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"MICROSURGERY: AN IMPORTANT TOOL FOR RECONSTRUCTIVE SURGERY-A REVIEW"

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ABSTRACT

Microsurgery is a general term for surgery requiring an operating microscope. Microsurgery is used to operate on very small structures, often requires miniaturized instruments, and has myriad uses. Microsurgery is used to reattach a severed hand or another amputated part to the body by reconnecting the small blood vessels and restoring the circulation before the tissue starts to die. The most obvious developments have been procedures developed to allow anastomosis of successively smaller blood vessels and nerves (typically 1 mm in diameter) which have allowed transfer of tissue from one part of the body to another and re-attachment of severed parts. Although microsurgery is used mostly in plastic surgery, microsurgical techniques are utilized by all specialties today, especially those involved in reconstructive surgery such as: general surgery, orthopedic surgery, gynecological surgery, otolaryngology, neurosurgery, maxillofacial surgery, and pediatric surgery. The aim of present article is to provide in depth knowledge about the technique of Microsurgery & its clinical utility

KEYWORDS

Principles of microsurgery, Microsurgery, Micromanipulation, Micrurgy, Free flap reconstruction, free tissue transfer, Replantation, Composite flaps, Flap harvest radial forearm flap, lateral arm flap, and flap monitoring.

INTRODUCTON

The advances in the techniques and technology that popularized microsurgery began in the early 1960s. The first microvascular surgery, using a microscope to aid in the repair of blood vessels, was described by vascular surgeon, Jules Jacobson, of the University of Vermont in 1960. Using an operating microscope, he performed coupling of vessels as small as 1.4 mm and coined the term "microsurgery." Hand surgeons at the University of Louisville (KY), Drs. Harold Kleinert and Mort Kasdan, performed the first revascularization of a partial digital amputation in 1963[1]. Nakayama, a Japanese cardiothoracic surgeon, reported the first true series of microsurgical free-tissue transfers using vascularized intestinal segments to the neck for esophageal reconstruction after cancer resections using 3-4mm vessels[2].

Contemporary reconstructive microsurgery was introduced by an American plastic surgeon, Dr. Harry J. Buncke. In 1964, Buncke reported a rabbit ear replantation, famously using a garage as a lab/operating theatre and home-made instruments[3]. This was the first report of successfully using blood vessels 1 millimeter in size. In 1966, Buncke used microsurgery to transplant a primate's great toe to its hand[4].

During the late sixties and early 1970s, plastic surgeons ushered in many new microsurgical innovations that were previously unimaginable. The first human microsurgical transplantation of the great toe (big toe) to thumb was performed in April 1968 by Mr. John Cobbett, in England[5]. In Australia work by Dr. Ian Taylor[6] saw new techniques developed to reconstruct head and neck cancer defects with living bone from the hip or the fibula. Although primarily developed and used by plastic surgeons, a number of surgical specialties now use microsurgical techniques. Otolaryngologists (ear, nose, and throat doctors) perform microsurgery on structures of the inner ear or the vocal cords. Maxillofacial surgeons and Otolaryngologists use microsurgical techniques when reconstructing head and neck cancer patients. Cataract surgery, corneal transplants, and treatment of conditions like glaucoma are performed by ophthalmologists. Urologists and gynecologists can frequently now reverse vasectomies and tubal ligations to restore fertility.

ILLUSTARTION OF MICROSURGERY TECHNIQUE[7, 8]

FREE TISSUE TRANSFER

Free tissue transfer is a surgical reconstructive procedure using microsurgery. A region of "donor" tissue is selected that can be isolated on a feeding artery and vein; this tissue is usually a composite of several tissue types (e.g., skin, muscle, fat, bone). Common donor regions include the rectus abdominis muscle, latissimus dorsi muscle, fibula, and radial forearm bone and skin lateral arm skin. The composite tissue is transferred (moved as a free flap of tissue) to the region on the patient requiring reconstruction (e.g., mandible after oral cancer resection, breast after cancer resection, traumatic tissue loss, congenital tissue absence). The vessels that supply the free flap are anastomosed with microsurgery to matching vessels (artery and vein) in the reconstructive site. The procedure was first done in the early 1970s and has become a popular "one-stage" (single operation) procedure for many surgical reconstructive applications (Fig.1 & Fig 2).

