

MICROSURGERY AND FLAP

Chimeric Flap for Reconstruction of Severe Traumatic Injuries of the Hand (a Case Report)

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Background: Injuries of the hand, including loss of digits, are devastating events. Patients often require multiple operative procedures, with prolonged recovery periods. The challenge for the reconstructive surgeon is to minimize the number of operations, shorten the recovery period, and restore the function and aesthetic appearance of the hand. When faced with a difficult reconstruction, the expense, morbidity of the donor site, and operative time must be taken into consideration. The chimeric composite flaps is combination of microanastomoses consist of two flaps or tissue, each with an isolated pedicle and a single vascular source.

Patients and Methods: We reported a case of 32-year-old man presenting with skin defect of hand, flexor and extensor tendon expose due to traffic accident after passed critical event and debridement we did chimeric flaps consist of free radial forearm flap and free dorsalis pedis flap based on radial pedicle system and dorsalis pedis pedicle system.

Result: 2 weeks postoperative, flap were vital with satisfactory functional and aesthetic outcome and almost all of graft was take as well as all of donor site graft.

Summary: In selected cases, the chimeric flap is a good option for the reconstruction of extensive, composite, and three-dimensional defects.

Keywords : *Chimeric flap, Free flap, free radial forearm flap, free dorsalis pedis flap.*

Latar Belakang: Cedera pada tangan, termasuk kehilangan jari-jari adalah kejadian yang sangat membuat kecacatan. Pasien sering membutuhkan banyak prosedur operasi, dengan akibat memperpanjang pemulihan. Tantangan bagi dokter bedah rekonstruksi adalah meminimalkan jumlah operasi dan memperpendek waktu pemulihan, serta mengembalikan fungsi dan estetika dari tangan yang mengalami trauma tersebut. Ketika kita menghadapi rekonstruksi yang sulit, biaya, morbiditas donor dan waktu operasi mesti menjadi pertimbangan. *Chimeric flap* adalah penggabungan dengan jalan mikroanastomosis dari dua flap kulit atau jaringan yang lain yang masing-masing mempunyai tangkai vaskularisasi tersendiri.

Pasien dan Metode: Kami melaporkan kasus laki-laki 32 th dengan defek di tangan, tendon fleksor dan ekstensor terbuka karena kecelakaan lalu lintas, setelah melewati masa kritis dan debridement tangan, kami melakukan rekonstruksi dengan menggunakan *chimeric flap* yang terdiri dari *free radial forearm flap* dan *free dorsalis pedis flap*.

Hasil: 2 Minggu post operasi, keadaan flap baik dengan keadaan fungsi dan estetik yang memuaskan. Hampir semua graft dan graft ditempat donor diterima dengan baik.

Ringkasan: Pada kasus tertentu, *Chimeric Flap* adalah pilihan yang bagus untuk rekonstruksi dari defek tiga-dimensi yang luas dan kompleks.

Kata Kunci : *Chimeric flap, Free flap, free radial forearm flap, free dorsalis pedis flap.*

Injuries of the hand are devastating events. Patients often require multiple operative procedures, with prolonged recovery periods. The challenge for the reconstructive surgeon is to minimize the number of operations, shorten the recovery period, and restore the function and aesthetic appearance.¹ There is often a large soft-tissue defect associated with these injuries, and soft-

tissue coverage of joints and other vital structures becomes critical. Multiple levels of the hand need to be reconstructed in the same operative setting.² When faced with a difficult reconstruction, the expense, morbidity of the donor site, and operative time must be taken into consideration.³

Chimeric flaps, as defined by Hallock, consist of multiple, otherwise independent

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flaps, each of which has an independent vascular supply but whose pedicles are all linked to a larger common source vessel.⁴ They are ideal for reconstruction of severe traumatic injuries of the hand because multiple areas can be addressed in one stage. The functional and aesthetic results are superior to those achieved with the conventional free flap using a single vascular pedicle.⁵ In this case, we describe a chimeric flap consisting of a free radial forearm flap and a free dorsalis pedis flap for reconstruction of severe traumatic injuries of the hand.

PATIENTS AND METHODS

A 32-year-old man sustained multiple injuries consisted of mild head injury, diaphragm ruptur, cruris fracture and degloving injury of the hand due to motorcycle accident.

