 1.02, 1.23).

3.5.3. *Other symptoms*

Leaky or loose dressings were not reported as a problem for 75.3% of patients, but were a bit of a problem for 19.6% and a big problem for 5.1%. Wound breakdown was not a problem for 88.5%, a bit of a problem for 9.4% and a big problem for 2.1% of the 96 patients who replied to the question. When asked if any other problems were encountered during

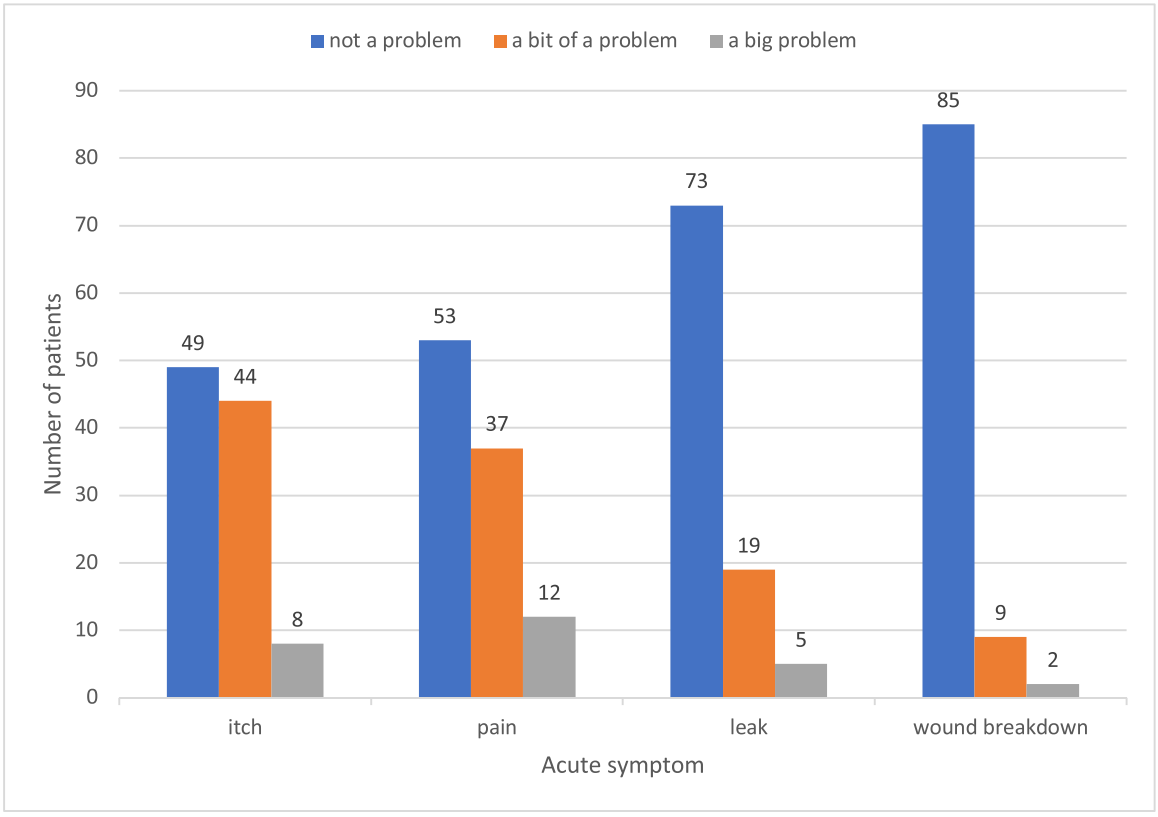

Fig. 2. Acute donor site symptoms reported by patients in order of frequency of experience.

healing, replies included "pimples", "it smelt and oozed" and "tightness-extreme pain walking."

3.6. *Patient-reported long-term outcomes*

3.6.1. *Color*

When asked "how does the color of your skin look now compared to your normal skin?" 105 patients answered the question. Normal color at the time of the survey was reported by 51.4% patients. Vascular problems (pink, red or purple) were reported by 23.8%, 3.8% and 2.9% responders respectively, with overall 24.3% of patients reporting a problem indicating hypervascularity. We found small but significant associations between vascularity and younger age (OR 1.05, p = 0.01 95% CI 0.97, 1.01) and increased %TBSA burn size (OR 1.09, p = 0.004 95% CI 1.02, 1.16).

