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ORIGINAL ARTICLE
Reconstructive

Internally Fabricated Chimera Anterolateral Thigh-Amputate Flaps for Metachronous Reconstruction

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Background: The chimera flap is a versatile and exciting tissue composition for the reconstruction of complex tissue defects.
Methods: Here, we present 2 cases of internally fabricated anterolateral thigh (ALT)-amputate chimera flaps for metachronous transfer.
Results: A 22-year-old man (case 1) developed extended soft tissue necrosis in both legs following meningococcal septicemia. Before unilateral amputation, a fasciocutaneous flap based on the posterior tibial artery perforators was saved and ectopically implanted onto the ipsilateral thigh, creating an ALT-amputate chimera flap. Three months later, it was shown that the islanded ALT-amputate chimera flap remained well vascularized on either pedicle alone. Thus, a "true chimera circulation" over the scar between the 2 flaps must have developed. Subsequent free tissue transfer to the remaining right lower leg was performed successfully with uneventful healing. A 57-year-old fisherman (case 2) suffered a traumatic avulsion of his left thumb, which was ectopically replanted onto the contralateral thigh, creating an ALT-amputate chimera flap. After 3 months, the flap was raised and orthotopically replanted successfully with arthrodesis through the metacarpophalangeal joint. The previously coapted radial digital lateral femoral cutaneous nerve was coapted in the palm, and an flexor digitorum superficialis (FDS) ring transfer was performed for flexor pollicis longus (FPL) reconstruction.
Conclusions: To the best of our knowledge, these are the first case reports using the descending branch of the lateral circumflex femoral artery system for (1) temporary ectopic implantation of a thumb and (2) temporary implantation of fasciocutaneous tissue based on posterior tibial artery perforators just before below knee amputation to reconstruct the contralateral leg. *(Plast Reconstr Surg Glob Open 2019;7:e2508; doi: 10.1097/GOX.0000000000002508; Published online 18 November 2019.)*

INTRODUCTION

The chimera flap has revolutionized the reconstruction of defects by providing multiple tissue components with spatial independence and circumventing the need for multiple microsurgical anastomoses.[1–3] Fabricated perforator-based chimera flaps involve the combination of 2 anatomically distinct tissue components through intraflap microanastomosis.[4,5] Components can either be anastomosed in a flow-through manner (sequential fabrication) or to a branch of the source vessel (internal fabrication) as thoroughly described by Hallock.[4] We present 2 cases of prefabricated chimera flaps of the latter type with tissue from an amputate in a metachronous fashion. These are the first reports using the descending branch of the lateral circumflex femoral artery system (LCFAS) for temporary (1) ectopic implantation of a thumb and (2) implantation of fasciocutaneous tissue based on perforators of the posterior tibial artery.

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PATIENTS AND METHODS

Case 1: Below Knee Amputation: Anterolateral Thigh-Posterior Tibial Artery Perforator Chimera Flap

A young man developed severe soft tissue necrosis in both legs following meningococcal septicemia (Fig. 1). The non salvageable left leg was scheduled for below knee amputation (BKA), preoperative computed tomography angiogram confirmed patent posterior tibial vessels and showed skin

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Fig. 1. Bilateral skin necrosis of lower limbs after meningococcal sepsis. Due to severe osteomyelitis of the left calcaneus, BKA of the nonsalvageable left lower leg was indicated.

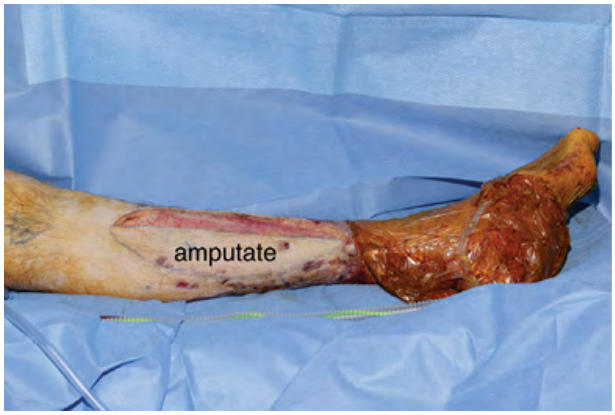

Fig. 2. Intraoperative view before below left knee amputation. The remaining healthy posterior tibial skin was used as an "amputate" flap as outlined.