Initially, life saving surgery was performed; patient underwent diaphragm repair through explorative laparotomy and debridement of hand injury. Problems are skin defect on dorsal site and palmar site. Extensor tendon group and flexor tendon were exposed, flexor digitorum superficialis tendon was lost, defect on first web-skin and metacarpophalangeal joint was dislocated. (Figure 1)

The plan was to reconstruct those defect using flap and tendon grafting taken from Palmaris longus tendon to reconstruct flexor tendon loss and reposition of metacarpophalangeal joint and fixation using K-wire. The patency of the dorsalis pedis, metatarsal arteries, and recipient radial vessels were all confirmed preoperatively by Doppler ultrasonography. Allen test was performed on left arm as donor of radial forearm flap to evaluate patency of radial and ulnar artery.

Microsurgically chimeric flap was our choice for covering the defect on the dorsal side of the hand with free radial forearm flap by end to side anastomose radial artery to radial artery of recipient and end to end anastomose between venae comitantes and cephalic vein and superficial vein. To cover the first web and the palmar site, we use free dorsalis pedis flap by end to end anastomose between the dorsalis pedis artery and radial artery of radial forearm

flap and end to end anastomose between comitantes vein of radial forearm flap and saphena magna vein of dorsalis pedis flap. The remaining defect was closed by skin graft. Both donor sites

were skin grafted after flap harvest. (Figure 2)

2 weeks postoperative day, flaps were vital with satisfactory functional and aesthetic outcome and almost all of graft was take. The donor site recovered uneventfully. Patient started to exercise by passive movement to prevent adhesion or stiffness of finger. Thumb tip sensory recovery was still good. (Figure 3)

DISCUSSION

The role of free tissue transfer in reconstruction of severe traumatic injuries of the hand is well established.^{2,6,7,8} The limitation of conventional free flaps is that each flap can be used to reconstruct only one area of the hand, and the patient would need multiple flaps and operations if more than one area of the hand was injured. More than one donor site would also be needed.^{1,7} The combination of functionally independent tissue components not only increases the flap size for defect coverage but also reduces the number of flaps and operations and the number of donor sites, and it may ultimately reduce treatment cost and rehabilitation time.¹ Simultaneous use of two free flaps may arguably have some technical difficulties. One of them is to find two adequate pairs of recipient vessels and perform two pairs of anastomosis, especially in patients who have had previous surgery or radiation.⁵

The chimeric flap (Figure 4), as defined by Hallock,^{1,4,6} consists of multiple flaps, each with its own individual blood supply, but all of the pedicles are linked to a common source vessel. Because of the single source vessel, microsurgical transfer can be accomplished with only one recipient site, which is a major advantage. A chimeric flap as originally conceived is truly a "polyflap" that has combined multiple, otherwise independent flaps, each with an independent vascular supply, but all linked to a common source vessel. Since the component parts of a chimeric flap can be composed of many different or even similar tissue types, these can individually and/or together restore any 3-dimensional defect

while simultaneously providing the required structural framework and immediate coverage.⁸ In Greek mythology, the chimera is a fire-breathing monster with a lion's head, a goat's body, and the tail of a serpent.⁶

Most of the chimeric flaps reported in the literature are based on the subscapular vascular system and the lateral femoral circumflex system.^{2,10} Yunliang Q has previously reported the free second toe transfer combined with a dorsalis pedis flap for reconstruction of severely injured hands with thumb loss.¹ Chung and Tong described a single case in which three flaps based on the same vessels were used: a dorsalis pedis flap, a second toe fillet flap, and a great toe wraparound flap.¹ The advantages of chimeric flaps is that they can be used to resurface larger defects, and the size of each flap can also be tailored to fit individual defects. With an intervening bridge of vessels between the flaps, there is great flexibility during inseting, thus allowing better restoration of function and aesthetics of the hand.¹

The chimeric flap has an economic design, the independent skin flaps offer easy inseting in a three-dimensional defect. Therefore, with the use of the chimeric flap, the surgeon is able to achieve a superior aesthetic result. When faced with a composite defect, such as traumatic loss of skin on the dorsal and ventral surface of the hand, one option is to transfer two free flaps; however, this takes more efforts in harvesting and requires two pairs of vascular anastomoses. The chimeric flap can be designed to cover all of the defects and requires only one pair of recipient vessels, thus saving time during the harvest and microsurgical anastomoses.⁶

