

Multistage Reconstruction of Large Arm Defect Using Keystone Type I Flap and Temporary Synthetic Skin Substitute

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Summary: Large arm defects remain a challenge to the reconstructive surgeon, as local and regional flaps are limited regarding size and free flaps have disadvantages such as poor color match, technical complexity, prolonged operative time, and the risk of total flap loss. Keystone flaps are fascia-based flaps and combine perforator-based vascularity with relative simplicity of nonmicrosurgical techniques and do not distort local anatomy in cases of malignant excision with wide defects. This article highlights the approach of a multistaged procedure to reconstruct a large arm defect using a keystone type I flap and a temporary synthetic skin substitute for closure in a patient referred to our department for wide resection of a large melanoma in situ on the posterior aspect of the left arm. The defect, measuring 14 cm × 8 cm, was initially reconstructed with a keystone type I flap. Part of the wound was temporarily covered with EpiGARD (Biovision GmbH, Ilmenau, Germany) to avoid excessive wound tension. One week later, the wound was partially narrowed, and a smaller EpiGARD was placed in office under local anesthesia. The multistaged approach was completed with direct closure 1 week later after removal of the smaller EpiGARD. No complications occurred and the result was satisfactory with a pleasing cosmetic result after an 8-month follow-up. In conclusion, the keystone flap allows reconstruction of large arm defects. Temporary synthetic skin substitute coverage can serve as a good addition for those cases where tension on the margins is observed at the price of a small in-office procedure. (*Plast Reconstr Surg Glob Open* 2023; 11:e4745; doi: [10.1097/GOX.0000000000004745](https://doi.org/10.1097/GOX.0000000000004745); Published online 10 January 2023.)

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Received for publication September 2, 2022; accepted November 11, 2022.

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Presented at the 13th European Plastic Surgery Research Council (EPSRC) Meeting, August 26–28, 2021, Vienna, Austria, and at the 58th Congress of Swiss Plastic Surgery (SGPRAC-SSCPRE), September 23–24, 2021, Bern, Switzerland.

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DOI: [10.1097/GOX.0000000000004745](https://doi.org/10.1097/GOX.0000000000004745)

Reconstruction of large posterior arm defects is challenging for the plastic surgeon due to insufficient local tissue available for reconstruction and anatomical limitations. Free flaps can be a single-stage and better option for large defects when no regional option seems possible, but they require more resources, longer operating time, and microsurgical expertise.¹ Pedicled flaps, such as the latissimus dorsi (LD) flap, the thoracodorsal artery perforator flap, and the lateral arm flap, have been the workhorse for many centers around the world for defects in this region, because they are easy to raise, reliable, and do not need microsurgical techniques.^{2–5} The keystone perforator island flap, described in 2003 by Behan,⁶ has gained popularity for extremity reconstruction. It has a good skin color and contour match with a short operative time.⁷ Among the principles guiding the keystone flap, the width should be at least equal to the defect; otherwise, the use of an additional flap or double opposite keystone flaps is suggested when the defect is so wide that a single local flap is not sufficient for coverage.⁶ The use of these local perforator flaps could be

Disclosure: The authors have no financial interest to declare in relation to the content of this article.

confronted to challenges of tension following reconstruction with an increased risk of necrosis. The authors report a case of a large soft tissue defect of the posterior arm following melanoma excision in which a multistaged reconstructive procedure was used for closure: a type I keystone flap, which consisted of a skin only curvilinear trapezoidal keystone design with two V-Y advancements at the outer external edge, accompanied by a temporary EpiGARD (Biovision GmbH, Ilmenau, Germany) in the first stage, followed by two other procedures that included replacement and removal of the EpiGARD (Biovision GmbH, Ilmenau, Germany) and direct closure.

CASE PRESENTATION

A 67-year-old Caucasian male patient was referred to our department for the resection and reconstruction of a large pigmented lesion on the posterior aspect of the left arm. The patient had a medical history of hypertension and a family history of melanoma in two first-degree relatives. The lesion had been previously biopsied and identified as a melanoma in situ. Wide excision with a margin of 0.5 cm was performed on right side decubitus position under general anesthesia. The exposed muscular fascia was covered with a vacuum-assisted closure (VAC) therapy. The dimension of the skin and soft tissue defect was 14 cm × 8 cm, resulting in exposition of the posterior brachial fascia covering the triceps brachii muscle (Figure 1). A week following surgery, the vacuum device was replaced. After histological confirmation of in sano resection, the authors planned and performed a reconstruction with a keystone type I flap (Figure 2). Thus, a dissection down to the incised deep fascia was performed, and the underlying tissue was mobilized until the defect could be closed. On closure, the authors noticed excessive tension at the posterolateral angle of the flap with risk of flap necrosis postoperatively. The authors then partially released the sutures, creating a residual defect of 3 cm × 2 cm, and used an EpiGARD for temporary closure (Figure 3).



