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ORIGINAL ARTICLE

Evaluation of Versatility of Reverse Thenar Perforator Flap in Reconstruction of Palmar and Digital Defects: Cadaveric study and Clinical Application

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Abstract

Background: ***The aesthetic replacement of palm and digit soft tissue remains a challenge due to the unique texture, color, sensitivity, and structural characteristics of glabrous Palamar skin. The reverse thenar perforator flap, first defined by Seyhan, offers a smooth skin option for repairing damaged soft tissue.***

Objective: ***To review the vascularity of the reverse thenar perforator flap using cadaveric dissection and to evaluate its versatility for covering volar hand defects.***

Material and Methods: ***This study was carried out through cadaveric dissection and clinical research. The cadaveric dissection was done on ten cadavers in the morgue of the Al-Azhar Faculty of Medicine. The clinical research involved ten cases of patients suffering from palmar and digital soft tissue defects who were subjected to reconstruction with a reverse thenar perforator flap.***

Results: ***In the cadaveric study, we found that four out of ten cadaveric dissection flaps had three perforators, four had a single perforator, and two had two perforators. Ten cases with soft tissue lesions in the index, palm, thumb, or first web space underwent reconstruction using a reverse thenar perforator flap technique. Flap sizes ranged from 1.6×4.2 to 6×2.4 centimeters, and donor sites were closed directly.***

Conclusion: ***The reverse thenar perforator flap is an elegant option that provides smooth skin for repairing palm, first web, thumb, and index finger abnormalities. It is appropriate for the replacement with a similar tissue' concept with minimal scarring of the donor area.***

Keywords: Digital faults; palmar defects; Flaps of Glabrous skin; Reverse thenar perforator flap

1. Introduction

The palmar surface of the hand is comprised of greatly specialized skin that possesses advantageous sensitivity and the capacity to maintain skin stability in order to withstand friction; reconstruction must take these features into consideration.[1] The literature has described numerous skin flaps for palmar resurfacing, all of which may offer wound coverage and even adequately conform to the contour; however, color and texture compromise the aesthetic qualities of reconstruction. [2] According to Harold Gilles' "like with like" replacement principle, the optimal substitute for skin loss on the palm and digits should provide cushioning, match in color and texture, be sensitive or capable of becoming sensitive, and not hinder hand movement and activity. Only glabrous skin can achieve this perfection.[3] The hand's volar surface is abundant with perforators that serve as a pedicle for perforator flaps. Most of these perforators arise from the deep palmar arch (DPA), superficial palmar arch (SPA), radialis indicis artery, a superficial palmar branch of the radial artery (SPBRA), and princeps pollicis artery.[4] Seyhan documented the reverse thenar perforator flap, which obtained a restricted quantity of perforators from either the SPA or SPBRA. [5]

This study aimed to study the vascularity of the reverse thenar perforator flap via cadaveric dissection and evaluate clinically its versatility for the reconstruction of digital & palmar defects of the hand.

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2. Patients and methods

This study was carried out in the Plastic Surgery and Anatomy Departments of Al-Azhar University between February 2022 and August 2023 as a cadaveric study and clinical cases.

The cadaveric study of the flap involved ten cadavers and was done in the Morgue of Al-Azhar Faculty of Medicine.

Selection criteria of the cadavers: Egyptian cadavers of both sexes with no evidence of pathology, previous injury, or congenital abnormality in the hands.

The clinical cases were done at Al-Azhar University Hospitals in Cairo and involved ten patients (7 males and three females) who were suffering from palmar and digital soft tissue defects and who were subjected to reconstruction with reverse thenar perforator flaps.

Inclusion criteria: All patients both males and females (age from 8 to 65 years) with various causes of soft tissue defects at the palm and digits that necessitate flap coverage.

Exclusion criteria: Patients not fit for surgery, patients with peripheral vascular diseases, psychologically unstable patients, patients with previous trauma at the donor site, Patients with large defects that need distant or free flaps, and patients refusing to participate in the study.

Preoperative preparations: All patients underwent a thorough history and clinical examination as well as a complete hand examination. Local examination: site of defect, size of the defect, associated injury (bone, tendons, nerves, or vascular), and donor site examination. Routine preoperative investigations to assess the fitness for surgery guided by the patient's age and co-morbid conditions.

Surgical Technique

Anesthesia:All the patients were operated under general or regional anesthesia. Choice of method was determined by the anesthetist according to patient status and compliance.

Flap design: The thenar crease serves as the keystone area, the cardinal line of Kaplan and a longitudinal line from the radial side of the second web space are outlined are marked. The point where these lines intersect determines the position of the perforator, which will be incorporated into the outline of the flap. By using an 8 MHz handheld Doppler probe, the perforators were identified around that point preoperatively.

Flap elevation: In our research, we raised the reverse thenar perforator flap by focusing on the perforators that originate from the confluence of the SPA and the SPBRA. The skin paddle was positioned in a parallel and medial orientation to the thenar crease.

