A Comparison of Full and Split Thickness Skin Grafts in Radial Forearm Donor Sites

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Abstract To formally evaluate the functional and aesthetic outcomes between full versus split thickness skin graft coverage of radial forearm free flap donor sites. A retrospective chart review of 47 patients who underwent pedicled or free radial forearm free flap reconstruction from May 1997 to August 2004 was performed. Comparisons were made between patients who had donor site coverage with split thickness skin grafts (STSG) or full thickness skin grafts (FTSG). There was no statistically significant difference between the STSG and FTSG in the number of post-

operative dressings, incidence of tendon exposure, time to healing at the skin graft donor site, and time to healing at the skin graft recipient site. The questionnaire data showed there was a trend toward higher scores with the radial forearm scar aesthetics and satisfaction in the FTSG group. Full thickness skin graft coverage of radial forearm free flap donor site is superior to split thickness skin graft coverage in terms of aesthetic outcome, and has no statistically significant difference in terms of tendon exposure, time to healing at the skin graft donor site, time to healing at the skin graft recipient site, or post operative pain.

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Background

The radial forearm free flap was first introduced into head and neck reconstruction in the early 1980's. The anatomy was initially described in China and used by Ian McGregor in 1983 for reconstruction after major ablative intra-oral surgery[1]. It has proven itself to be an extremely reliable flap for reconstruction because of its standard anatomy, large caliber vessels, good sensory supply, quality and quantity of forearm skin. It is generally technically easy to harvest and a safe flap for reconstruction.

The primary morbidity of the flap has been the management of its donor site. The defects are generally large and require skin grafts for closure, which are aesthetically undesirable. In addition there is the potential for exposure of the underlying tendons with the inherent risk of tendon loss. This can occur in instances of poor skin graft take. Long healing times of the granulating donor bed can be distressing to the patient for many weeks.

Traditionally, defects too large to be closed primarily were closed with a split thickness skin graft. In the mid-nineties, some groups began grafting these defects with full thickness skin grafts[2–4]. The potential disadvantage is the risk of decreased graft take compared to split thickness grafts, which increases the theoretic chance of tendon exposure. This could result in a longer healing period requiring more wound care as well as additional procedures. In addition there are a limited number of donor sites that are both large enough to cover the defect created by the radial forearm free flap and that can be closed primarily after full thickness skin harvest.

The potential advantages of full thickness grafting are more durable coverage of the radial forearm donor site as well as an aesthetically more acceptable donor site after healing. Anecdotally, full thickness grafts may decrease pain from harvest, potentially decreasing the short-term morbidity of the procedure.

Prior studies support full thickness grafting as a reliable option for wound coverage. What is not clear in the literature is whether split thickness or full thickness grafts are better in this clinical situation. Sidebottom et. al. in a prospective randomized trial suggests that split thickness donor sites require more dressings[5]. They found no difference between full and split thickness skin grafts in graft take or dressing changes at the recipient sites, nor in pain assessment or aesthetics. In the study of 64 patients only 7 returned a questionnaire survey focused on pain and aesthetic outcomes. Grafts were harvested from groin or abdomen. Van der Lei et al., in a small series of 5 patients report a superior aesthetic appearance in these full thickness grafted patients[6]. Grafts were taken from the same arm and combined with a VY advancement flap for closure. Sleeman et. al. described the use of full thickness grafts from the abdominal wall and claimed better healing, better aesthetic results[7]. These conclusions, though, were not supported by objective data. Other studies tend to concur with an improved aesthetic result, better coverage without increased morbidity with the use of full thickness grafts. Most published studies tend to have a small number of patients and aesthetic results are reported in an anecdotal manner. The purpose of this study was to evaluate whether full thickness skin grafts have a clinical advantage over split thickness skin grafts by formal evaluation of a larger patient cohort with questionnaires and statistical analysis.

Methods

We performed a retrospective review of a single surgeon's experience at Loyola Medical center on 55 patients who have undergone radial forearm reconstructions using both free and pedicle flaps between May 1997 and August 2004. Only patients with complete charts were included for analysis.

There were two post op deaths secondary to post op MI and one failed free flap requiring a second radial forearm free flap which was successful. Six patients had incomplete charts. A total of 47 charts were included in the study.

