Microsurgery Reconstruction in Plastic Surgery Division FKUI - RSCM, From 2009 - 2010

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Background: Microvascular surgery is the ability to repair very small blood vessels. Once the technique is mastered it becomes possible to revascularize and replant incomplete or complete digital amputations, and to design free tissue transfer procedures for the reconstruction of a large variety of damaged parts.

Method: This study included 17 cases of microsurgery in the last 1 years admitted to Division of Plastic and Reconstructive Surgery RSCM between February 2009 to February 2010. All patient were subjected to through clinical examination and appropriate laboratory and radiological investigations.

Result: Trauma is the most common etiology of soft tissue defect (10 cases, 58,8%), followed by tumor and infection (5 and 2 cases respectively). Defect is located 35,3% on the head/neck, 23,6% on the knee/lower leg, 23,6% on ankle/foot, and 17,6% on upper extremity. In this study we performed 9 anterolateral thigh (ALT), 6 radial forearm, 1 chimera flap, and 1 fibula flap. Flaps were vital in 13 cases, compromised in 4 cases, with 2 of them salvaged and survived. Vitality rate of ALT flap was 88,9% (7 vital, 1 non vital, 1 salvaged), 83,8% in RFFF (4 vital, 1 non vital, 1 salvaged) and 100% in fibular flap.

Summary: The use of microvascular techniques has revolutionized reconstruction method and expanded the range of options for reconstructing a large anatomic defects in patients. If compare with advance center, the success of micro-surgery in our division is still under them. Expected to be approached with increasing operator experience and number of cases was undertaken.

Keywords: *microvascular , microsurgery , reconstruction , flap*

Latar belakang: Operasi bedah mikro adalah kemampuan untuk memperbaiki pembuluh darah yang sangat kecil. Setelah teknik ini dikuasai, memperdarahi dan menanam kembali amputasi komplit maupun tidak komplit menjadi mungkin, serta dapat digunakan untuk mendesain prosedur transfer jaringan bebas untuk merekontruksi berbagai macam jenis jaringan yang rusak.

Metodologi: Penelitian ini melibatkan 17 kasus bedah mikro pasien yang dirawat di Divisi Bedah Plastik dan Rekonstruksi RSCM dalam 1 tahun terakhir periode Februari 2009 sampai Februari 2010. Semua pasien yang menjadi subjek penelitiaan sudah melalui pemerikaan fisik, laboratorium dan pemeriksaan radiologi yang sesuai.

Hasil: Trauma adalah penyebab paling umum dari defek (10 kasus, 58,8%), 5 kasus oleh tumor dan 2 kasus oleh infeksi. Defek yang terletak di kepala/leher 35,3%, di lutut/tungkai bawah 23,6%, di pergelangan kaki/kaki 23,6% dan ekstremitas atas 17,6%. Dalam studi ini kami melakukan 9 kasus ALT, 6 kasus RFFF, 1 kasus flap chimera, dan 1 kasus flap fibula. 13 kasus adalah flap vital , 2 kasus flap tidak vital dan 2 kasus flap tidak vital yang berhasil diselamatkan. Persentase untuk vitalitas flap pada ALT adalah 88,9% (7 kasus memiliki flap vital, 1 kasus tidak vital dan 1 kasus tidak vital yang berhasil diselamatkan), 83,8% di RFFF (4 kasus vital flap, 1 kasus tidak vital dan 1 kasus tidak vital yang berhasil diselamatkan) dan 100% vital flap pada fibula.

Ringkasan: Teknik mikrovaskuler telah merevolusi metode rekonstruksi dan memperluas pilihan untuk merekonstruksi cacat anatomi pada pasien. Dibandingkan dengan pusat studi yang lebih berpengalaman , keberhasilan bedah mikro di divisi kami masih dibawah mereka. Diharapkan dengan bertambahnya pengalaman operator dan banyaknya kasus yang dikerjakan, akan mendekati

Kata kunci: *microvascular , microsurgery , reconstruction, flap*

The common basis of all microvascular surgery is the ability to repair very small blood vessels. Once the technique is mastered it becomes possible to revascularize and replant incomplete or complete digital amputations, and to design free tissue transfer procedures for the reconstruction of a large variety of different types of damaged parts.