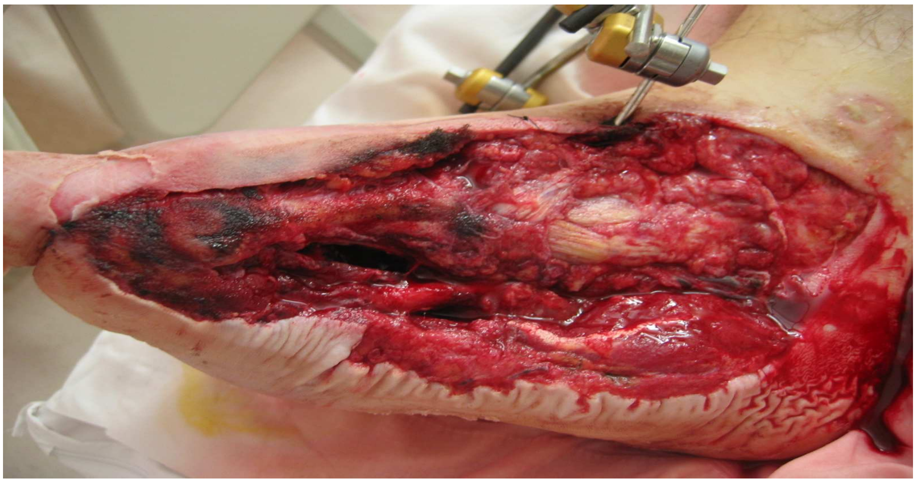

Figure 1: Traumatic foot/ankle soft tissue wound from motor vehicle accident

Figure 2: Anterio-lateral thigh flap free-tissue transfer reconstruction

REPLANTATION:

Replantation is the reattachment of a completely detached body part. Fingers and thumbs are the most common but the ear, scalp, nose, face, arm and penis have all been replanted. Generally replantation involves restoring blood flow through arteries and veins, restoring the bony skeleton and connecting tendons and nerves as required.

Initially, when the techniques were developed to make replantation possible, success was defined in terms of a survival of the amputated part alone. However, as more experience was gained in this field, surgeons specializing in replantation began to understand that survival of the amputated piece was not enough to ensure success of the replant. In this way, functional demands of the amputated specimen became paramount in guiding which amputated pieces should and should not be replanted. Additional concerns about the patients ability to tolerate the long rehabilitation process that is necessary after replantation both on physical and psychological levels also became important. So, when fingers are amputated, for instance, a replantation surgeon must seriously consider the contribution of the finger to the overall function of the hand. In this way, every attempt will be made to salvage an amputated thumb, since a great deal of hand function is dependent on the thumb, while an index finger or small finger may not be replanted, depending on the individual needs of the patient and the ability of the patient to tolerate a long surgery and a long course of rehabilitation.

However, if an amputated specimen is not able to be replanted to its original location entirely, this does not mean that the specimen is unreplantable. In fact, replantation surgeons have learned that only a piece or a portion may be necessary to obtain a functional result, or especially in the case of multply amputated fingers, a finger or fingers may be transposed to a more useful location to obtain a more functional result. This concept is called "spare parts" surgery.