The outcomes between split and full thickness skin grafts of the radial forearm donor sites were compared. Split thickness grafts were performed exclusively in early cases and full thickness grafts were used selectively and with increased frequency in later cases. In addition we conducted a telephone survey using a questionnaire addressing the aesthetics of donor and recipient sites as well as postoperative pain. Surveys were completed by 18 of the 47 patients (38.3% of studied patient population).

The full thickness grafts were harvested primarily from the groin or abdomen in an elliptical shape. The groin was the preferred donor site if available for harvest. The wounds were closed primarily with subdermal 3–0 Vicryl and Steri-strips (3M Corporation, St. Paul, MN) followed by an occlusive dressing for 1-week post operatively.

Split thickness grafts were harvested using a dermatome settings ranged from 0.12 to 0.16 in. in thickness. Wounds were all dressed with Glucan and Exudry. Exudry was removed in 48 h and donor site wounds were left open to air. Glucan was gradually removed in the following 2–3 weeks.

Forearm wound edges were advanced and tacked down with 3–0 vicryl sutures. Subsequent skin grafts were quilted and sutured in place with 4–0 chromic sutures. Grafted sites were dressed with Xeroform (Kendall, Mansfield MA), soaked Peripads, and wrapped in Kerlix gauze. At the end of each case a sugar tong splint was applied. The splint and dressing were removed on the fifth post op day and replaced with an orthotic volar-based splint. Routine Xeroform dressings were applied to protect the graft for a minimum of 3 weeks post-operatively.

All patients followed the same operative protocol.

After hospital discharge patients were seen weekly for the first 4 weeks post op then every 2 weeks until adequate healing occurred. In patients treated during the last 2 years of the study post-op visits were spread out to every 2 weeks for the first post op month. After the first month visits were dictated by the status of the wound. In our study wounds were considered healed when patients could be safely discharged from follow-up by the plastic surgery service and no longer required local wound care. No patients discharged from the plastic surgery clinic returned for further wound care.

The outcomes used for comparison were the following: incidence of graft loss, number of post op dressings, tendon exposure, time to healing at skin graft donor site, time to heal at skin graft recipient site, and need for additional procedures.

Co-variables evaluated were patient age, gender, history of diabetes, past smoking history, peripheral vascular disease, coronary artery disease, and active smoking.

All outcome data was statistically compared between split and full thickness grafts using the *T*-test except for graft loss which was analyzed using Chi-square testing and Fisher's Exact test. Regression analysis was used to determine the influence of co-variables on post-op outcomes. Significance was taken at *p*-value <0.05.

The following parameters were assessed by the use of a telephone questionnaire: patient subjective assessment of the scars, personal satisfaction with the scars, postoperative pain of the skin graft donor site, alteration of sensation and postoperative pain control. A total of 18 patients were surveyed. These parameters were then statistically compared between split and full thickness grafts using the *T*-test, Wilcoxon rank-sum (Mann–Whitney) test and Fischer exact test. The SAS system was used for our statistical analysis.

Results

We reviewed the charts of 47 patients. Major complications included two postoperative MI's which resulted in deaths, one secondary to post-op airway loss. Both occurred in elderly patients after undergoing major oncologic tumor resections combined with microsurgical reconstruction. One post-operative hematoma resulted a compartment syndrome requiring a return to OR and hematoma evacuation. This patient recovered with no untoward events and complete graft take. One failed flap required re-operation with a second radial forearm free flap, which was successful.

Thirty-three (70.2%) of the patients were male and 14 (29.8%) were female. The mean age of the study group was 55.2 (SD 15.6) years. Twenty-nine (61.7%) of the 47 patients were had a history of smoking. Ten patients (21.3%) were still smoking at the time of operation, four (8.5%) had a history of diabetes and eight (17%) of the patients had a history of peripheral vascular disease and/or coronary artery disease. The patient demographics are shown in Table 1.