The first successful end-to-end anastomosis of the carotid arteries in sheep was re-

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ported in 1889 by Jassinowski, who used fine, curved needles and silk sutures. Advances in magnification technology paralleled those in surgical technique and were essential to the evolution of modern microsurgical techniques. The first compound microscope as invented by Zacharias and Hans Janseen in 1950. Nylen introduced the operating microscope for otolaryngologic surgery.

The term microvascular surgery was coined by Jacobson, who desired operating on small blood vessels under microscope magnification and demonstrated a 100% patency rate in vessels from 1.6 to 3.2 mm in diameter. These technical advances, along with increased interest in and knowledge of fine vascular anatomy, have made available the wide variety of microsurgical reconstruction options included in the armamentarium of reconstructive surgeons today[1].

Microsurgery Historical Background

The early history of blood vessel surgery was reviewed by Wintermantel. Some of the first surgical instruments and operative procedures for blood vessel surgery were described by Stromayr, in 1559, and Scultetus, in 1666. At the end of the 19th century, pioneering surgeons such as Alexis Carrel and Peyr not only demonstrated the feasibility of vascular anastomosis with predictable patency rates, but also developed the techniques, some of which are still employed today.

Improved anesthetic techniques and the introduction of antibiotics were important factors that have allowed more complex surgical procedures to be developed in the 20th century. The search for more sophisticated instruments and suture materials for vascular surgery began in the 1940s, in response to the large number of vascular injuries that occurred during the World War II [1]. Four factors were found to be essential for the success of repairing blood vessels with diameters of 1.0 milli-meter or less: (a) High magnification should be achieved with the operating microscope, (b) Delicate handling of the tissues with fine instruments, (c) A satisfactory technique for microvascular coaptation, (d) Special microsutures

Microvascular Anastomotic Techniques

A large number of different techniques have been investigated for making microvascular anastomoses. Techniques can be classified into two main categories[1]:

Type of Anastomosis

Microvascular anastomoses can be classified according to the technique used for their construction:

1. End-to-End Anastomosis

The end-to-end anastomosis was the first technique used and remains the most widely applicable. Ideally the two cut vessel ends are held loosely together in a double approxi-mating microvascular clamp; anastomosis is then made by first securing the front wall and then rotating the clamp to facilitate repair of the back wall.

2. End-to-Side Anastomosis

The end-to-side anastomosis has been im-portant for the revascularization of free tissue transfers. Godina recommended it as the method of choice for arterial anastomoses when free flap transfers are used in lower ex-tremity reconstruction. He attributed the fol-lowing advantages to end-to-side anas-tomosis: a high success rate, preservation of all existing vessels in the injured extremity, allowance of greater freedom in operative planning, and provi-sion of direct access to the vessels ensur-ing technical simplicity.

3. End-to-Side Branch Anastomosis

It is a modification of the end to side anasto-mosis, in which an arterial branch or venous tributary, located at the selected anastomotic site, is used as a recipient site vessels. The donor vessel is anastomosed to the side branch using a conventional end-to-end technique. This method of anastomosis, if available, may be preferable to an end-to-side technique, especially if clinical condi-tions are sub-optimal.

4. End-in-End Anastomosis

This technique was introduced into microsurgery by Lauritzen. It requires the upstream vessel to be placed inside the downstream vessel to make an overlap, or sleeve, in order to prevent leakage. Proponents of the technique feel that it is superior to end-to-end sutured anastomosis because it is faster, there is less intimal dissection, aneurysms at the anastomotic site have not been reported, and resistance to irradiation is greater[2].