perforators. Given the extensive area of the right leg requiring resurfacing, it was attempted to salvage the normally discarded skin from the BKA for this purpose. An ellipse of healthy skin was marked (8 cm × 20 cm) based on the posterior tibial artery perforators previously shown on the computed tomography angiogram and in situ identified with a handheld Doppler (Fig. 2). For BKA soft tissue coverage, a skewed posterior flap based on the peroneal vessels was used. To minimize complications, it was decided not to transfer the flap directly into the defect and to ectopically implant it onto the ipsilateral thigh, internally prefabricating a chimera flap using the descending branch of the right LCFAS as "mother" vessel. This design safeguarded the oblique branch of the LCFAS upon which the anterolateral thigh (ALT) flap was noted to be based upon, allowing a metachronous transfer of a much larger ALT-amputate chimera flap 3 months later (Fig. 3). The ALT-amputate chimera flap could now be designed with 16 cm width and 29 cm length while still achieving primary closure. The amputate was supplied by the descending branch, and the ALT was supplied by the oblique branch of the LCAFS. The ALT-amputate flap was islanded completely on the 2 vascular pedicles, and an Acland clamp was placed on each branch sequentially

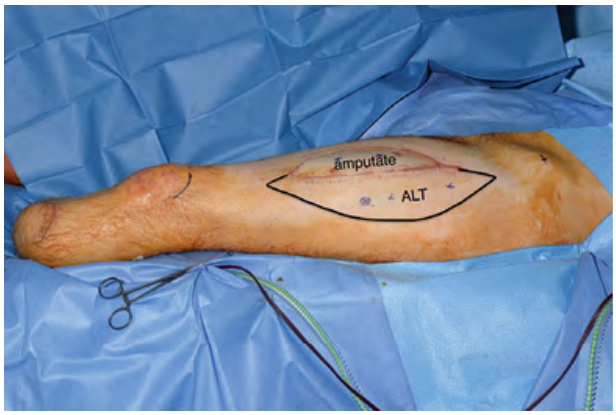

Fig. 3. A modified skew flap based on the peroneal vessels was used for soft tissue reconstruction over the stump. ALT-amputate chimera flap in situ 3 months after ectopic implantation. Superior is the amputate flap internally fabricated onto the descending branch, and the ALT flap based on the oblique branch of the LCFAS is shown inferior.

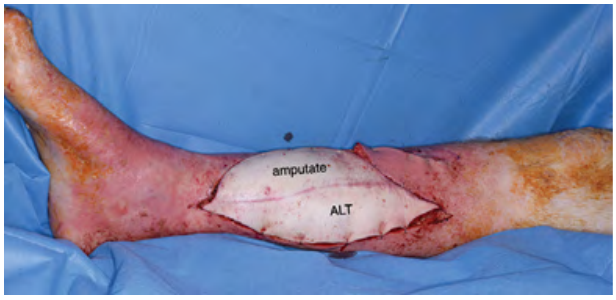

Fig. 4. The internally fabricated ALT-amputate chimera flap used for contralateral leg resurfacing intraoperatively after free microvascular transfer.

for several minutes. It was shown by the handheld Doppler that the entire chimera flap remained well vascularized on either the descending branch (entering the amputate only) or the oblique branch (entering the ALT flap only) alone. Thus, a "true chimeric circulation" over the scar between the 2 flaps must have developed. The flap was harvested