TRANSPLANTATION:

Microsurgical techniques have played a crucial role in the development of transplantation immunological research because it allowed the use of rodents models, which are more appropriate for transplantation research (there are more reagents, monoclonal antibodies, knockout animals, and other immunological tools for mice and rats than other species). Before it was introduced, transplant immunology was studied in rodents using the skin transplantation model, which is limited by the fact it is not vascularized. Thus, microsurgery represents the link between surgery and transplant immunological research. The first microsurgical experiments (porto-caval anastomosis in the rat) were performed by Dr. Sun Lee (pioneer of microsurgery) at the University of Pittsburgh in 1958. After a short time, many models of organ tranplants in rat and mice have been established. Today, virtually every rat or mouse organ can be transplanted with relative high success rate. Microsurgery was also important to develop new techniques of transplantation that would be later performed in humans. In addition, it allows reconstruction of small arteries in clinical organ transplantation (e.g. accessory arteries in cadaver liver transplantation, polar arteries in renal transplantation and in living liver donor transplantation).

GENERAL CONCEPTS OF MICROSURGERY

Microsurgery uses the operating room microscope or high-powered loupe magnification to aid in the techniques of microvascular surgery to anastomose small vessels and nerves[9].Microsurgical reconstruction is used for complex reconstructive surgery problems when other options such as primary closure, healing by secondary intention, skin grafting, or local or regional flap transfer, are not adequate. Microsurgery may not be the best solution for all reconstructive dilemmas and usually is not the first choice in the reconstructive ladder. However, it can offer the reconstructive surgeon an important tool to achieve complex reconstruction by proceeding with free tissue transfer from distant sites. Free tissue transfer includes flaps such as isolated transfers, composite tissue transfers, functioning free muscle transfers, vascularized bone grafts, and toe transplantation. In addition, specific tissue transfers such as neural grafts or vein grafts are also considered free tissue transfer. In specific cases, such as large defects of the face after tumor resection, free tissue transfer may be the best option for closure of the defect.

HISTORY OF THE PROCEDURE

The field of microsurgery began with the introduction of the operating microscope when Jacobson and Suarez described the anastomosis of blood vessels. In the 1960s, as microsurgical techniques were perfected, increasing success was seen with digital artery repairs and finger replantation. This laid the foundation for microsurgical composite tissue transfer, which became popular in the 1970s. In the 1980s, an emphasis was placed on improved function with autologous tissue transplantation, which is exemplified in mandibular reconstructions for cancer. Composite grafts consisting of soft tissue and bone aided in stabilizing the mandible, assisted with mastication, and allowed for reliable coverage during the postoperative period, when radiation usually was required. Today, microsurgical techniques have become an integral part of the armamentarium for plastic surgeons, allowing for soft tissue coverage and function after trauma or oncologic resections.

INDICATIONS

The indications for tissue transfer utilizing microsurgical techniques include the need to cover exposed vital structures such as joint surfaces, tendons, vessels, and bone denuded of periosteum; the need to restore shape, such as in the breast after mastectomy; and the need to restore function, such as in the muscles of the face. Finger reimplantation or transfer may represent another aspect of this technique. Microsurgery may also be used as a new approach to achieve lymphatic drainage in cases of lymphedema[10]. The indications for microsurgical reconstruction and the type of flap used depend on the type of tissue required and the size and location of the defect. Defects can be an isolated tissue type, such as soft tissue defects on the dorsum of the hand, or some combination of skin, subcutaneous tissue, nerves, muscle, tendons, cartilage, bone, and mucosa.

Free flaps can be categorized into 2 different types of transplants. Isolated tissue transplants include skin, fascia, muscle, nerve, or bone individually. The more common composite tissue transplant represents a more complex flap and provides more than one type of tissue. Such flaps include myocutaneous, osteocutaneous, or innervated myocutaneous flaps. Historically, reconstruction of a defect was based on a reconstructive ladder, with local and simple procedures being performed prior to more extensive procedures or distant tissue transfers. Today, the use of free tissue transfer is no longer seen as the apex of the reconstructive ladder. Instead, it is a generalized tool for complex or composite tissue transfers, for treating wounds with poor healing or inflow, and for situations in which postoperative radiation may play a factor in wound healing. The table 1. below shows the examples of free tissue transfer.

