

Use of Skin Substitute to Facilitate Tension-Free Closure Over the Vascular Pedicle and Selective Periphery in Upper Extremity Microvascular Reconstruction

Megan Daniels, MD¹, Naomi Ghahrai, BS¹, Rendell Bernabe, MD², Megan Newsom, MD², Ja Hea Gu, MD², Prabhu Senthil-Kumar, MD², Paschalia Mountziaris, MD, PhD², Ramon DeJesus, MD^{2,3,4} ¹Virginia Commonwealth University, School of Medicine | ²Virginia Commonwealth University, Division of Plastic Surgery | ³Central Virginia VA Health Care System, Richmond, VA, USA | ⁴Naval Medical Center Portsmouth



Introduction

- Microvascular surgery, such as free tissue transfer and revascularization for digital amputation, provides a robust approach to reconstructing upper extremity defects.
- Complication rates can be high, with the most common cause of return to the operating room being thrombosis of the tissue vasculature.
- To mitigate that risk, attempts to lessen thrombogenic pressure on the soft tissue and the pedicle are essential.

Objective

- In this study, we describe the use and safety of using a skin substitute (SS) for tension-free closure (TFC) in microvascular upper extremity reconstruction.

Methods

- IRB-approved retrospective review
- Inclusion criteria:
 - Between June 2024 and March 2026
 - Patient underwent upper-limb microsurgery with TFC using SS over the vascular pedicle and/or noncritical aspects of the flap periphery
 - Follow-up for at least 30 days
- 13 patients (for a total of 14 cases) were included for analysis of patient demographics, comorbidities, flap characteristics, and surgical outcomes.