It is not necessary for the perforator to be centered in the flap in order to ensure flap perfusion. The eccentric position of the perforator within the flap is secure and safe. The surgery is performed with magnification by using a surgical loupe (3.5X) in order to enhance vessel visibility. A pneumatic tourniquet is used with no need to exsanguinate the upper limb. The first incision is made along the radial border of the designed flap, starting from the metacarpi-phalangeal crease proximally and extending downward to involve the thenar fascia. To maintain the integrity of small venules and lymphatics, it is essential to retain a layer of subcutaneous tissue surrounding the perforators during dissection. Once the flap has been fully raised, the tourniquet should be released. It is desirable to estimate the perfusion of the hand, specifically the blood flow to the index and middle digits. Hemostasis is ensured before closing the wound.

Postoperative care and follow-up: Adequate positioning of the patient's hand was ensured. The surgical dressings were examined and confirmed not to be tight. Hand activity restrictions, including grasping and range of motion, were carefully reviewed, as they may impact pressure or tension on the flap. The patient was prescribed broad spectrum antibiotics, anti-inflammatory drugs, adequate pain killers to help relieve the pain and anxiety.

CADAVERIC STUDY

Three perforators supply four of the ten flaps of cadaveric dissection, as shown in Figure 1. The distal perforator was always the largest, originating primarily from the SPBRA. We sacrificed the proximal two perforators to facilitate flap rotation. Four cadavers had a single perforator supplying our flap (two of them originating directly from the SPA, one from the DPA, and one from the Princeps pollicis artery). Two cadavers had two perforators supplying the flap (one arises from the SPBRA, whereas the other originates from the SPA).

Figure 1. Shows the number of perforators supplying the flap in cadaveric dissection. A: three perforators, B: two perforators, C: one perforator. (The red arrows point to the perforator).

3. Results

Table 1. Show baseline characteristics of the studied patients

		TOTAL (N=10)
AGE (YEARS)	Mean± SD	37.0 ± 14.96
	Range	11 - 56
SEX	Male	7 (70%)
	Female	3 (30%)

Table 2. Show location of the defect in the studied patients

	TOTAL (N=10)
FIRST WEB	2 (20%)
PROXIMAL PHALANX OF THE INDEX FINGER	1 (10%)
PROXIMAL PHALANX OF THE THUMB	2 (20%)
ULNAR SIDE OF THE PALM	5 (50%)

Table 3. Show causes of the defect in the studied patients

	TOTAL (N=10)
CHEMICAL BURN	1 (10%)
DUPUYTREN'S DISEASE	5 (50%)
ELECTRICAL BURN	2 (20%)
POWER TOOL	2 (20%)

Table 4. Show the size of the defect in the studied patients

		TOTAL (N=10)
DEFECT LENGTH (CM)	Mean± SD	1.9 ± 0.28
	Range	1.5 - 2.3
DEFECT WIDTH (CM)	Mean± SD	3.2 ± 1.04
	Range	1.7 - 4.9

Table 5. Show the dimensions of the flap in the studied patients

		TOTAL (N=10)
FLAP LENGTH (CM)	Mean± SD	2.3 ± 1.34
	Range	1.5 - 6
FLAP WIDTH (CM)	Mean± SD	4.4 ± 0.88
	Range	2.4 - 5.5

Table 6. Donor site closure and duration of surgery of the studied patients:

		TOTAL (N=10)
DONOR SITE CLOSURE	Primary	10 (100%)
DURATION OF SURGERY (MIN)	Mean ± SD	78 ± 12.74
	Range	60 – 100

Table 7. Source of perforator of the studied patients:

	TOTAL (N=10)
SPBRA	6 (60%)
TERMINAL BRANCH OF THE SPA	4 (40%)

Table 8. Complications of the studied patients

		TOTAL (N=10)
FLAP COMPLICATIONS	Flap congestion	1 (10%)
	Partial distal necrosis (0.6 cm)	1 (10%)
	No	8 (80%)
DONOR SITE COMPLICATIONS	First web space adduction contracture	1 (10%)
	No	9 (90%)

CASE PRESENTATION

Figure 2. 56-year-old man with Dupuytren disease in his right hand. The surgical plan includes designing a flap before the operation (seen above on the left). The image above, on the right, shows the intraoperative view of the flap after its raising. Initial following surgery view following flap in setting (in the lower left). Postoperative view of the flap and the donor area (below & to the right).

Figure 3. 11-year-old male patient underwent treatment for a post-electrical burn skin and soft tissue defect Preoperative view of a post-electrical burn defect at the base of the thumb (above, left). The intraoperative view after flap elevation (above and to the right). Flap in setting (below and to the left). Postoperative view of the flap and the donor area (below & to the right).