The chimeric flap also solves the problem of deficiency of recipient vessels. This method is useful when recipient blood vessels are limited because of the wide resection of the primary tumor, massive trauma, radiotherapy, or when preserving a major vessel in the limb.^{6,11} Types of chimeric flaps in clinical use by Koshima: Branch-based chimeric flap, Perforator-based chimeric flap, and Microsurgically- chimeric flap.¹⁰

Chimeric flap linked by the microsurgical anastomosis adding other

components to a simple composite flap by microvascular anastomosis to a branch of axial vessel can create another type of chimeric flap. The anastomotic site of axial vessels can be a proximal branch or the distal end. This forms a compound flap that is supplied by a single vascular source.^{6,12} Koshima et al created a chimeric flap by adding a free composite flap to the lateral femoral circumflex system using microanastomoses at the distal end or to a muscle branch. This new flap consists of two or more flaps with a single vascular source.¹⁰ Choosing the distal end of axial vessels can be described as bridging, flow-through, chain-link, or chain-like flaps.¹⁰

A chimeric flap usually requires a vascular flow-through with linkage achieved by creation of a microanastomosis. A chimeric flap creates a compound flap that contains multiple tissue structures that are linked together to achieve a common purpose; however, the disadvantage of this type of flap is that circulation through their disparate vascular pedicles must then be reestablished by the microsurgical technique.⁶

Robinson was the first to describe the use of the dorsalis flap as a free flap in 1976, and Cobbett reported the first successful toe-to-thumb transfer in 1969. All of these flaps can be used for reconstruction of upper extremity defects, but the limitation is the size of defect that they may resurface.¹ The first free radial forearm flap was described in Chinese literature in 1978.¹³ The dorsalis pedis flap and radial forearm flap are both very thin fasciocutaneous flaps that are ideal for resurfacing defects of the hand.^{1,2} When combined, these two flaps provide an excellent combination for reconstruction of severe traumatic injuries of the hand with loss of the thumb.¹ In this case the flap was chimeric type by microsurgically due to conjoint flap between the free radial forearm flap and free dorsalis pedis flap according to type B classification of Isao Koshima.

The main drawback of this technique was the sacrifice of a radial artery in the donor site of the radial forearm flap. The patency of the ulnar artery must be confirmed before surgery to ensure perfusion of the arm postoperatively.¹³ Tendon expose after flap



harvesting also have consequence of adhesion of tendon gliding resulting stiffness of finger, which can be minimized by preserving the paratenon fascia with meticulous dissection suprafascially as Fu Chan Wei suggested when harvesting this flap.¹⁴

The disadvantages of dorsalis pedis flap are resistance to skin graft "take", which cause donor site morbidity. Therefore gentle pressure dressing is necessary. The skin graft on the foot was prone to hypertrophic scarring caused by friction of the skin graft against footwear when

patients walked. Patients must be informed of this problem before surgery. Therefore, a pressure garment can be applied to the donor site postoperatively to prevent friction and scar proliferation.¹

In addition, if used double flap as a chimeric free flap, the common vascular pedicle requires microanastomoses at only a single recipient site.^{6,11}

The disadvantages of the chimeric flaps include: the variation of perforators, the requirement of a learning curve, and,



Figure 1. a. Dorsal right hand need to be resurfaced (left) b. palmar right hand showed skin defect of first and second digit. (right)



Figure 2. a. Design of left radial forearm flap for donor. (left) b. Donor design of dorsalis pedis



Figure 3. Two weeks post-operative

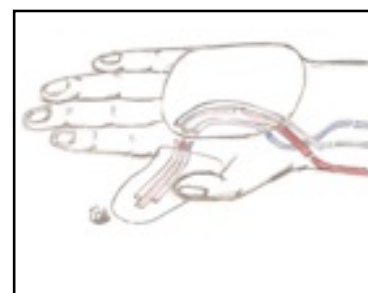


Figure 4. Chimera Flap

sometimes, the need for a second venous drainage or shifting to double flaps.⁶

SUMMARY

We reported patient with severe and multiple defect of the hand, patient underwent a single-stage reconstruction using the microsurgically chimeric flap. The result was good. Chimeric flap is one of the established modalities to reconstruct other skin and tissue complex defect.

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