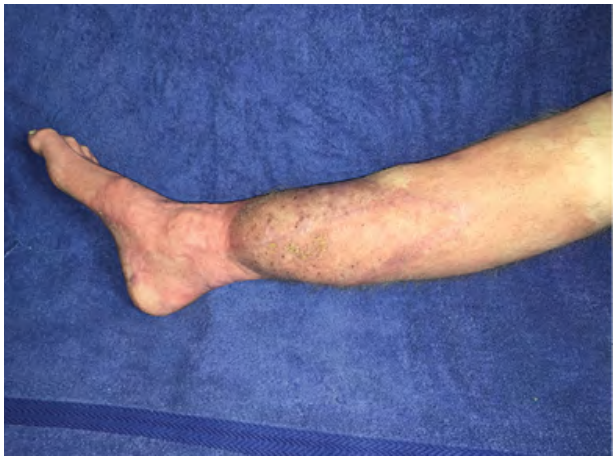

Fig. 5. Nineteen months later with a completely integrated flap. Note the developed claw toes which are planned to be addressed.

and transferred to the contralateral leg. The oblique artery was anastomosed end to end to the proximal posterior tibial artery as was the concomitant vein to the proximal tibial vein, and the descending artery end to end to the distal end of the posterior tibial artery, creating a chimera flap (Fig. 4). Flap healing was uneventful, and the patient can ambulate independently 19 months after sepsis (Fig. 5). The developing claw toes will be addressed in the near future.

Case 2: Nonorthotopically Replantable Thumb: Chimeric ALT-Thumb Flap

A fisherman suffered a traumatic avulsion of his left thumb. The amputation was through the metacarpophalangeal joint, with circumferential loss of soft tissue up to the interphalangeal joint. Vessel stripping and soft tissue loss implied that this thumb was not orthotopically replantable. The remaining thumb base was covered with a pedicled groin flap to preserve future options (Fig. 6). The amputated thumb was ectopically replanted onto

Fig. 6. Overview 1 week after ectopical replantation of the left thumb to the right thigh and soft tissue reconstruction of the thumb base with a pedicled groin flap.

Fig. 7. This photograph outlines the design of the ALT-thumb chimeric flap off the descending branch with the flap based on the first and the thumb on the second perforator.

the contralateral thigh with end-to-end anastomosis to the second of 2 perforators for the ALT flap (Fig. 7). The diagram outlines the chimeric circulation bypass of

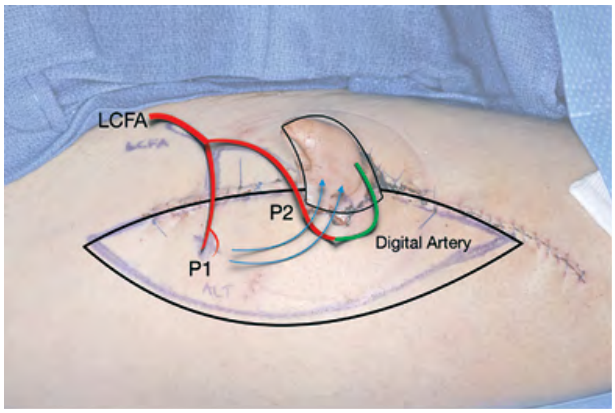

Fig. 8. The diagram highlights the arterial anastomosis of the digital artery (green) to the second perforator (red), coming off the descending branch of the LCFA. The blue arrows indicate the chimeric circulation bypass of the second perforator anastomosis having developed 3 months after ectopic replantation. Note that the venous and nerve anastomoses have not been implemented within this diagram. LCFA, lateral circumflex femoral artery.

the second perforator anastomosis (Fig. 8). This design preserved the first perforator allowing preservation of the ALT flap, for subsequent design of a chimeric ALT-amputate flap. The radial digital nerve coapted to the lateral femoral cutaneous nerve. The ectopically replanted thumb was protected by a transparent plastic cup sutured to the skin for 3 months.

At harvesting the flap, the pedicle to the thumb was not skeletonized, due to the risk of injury to the scarred pedicle. The chimeric flap was raised on the proximal perforator (Figs. 8 and 9). Arthrodesis through the metacarpophalangeal joint was performed, and the artery and vein of the flap pedicle (descending branch) anastomosed to the superficial radial vessels in the first web space in an end-to-end fashion. The previously coapted radial digital lateral femoral cutaneous nerve was harvested and coapted in the palm with incomplete return of sensation to the radio-palmar aspect of his thumb 1 year later. A flexor digitorum superficialis (FDS) ring finger tendon transfer was used for flexor pollicis longus (FPL) reconstruction. The chimera flap healed uneventfully, and the flap has been debulked twice (externally) until now (Fig. 10).