Pigment problems (darker/browner, lighter/whiter or mixed darker and lighter) were reported by 12.4%, 10.5% and 10.5% respectively, with overall 31.8% of patients reporting a problem indicating dyspigmentation. We also found an associationbetween increased Fitzpatrick skin type and the increased development of hyperpigmented donor sites (OR 2.62, p = 0.008 95% CI 1.29–5.32). See Fig. 3.

3.6.2. *Stiffness or firmness*

When asked "does your donor site feel stiff or firm compared to normal skin?" 86.8% felt it was normal, with 10.4% thinking it was a bit stiff/firm and 2.8% thinking it was very stiff/firm. For the patients who indicated that donor-site stiffness was greater than normal skin, regression analysis showed that the odds of experiencing stiffness from a thin harvest was 11.9 times greater than if they had a *super-thin* harvest than a *thin* harvest (p = 0.006, 95% CI 2.1, 69.7). We also found an association with younger age of patient, although the effect was mild (OR 1.10, p = 0.004, 95% CI 1.03–1.15).

3.6.3. *Raised or indented texture*

When asked "does your donor site feel raised or indented compared to normal skin?" 81.1% felt it was normal, with 14.2% reporting it as being slightly raised, 2.8% reporting is as feeling bumpy or uneven and 1.9% reporting it feeling indented. For the patients who indicated that donor-site height was greater than normal skin, regression analysis showed that the odds of experiencing stiffness from a *thin* harvest was 14.4 times greater than if they had a *super-thin* harvest (p = 0.002, 95% CI 2.6, 80.5). This was also slightly more likely in younger patients (OR 1.09, p = 0.004, 95% CI 0.012, 1.15).

3.6.4. *Sensation*

When asked "does your donor site have the same sensation/feeling now as your normal skin?" 89.7% patients had normal sensation. Increased sensitivity was reported by 4.7% patient, decreased sensation by 3.8%, painful by 0.9% and itchy by 1.0%. Regression analysis showed that the odds of experiencing normal sensation after a *super-thin* harvest was 13.3

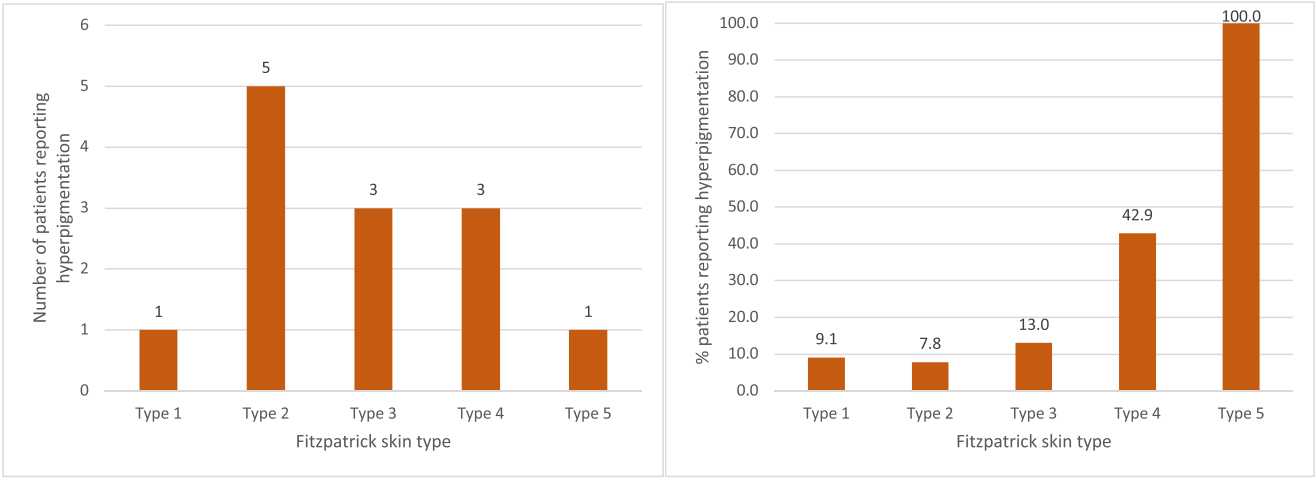

Fig. 3. Charts demonstrating the number of patients with hyperpigmentation at the donor site according to their recorded Fitzpatrick skin type. The chart on the left gives raw number of patients, and that on the right gives % of patients for that Fitzpatrick skin type who reported hyperpigmentation at the donor site. While this was significant, the numbers should be interpreted with caution as there are relatively few patients with Type 4 and above.

times greater than if they had a *thin* harvest (p = 0.001, 95% CI 3.0, 58.8).