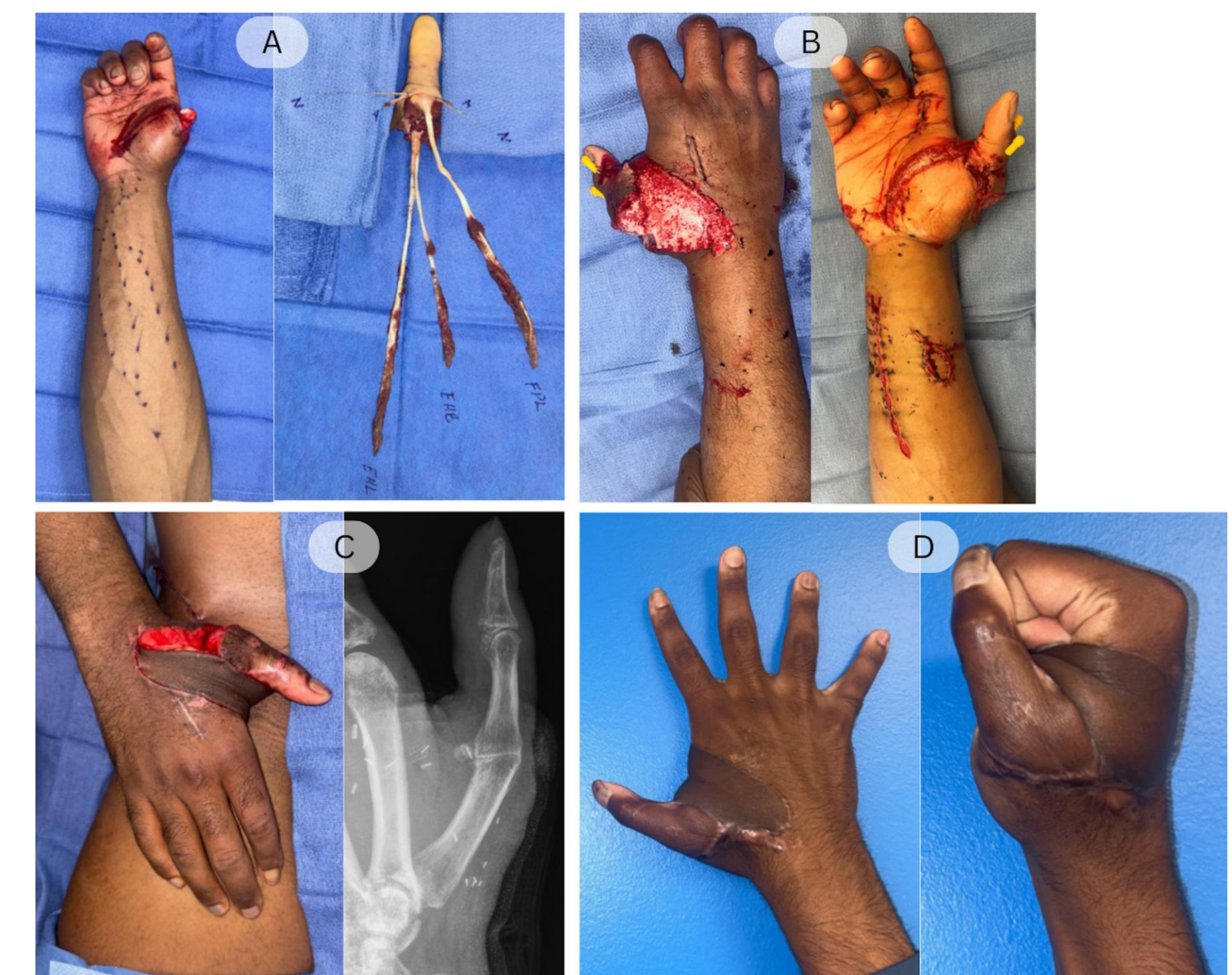
Results

| <i>Demographic and Clinical Characteristics</i> ^o | |
|---|---------------|
| Age – yr | 36.3 ± 16.4 |
| Body-mass index* | 29.2 ± 4.9 |
| Defect Etiology | |
| Mechanical Trauma – no./total no. (%) | 9/13 (69.2) |
| Crush – no./total no. (%) | 6/13 (46.2) |
| Avulsion – no./total no. (%) | 2/13 (15.4) |
| Penetrating – no./total no. (%) | 1/13 (7.7) |
| Burn – no./total no. (%) | 2/13 (15.4) |
| Congenital – no./total no. (%) | 1/13 (7.7) |
| Oncologic – no./total no. (%) | 1/13 (7.7) |
| Defect Location | |
| Forearm – no./total no. (%) | 5/13 (38.5) |
| Finger(s) – no./total no. (%) | 4/13 (30.8) |
| Thumb – no./total no. (%) | 3/13 (23.1) |
| Elbow – no./total no. (%) | 1/13 (7.7) |
| Antecubital fossa – no./total no. (%) | 1/13 (7.7) |
| <i>Reconstructive Characteristics</i> ^o | |
| Free Tissue /Microvascular Reconstruction Type | |
| Free Tissue Transfer – no./total no. (%) | 10/14 (71.4) |
| ALT – no./total no. (%) | 4/14 (28.6) |
| DIEP – no./total no. (%) | 1/14 (7.1) |
| Flow-Through Ulnar A. – no./total no. (%) | 1/14 (7.1) |
| SCIP – no./total no. (%) | 1/14 (7.1) |
| Toe-to-Hand – no./total no. (%) | 1/14 (7.1) |
| Gracilis – no./total no. (%) | 1/14 (7.1) |
| Fibula – no./total no. (%) | 1/14 (7.1) |
| Digital Amputation Revascularization – no./total no. (%) | 4/14 (28.6) |
| Skin Substitute Size (cm ²) – Median (IQR) | 100 (25-180) |
| <i>Primary and Secondary Outcomes</i> ^o | |
| Primary Outcomes | |
| Return to Operating Room in first 30 days – no./total no. (%) | 3/14 (21.4) |
| Total flap loss – no./total no. (%) | 1/14 (7.1) |
| Partial flap loss – no./total no. (%) | 1/14 (7.1) |
| Secondary Outcomes | |
| LOS – Median (IQR) | 11 (8-15) |
| Length of Follow Up | 253.1 ± 157.2 |
| Time to Secondary Procedure(s) | 143.5 ± 105.4 |
| Need for Secondary Procedure(s) – no./total no. (%) | 9/14 (64.3) |
| Local Tissue Rearrangement (LTR) – no./total no. (%) | 4/14 (28.6) |
| Debridement, Liposuction, and LTR – no./total no. (%) | 1/14 (7.1) |
| Debridement and Skin Grafting – no./total no. (%) | 2/14 (14.3) |
| Skin Grafting – no./total no. (%) | 2/14 (14.3) |

^o Plus-minus values are means ± SD. Interquartile ranges are median (1-3rd quartiles). Percentages may not total 100 because of rounding. * The body-mass index is the weight in kilograms divided by the square of the height in meters. ALT- Anterolateral thigh, DIEP- Deep inferior epigastric perforator flap, SCIP- superficial circumflex iliac artery perforator

Conclusion

- Reconstruction of upper extremity defects has improved with new microsurgical techniques.
- Challenges remain in bulk, color match, function, and local tissue availability without tension.
- Our technique aims to reduce pressure caused by factors such as swelling, body habitus, and tight closures.
- This retrospective review shows skin substitutes provide safe and effective closure.



A. Intraoperative thumb avulsion amputation, B. TFC over vein grafts needed for arterial and vein reconstruction, C. Definitive closure with a pedicled groin flap, D. 5 months post-operative follow-up with excellent range of motion and color match

References

1. Zhang Y, Gazyakan E, Bigdeli AK, Will-Marks P, Kneser U, Hirche C. Soft tissue free flap for reconstruction of upper extremities: A meta-analysis on outcome and safety. *Microsurgery*. 2019;39(5):463-475. doi:10.1002/micr.30460