

# Use of Innovative Technologies in Pediatric Lower Extremity Reconstruction

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**Summary:** The anterolateral thigh (ALT) free flap has proven to be a reliable option for the coverage of soft tissue defects in adults and more recently in the pediatric population. When considering the use of the ALT flap in the pediatric patient, there are few studies that detail techniques specific to pediatric free flap management. We present a unique case of a 14- × 8-cm ALT flap used for traumatic wound coverage in a distal tibial injury in a 6-year-old girl. This case highlights innovative techniques in pediatric perioperative free flap monitoring and the use of continuous external tissue expansion to achieve delayed primary closure of the donor site. (*Plast Reconstr Surg Glob Open* 2016;4:e825; doi: 10.1097/GOX.0000000000000820; Published online 1 August 2016.)

The anterolateral thigh (ALT) flap is a well-known, reliable option for the coverage of soft tissue defects in adults, providing a large skin paddle, long pedicle, and low donor-site morbidity.<sup>1</sup> Studies have shown reliable application in the pediatric population, provided the perforators are well-developed, the pedicle length is appropriate, and the perforator dissection is technically feasible.<sup>2-5</sup> Although the volume of data detailing outcomes of pediatric microsurgical tissue transfer is growing, studies focused on perioperative management and reduction of donor site morbidity from both functional and aesthetic perspectives are limited.

## SURGICAL PROCEDURE

Five days after debridement and preparation of the lower extremity wound with negative pressure therapy, the contralateral ALT flap was harvested and anastomosed to the recipient posterior tibial vessels. Two DermaClose devices were applied sequentially to the wound at the time of free flap harvest and left in place for 1 week. On return to the operating room 1 week later, the postexpansion tissue was viable, and the wound was easily reapproximated.

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## CASE REPORT

The patient is a 6-year-old female restrained passenger in a motor vehicle accident, sustaining a right Gustilo III B distal tibia fracture with segmental bone loss of 5 cm, which was externally fixated with a resulting 14- × 8-cm soft tissue defect at the medial distal leg (Fig. 1). Four days later, the wound was debrided and negative pressure dressing applied. Five days after negative pressure dressing application, she underwent reconstruction of the wound using a free left ALT flap (Fig. 2) and DermaClose placement to the donor site.

Three perforators were dissected back to the profunda takeoff and anastomosed end to end to the posterior tibial artery and venae comitantes using 8-0 nylon sutures and venous coupler, respectively. The end-to-end arterial anastomosis was chosen as it provided a more suitable size match than the end-to-side option. With the posterior tibial artery clamped, Doppler of the dorsalis pedis pulse confirmed adequate distal perfusion. Both artery and vein had audible external Doppler signals, palpable pulses, and the flap was bleeding without congestion. The cephalad and caudal portions of the donor site were closed primarily, leaving a 14- × 8-cm wound that could not be reapproximated. Two DermaClose devices were placed to sequentially close the donor site wound. One week later, the wound was easily reapproximated and closed (Fig. 3).

ViOptix tissue oximetry device (Fremont, Calif.) was placed on the skin paddle for postoperative monitoring, and a modified pediatric dangle protocol was followed for 11 days. This protocol involves assessment of the lower extremity free flap characteristics before and 5 minutes after extremity dangle for increasing time periods each

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**Fig. 1.** External fixation of lower extremity with a resulting 14- × 8-cm soft tissue defect at the medial distal leg.

subsequent day. Five minutes after the flap is returned to rest from the dependent position, return to original color is documented “pass,” and the protocol continues. If the flap does not return to original color or if excessive throbbing persists over 5 minutes, “fail” is documented and the protocol for that day is repeated until “pass” is achieved. The protocol terminates with completion of six 30-minute dangle sessions in 1 day. Monitored characteristics include color, temperature, swelling, pain, and ViOptix signal and signal quality. Change in signal was recorded following 5-minute return to rest after dangle.

## DISCUSSION

When considering the ALT flap in pediatric lower extremity reconstruction, evidence-based guidelines for perioperative management are limited. We believe that the modified dangle protocol for pediatric lower extremity free flaps can be a useful tool for ensuring proper healing in this population. Utilization of ViOptix, with clinical signs and reported symptoms during daily increasing use, enabled continuous noninvasive monitoring of flap viability. Specific to the pediatric population, addition of ViOptix provides an additional data point to assist staff who may be relatively unfamiliar with free flap monitoring in this population, which becomes especially important as young patients may be unable to self-report symptoms. Additionally, this protocol expedited the progress of the dangle