Method of Fixation

Many methods of anastomotic fixation have been investigated since surgeons first started using microvascular techniques. The goal has been to find simpler and faster techniques without decreasing patency rates.

a. Sutured anastomoses.

The technique of suturing microvascular anastomoses has been widely used since Jacobson and Suarez first reported their successful results in 19604. Suture technique has made great progress since that time and remains the most widely used method of fixation. Many variations of sutured anastomoses have been described. These can be thought of as falling into two categories: different kinds of suture material and varying methods for placing the sutures. The goal is to copt the vessels with minimal risk of intravascular thrombosis. Decreased blood flow, alterations in blood constituents, and vessel wall damage are the three main factors that lead to intravascular thrombosis.

b. Laser techniques

Some investigators have attempted to weld blood vessels together using laser beams. The intense monochromatic light of a laser beam produces heat on absorption. A "spot weld" is accomplished by thermally induced coagulation necrosis at the site of application. The most widely used laser beams are the argon laser, the Neodymium: YAG (yttrium-aluminium-garnet) laser, the CO2 (carbon dioxide) laser, and the thulium-holmium-chromium: YAG (THC:YAG) laser. Jain10 has investigated the use of the Neodymium: YAG laser for the repair of injuries to small arteries, and he reported that laser end-to-side anastomosis had many advantages over suturing. They were fast to use, no sutures to act as foreign bodies, no needle passage trauma, less variance of results due to different skill levels of the surgeon, and it could reach deeper parts of the body not easily accessible to sutures. Bailes et al found, in their histological studies, that the healing process of laser assisted microvascular anastomoses did not differ from that seen with other techniques. Other researchers have investigated the use of a CO2 laser. Although both techniques yielded similar patency results, aneurysm formation was a consistent problem.

c. Electrocoaptation

The principle behind electrocoaptive microvascular anastomosis is to produce an adherent and localized coagulum by the passage of high frequency electric current through the adjacent tissues. The current is applied to the anastomotic site with the aid of bipolar electrode forceps. The major problem with the use of electrocoaptation methods is difficulty in determining the correct amount of electrical current necessary to produce just the right amount of coagulation. The technique has not been widely used. For electrocoaptive microsurgical anastomoses to become clinically feasible, there needs to be better understanding of the electrical welding mechanism and development of better equipment.

d. Mechanical devices

Staplers and couplers have been used both experimentally and clinically for vessel repair for long time. The devices investigated can be classified into three types: individual circumferential metallic staples, everting pinned ring devices, and extra lumen cuffs and bushings. In general mechanical devices have not been accepted for widespread use. In the laboratory, they have been shown to produce rapid and successful methods for microvascular anastomosis but, in almost all cases, they have been technically difficult to use.

e. Adhesives anastomoses.

A number of different types of adhesive microvascular anastomoses have been investigated. These include cyanoacrylic adhesives, polyurethane resin, adhesive tapes, and fibrinogen adhesives. Cyanoacrylate adhesives coapt the vessels satisfactorily. They have not become available for general clinical use, however, because of their potential to generate severe inflammatory reactions and the fibrosarcomas found in some laboratory animals after their use.

Free Flap

Autologous tissue transplantation describes the surgical technique to transfer tissue from one location in the body to another using the operating microscope and techniques of microvascular surgery to perform small vessel anastomoses. Free flaps include isolated transfer, composite tissue transfer, and functioning free muscle transfer. Structural transfers such as vascularized bone grafts or toe transplantation for hand reconstruction as well as specific tissue transfers such as vascular and neural grafts are also an integral part of the microsurgical reconstruction armamentarium.