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Table 1

Examples of Free Tissue Transfer

Defect Type	**Tissue Defect**	**Common Flaps**
Coverage of exposed structures	Open tibial fractures in the distal third of the leg	Latissimus dorsi muscle free flap; gracilis muscle free flap
Dead space	Obliteration of maxilla defect after maxillectomy for cancer	Rectus abdominus muscle free flap
Tissue defect	Breast reconstruction	Transverse rectus abdominus myocutaneous (TRAM) free flap; deep inferior epigastric perforator (DIEP) flap; superior gluteal artery perforator (SGAP) free flap
Bone and soft defect	Mandible reconstruction	Fibula osteocutaneous free flap
Bone and soft defect	Infraorbital and maxillary defect	Parascapular osteocutaneous free flap
Facial muscle denervation	Facial paralysis with muscular atrophy	Gracilis muscle free flap
Digital amputation	Thumb amputation	Great toe composite free flap
Digestive tract defect	Esophageal reconstruction	Jejunum free flap; anterior lateral thigh (ALT) free flap
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Bone and soft	Infraorbital and maxillary	Parascapular osteocutaneous free flap

defect	defect	
Facial muscle denervation	Facial paralysis with muscular atrophy	Gracilis muscle free flap
Digital amputation	Thumb amputation	Great toe composite free flap
Digestive tract defect	Esophageal reconstruction	Jejunum free flap; anterior lateral thigh (ALT) free flap

CONTRAINDICATIONS[11-20]:

Contraindications for microsurgical free tissue transfer fall into 2 categories: patient issues and surgical issues.

PATIENT ISSUES

Patient issues associated with the patient include any condition that may put the patient's life in danger or significantly increase the probability of postoperative flap loss. The time required to harvest and insert a flap is relatively long. Therefore, any medical condition that inhibits the patient's ability to withstand prolonged anesthesia, such as severe respiratory disease, is an absolute contraindication. Microsurgical free tissue transfer is absolutely contraindicated in patients who are critically ill, have ongoing sepsis, or have uncontrolled coagulopathy.

Relative contraindications include any condition that increases the risk of intraoperative or postoperative complications. Common conditions that are not contraindications but can increase the risk of complications include cardiovascular disease, diabetes mellitus, Raynaud syndrome, scleroderma, other collagen vascular diseases, smoking, radiation, and ongoing infections. In general, a thorough review of the patient's medical history and current conditions is critical when formulating a treatment algorithm and timing for a patient.

SURGICAL ISSUES

Surgical issues include the lack of a properly trained surgeon or surgical team (this is usually not an issue today because microsurgery is common and a major part of most plastic surgery training programs). Other surgical issues include limited resources that might inhibit the staff from properly caring for the patient intraoperatively or postoperatively or the lack of access to specialized microsurgical instruments.

HISTORY AND PHYSICAL EXAMINATION

Preoperative assessment of the patient should include an in-depth review of the patient's current conditions, past medical history, past surgical history, previous history with anesthesia, and current medications. The social history is important to identify possible issues with substance or tobacco use as well as to better understand the patient's support network for postoperative care. The physical examination is used to identify the current defect or to anticipate a presumed defect (in the case of an oncologic procedure). The ability to anticipate the operative defect and plan for appropriate reconstructive repair is imperative for a successful restoration of form and function.

LAB STUDIES

Because of the possible long operative and fluid shifts associated with microsurgical cases, a complete blood count, type and screen or type and cross, coagulation panel to rule out either coagulopathy or a hypercoagulable state, and basic chemistries are routinely ordered preoperatively. ECG and chest radiography are also a part of the routine preoperative workup. Additional laboratory studies and tests such as pulmonary function tests are necessary, depending on the general health and age of the patient.

IMAGING STUDIES

Imaging studies are an important part of the preoperative workup for specific defects and reconstructive procedures. However, imaging studies are not performed routinely in every case. Computed tomography (CT) scans of the head and neck may be useful in understanding the expected defect. In mandibular reconstruction, 3-dimensional CT scans may help visualize the anticipated defect in 3 dimensions. In lower extremity reconstruction, angiography is useful to determine the zone of vessel injury and the location of recipient vessels. Lower extremity angiography is also useful prior to free fibula harvest in patients who have peripheral vascular disease.