**Fig. 2.** Postoperative image showing ALT coverage of lower extremity wound.

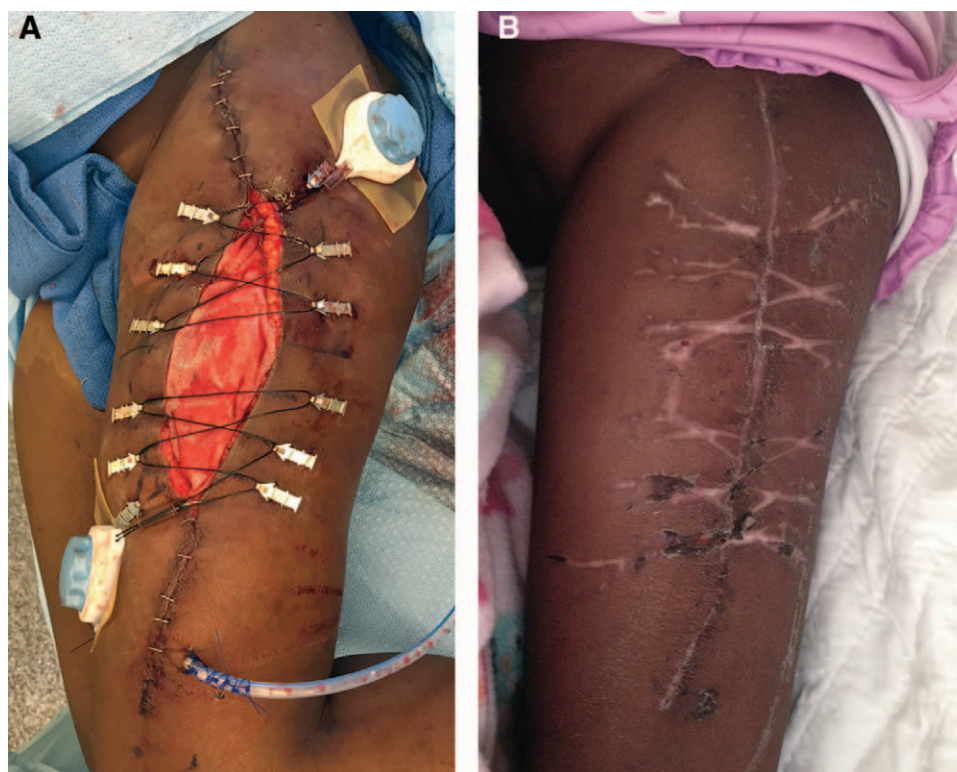
protocol compared with the author's typical practice. These innovations can minimize morbidity in the pediatric patient, in which a maximally functional lower extremity after free tissue transfer is of utmost importance.

The goals of pediatric free tissue transfer for lower extremity reconstruction include maximizing functional outcome and minimizing donor site morbidity. The donor site must be considered from functional, aesthetic, and psychological perspectives in the pediatric population.<sup>3,4</sup> Because of the size of the pediatric thigh and anatomy of the dissection, the donor site is often too wide to allow primary closure.<sup>2</sup> Split thickness skin grafting (STSG) is often required for defect coverage, which produces unsightly scarring and irregular pigmentation at the donor site.<sup>6</sup> Additionally, STSG in the pediatric population carries an increased risk of hypertrophic scarring and potential growth limitation; thus, STSG should be avoided whenever possible.<sup>2,7</sup> However, attempting to close the donor site primarily under excessive tension can cause compartment syndrome and should also be avoided.<sup>8</sup>

For over 20 years, successful donor site coverage avoiding STSG has been achieved in the adult population using internal tissue expansion.<sup>9</sup> Tissue expansion before flap transfer is useful for planned reconstruction but is often not feasible in the setting of trauma that calls for immediate skin grafting, followed by internal tissue expansion to later replace the graft.<sup>7</sup>

More recently, DermaClose has gained popularity for the closure of donor site defects in the adult microsurgical population.<sup>10</sup> By delivering a continuous force to the wound edges, it expands the surrounding tissue, allowing for clo-





**Fig. 3.** Initial application of DermaClose devices to ALT donor site (A) and reapproximation and closure 1 week later (B).

sure shortly after application.<sup>10</sup> DermaClose is applied directly to open wounds, eliminating the need for STSG and staged closure. We believe that continuous external tissue expansion is a safe alternative method for closure of the pediatric ALT donor site, avoiding the undesirable sequelae of STSG. The innovative techniques presented herein, including CETE for delayed primary closure of a large ALT donor site, and ViOptix tissue oximetry for noninvasive continuous monitoring of the lower extremity free flap during graded increase in activity, have immense implications for limb salvage and reconstruction in the setting of pediatric trauma.

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