Fig. 1. The 14 cm × 8 cm defect on the posterior left arm after wide excision with a margin of 0.5 cm.



Fig. 2. Postresection defect and design of a keystone flap type I.



Fig. 3. The defect was successfully covered with the keystone type I flap and a 3 cm × 2 cm EpiGARD (Biovision GmbH, Ilmenau, Germany).

One week later, the authors could reapproximate the edges of the wound in the office under local anesthesia, and the EpiGARD was replaced with a smaller one, and another week after that the authors were able to carry out definitive closure after removal of the EpiGARD on the residual defect. A sterile mild wound compressive dressing was applied. To avoid direct pressure on the keystone type I flap, the patient was restricted to left lateral decubitus positioning for the first postoperative week. No complications occurred such as wound dehiscence or infection, and there were no functional problems related to the arm. The result was satisfactory with a pleasing cosmetic result after an 8-month follow-up (Figure 4).

DISCUSSION

Reconstruction of large arm defects remains challenging for the reconstructive surgeon as local flaps, such as the pedicled lateral arm flap, may be appropriate only for smaller defects.^{5,8} Pedicled flaps from the trunk, such as the LD flap, and free flaps are more appropriate for large-sized defects, but have disadvantages, such as donor site morbidity, longer operative time, longer postoperative recovery, and higher economic costs.^{1,8} Among the regional reconstructive options that have been described in the past years, the LD flap was an ideal option for upper arm defects.² Although seeming simple to harvest with a reliable and predictable vascular anatomy, the donor site morbidity remains



Fig. 4. Results at 6-month postoperative follow-up.

considerable.⁹ The evolution led to the introduction of the split LD flap in the 1980s by Tobin et al,¹⁰ which was latter popularized by many authors proving the reduction in seroma formation and better functional and aesthetic outcome.⁸

The introduction of perforator-based flaps has significantly led to the reduction of donor site morbidity.¹¹ Although the thoracodorsal artery perforator flap is an elegant option, there are some drawbacks. It requires a steep learning curve with the need of expertise and experience in terms of proper harvest due to the need for refined microsurgical techniques.^{4,12}

The introduction of the keystone perforator island flap was originally described and classified by Behan⁶ in 2003 and has greatly increased the reconstructive armamentarium for plastic surgeons with several advantages. The keystone perforator island flaps can be used as primary reconstructive options or in combination with other flaps to cover large-sized defects. They can easily be harvested and require less operative time, and the use of microsurgical dissections is avoided as they receive blood supply from one or more perforating vessels that run through a broad subcutaneous bed directly beneath the flap.^{11,13} In this case, the authors highlight the role a temporary EpiGARD can play when faced with tension following reconstruction with a keystone type I design. EpiGARD, which is a two-layer, nonmedicated wound dressing, was developed in 1973 and has been used worldwide for temporary coverage of open wounds.

It has an approximate cost of 30 euros for a single 12 cm × 30 cm unit.¹⁴ The two layers of EpiGARD address two needs: the outside protects the wound against bacteria and the inside serves as a foam and analog to the micro-anatomy of human skin.¹⁴ Despite being a tissue coverage following surgical excision in oncological settings, use in the early phase of VAC dressing has been favored because of its established reliability and safety.^{15,16} To better protect the wound from potential contamination, EpiGard was chosen over other temporary tissue coverage methods such as Xeroform. At the same time, it was preferred over VAC dressing because the granulation tissue produced by the latter would have made the tissues less mobile, preventing the good mobilization required for the reconstruction stage.

Although a multistaged procedure was necessary, this did not impair the good result achieved by a simple and reliable procedure with a short operative time, fast recovery period with a low complication rate, and economic impact.

CONCLUSIONS

A combined approach based on keystone type I flap with a synthetic skin substitute can be used as a multistaged procedure that allows reconstruction of large size upper arm defects. This is a pragmatic option, especially for patients with good compliance. It provides optimal results while avoiding the donor site morbidity of other more challenging techniques.

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PATIENT CONSENT

The patient provided written consent for the use of his image.

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