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Use of Skin Grafts in Free Flap Reconstruction

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1. Introduction

Free flap reconstruction often results in a composite defect at the donor site. Many of these defects can be closed primarily (scapular free flaps, rectus abdominis free flap, and antero-lateral thigh free flaps). However, some donor sites, such as fibular free flaps and radial forearm free flap, are particularly difficult to close primarily and require the use of skin grafts for coverage of the underlying muscle and tendon. There are several options available for obtaining material to cover the donor site defect.

1. Split thickness skin grafts harvested from a different anatomical site than free flap donor site
2. Split thickness skin graft harvested from the free flap donor site
3. Full thickness skin grafts harvested from a site adjacent to free flap donor site

Coverage with a skin graft compared to primary closure has not been shown to have increased complication rates [1] and decreases wound tension leading to less wound contraction, or worst yet, compartment syndrome [2]. We will discuss the different options for closure of free flap donor sites with skin grafts and the techniques to employ these options in the clinical practice.

2. Split thickness skin graft from a different anatomical site

The most common soft tissue free flap donor sites used in reconstructive surgery that require adjunctive closure techniques are the radial forearm and fibular free flap donor sites.

Preoperative considerations for taking a split thickness skin graft from a different anatomical site to close the defect include:

1. Skin thickness at the donor site. Elderly patients have thinner skin which can make taking a split thickness skin graft from certain areas difficult.
2. Need for a skin graft versus primary closure.

Advantages include:

1. Larger sized skin graft can be taken to account for shrinkage of the skin graft and decreased need for meshing.
2. Thicker skin graft can also be harvested from anatomical sites with thicker skin for better cosmetic outcomes i.e. better color retention and less contraction with healing.
3. Reduces free flap donor site wound tension closure.

Disadvantages include:

1. Color and hair mismatch
2. Increased morbidity from second donor site – pain, infection, wound care
3. Cosmetic defect at skin graft donor site
4. More wound care needed at free flap site compared to primary closure

We recommend harvesting the skin graft from an anatomical location that can be easily concealed such as the anterior or medial thigh, hip, or buttocks. The need for assistance in post-operative wound care can make the buttocks less advantageous. Special considerations for covering a free flap donor site include the underlying tissue and the thickness of the skin graft. Some free flap donor sites are left with minimally vitalized structures such as tendons and thicker skin grafts have higher metabolic demands. Thicker skin grafts placed over tendons may result in graft failure at those areas.

Harvest of the skin graft should be performed in a standard fashion.

1. First the patient should be positioned so the skin graft donor site is easily accessible to the surgeon.
2. The skin should be prepped initially with betadine and residual betadine should be washed off so the skin is clean. DuraPrep (3M, St Paul, MN) should not be used because it is difficult to remove.
3. Mineral oil should be applied liberally to the skin surface to facilitate movement of the dermatome.
4. An appropriately sized blade should be chosen (2, 3, or 4 inches) and a powered dermatome should be used (e.g. Zimmer, Warsaw, IN). The blade should be adjusted to the desired thickness, generally between 0.014 and 0.018 inches.
5. Position the blade at one end of the donor site and engage the skin with the dermatome at a 90-degree angle. Once engaged, shift to a 30 to 40-degree angle to the skin with an assistant using tongue depressors to keep the skin taut as the dermatome is advanced with constant downward pressure to harvest the skin graft in one piece.

6. Once the appropriately sized skin graft has been harvested, angle the blade up to terminate the harvest and carefully lift the skin graft away.
7. Punctate bleeding may be stopped with a combination of pressure, thrombin, and epinephrine soaked gauze. The donor site may be dressed with fibrin glue and covered with a tegaderm. The skin graft should be placed in saline until transfer to site for coverage.

While the skin graft may be harvested at the time of free flap resection, an alternative is delayed harvest with interval placement of Integra artificial dermis (Integra Lifesciences Corp, Plainsborough, NJ). Integra is a two layered product with a silicone outer layer that acts as a barrier for infection, heat, and moisture loss. The second layer is a matrix of cross-linked fibers that acts as a scaffold for dermal regeneration. An alternative is Oasis wound matrix (Cook Biotech Inc, West Lafayette, IN) which is an absorbable matrix derived from porcine intestinal sub mucosa. The matrix material is cut to a size to completely cover the defect. If Integra is used, the silicone layer is removed 2-3 weeks later once the dermis has regenerated. Then an epidermal layer is applied.

Advantages of using an absorbable matrix include allowing the patient to heal first from their primary resection and free flap before adding on another surgical site. Integra can allow a neodermis to form over minimally vitalized structures such as tendon to improve coverage and decrease risk of tendon exposure. It can also enhance cosmesis with better skin mobility after application of the epidermal layer or split thickness skin graft [3].

3. Split thickness skin graft from free flap donor site

The main advantage of harvesting the skin graft from the flap skin paddle is to avoid the donor site morbidity of an additional donor site. Studies have not shown any difference in morbidity of the free flap site when closing with a skin graft taken from the myo/osteocutaneous skin paddle versus from a different anatomical site. [4, 5].

