Perforator flaps in Upper limb reconstruction

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ABSTRACT

The quality of reconstruction of upper limb defects either following traumatic injury or burn has multiple aspects including the functional and the cosmetic point of view. The introduction of the perforator-based flaps showed advances in upper extremity reconstruction. It gave good result in the site of the recipient and decreases the damage at the site of the donor. In our study 30 patients having soft tissue defects of the upper limb, the cause was either posttraumatic or post burn they were managed using local perforator flaps. There are two different types of flap: “pedicled perforator flap” and “transposition perforator flap”. No major coverage problem occurred in all cases except minimal, only aesthetic, donor-site morbidity. Necrosis of the tip of the flap had occurred in 6 cases. Only one case needed surgical procedure the coverage of medium size defects in the upper extremity, can be managed by local perforator flaps with good surgical outcome and cosmetic as well as functional result.

To sum up they can offer a good choice in coverage of complex soft tissue defects of the upper extremity. The preoperative detection of the perforators in case of “transposition flaps” greatly facilitates the operation.

KEY WORDS: Flaps, Perforator, soft tissue reconstruction, Local flaps.

INTRODUCTION:

The soft tissue reconstruction carries many aspects of implication including the cosmetic point of view, the donor site morbidity and replacing like with like. The upper limb has both functional and cosmetic aspect it accomplishes complex functional tasks, which requires stable and pliable skin. One of the most common causes of soft tissue defects are trauma followed by burns and tumors.

Local flaps established in the upper extremity was based on radial and ulnar vessels which require the sacrifice of major artery. The introduction of perforators allowed the the researches in raising the concept of [1-3] the so-called perforator-based flaps which spare the major artery and spare the donor morbidity the definition of perforator flap is the flap that depend on its supply on a perforator artery. post-traumatic or post-burn excision which could be either intramuscular or
intraseptal course. These flaps became more popular in skin and soft tissue coverage all over the body especially upper limb. [4-7].

There are two types of perforator flap the pedicled where there is a long pedicle gives the blood supply to a skin paddle which is distal to the pedicle. [8-10]. The location of perforators can determine by several studies [1, 8, 11, 13, 14, 15, 18] so, there is no need to identify and dissect the single perforator vessels. Taking advantage of the long pedicle, this type of flap provides a very ample arch of rotation and carry the ability to supply more distant defects.

The 2nd type is the transposition flap, which is based on a single random perforator artery that supply paddle of skin beside the defect where coverage is needed. In this case there is a short pedicle which needs rotation of the flap to reach the recipient site [17]. In our study, we had 20 patients managed by transposition flap and pedicled flaps was used in 10 cases.

PATIENTS AND METHODS:

From 2019 to 2020, 30 patients underwent reconstruction of the upper limb defects by local perforator flaps. Our study included 21 males and 9 females. Their age ranged from 20 to 63 years. Trauma was the cause in 23 cases while 7 cases a pedicled perforator flap was used post burn contracture resection.

Regarding pedicled perforator flaps there is a long pedicle which gives the blood supply to a distant skin paddle. The perforator arteries enter the pedicle and supply the skin island. The site of the perforators is often consistent, this was determined by several studies [1, 4, 8, 11, 13, 14, 19]. So, identification of the perforators and their dissection is not necessarily. The pedicled perforator flaps give the advantage of large arch of rotation.

As for Transposition flaps is based on a single perforator which supply a skin paddle adjacent to the defect to be covered. As it has short pedicle it supplies the recipient site by rotation up to 180°

The Operative procedure
Pedicled fasciocutaneous flap:
In cases of Upper limb, pedicled flaps most commonly based on radial and posterior interosseous artery which is shown Figure (1) A Skin incision is used to expose the subcutaneous tissue and determine the pedicle. Then we undermine the skin which is done to help us preserve the suprafascial tissue. then Two longitudinal incisions were made on the fascia which is done approximately 3 cm apart.

This help to form a skin paddle with the long axis centered over pedicle. Which is shown in And At the distance that is estimated from the pivot point on the proximal surface of the forearm the skin island is made after which the tourniquet is deflated and revascularization is observed skin graft is not needed in cases when the defect width is not more than 3 cm
Fig. (1): An intraoperative photo for coverage of hand defect with harvesting of a pedicled perforator.

**Transposition fasciocutaneous/ cutaneous flap:**
The perforator vessel may arise in any of the deep arteries in the upper limb. The perforator is raised from the subdermal plexus [4, 18] the perforator which is shown in Figure (2) could reach the skin either directly or indirectly through intermuscular septum or through the muscle. In these cases, the length of the pedicle remains relatively short, so the transposition flaps better be harvested in the proximity to the defect. The transposition flaps reach the recipient area by rotation.

Fig. (2): An intraoperative photo of a case of open injury at the ulnar aspect of the wrist that needed flap coverage. The arrow showing one of the radial artery perforators 3cm from radial styloid identified as it pierce the deep fascia to reach the supplied area.
Intraoperatively the skin incision should meet two requirements: 1st it is important to provide a direct view of the feeding artery 2nd it should be conveniently located in order to allow for an elliptical design of the flap.