Selection of Tissue Transplantation

Free flaps can be categorized into two different types of transplants. Isolated tissue transplants include skin, fascia, muscle and bone. More commonly "composite tissue transplant" represents a more complex flap and provide more than one function. Examples include myocutaneous, osteocutaneous, or innervated myocutaneous flaps. Determining the type of tissue deficiency and surface requirements will determine the type of flap to be selected. Tissue transplants are selected with respect to recipient site requirements, vascular pedicle length, donor site morbidity and anticipated aesthetic result. For example, a myocutaneous latissimus dorsi flap would not be transplanted to the dorsum of the foot due to its bulk and the fact that the donor tissue does not match the dorsum of the foot. Other flaps such, as an isolated skin flap (radial forearm flap or lateral arm flap) would be considered a better transplant [3].

If a flap would be used purely for resurfacing, such as on the dorsum of the hand so that secondary tendon reconstruction can be performed, a large bulky flap would not be required. However, if there is significant dead space, a large muscle flap such as a latissimus dorsi flap should be considered. If a vascularized bone flap is to be selected, the cross section of the bone defect, available vascular supply, and fixation of the vascularized bone graft must be taken into consideration. Not all flaps are selected to replace missing tissue. There are instances where tissue coverage exists but is insufficient in texture or quality. There are free flaps that are performed for purely aesthetic reasons such as the resurfacing of extremities. This is an unusual use of free tissue transfer and it is only used in special cases. A combination of the above selection factors is what determines free flap selection.

Timing of Free Tissue Transfer

The timing of the wound closure using microsurgical techniques is important. In severe injuries of the lower extremity with associated soft tissue defects, early aggressive wound debridement and soft tissue coverage with a free flap within five days was found to reduce postoperative infection, decrease flap failure, nonunion and chronic osteomyelitis[4,5]. When deciding to perform a primary closure with a free flap two keys factors should be considered; the presence of an exposed vital structure and the risk of infection. A vital structure is defined as "one that will rapidly necrose if not covered by adequate soft tissue. "The decision of what constitutes a vital structure depends on circumstances. Tissues such as vessels, nerves, joint surfaces, tendons and bone denuded of periosteum, may lose function and may create an environment resulting in infection when left exposed for long periods of time. In the decision making process, the surgeon must consider the risk of leaving the vital structure exposed, its functional importance, and the probability of differential recovery of function considering primary or delayed primary coverage[1].

The risk of infection is the second important factor that should be considered, because it may jeopardize the quality of the functional recovery or the free flap. The flap may be named after the first describing author, or it may be named according to several anatomical features, including the type or name of the tissue(s) (skin, muscle, musculocutaneous, fasciocutaneous), the location from where it is harvested (anterior lateral thigh), the type of vascularization (number of pedicles, septocutaneous, anterograde and retrograde flow) the name of the main feeding artery (dorsalis pedis flap), the shape of the flap (island flap), the origin of the flap (local versus distant flap) and way that are transplanted (free, microvascular flaps).For practical use it seems best to divide muscle from fasciocutaneous flaps. We use classic flap terminology. Attention is focused on the few most useful free flaps with which most problems can be adequately solved[3].

Specific Tissue Transfer

The commonly used fasciocutaneous free flaps are the radial forearm flap, scapular flaps, ALT flap, dorsalis pedis and groin flaps.

Radial Forearm Flap

This is a thin well-vascularized fasciocutaneous flap on the ventral aspect of the arm. The flap is based on the radial artery, which can achieve a 20 cm pedicle and has a diameter of 2.5 mm. The venous drainage is through the venae comitantes of the radial artery but the flap can include the cephalic vein, the basilica vein or both. The flap can contain the lateral antebrachial cutaneous nerve or the medial antebrachial cutaneous nerve and serve as a neurosensory flap. The size of the flap can be 10 x 40 cm^2. The advantages of this flap are: a long pedicle, and potential sensory inervation. Preliminary tissue expansion will increase the flap dimensions and more importantly, it will allow direct closure of the donor defect[5].