COMMON FLAPES [21-23]

After the decision has been made to proceed with a microsurgical reconstruction, the optimal flap must be chosen. This decision is based on the size of the defect, the type(s) of tissue required for the repair (bone, muscle, fascia, tendon, nerve, skin), the length of vascular pedicle, and the reliability of the flap.

Perforator flaps involve the dissection of terminal blood vessels into a tissue segment. These flaps have not only gained significant popularity in the last decade as a result of a better understanding of the anatomy and blood supply to specific tissue territory but have revolutionized the field of microsurgery. By dissecting the blood vessels to the flap and sparing the surrounding tissue, large flaps can be harvested with minimal functional loss to the patient.

Three are three common perforator flaps: the anterior lateral thigh (ALT) flap, the superior gluteal artery perforator (SGAP) flap, and the deep inferior epigastric artery perforator (DIEP) flap.

The following is a list of common, reliable flaps that are used in reconstructive surgery.

ANTERIOR LATERAL THIGH FLAP

The anterior lateral thigh (ALT) flap is a fasciocutaneous flap that has become popular in recent years. The flap is located over the middle third of the thigh anterior and lateral to the rectus femoris and the vastus lateralis muscles. Although the flap is supplied by musculocutaneous perforators 85% of the time, it can be raised as a perforator flap, allowing for minimal disruption of the underlying musculature. It is usually used for coverage of defects when a relatively thin flap is required but can be harvested with parts of the vastus lateralis muscle when a flap with more volume is required.

- Type - Fasciocutaneous
- Dominant pedicle - Septocutaneous branches of the descending branch of the lateral circumflex femoral artery and venae comitantes
- Innervation - Sensory derived from the lateral femoral cutaneous nerve (L2-3)

RADIAL FORE ARM FLAP

This is a useful and versatile flap with a long vascular pedicle and thin, pliable skin that was widely used in China before becoming popular in the western literature. The flap is based on the radial artery and can achieve a pedicle length of 20 cm and a diameter of 2.5 mm. The flap size can reach an area of 10 X 40 cm^2.

Raising this flap sacrifices a major artery to the hand; therefore, before harvesting this flap, check that the perfusion to the hand is preserved through the ulnar vascular system. The osteocutaneous flap risks radius fracture if not carefully harvested. In addition, exposure of the flexor tendons must be avoided by careful preservation of the paratenon and coverage of tendons with surrounding muscle bellies prior to skin grafting.

- Type- Fasciocutaneous or osteocutaneous
- Dominant pedicle - Radial artery, venae comitantes and cephalic vein
- Innervation - Medial and lateral antebrachial cutaneous nerves (sensory)

LATERAL ARM FLAP

The flap can be harvested as a fasciocutaneous, innervated fasciocutaneous, or de-epithelialized subcutaneous fascial flap. The flap is supplied by the posterior radial collateral vessels. The flap does not sacrifice a major vessel in the arm and may be harvested in the same upper extremity that requires reconstruction. The flap may be bulky, and the pedicle may be short (up to 7 cm). The posterior brachial cutaneous nerve (C5-6) innervates the flap when it is harvested as a sensate flap. The donor site may be closed, if laxity is present in the upper arm, or skin grafted. In either case, the donor scar may be conspicuous.

- Type - Fascial or fasciocutaneous
- Dominant pedicle - Posterior radial collateral artery and venae comitantes (branch of profunda brachii artery)
- Innervation - Posterior cutaneous nerve of the arm (sensory); additional sensory from the posterior antebrachial cutaneous nerve

SCAPULAR FLAP

The pedicle for this flap is long and reliable. It is a thin, sometimes hairless, skin flap from the upper back and can be de-epithelized and used as subcutaneous fascial flap, pedicled flap, or free flap. However, this flap has several drawbacks. The patient must be positioned in either the lateral decubitus position or prone position for harvest; the sensory innervation is not reliable; and the skin may be too bulky, depending on the body habitus of the patient.