3.6.5. *Patients' perceptions of long-term impact*

When asked "does your donor site bother you now?", 95 patients selected "my donor site doesn't bother me at all". Eight patients selected "it bothers me a little" and one "it bothers me a lot." See Table 3 for free comments from patients on why their donor sites continued to bother them.

When asked "does your donor site look the same or about the same as your normal skin?" 69.5% (n = 73) of patients reported their scar was looking normal at the time of the survey. Of these, 62 patients reported on the length of time it took for the skin to return to normal: 56.4% (n = 35) were normal after 6 months, and 90.3% (n = 56) by 12 months. This equates to a third (32.7%) of patients reporting normal or near normal looking donor sites at six months and half (52%) patients reporting normal or near normal looking donor sites at 12 months. See Table 3 also for free comments from patients who did not think their donor site looked normal at the time of survey.

3.6.6. *Thin versus super-thin grafts*

Overall, the commonest association with adverse outcome that we found on regression analysis was that *super-thin* harvests (0.003 – 0.005 in.) had significantly less morbidity than *thin* harvests (0.006 – 0.008 in.). Patients with *super-thin harvests* had significantly fewer problems with stiffness or firmness, raised or indented scars and altered sensation at their donor sites than those with *thin* harvests. For a summary of this see Table 4 and Fig. 4.

4. Discussion

4.1. *Key findings*

This survey gives important points that are useful for discussing likely recovery following a STSG with a patient. Pain

Table 3 – Free comments from patients who selected that their donor site bothered them, and who did not think that their donor site looked like normal or nearly-normal skin. Where a heavy repetition of very similar comments was found, these have been summarised with the total number of patients reported.

"Does your donor site bother you now?"	"Does your donor site look the same or about the same as your normal skin?"
• Itchy, and scar is not same to my normal skin • Doesn't look nice • Looking at it not dealing with it really. • Look of it • Scaring and loss of feel • Its lighter than my skin with a tan line around it • Is a bit sore and itchy • Stiffness	• Colour/different colour/skin colour/discolouration n = 14 • Colour and texture n = 3 • Slightly raised and textured • Colour is obvious • Darker, obvious circle • Darker than other places • It's much darker in appearance, looks like a BIG ugly scar • It's still pinkish/reddish n = 3 • It looked patchy. I now have a tattoo to hide it • it looks as if I'm sunburnt • you can see the square patches rather noticeably

Table 4 – Summary of reported symptoms for patients who had thin versus super-thin STSG harvests. The percentage of patients from each group experiencing each problem is given, as well as raw numbers, which are notably lower for the thin group. P-values are given and marked with an asterix where significant, with relevant odds ratios provided.

	Super-thin 0.003–0.005 in. graft	*Thin* 0.006–0.008 in. graft	Odds ratio (OR)	*P* value
Itch problem %	46	70	n/a	0.30
(n = 79)	-29	-7		
Pain problem %	37.5	76.9	n/a	0.109
(n = 77)	-24	-10		
Hypervascular %	16.7	38.5	n/a	0.192
(n = 79)	-11	-5		
Pigment difference %	31.8	46.2	n/a	0.091
(n = 79)	-21	-6		
Stiff/firm %	10.8	38.5	12	0.006*
(n = 78)	-7	-5		
Raised or indented %	12.5	46.2	14.4	0.002*
(n = 77)	-8	-6		
Altered sensation %	6.1	46.2	13.4	0.001*
(n = 79)	-4	-6		

and itch are reported as short-term problems, each by half of all patients. Significant long-term problems include pigment changes in a third, and hyper vascular scars in a quarter at between one- and two-years post-surgery. It may be reassuring to hear however, that 70% of patients thought their donor site looked normal or nearly normal by this time and 50% at one year. These figures are for our unit and practices, however and other authors have reported 25% patients saying their donor skin looked like normal skin at one year.[2].