Scapular Flap

It is a thin, usually hairless, skin flap from the posterior chest and can be deepithelialized and used as subcutaneous fascial flap, pedicled or free flap. The flap is perfused by the cutaneous branches of the circumflex scapular artery (CSA) and drained by its venae comitantes. The length of the pedicle is 5 cm and the diameter of the artery is 2.5 mm. The cutaneous territory can be 20 x 7 cm^2 and can be divided in two components: a horizontal territory (horizontal scapular flap) and a vertical territory (parascapular flap) based on the branches of the circumflex scapular artery after the vessel courses through the triangular space. Innervated by the lateral posterior cutaneous branches of the intercostal nerves, this flap has no potential for being used as a sensate flap. Preliminary expansion of the territory of the scapular flap will increase the flap dimensions and permit direct donor site closure.

Anterolateral Thigh Flap

The anterolateral thigh flap lies on the axis of the septum dividing the vastus lateralis and the rectus femoris muscles. This is depicted by the flap outline in the figure below on the left. Arterial inflow is supplied by the descending branch of the lateral femoral circumflex artery (middle and right figures below). This branch arises from the profunda femoral trunk. The lateral femoral circumflex artery distributes both ascending and descending branches, the latter supplying the perforators to the anterolateral thigh flap. The pedicle can be as long as 7 or 8 centimeters. Depending on the point of ligation, the artery size can vary from 1 to 3 millimeters in size, with the major draining vein running slightly larger. The flap can be innervated by a major branch of the lateral cutaneous nerve of the thigh. This branch enters the flap at the superior aspect, and can be traced proximally to provide length[3].

Dorsalis Pedis Flap

This is a thin sensate fasciocutaneous flap from the dorsum of the foot. It is based on the dorsalis pedis artery, which originate from anterior tibial artery and its venae comitantes[2,5]. The length of the pedicle is 6 to 10 cm and the diameter of the artery is 2-3 mm. The nerve supply comes from the branches of deep and superficial peroneal nerves. The size of the flap is 6 x 10 cm2 and it can be raised as a skin flap alone or in combination with the second metatarsal bone as an osteocutaneous flap or in combination with 1st and 2nd toe transfer.

Groin Flap

The groin flap provides a large skin and subcutaneous tissue territory based on superficial circumflex iliac (SCIA) artery and vein. The length of the pedicle is 2 cm and the diameter 1.5 mm. The dimension of the flap can be up to 10 x 25 cm^2. Preliminary expansion of the lateral groin skin beneath the deep groin fascia will expand flap dimensions and allow direct donor site closure[1].

PATIENTS AND METHODS

Table 1. Sex

Sex	Amount	Percent
Male	7	41,2
Female	10	58,8

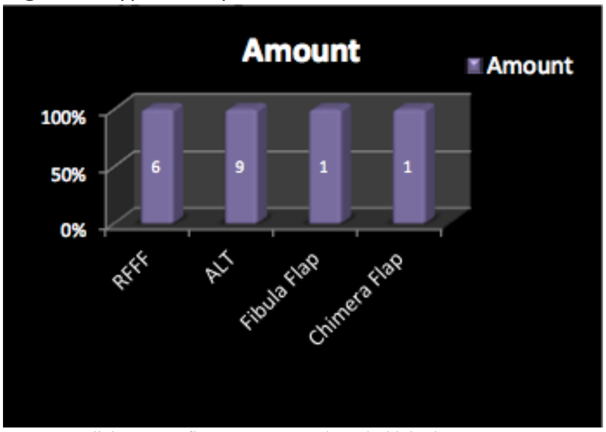
Table 2. Causes of the defect

Causes	Amount	Percent
Trauma		
burn	3	17,6
fracture	7	41,2
Tumor	5	29,4
infection	2	11,7

Table 3. Site of defect

Site of defect	Amount	Percent
Head / Neck	6	35,3
Upper extrimity	3	17,6
Trunk / Upper leg	0	0
Knee / lower leg	4	23,6
Ankle / foot	4	23,6