- Type - Fascial, fasciocutaneous, or osteocutaneous
- Dominant pedicle - Circumflex scapular artery and vein
- Innervation - Lateral and posterior cutaneous nerves of third to fifth intercostal nerves (sensory)

GROIN FLAP

The groin flap can provide a large skin and subcutaneous tissue territory based on the superficial circumflex iliac artery and vein. It is particularly helpful when thin tissue coverage is required. The flap can be as large as 10 X 25 cm^2. A tissue expander can be placed under the deep groin fascia, which can expand the flap and allow for direct donor site closure. The small diameter of the superficial circumflex iliac artery and variable vascular anatomy make this flap less popular compared to other free tissue transfers.

- Type - Fasciocutaneous
- Dominant pedicle - Superficial circumflex iliac artery and venae comitantes and superficial circumflex iliac vein

SUPERIOR GLUTEAL PERFORATOR FLAP

The superior gluteal artery perforator (SGAP) flap is a perforator flap used mainly for breast reconstruction. The abdomen is the most common harvest site for autologous breast reconstruction; however, in some cases, such as patients who have excessive scarring or are very thin, the abdomen is not an option as a donor site. The gluteal region and the SGAP flap offer alternatives when the abdomen is unavailable as a donor site.

- Type - Fasciocutaneous
- Dominant pedicle - Superior gluteal artery perforators

LATISSIMUS DORSI FLAP

This flap is a very reliable flap with large muscle mass that can be harvested with or without a skin paddle. The primary vascular pedicle can be as long as 8 cm. If additional tissue is needed, the latissimus dorsi muscle may be raised with the serratus anterior muscle and/or scapular flap on one pedicle. One drawback is the need for positioning the patient in a lateral decubitus position for harvests.

- Type - Muscle or musculocutaneous
- Dominant pedicle - Thoracodorsal artery and vein
- Minor pedicle - Perforators from the posterior intercostal arteries and 7 lumbar artery and venae comitantes
- Innervation - Thoracodorsal nerve (motor)

RECTUS ABDOMINIS FLAP

This is a reliable flap with a large muscle mass and skin paddle. The vertically oriented muscle extends between the costal margin and the pubic region and is enclosed by the anterior and posterior rectus sheaths. It has 2 dominant pedicles, based on the superior epigastric artery and vein and the inferior epigastric artery and vein.

The pedicle is large and reliable. The flap may be harvested with the patient in a supine position. One drawback to this flap is the possibility of abdominal hernia after sacrifice of one of the rectus abdominus muscles. Careful closure of the layers of the abdominal wall is critical to prevent this occurrence. In recent years, the perforator flap based on the inferior epigastric artery and vein (DIEP) has become popular as a donor site for breast reconstruction. Its main advantage is the decreased morbidity to the abdominal wall.

- Type - Muscle or musculocutaneous (TRAM, VRAM, muscle sparing TRAM)
- Dominant pedicles - Deep inferior and superior epigastric arteries and veins
- Innervation - Seventh to twelfth intercostal nerves (motor) and lateral cutaneous nerves from seventh to twelfth intercostal nerves (sensory)

GRACILIS FLAP

The gracilis muscle has a dominant pedicle and several minor pedicles. It is a thin and flat muscle that lies between the adductor longus and sartorius muscles anteriorly and the semimembranosus muscle posteriorly. The dominant pedicle is the ascending branch of medial circumflex femoral artery and the venae comitantes. This flap is useful for reanimation of facial paralysis or for extremity muscle function. The vascular pedicle is usually short, and the vessels are small. The skin paddle is typically unreliable.