DISCUSSION

The internal fabrication of ALT-amputate chimeric flaps has advantages over ectopic replantation: first, the anastomoses of the ectopic implantation do not need to be skeletonized for orthotopic replantation (minimizing potential injury), as the circulation of the amputate can rely on newly developed collateralized blood flow. This phenomenon has not been described before, and we name it "true chimeric circulation" indicating that the entire chimeric flap can survive on either pedicle independently. Second, the variation of vessels in the ALT region allows ease of caliber matching with the amputate vessels, and easy setup for microsurgical anastomosis. Third, the chimeric flap can include specialized components such as the lateral femoral cutaneous

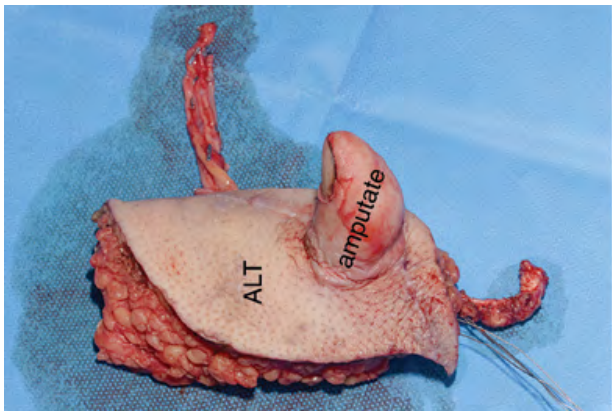

Fig. 9. ALT-thumb chimera flap with the descending branch (top) accompanied by the lateral femoral cutaneous nerve, which had been coapted to the common digital nerve of the thumb 3 months earlier, and flexor pollicis longus tendon next to the proximal phalanx bone cerclages (bottom). The extensor tendons are hidden underneath the flap.

Fig. 10. Clinical result 12 months after orthotopic replantation and thinning out twice (externally). The various contributions of the different flaps are outlined. amp, amputate; GF, groin flap.

nerve for nerve reconstruction or fascia for tendon reconstruction or bone. Fourth, the chimeric flap allows the capture of the additional flap territory of the "host" flap allowing creation of a larger "super" flap that may exceed normal dimensions for that flap, while still facilitating primary closure of the donor site.

The use of tissue from a BKA to create a large chimeric flap for resurfacing purposes rather than for secondary orthotopic replantation has not been previously described. Of course, there are a number of descriptions of ectopic replantation of body parts, originally described by Godina et al,[6] and subsequently in a recent systematic review detailing 38 published cases.[7] The use of a chimeric free flap together with an amputate has only been described in 2 cases for complex hand reconstruction[8] and in 1 case of lower limb replantation.[9] There are also reports of a "piggyback" method utilizing a similar concept of ectopic replantation to a groin flap, but with the chimeric flap raised as a pedicled rather than free flap.[10]

Chimera flaps have drawbacks that must be recognized. Complex reconstructions sometimes require complex solutions which may be too complicated to achieve with basic surgical techniques. It seems likely that the use of chimeric flaps has a learning curve as one exists for perforator flaps, as these are sometimes included in the chimeric flap. Not all components of the chimeric flap can always be monitored, just because the "mother" vessels are patent does not necessarily imply that every component is perfused (eg, bone in case 2). Furthermore, the patient's mindset is not always capable to accept ectopic implantation of an amputate, even if it was only for a limited period of time.

CONCLUSIONS

The use of internally prefabricated chimeric flaps has the advantage of (1) salvage of an amputate, (2) increasing the ease of secondary pedicle dissection by basing the chimeric flap on an adjacent undissected pedicle, (3) fashioning of a "super" flap that has dimensions exceeding that of the normal flap territory while still allowing donor site primary closure, and (4) the inclusion of specialized tissue including nerve, fascia, or bone.

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