Figure 1. Type of Flaps



RFFF = Radial Forearm flap, ALT = Anterolateral Thigh Flap

Table 5. Operator for the surgery

Operator	Amount	Percent
Plastic and Orthophaedic	11	64,7
Plastic and ENT medicine	1	5,9
plastic	5	29,4

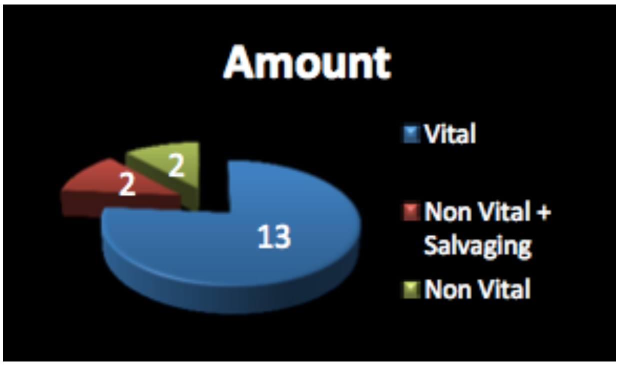


Figure 2. The Vitality of the Flap

Table 7. The vitality for ALT, RFFF,fibula and Chimera flap

Type of Flap	Vital	Non Vital + Salvaging	Non Vital
ALT	7	1	1
RFFF	4	1	1
Fibular	1	-	-
Chimera	1	-	-

This study included 17 cases of microsurgery in the last 1 years admitted to division of plastic and reconstructive surgery, Departemen of Surgery Faculty of Medicine, University of Indonesia, Cipto Mangunkusomo Hospital (RSCM) between February 2009 to February 2010. All patient were subjected to through clinical examination and appropriate laboratory and radiological investigations.

RESULT

There are 17 cases of microsurgery from February 2009 until 2010, 7 patients were female and 10 patients were male, whose age ranges from 17 to 51 years (table 1. Sex). The cause of defect was trauma in 10 patient (burn 3 cases, fracture 7 cases), tumors in 5 patients and infection in 2 patients (table 2. Causes of the defect). Head/Neck was the commonest site (6 cases or 35,3% for each sites) and then followed by knee/lower leg (4 cases, 23,6%), ankle/foot (4 cases, 23,6%) and upper extremity (3 case, 17,6%) (Table 3. Site of defect). The smallest size of the defect was 4x5 cm, while the largest one was 15x20. This study use ALT flap for 9 cases, RFFF for 6 cases, fibula flap for 1 case and chimera flap 1 case (Figure 1. Flap type). From

17 cases, the operation was done with Plastic surgeon alone 5 cases, done with orthophaedic surgeon for 11 cases and with Ear, nose, and throat medicine for 1cases (Table 4. Operator for the surgery). The success of operation was 88, 3% (13 cases has vital flap and 2 cases has non vital flap and 2 cases has vital flap after salvaging) (Table 5. The vitality of the Flap) (Table 6 . The vitality for ALT, RFFF, fibula and Chimera flap).

DISCUSSION

There are 17 cases of microsurgery in the last 1 years admitted to Division of Plastic and Reconstructive Surgery, Departemen of Surgery Faculty of Medicine, University of Indonesia, Cipto Mangunkusomo Hospital (RSCM) between February 2009 to February 2010. Trauma was the commonest cause of soft tissue defect (10 cases, 58, 8%), 5 cases caused by tumor (29, 4%), and 2 cases caused by infection (11, 7%). Head/Neck was the commonest site (6 cases or 35,3% for each sites) and then followed by knee/lower leg (4 cases, 23,6%), ankle/foot (4 cases, 23,6%) and upper extremity (3 case, 17,6%). Khouri, Roger K. M.D.; Cooley, Brian C et al.; in The International Microvascular Research Group (A Prospective Study of Microvascular Free-Flap Surgery and Outcome), from 439 cases they find that the commonest causes was tumor 179 cases (36,3%), trauma 164 cases (33,3%), chronic wound 38 cases (7,7%), osteomyelitis 25 cases (5,1%), congenital anomaly 19 cases (3,9%), burn injury 17 cases (3,4%) and others 51 cases (10,3%). And they also found that the commonest site was in head 135 case (27,4%) followed by upper extremity 81 case (16,5%), breast 72 case (14,6%), trunk/upper leg 31 case (6,3%), knee/lower leg 104 case (21%), and ankle/foot 69 case (14%)[6] .