Advantages:

1. Elimination of second skin graft donor site and associated morbidity which include potential for infection and pain which is often worse than the primary surgical site, and a second scar.
2. Reduction in free flap donor site wound tension closure.

Disadvantages:

1. Contraction of skin graft often requiring meshing and/or purse string suture technique
2. More wound care needed compared to primary closure
3. Risk of tendon exposure in certain areas such as radial forearm or fibula skin paddle

Harvest of the skin graft should be performed in the same fashion as described above with harvest from a separate donor site.

1. The skin graft should be harvested over the area in approximately the same size as the skin paddle that is to be harvested with the free flap (Figure 1).



Figure 1. Split thickness skin graft taken from the flap site on the forearm.

2. The skin graft should be preserved in saline while the free flap is harvested. Once it is ready to fill the donor site, the skin graft should be measured and determined if meshing is needed. A 1:1.5 meshing grid is often adequate.
3. To reduce the wound bed surface area, a purse string suture technique may be employed (Figure 2). This technique is able to reduce the defect area by as much as 44.5% [6]. An absorbable suture such as 3-0 Vicryl (Ethicon Inc, Somerville, NJ) can be run in a subcuticular fashion along the periphery of the defect. The suture should be pulled taught so the circumference of the defect is reduced.



Figure 2. Purse string suture technique.

4. The meshed or non-meshed skin graft is then sewn in place to cover the donor site. If it is not meshed, small ventilation holes must be added in the graft to prevent fluid accumulation underneath the graft. (Figure 3a and 3b) Figure 4 shows a fully healed radial forearm donor site.



Figure 3. (a) Closure of donor site defect with non-meshed skin graft and purse string suture technique. (b) Closure of donor site defect with meshed skin graft and purse string suture technique.



Figure 4. Fully healed radial forearm free flap donor site after purse string suture and meshed skin graft.

An alternative to fully elevating the skin graft is leaving one side hinged [7]. This decreases the amount of contracture, curling, scarring along the hinge site, and disruption of the graft. Additionally, it also maintains the orientation of the skin graft.

Special considerations include the thickness of the donor site. Often the elderly have thin skin which makes harvest from certain areas of the body such as the forearm challenging. Skin thickness stays relatively constant until about the 7th decade of life when it diminishes and can make skin grafts 0.015 inches in thickness or greater difficult to harvest in one piece [8].

4. Adjacent full thickness skin graft [9]

Preoperative considerations for using adjacent full thickness skin graft for coverage include the size of the defect. Because the skin graft will be taken from skin adjacent to the incision relating to the vascular pedicle, the laxity of the skin and circumference of the arm in relation to the donor defect must be measured. Skin that is not lax enough with a large donor defect to cover will result in circumferential skin tension around a limb and could result in compartment syndrome.

Advantages:

1. Better cosmesis with full thickness skin graft closure
2. Elimination of second skin graft donor site
3. Reduction in free flap donor site wound tension closure.

Disadvantages:

1. Only small defects can be covered
2. Full thickness skin graft donor site may have high tension with closure
3. Adjunctive closure techniques such as purse string suture may be necessary for coverage of the defect
4. More wound care needed compared to primary closure

Technique:

1. The donor defect must be measured and divided into 4 right triangles (Figure 5 – yellow area).
2. Each right triangle will correspond to one half of one side of the incision corresponding to the vascular pedicle (Figure 5 – red and blue areas).
3. The red and blue areas in Figure 5 are then harvested as full thickness skin grafts and divided in half to yield 4 right triangles which are then used to close the defect corresponding to the yellow area in Figure 5. A purse string suture technique may be used to decrease the defect size and decrease the amount of skin harvested.

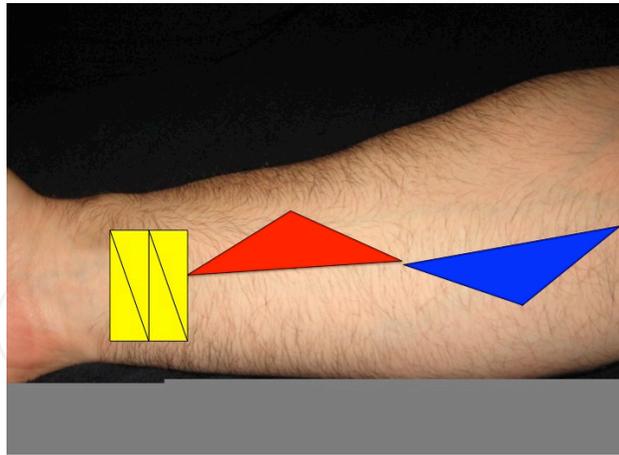


Figure 5. Schematic of full thickness skin grafts taken from skin adjacent to the incision for the vascular pedicle.

5. Conclusion

There are a variety of methods to close free flap donor sites including primary closure, full thickness, and split thickness skin grafts. None of these techniques have increased morbidity to the free flap donor site and the use of skin grafts help to decrease wound tension closure compared to primary closure. The main difference between the various methods is the variation in cosmetic outcome. This can be mitigated with purse string sutures, thicker skin grafts, and use of an artificial wound matrix.

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