In addition, we were able to demonstrate four main themes when looking at factors that may affect donor site morbidity, allowing treatment and advice to be tailored more specifically to the individual. It is important to stress that the effects of the first two were very minor. Firstly, we found an association with patient age, with younger patients being slightly more likely to report problems with itch, hypervascularity, stiffness and raised textural changes. This may indicate a that more vasoactive scar is seen in younger patients, with increased development of hypertrophic or raised scarring, as suggested by previous work[6]. Secondly, increased %TBSA burn size marginally increased itch, pain and hypervascularity at the donor site, but with perhaps less of an association than may be expected. We hope this reflects the provision of good donor site dressings and analgesia during the post operative period for patients with large burns. However, it may be that this data is not accurately recalled retrospectively, and that separating donor pain from overall itch and pain is particularly difficult for patients with larger burns.

Thirdly, hyperpigmentation was more likely to occur in people with higher Fitzpatrick skin types, although low numbers of patients with high Fitzpatrick skin types mean that these results should be read with caution. As the development of hyperpigmentation may be controlled by reducing UV exposure in the first two years, it allows advice to be targeted particularly towards those with more pigmented skin, to be particularly judicious when applying sun protection to donor sites as well as the burn wound itself.

Finally, we found that patients with *super-thin* (0.003–0.005 in.) harvest had reduced donor site complications across the board, although several of these did not reach significance in the current study, possibly due to relatively low numbers of patients receiving *thin* grafts in our unit (13 *thin* versus 66 *super-thin* of those who responded to the questionnaire.) It was shown however, that patients with *thin* grafts were over 12 times more likely to have stiffness, textural changes and altered sensation than those with *super-thin* harvests.

4.2. *Super-thin grafts and their donor sites*

As a unit we have moved towards *super-thin* grafts being the standard of care in the belief, supported by many of the findings in this present study, that the results are superior. Our commonest dermatome setting is 0.004 in., which is much thinner than commonly quoted in the literature, which ranges between 0.008 and 0.014 in. [7–12]. A survey of British plastic surgeons reported median settings of 0.01 in., but up to 0.025 in.,[13] and a survey of Australian and New Zealand surgeons reported harvest thicknesses of between 0.003 and 0.012 in. are used on paediatric patients.[14].

It has previously been demonstrated that STSG donor site healing time and subsequent increased complications including hypertrophic scarring are related to harvest thickness[15–17] with time to epithelialization over two weeks being associated with poor donor site outcomes[2,3]. We did not ask patients about days to healing, due to significant likelihood of recall bias after two years, and it was poorly recorded during preliminary retrospective note reviews. Instead, we asked if the donor site took more or less time to heal than the burn wound. Of the patients who could remember, 84% thought they healed in the same or less time than their burn wound, indicating that we generally did not create a worse wound than we treated.

An accepted dogma is present that thinner STSG produce poorer cosmetic results at the recipient site than thick STSG or full-thickness skin grafts (FTSG) due to increased