The average number of dressings in the entire study group was 55 (SD 42.2), with a minimum of 22 and maximum of 198. The healing time of donor sites and recipient sites were 16.8 (SD 12.13) and 45.85 (SD 31.7) days respectively. The minimum numbers for healing time

Table 2 Dressings and healing times for entire study group

Average number of dressings	55 (SD 42.286)	Min/Max 22/198
Time to heal donor site	16.8 (SD 12.13)	Min/Max 8/70
Time to heal recipient site	45.85 (SD 31.7)	Min/Max 9/142

of the donor and recipients sites were 8 and 9 days with a maximum of 70 and 142 days. This is shown in Table 2.

There were 31 patients (66%) that had split thickness skin grafts performed and 16 (34%) that had full thickness skin grafts performed. Graft loss was graded as a percentage of the total amount of the skin graft that was lost during healing. Grade 0 was 0% graft loss, grade 1 <5%, grade 2 5–10% and grade 3 >10%. This was determined by chart documentation. Thirty-nine patients (83%) had minimal to no skin graft loss, five patients (10.6%) had between 5–10% skin graft loss and three patients (6.4%) had greater than 10% of skin graft loss. Ten patients (21.28%) had evidence of tendon exposure during clinical follow up. All of these cases of skin graft loss and tendon exposure went on to heal with local wound care, none required any additional procedure. This is shown in Table 3.

The results of mean donor site healing time, mean recipient site healing time, mean number of dressings and number of tendon exposures were compared between the split thickness and full thickness patient populations. This showed no statistical difference in donor site healing times in the split thickness group (15.0 days, SD 5.2) versus full thickness group (13.6 days, SD 4.5) with a *p* value of 0.3577. The respective recipient site healing times between the split thickness and full thickness groups of 41.1 days (SD 28.1) and 55.0 days (SD 37) were not statistically significant, *p* value of 0.1575. Although, the number of wound dressings were increased in the full thickness group 70.5 (SD 57.9) compared to the split thickness group 47.0 (SD 29.5). This did approach statistical significance with a *p*-value of 0.0705. There were five tendon exposures in each group which was not shown to be statistically significant *p*-value 0.2740. These findings are shown in Table 4. There was no statistical difference in the distribution of patients by degree of skin graft loss when the split thickness and full thickness groups were compared. This is shown in Table 5.

Table 1 Demographics

Males	33 (70.2%)
Females	14 (29.8%)
Age in years	55.2 (mean, SD 15.6)
Current smokers	10 (21.3%)
History of smoking	29 (61.7%)
Diabetes	4 (8.5%)
PVD/CAD	8 (17.0%)

Table 3 Study outcomes all patients

Split thickness	31 (66%)
Full thickness	16 (34%)
Graft loss (% graft loss)	
Grade 0 (0%)	23 (48.9%)
Grade 1 (<5%)	16 (34.1%)
Grade 2 (5–10%)	5 (10.6%)
Grade 3 (>10%)	3 (6.4%)
Tendon Exposure	10 (21.28%)

All wounds healed with local wound care

Table 4 Comparison between split and full thickness grafts

	Split	Full	P value
Donor Site Healing (mean number of days) *	15.0 (SD 5.2)	13.6 (SD 4.5)	0.3577
Recipient site healing (mean number of days)	41.1 (SD 28.1)	55.0 (SD 37)	0.1575
Number of wound dressings (mean)	47.0 (SD 29.5)	70.5 (SD 57.9)	0.0705
• Two split thickness outliers deleted	Tendon exposure (number of patients)	5 (16.1%)	5 (31.3%)
			0.2740

After regression analysis of the previously mentioned co-variables only history of smoking was a significant parameter. This was associated with a delay in donor site healing.

Questionnaire results were acquired from 18 of the 47 patients included in the study, 38.3% of the study population. Eleven of those patients had split thickness grafts and seven had full thickness grafts. Reasons for the low number of responses include: death since time of surgery, change in address, or disconnected phone.

Donor Site Pain

In regard to donor site pain measured on a scale of 1–10 (1=no pain, 10=worst pain), 3 of the split thickness patients had scores of greater than or equal to 3 where as only one of the seven full thickness patients gave a score of greater than three. Overall patients had minimal to no pain in both groups with a mean score of 1.111. There was no statistical difference between the two groups (P value 0.7053).

