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CASE REPORT

Hand/Peripheral Nerve

The Pediatric Arterialized Venous Flow-through Flap

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Summary: Arterialized venous flow-through flaps are solely vascularized through the venous plexus. The flaps were first described 40 years ago; however, reports of venous congestion and ischemia discouraged surgeons from adopting them into their armamentarium. Nevertheless, recent studies have demonstrated a resurgence of venous flow-through flaps for reconstruction of small to medium defects of the hand and digits. Although current data report variable levels of success in adults, no case reports have been published in the pediatric population for this type of flap. In this study, an arterialized venous flow-through flap from the medial forearm was used to reconstruct a volar hand defect in a young child. Flap markings, surgical technique, and aftercare are described. The surgery was uncomplicated, and the postoperative outcomes were aesthetically and functionally excellent. Venous flow-through flaps restore full-thickness defects, are relatively easy to perform, allow an early return to daily activities, and have almost no morbidity. These flaps offer excellent options for pediatric hand and finger defects. *(Plast Reconstr Surg Glob Open 2021;9:e3488; doi: 10.1097/GOX.0000000000003488; Published online 24 March 2021.)*

Repairing volar soft tissue defects constitutes a reconstructive challenge.[1] Small defects can be managed with locoregional flaps, whereas larger defects usually require free flap reconstruction. The ideal volar soft tissue flap should have good color and texture match, have the potential to be sensate, and should maintain a good range of motion of the digits. Good results have been previously published with heterodigital flaps and first dorsal metacarpal artery flaps, but there are significant limitations.[1,2]

First described in 1981, arterialized venous flow-through (AVFT) flaps have been primarily advocated for the reconstruction of soft tissue defects of the hand and fingers.[3] Unlike conventional free flaps, where the tissue is vascularized by an arterial pedicle, AVFT flaps' inflow and outflow are both venous. Although AVFT flaps' survival physiology is not completely understood, previous literature has shown some venous congestion and ischemia during the early postoperative period.[4–6]

Despite some limitations, AVFT flaps offer great promise in the pediatric population. The flaps have good color match, have almost no donor site morbidity, and allow for early return to activities.

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To the best of our knowledge, this case report presents the first known AVFT flap used in a pediatric patient. This report aims to highlight the flap's use for volar reconstruction in children and to highlight some techniques used to improve outcomes.

CASE REPORT

A 10-year-old right-hand–dominant girl developed a composite hemangioendothelioma on the palmar aspect overlying the fourth metacarpophalangeal joint. The irregular shape and nondescript borders were roughly measured at 25 × 21 mm on the preoperative magnetic resonance imaging, and the depth was estimated to include subcutaneous tissues extending below the palmer fascia. The patient underwent surgical excision to clear margins verified intraoperatively by pathology. The resulting defect was a full-thickness volar deficit between the 3rd and 4th metacarpal rays, extending from 3 cm proximal to the metacarpophalangeal joint to the junction of the 3rd web-space (Fig. 1). The paratenon of the flexor digitalis superficialis was removed with the specimen. The hemangioendothelioma also encompassed the common digital artery, with the 3rd digit, and radial digital nerve of the 4th digit. Due to the full-thickness tissue loss at the web-space, neurovascular pedicle excision, and paratenon excision, a fascio-cutaneous flap was required. The AVFT flap from the medial forearm was chosen to restore all deficits in a one-stage procedure with almost no morbidity with the straight-line closure.

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Fig. 1. Operative defect of the volar right hand involving the web-space, tendon sheath, 3rd & 4th digit common digital artery, and 4th digit radial digital nerve. A vessel clamp can be seen in the distal wound on the chosen outflow vein.

An immediate reconstruction was performed with an AVFT flap pre-marked and harvested on the volar proximal forearm measuring 30 × 20 mm (Fig. 2). The proximal forearm was chosen, as opposed to the distal forearm, due to the branching network of superficial veins, the laxity of skin, and the ability for primary closure, as well as the availability of a branch of the medial antebrachial cutaneous nerve.

The venous flap was dissected under loupe magnification and included 1 arterialized inflow vein, 1 arterialized outflow vein, and 1 supplemental venous outflow vein to decrease the risk of postoperative congestion. A branch of the medial antebrachial cutaneous nerve was divided to reconstruct the radial digital nerve of the ring finger. The AVFT was procured in 17 minutes, and the donor site was closed primarily in a tension-free straight line. After reversing the flap, to facilitate antegrade flow-through venous valves, end-to-end anastomoses were performed under microscopic magnification with 9-0 nylon sutures for the arterialized veins. A 1.5-mm venous coupler was used to anastomose the second outflow vein with a dorsal vein of the third web-space (Fig. 3).

Fig. 2. Venous flow-through flap from proximal medial forearm, including labeled veins (A for artery-vein, vein-artery flow through, and V for distal venous outflow). The flap includes a branch of the medial antebrachial cutaneous nerve used to reconstruct the radial digital nerve of D4.

Fig. 3. Immediate postoperative result displaying the donor site of proximal forearm and free-tissue reconstruction of the palmer right hand with excellent vascularization in the absence of congestion.

A loose bulky dry dressing was applied, and the hand and fingers were allowed to mobilize immediately on postoperative day 1. The patient was given 80 mg of aspirin daily for a month, and the patient was discharged from hospital 24 hours postoperative. At 1

week of follow-up, the flap displayed mild hyperemia, and had returned to normal color, texture, and mobility by 5 weeks postoperative. Normal range of motion was observed postoperative immediate, and was maintained at 1-year postoperative (**See Video [online],** which displays postoperative 1-year video showing a normal range of motion and function, and excellent cosmesis.). Normal sensation of the 4th digit was restored by 3 months postoperative.

DISCUSSION

AVFT flaps are viable reconstructive options that address the challenges faced in reconstructing defects of the palmer hand and digits. To maximize the success rate of this flap, the donor site should be chosen based on the quality and number of branching veins observed in the skin, often in the proximal or distal forearm. The superficiality and branching will improve the flap survival, as choked vessels open and the dermal plexus becomes vascularized through the reversed flow. Moreover, the flaps should be thin and include extra outflow veins to help reduce flap congestion. Congestion can complicate postoperative recovery with a lengthened hospital stay and overall morbidity.[7]

This pediatric case successfully highlights the advantages of the AVFT. The primary closure of a 3-cm donor site of the medial forearm in a young patient does not carry any morbidity. The rapid harvest and reduced hospitalization associated with the flaps is advantageous to the patient and their family. Moreover, the rapid return of range of motion, return to daily activities, and great cosmesis make the AVFT flap an excellent choice for children. The main limitation of these flaps is technical. Pediatric hand and finger vascular pedicles are small and spastic, and therefore good instrumentation and experience are critical for success.

CONCLUSIONS

This case report represents the first successful AVFT flap in the literature used for a pediatric volar hand defect. This report aims to expand the reconstructive armamentarium for volar hand defects. By following the principles highlighted above, the AVFT flap can be successfully used to achieve excellent functional and aesthetic outcomes of hand defects in the pediatric population with minimal donor site morbidity.

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