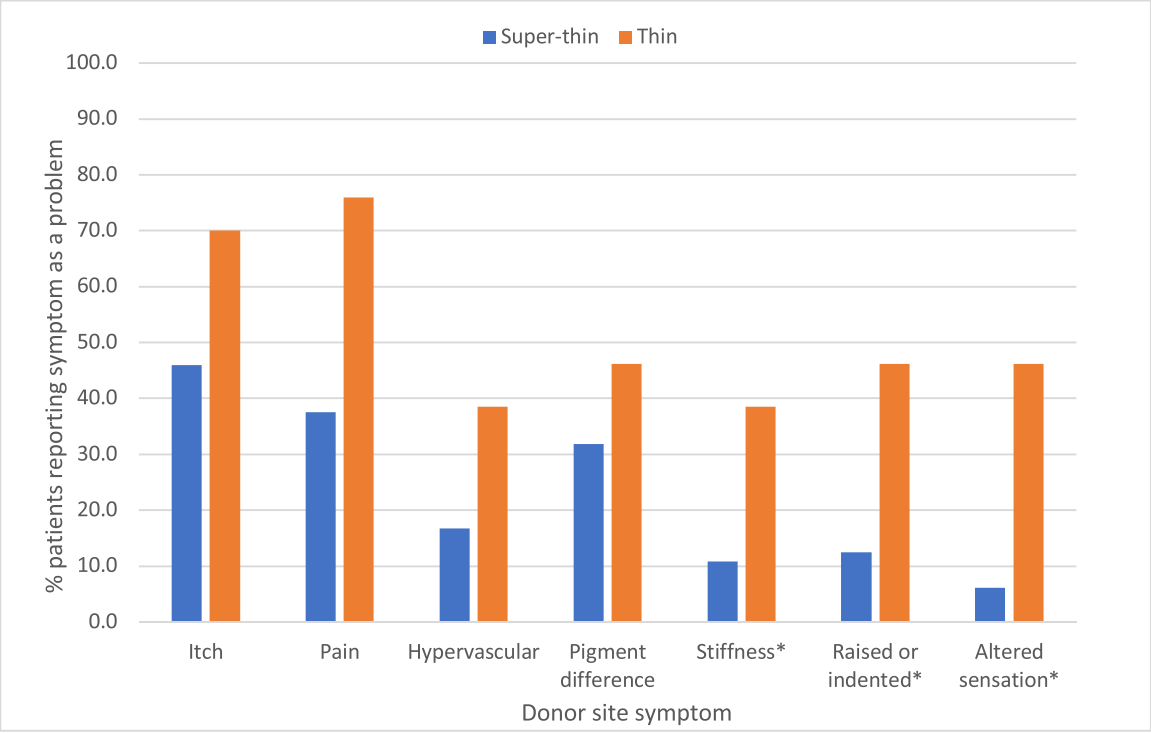

Fig. 4. Graph to show reported symptoms that patients with *thin* versus *super-thin* STSG harvests reported. The columns show % of patients reporting those symptoms for each group. Although a trend can be seen for lower adverse outcomes in all categories in the *super-thin* group, these findings were significant in three categories, marked with an asterix on modelling.

secondary contracture and contour differences.[3] This dogma is being increasingly challenged, however. One prospective study of pediatric palmer burns demonstrated no difference in contracture or sensation between those treated with FTSG or STSG, although FTSG produced more pliable wounds[18]. A systematic review of paediatric palmer burns reviewing data from 544 burns was inconclusive in trying to demonstrate that FTSG were superior to STSG.[19] One prospective trial comparing STSGs harvested at 0.015 in. with those at 0.025 in. for in the treatment of hand burns, found no difference in motion, appearance or satisfaction at the recipient site between the two groups. The thicker group did however have more donor site complications, including an increased need for secondary skin grafting.[17] Similarly, "thin" (0.008–0.011 in.) STSG, have been compared to "ultra-thin" (≤0.007 in.) STSG in a further study. It was shown that healing time was faster in the "ultra-thin" group, with equivalent functional outcomes at the recipient site between both groups.[16] However, the thinnest setting used in that study was 0.005 in., whereas 67% of patients in the present study were harvested at 0.003 or 0.004 in. where thickness was recorded.

We have a similar experience, and despite using even thinner grafts, with the vast majority harvested at ≤ 0.005 in., do not experience significant contour defects or secondary contracture. We believe that the use of *super-thin* grafts with careful dermal preservation and proactive early use of pressure, massage and silicone in fact contribute to superior aesthetic results at the graft site with smoother contours and less over-grafted and textural meshed appearance. We note a learning curve when using super-thin grafts, and minimal handling of the graft, the use of mesher boards to transfer grafts, saline irrigation to prevent desiccation and help with moving the graft, and education of staff are all required.

Any study involving thickness of donor site harvest must be interpreted with caution as because ofinevitable variation in thickness with any given dermatome setting, depending on the pressure applied, angle of the dermatome, traction applied to the skin or pre-tumescence. It has been shown that dermatomes set at 0.012 in. produce grafts between 0.006 and 0.025 in..[10].

4.3. *Factors affecting donor site morbidity*

Multiple studies and metanalyses have examined other factors that may reduce morbidity from donor sites, including the use of various donor site dressings; addition of topical agents, or reapplication of excess harvested STSG. A large metanalysis of 58 randomized controlled trials (RCTs) concluded that moist dressings including hydrocolloids decreased days to healing, pain and infection.[8,20] This was supported by a further metanalysis of 41 articles that concluded moist dressings reduced pain and better re-epithelialization rates.[21] Thus our standard interface dressing is alginate, in common with the majority of burns units in Australia and the United Kingdom.[13,22,23] More recently, the use of biological dressings including human amniotic membrane and honey over non-biological dressings has been proposed by one metanalysis of 10 studies.[24] This is not something we have much experience of in our unit. We do

however commonly use ReCell on the donor site, as it has been demonstrated to significantly reduce healing time of donor sites. [25] Unfortunately, whether or not ReCell had been used on the donor site was so poorly documented in the operation notes, we could not include it in this analysis.