In this study we performed 4 kind of Flap consist of ALT (9 cases, 53%), RFFF (6 cases, 35,3%), Chimera Flap (1 case, 5,9%), and fibula Flap (1 case, 5,9%). We have 76,5 % (13 cases) vital flap, 11,8% (2 cases) non vital flap and 11,8% (2 cases) non vital ongoing salvaging. The percentage for flap vitality in ALT was 88,9% (7 case has a vital flap, 1 case has non vital flap and 1 case has a non vital flap ongoing salvaging), 83,3% in RFFF (4 case has a vital flap, 1 case has non vital flap and 1 case has a non vital flap ongoing salvaging) and 100% in fibular flap. And from all the 17 cases operation, only 5 operations had done by plastic surgeon alone. Eleven cases were done with orthopedics division, and 1 case done with ear nose and throat medicine.

Free tissue transfer has become common place in many centers around the world. The numerous advantages include stable wound coverage, improve aesthetic and functional outcomes, and minimal donor site morbidity. Since the introduction of free tissue transfer in the 1960s, the success rate has improved substantially and is currently 95-99% among experienced surgeons[3].

A radial forearm free flap is a versatile fasciocutaneous flap first described by Yang et al. and Song et al. from China in 1982, who used it to treat burn contracture. Therefore, the flap is also known as the "Chinese" flap. The radial forearm osteofasciocutaneous flap is an adaptation of the radial forearm flap incorporating a segment of the radius. The radial forearm flap is extremely reliable. The overall flap success rate of microvascular free tissue transfer in larger series is 90-98%.

Nevertheless, all microvascular procedures are dependent on the experience of the surgeon and various patient factors. Flap failure is mostly caused by venous failure with thrombosis at the anastomosis[5]. A take-back rate of 10% is expected, and about half of these flaps are successfully salvaged. In this study we have 83,3% success of RFFF. The anterolateral thigh flap is one of the most versatile and useful perforator flaps for multidimensional reconstructions at all body sites. The anterolateral thigh flap is indicated for reconstruction of a diverse range of defects of various surface areas and depths; it can be used as an ultra thin flap for resurfacing, rolled up for filling in dead space, or taken with muscle to obliterate spaces or provide bulk. The anterolateral thigh flap has been used in trauma salvage as a flow-through flap, as a tissue carrier, and to piggyback additional flaps. The flap can be raised pedicled (proximally or distally) or free, suprafascial or subfascial, further thinned, or harvested with muscle or additional tissue components. Fuchan Wei, M.D., Vivek Jain, M.Ch. (Ortho.) et all, in Have We Found an Ideal Soft-Tissue Flap? An Experience with 672 Anterolateral Thigh Flaps. In their study, they found that 643 of 672 flaps survived completely, providing a success rate of 95.68 percent. Of the 29 failed cases, 12 were complete failures and 17 were partial failures[3].

SUMMARY

Building on the creative efforts of early pioneers and subsequent contributors, microsurgery matured as a specialty by the close of the twentieth century. During this period, new tissue donor sites and flap ariations were described and research was continued on limb/ digit replantation and free-tissue transfer worldwide.

The use of microvascular techniques has revolutionized reconstruction and expanded the range of options for reconstructing large anatomic defects in patients. Microsurgery is complex and technically demanding, but with careful preparation and proper execution, it can be beneficial to the patient.

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