4. Discussion

The terminal branch of the SPA typically provides 3 to 6 perforators to the radial aspect of the midpalm, as shown by Omokawa et al.[6], while Kim and Hwang[7] reported that it is supplied by single or pair cutaneous perforators from the Princeps pollicis artery. Vasconez et al.[8] demonstrated that one or two cutaneous perforators supply the thenar area from the radialis indicis artery. Also, a perforator was identified by Orbay et al. [9], located at the intersection of the axis of the second web, the third digital ray, and the axis of the outstretched thumb (the Kaplan line).

Omokawa et al.[6] stated that because of the extensive collaterals and perforators that are present in the palm, it is probable to design a reverse flap at the palmar aspect of the hand. For primary closure, a flap that is designed in a parallel fashion to the thenar crease is a better alternative to a flap that is designed in a transverse or longitudinal orientation, as stated by Seyhan[5]. The terminal branch of the SPA supplies the radial mid-palmar island flap, as detailed by Kim & Hwang[7]. The placement of our flap is comparable to that of the described flap; however, the pedicle exhibits dissimilarities. The pedicle of our flap is located at the location where the cardinal line of Kaplan intersects with a longitudinal line that starts at the radial side of the second web space. It contains the dense connection between the terminal branch of the SPA and the SPBRA. We exclusively utilized the perforating branches derived from these arteries. Seyhan5 performed the initial skin incision along the ulnar border of the flap, reaching the thenar fascia. We recommend performing the initial skin incision along the radial border of the flap, as this will facilitate easier dissection over the thenar muscles. The SPA is related to other arteries, as established by Kim and Hwang[7]. These arteries include the SPBRA, as well as the palmar digital arteries of the thumb and index finger. It was not necessary to use a Doppler flow meter or a handheld Doppler to confirm the perforator's precise location. According to our research, the dissection started along the flap's radial border. The careful preparation prior to surgery prevented any potential harm to the perforator. Following the release of Dupuytren contracture, managing skin defects is still challenging. Both secondary wound healing and full-thickness skin grafting are options for covering these defects. Seyhan[5] determined that the reverse thenar perforator flap is a viable option for treating such lesions, provided that there is a suitable tissue match and appropriate thickness. After relieving their Dupuytren contracture, we performed a reverse thenar perforator flap procedure on five patients. Prior to surgery, none of our patients suffered from thumb contractures as a result of the thenar fascia Dupuytren disease. During the procedure, we removed the diseased palmar fascia and its prolongations. Then, we transferred a small, healthy thenar fascia underneath the flap to the defect. We achieved excellent outcomes with a decent range of motion and patient satisfaction. During follow-up, none of our patient's Dupuytren contractures recurred. Omokawa et al.[10] confirmed that up to two centimeters of the donor site can be closed first. Orbay et al.[9] and Seyhan5 emphasized that the maximum width needed to close the donor site primary is 2.5 centimeters. Seyhan[5], whose patients presented with Dupuytren contractures or post-burn contractures, reported that none of his patients suffered from adduction contracture of the first web. However, we saw a case that had adduction contracture of the first web, despite a flap width of 2.4 centimetres. In cases of anomalies in the index finger, the radialis indicis artery and the terminal branch of the SPA are carefully dissected before dividing the SPA, especially when more length of the pedicle is needed. Anatomically related to the radialis indicis artery, the terminal branch of the SPA allows for additional dissection using an extra pedicle approach.[5] Omokawa et al.[6] found that this connection was present in forty-two percent of the specimens they dissected in their research, while Bilge et al.[11] estimated it to be 34%. Omokawa et al.[6] identified an association between the Princeps pollicis artery of the thumb and the terminal branch of the SPA in eighty-five percent of the dissected specimens. Similarly, Bilge et al.[11] found this connection in sixty-two percent of the investigated specimens. Seyhan[5] suggested conducting a preoperative Doppler flowmeter examination to confirm these connections. We advise digital subtraction angiography as an alternative method when the Doppler examination fails to clearly identify the connection in a patient. If these connections are present, the flap can reach a pulp defect in the index finger or thumb; otherwise, our flap is not suitable for reconstructing defects in the other digits. Reducing sensory recovery is the primary consequence of this flap; thus, Seyhan[5] recommends identifying the palmar cutaneous branch of the median nerve, which can be involved in the flap. Following this, the divided digital nerve can be sutured to this nerve to confirm sensory innervation to both the index finger and the thumb. The reverse thenar perforator flap has several additional problems, such as difficulty in the detection of the perforator and a limited amount of tissue. Utilizing the reverse thenar perforator flap necessitates a technically challenging process, which is an additional drawback.

4. Conclusion

The reverse thenar perforator flap is an elegant and pretty alternative for reconstructing soft tissue anomalies of the glabrous skin. Both the recipient & donor sites show marvelous aesthetic results. It provides glossy skin to the thumb, pulp of the index finger, first web space, & ulnar side of the palm, especially after the release of Dupuytren contracture. It is suitable for the "replacement with similar tissue" concept and enables direct closure of the donor site with minimal scarring.

Disclosure

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