The findings that younger patients and those with darker skin reported donor site morbidities more frequently echoes the findings of an observational cohort study of 72 patients one year after STSG harvest using the patient-reported Patient and Observer Scar Assessment scale (POSAS). [2] The chosen donor site was usually thigh and the harvest was 0.007 in. thick. In their study, color was the most common abnormality, with 84% reporting minor or major differences. By comparison, 51% of patients in the current study reported normal color, which may be due to out thinner STSG or because follow up in the present study was longer.

4.4. *Limitations*

This study was limited by its retrospective design, which revealed gaps in data collection in some aspects of the operation. This has led to the creation of an operation note template in our unit to improve the noting of aspects including the thickness and %TBSA of the STSG donor site harvest and the use of ReCell. In addition, the time to epithelialization was not accurately recorded. This is unlikely to be something that could be addressed adequately in our unit without repeated daily examination of the donor wound to quantify healing, which would lead to undue patient discomfort and inconvenience. In addition, being a State-wide service, many of the donor sites are checked remotely by nurses and doctors in hospitals around the state after a week of initial dressings being left intact.

Finally, although the regression analysis shows strong evidence that the *super-thin* harvests improve itch and texture of the donor-sites and that these sites are more likely to return to normal sensation, it is important to note that the 95% confidence intervals are wide, indicating a high degree of variability within the group. The relatively small sample sizes of patients with *thin* grafts mean these results must be interpreted with extreme caution, and may lend itself to a cross-site prospective study together with a unit where the practice is to harvest grafts thicker than we harvest. Similarly, conclusions about patients with higher Fitzpatrick skin type having a higher incidence of hyperpigmentation must also be tempered. Extremely low numbers of patients with higher Fitzpatrick types mean that verification of these results would involve a prospective study of donor-site appearance with particular consideration to recruit patients with a more even distribution of Fitzpatrick skin types.

4.5. *Study strengths*

This study differed from previous studies in several ways. The patient perspective was at the forefront, and the questionnaire was designed to harness the use of modern mobile phone technology in order to minimize inconvenience to the patient. The response rate of 43% was higher than that of similar studies of patient questionnaires about donor sites, which were 27% [1] and 20% [20]. We felt that given the long follow up period of between one and two and a half years it was more than the rate we would usually expect from our population who disperse throughout Western Australia following discharge, and better than our previous experience of using mobile phone based questionnaires within our unit, although it is less than one study with a 63% response rate [2]. Age is no barrier to technology use, with the cohort of responders being older than non-responders and the oldest patient responding being 86 old. The follow up was significantly longer than other similar studies.[1,2] This meant that as well as ask about short-term metrics such as pain, and itch, we also asked about long-term scar quality.

We developed the questionnaire with the help of patients, asking them what was important to them and if we missed anything in the questionnaire until we felt that saturation had been met. Because of this we believe it is a true reflection of patients' perceptions of the commonest iatrogenic injury we produce as burns surgeons.

In addition, this is the first paper that we have found examining the difference in outcomes between *thin* (0.006–0.008 in.) and *super-thin* (0.003–0.005 in.) STSG harvests on the donor site morbidity, and we have shown the *super-thin* to be superior in terms of stiffness, raised scar and sensation at the donor site.

5. Conclusion

This survey demonstrates the experience of 107 patients between one and two years after harvest of a split skin graft. It has produced useful information for consenting patients. Itch and pain were the main short-term problems for about half of the patients each during the recovery period. Two years post-surgery, about one third of patients had pigment changes and a quarter had hyper vascular donor sites.

Patients with higher Fitzpartick skin types were more likely to report hyperpigmented donor sites, and those who had *super-thin* graft harvests, 0.005 in. or less, had a better donor site experience overall than those with thicker harvests.

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Declaration of authors

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Collaborators

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Declaration of Competing Interest

All authors declare no financial or personal associations that could inappropriately influence this work.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.burns.2023.10.016.

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