The transposition perforator flaps is also called propeller flaps when the rotation arc exceeds 90 degrees this term was 1st introduced by Hyakusoku in 1991 [20] these flaps has a greater arc of rotation and a larger skin paddle that’s why it is usually preferred for coverage of larger defects.

RESULTS:

In both group there were no cases of total flap loss however there were partial flap loss in 6 cases of transposition flap while pedicled flaps showed one case of partial flap loss in 5 cases of partial loss cases no further surgery was required. While only one case managed with debridement and advancement of the flap. In cases of transposition flaps risk of congestion and flap loss is reduced by soft tissue surrounding the pedicle also the avoidance of excessive skeletonization of the vessels is helpful to prevent kinking congestion of the vessel the second possible reason for failure is kinking of the pedicle which could be prevented by providing enough pedicle length and anatomical barriers removal. The perforating artery and vein must be released from any surrounding adhesions such as intermuscular septa. These barriers could compromise blood flow to the pedicle.

DISCUSSION:

The rich vascular supply of the Forearm by two main arteries the radial and the ulnar artery give reliable flap reconstruction through reversal flow mode provided that there is patent and complete palmar arch, which allow the reversal of the arterial inflow in the flap pedicle. However, the disadvantage of these flaps is the sacrifice of one of the two main arteries of the forearm. the introduction of the posterior interosseous flap give better improvement as the posterior interosseus flap has the same concept as the other distally based flaps but it has the advantage of being based on a [non-dominant] artery which can be sacrificed without any major consequence to the hand vascularity. However, regarding its disadvantages, it requires more meticulous dissection because of the smaller pedicle with smaller venae committantes. [21-25].

“The local perforator flaps” are gaining popularity. they are relatively easy and quick to harvest they cover the defects with similar soft tissue, and they have possibility intraoperative free style flap design [5]. This could be either pedicled or transposition type which rely on small perforators arising from the main arteries [11] Many perforator branches arises from radial and ulnar arteries that pierce the deep fascia to supply a skin territory which are connected to each other by the perforasomes. The perforator veins drain directly into the deep venous. In cases of propeller flaps the pivot point should be safely located according to the site of the perforator the proximal dissection of the pedicle is quite easy and quick under loupe magnification with no need for operative microscope. In cases of pedicled flaps it gives the ability to cover more distal defects such as in posterior interosseous flaps also in cases of radial forearm flap the scar appearance in the volar aspect in the forearm remain an issue which should be discussed with the patient. The posterior interosseous flap carries a good alternative. In our experience the posterior interosseous
flap is can be very reliably used to cover defects of the first web space and the dorsal aspect of the hand.

In cases of Transposition perforator flaps the perforator artery originates from any deep artery in the upper limb. Which could be indirect perforator or direct perforator in any case the artery perforates the fascia and merges into a very rich superficial vascular network. There is high concentration of perforators around the elbow and the wrist joint [4, 18] for this reason, transposition flaps are more likely to be used for defects located around these joints

Transposition perforator flaps are indicated in medium size defects and they should be harvested in the proximity of the recipient area. This is due to the short length of the pedicle. They may be harvested with or without the fascia. The harvesting of fascia with the flaps helps to increase the mechanical resistance of the flap also increases its vascularity as the vascular network which is present above the fascia has multiple connection with the subdermal plexus and contributes to the skin perfusion.

The identification of the location of the perforator which is most reliable is very helpful this can be done preoperatively be several methods to map the perforators and provide information useful for flap design [14]. WE can use a Doppler investigation it is considered the preferable preoperative diagnostic procedure because it has the best cost effectiveness ratio in addition it is widely available and widely used in clinical practice. But on the other hand, it is not accurate as other proposed investigations. In Matei et al. [14] experience he used doppler investigation in group of 10 patients in cases of transposition flaps which showed disappoint results where only accurate perforator identification done in 20 % of patients. This is due to false positive result by mistaking the main vessel with the perforators especially in forearm and the false negative in using wrong frequency or the application of excessive pressure to the Doppler probe that causes closure of the probe.

In our experience in cases of transposition flaps the preoperative identification of perforators was mainly successful however it needs expert training and it is operator dependent it carries high benefit of facilitating surgery and reduces operative time.

Also, we used colored duplex for some cases for perforator identification which showed superior accuracy than handheld doppler in perforator identification it also helps in detection of the size of the perforator for better estimation of its efficiency to supply the flap. Other investigation including raw ct and contrast angiography are time consuming in addition to being invasive

**CONCLUSION:**

Local perforator flaps carry the benefit of efficiently replacing the recipient site with similar soft tissue from nearby donor site this gives it a cosmetic advantage. Furthermore, it has limited morbidity by sparing the main axial vessels of the limb

The above-mentioned criteria of these flaps give great advantage to almost all other regional flaps to cover small to medium size defects of the upper limb. Perforator-based flaps characterized by simplicity and less time consumption rather than many surgical procedures.
Despite their relative simplicity, perforator flaps are microsurgical non microvascular surgery which needs microsurgical expertise during dissection phase of the vessels which should be always carried out under loupe magnification.

In our point of the more simple surgical technique in relation to free flaps along with results both cosmetically and functionally results in addition to the contained donor site morbidity give the privilege to make the perforator-based flaps in flap an ideal choice to cover complex soft tissue defects of the upper limb

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