- Types - Muscle or musculocutaneous
- Dominant pedicle - Ascending branch of medial circumflex femoral artery and vein
- Innervation - Anterior branch of obturator nerve (motor) and anterior femoral cutaneous nerve (sensory)

TENSOR FASCIA LATA FLAP

The tensor fascia lata (TFL) flap has one dominant vascular pedicle, which is the ascending branch of the lateral circumflex femoral artery from the profunda femoris and venae comitantes. The size of the muscle is up to 15 X 5 cm^2, and the skin flap can achieve a size of 7-9 X 22-26 cm^2.

- Type - Muscle, musculocutaneous, musculofascial, or musculofasciocutaneous
- Dominant pedicle - Ascending branch of the lateral circumflex femoral artery

OMENTAL FLAP

The omental flap allows for a large volume of pliable tissue; however, this flap harvest requires a laparotomy. The omentum flap is ideal for obliteration of irregular dead space cavities or when thin coverage is required over an exposed tissue such as bone.

The omentum is considered a visceral structure containing fat and blood vessels within a thin membrane. It extends from the stomach to beyond the transverse colon and covers the anterior aspect of the peritoneal contents. It has 2 dominant pedicles, the right gastroepiploic artery and vein and a left gastroepiploic artery and vein. Prior intra-abdominal surgery, which can create extensive omental inflammatory adhesions, may preclude use of the omental flap.

- Type - Vascularized fat
- Dominant pedicle - Right or left gastroepiploic artery and vein

JEJUNAL FLAP

This flap is reserved for pharyngeal or esophageal reconstruction. The intestinal mucosa does not tolerate ischemia; therefore, revascularization must proceed immediately. Postoperative monitoring may be performed with a sentinel loop of intestine that is exteriorized.

- Types - Vascularized intestine
- Dominant pedicle - Jejunal artery and accompanying vein

FIBULA FLAP

This flap offers a large segment of bone that may be recontoured by osteotomies with or without a skin paddle. In patients with abnormal distal extremity pulses, an angiography or magnetic resonance angiography (MRA) of the lower extremity is indicated. The skin paddle is reliable when care is taken to preserve the fasciocutaneous perforators.

- Type - Osseous long bone or osteocutaneous
- Dominant pedicle - Peroneal artery and vein
- Innervation - Superficial peroneal nerve (sensory)

GREATTOE FLAP

The great toe flap can be used to reconstruct part of the thumb or as a neurosensory flap. This flap allows composite tissue reconstruction for loss of the thumb without significant loss of function to the foot. However, some patients may not wish to sacrifice a great toe for aesthetic reasons.

- Type - Composite (bone, tendon, nerve, skin, nail) or fasciocutaneous
- Dominant pedicle - First dorsal metatarsal artery and vein
- Minor pedicle - First plantar metatarsal artery and vein
- Innervation - Digital nerves (sensory), dorsal cutaneous nerves from superficial peroneal nerve, deep peroneal nerve

CONCLUSION

It may be concluded that the microsurgery is specialized surgical technique of observing through a compound microscope when operating on minute structures of the human body. Microsurgery has made possible significant advances in surgery on humans, especially in delicate operations on the inner ear, eye, brain, and nerve fibres and small blood vessels in general. The technique also has applications in research on cells, cell constituents, and embryos and is used in various other biomedical areas of study.

Reconstructive microsurgery is now in a new stage. Because of continued developments in technology, as well as a better understanding of the anatomy, anastomosis of very small vessels (0.3 mm) is now possible. These highly challenging procedures are referred to in the literature as supermicrosurgery. They allow anastomosis of perforator flaps such as the medial plantar flap to perforator recipient vessels. Additional applications include complex digit reimplantation and lymphatic anastomosis.

Although microsurgery continues to develop, the basic principles of microsurgery, as follow, remain the same:

- Select patients carefully.
- Develop a careful preoperative plan.
- Use a well-defined workhorse flap.
- Obtain full patient consent.
- Pay attention to intraoperative details.
- Perform meticulous microsurgical technique.
- Remain vigilant during postoperative care.

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