Radial Forearm Scar

Radial forearm scars were graded on a five-point scale (5- excellent 4-good 3-satisfactory 2-fair 1-poor). The overall mean score was 3.28. In the split thickness group eight of eleven patients gave a score less than or equal to 3. Five of the seven in the full thickness group gave a score of greater than or equal to 4. Although the mean score of the full thickness group (3.57) was higher than that of the split thickness group (3.09), on statistical analysis there was no statistical significance, p value 0.4569.

Graft Donor Site Scar

Graft donor site scars were scored on the same 5-point scale. The overall mean score was 3.83. Eight of eleven patients in the split thickness group and five of the seven in

the full thickness group gave scores of greater than or equal to 4. The mean score of the split group (4.09) was higher than the full thickness group (3.43) but this was not statistically significant (P value 0.2733).

Radial Forearm Scar Satisfaction

Satisfaction with the resulting scar was graded on a 100-point scale (0 no satisfaction, 100 completely satisfied with resulting scars). The mean score for the entire group was 73.6. In the split thickness group five of eleven gave a score of greater than or equal to 71. Six of seven patients in the full thickness group gave scores of greater than or equal to 71. In the split thickness group the mean score was 65 verses a mean score of 81.4 in the full thickness group. This was not found to be statistically significant (P value 0.3123).

Graft Donor Scar Satisfaction

This was also scored on a 100-point scale. The mean value was 83.4 in both the split and full thickness skin graft groups. In the split thickness skin graft group, the graft donor scar satisfaction was 85.9% vs. 79.6% in the full thickness skin graft group, with no statistically significant difference.

Alteration of Sensation of Recipient Site

In the split thickness group five of eleven had altered sensation and four of the seven in the full thickness group had altered sensation in the region of the radial forearm. There was no statistical significance in this parameter. In regard to the graft donor site one patient in each group reported an alteration of sensation in that region, again no statistical significance between groups.

Alteration of Sensation of Donor Site

In the split thickness group, 1/11 (9%) had altered sensation versus 1/7 (14.2%) in the full thickness group. These differences were not statistically significant.

Post Op Pain Control

Of the overall group 88.9% of the patients surveyed found their pain control to be adequate. Only two patients one in

Table 5 Graft loss comparison between split and full thickness grafts

Graft Loss%	Split	Full
Grade 0	17	6
Grade 1	9	7
Grade 2	3	2
Grade 3	2	1

• Fisher's exact test P value 0.7357

Table 6 Questionnaire results

Donor Site Pain Scores (Rating scale 0-10)

Score	Total patients	Split Grafts (11)	Full Grafts (7)
0	12	8	4
1-3	4	2	2
4-6	1	0	1
7-10	1	1	0
Mean score	1.111	1.182	1.000

Radial Forearm Scar (Rating scale 1-5)

5- Excellent, 4-Good, 3-Satisfactory, 2-Fair, 1-Poor

Score	Total patients	Split Grafts (11)	Full Grafts (7)
1	1	1	0
2	5	3	2
3	4	4	0
4	4	0	4
5	4	3	1
Mean score	3.28	3.09	3.57

Graft Donor Site Scar (Rating scale 1-5)

5- Excellent, 4-Good, 3-Satisfactory, 2-Fair, 1-Poor

Score	Total patients	Split Grafts (11)	Full Grafts (7)
1	1	0	1
2	2	1	1
3	2	2	0
4	7	3	4
5	6	5	1
Mean score	3.83	4.09	3.43

Radial Forearm Scar Satisfaction (Rating scale 0- no satisfaction, 100- total satisfaction)

Score	Total patients	Split Grafts (11)	Full Grafts (7)
<50	2	2	0
50-60	5	4	1
61-70	0	0	0
71-80	4	1	3
81-90	1	0	1
91-100	6	4	2
Mean score	73.6	65	81.4

Table 6 (continued)

Graft Donor Scar Satisfaction (Rating scale 0- no satisfaction, 100- total satisfaction)

Score	Total patients	Split Grafts (11)	Full Grafts (7)
<50	0	0	0
50-60	4	2	2
61-70	1	1	0
71-80	2	1	1
81-90	2	1	1
91-100	9	6	3
Mean score	83.4	85.9	79.6

Altered Sensation of Recipient Site

	Yes	No
Split	5	6
Full	4	3

Altered Sensation of Donor Site

	Yes	No
Split	1	10
Full	1	6

Adequate Pain Control

	Yes	No
Split	10	1
Full	6	1

the split thickness group and one in the full thickness group complained of inadequate pain control. Questionnaire results are shown in Table 6.

Discussion

In comparing split thickness grafting to full thickness grafts the donor site healing times were similar. Comparison of healing times of the grafts at the radial forearm recipient site approached statistical significance demonstrating longer healing times in full thickness grafting which is consistent with clinical expectations. This may be reflected in the trend of increased dressings required for the full thickness grafts even though it was not shown to be statistically significant.

Although both groups experienced some degree of graft loss and tendon exposure, the morbidity was minimal. Areas of graft loss or tendon exposure were typically small in area requiring only local wound care for healing and no additional procedures. The only morbidity appeared to be an extended period of local wound care in a small number of cases. There were no cases of tendon loss in either group.

Although the questionnaires only represent 38.3% of the study population some emerging trends seemed to be reflected. Overall, donor site pain was not a significant clinical problem in split or full thickness grafts donor sites. There was also a general satisfaction with the donor site scars in both groups with no statistical difference between groups. There may be a slight increase in the aesthetics and satisfaction with donor site scars favoring the split thickness group. If this were significant it could be argued that full

thickness donor sites still have the advantage of being located in less conspicuous locations (groin or lower abdomen) than the split thickness grafts which are typically harvested from the thighs. The full thickness donor sites were still considered satisfactory. Both groups had similar complaints regarding the alteration of sensation which correlates with clinical expectations.

In regard to the radial forearm scar aesthetics and satisfaction on our survey there seemed to be a general trend of higher scores for both parameters in the full thickness group compared to the split thickness group, although this was not statistically significant.

Unfortunately, the size of our patient population may not be large enough to bear out statistical differences. Based on the data accumulated in this study we do believe that full thickness grafting is clearly attainable with minimal clinical morbidity in comparison with split thickness grafting. There appears to be a trend that the resulting radial forearm scars are more aesthetic and acceptable after full thickness grafting. Full thickness grafts most likely have no difference in postoperative pain compared to split thickness grafts based on our questionnaire results. There also appears to be no probable difference in the long-term impact of donor site scarring in full versus split thickness grafted sites. All of these factors should be considered in deciding on the use of a full or split thickness graft for closure of radial forearm donor sites. A prospective, randomized clinical trial as well as a larger collection of patients may more clearly answer these clinical questions in lieu of the inherent biases and limitations of a retrospective study. A postoperative questionnaire performed in a prospective manner may also more accurately assess the parameter of postoperative pain.

The donor sites harvested in this study were taken subfascially, Avery et al. has compared recovery of sensation in donor free flaps[8]. However, to date there are no known studies comparing donor sites raised in a subfascial versus suprafascial approach. There is more recent data exploring the benefits of donor healing in free flaps raised in a suprafascial manner. Chang et al. has a series of over 400 patients, 49 of whom were studied prospectively using a suprafascial dissection with 100% graft take onto the donor site[9]. A similar study by Avery et al. compared full versus split thickness skin grafting to suprafascial radial forearm donor sites, which demonstrated 100% early and complete graft take in full thickness grafts and one area of partial loss in the split thickness group[10]. It is believed that the presence of tendon coverage with suprafascial dissections lends to a more robust tissue bed for graft take and growth, particularly with a full-thickness graft is used for coverage [11]. The use of a subfascial approach to harvest the radial forearm free flap in our patient groups may have contributed to our high rates of tendon exposure in both the full-thickness and split-thickness groups.

Conclusion

Full thickness skin grafting does not appear to increase the morbidity of radial forearm donor sites closure. In the long term it may enhance the aesthetics of the donor site. The potential of increased wound care does not seem negate the potential benefit. In regard to postoperative pain management there is probably no benefit compared to split-thickness grafting. Further studies should be conducted help answer these clinical questions regarding aesthetics and true effect on post op pain on both split and full thickness donor sites. Additional studies also need to be completed directly comparing donor site morbidity in radial forearm free flaps harvested through both the subfascial and suprafascial approach.

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