

Dorsal Metacarpal Artery Flaps

ABDELLATIF ARAFA, M.D.

The Department of Plastic and Reconstructive Surgery, Shebin El-Kom Teaching Hospital

ABSTRACT

Background:

The dorsal metacarpal artery perforator flap is a versatile solution for resurfacing soft-tissue defects of fingers, dorsum of the hand and web space. The author presents his experience in applying this flap for a variety of finger wounds for which conventional means may not be amenable.

Soft-tissue defects in the fingers, dorsum of the hand and web space are common and usually require adequate reconstruction with flaps to prevent functional deficits.

Objectives: The aim of this article is to review published anatomy of the dorsal metacarpal arteries (excluding the first) and present the author's experience in using various types of dorsal metacarpal artery flaps for reconstruction of fingers, thumb, dorsum of the hand and web space. The author presents his experience in applying these flaps for a variety of finger wounds and contractures.

Methods: A total number of twelve cases of various types of dorsal metacarpal artery flaps were done in Shebin Elkom Teaching Hospital from March 2013 to March 2015 with age ranges from 2 years till 65 years with mean age was 30.3. Ten cases were males and two cases were females. Seven cases were second dorsal metacarpal artery flap. Two cases were double pivot for thumb reconstruction after trauma and first web space reconstruction and three cases were classic type for dorsal hand reconstruction. Other two cases of extended second dorsal metacarpal artery flap for reconstruction of the fingers. One case of Boomerang flap from the dorsum of the third dorsal finger to reconstruct the tip of the second finger. Two cases of third dorsal metacarpal artery flap for reconstruction of the dorsum of the hand. Two cases of fourth dorsal metacarpal artery flap for reconstruction of the dorsum of the hand and little finger. All flaps survived completely with adequate postoperative results. Follow for at least 3 months.

Results: All flaps were survived with good functional results and acceptable cosmetic appearance.

Conclusion: The dorsal metacarpal artery flaps are good alternative for reconstruction of soft-tissue defects of the fingers, dorsum of the hand and web space. Its advantages are simple technique, thin tissue, and minimal donor site morbidity.

Key Words: *Dorsal metacarpal artery flap – Hand flap.*

INTRODUCTION

The first author who used an axial pattern flap from the dorsum of the index finger was Hilgenfeld [1] who employed the flap in thumb reconstruction. Later Holevich [2] and Fouchearnd Braun [3] refined the concept by narrowing the pedicle until finally true island flap based on the first dorsal metacarpal artery was developed.

The second dorsal metacarpal artery did not enjoy the same popularity: First experiences were published by Vilain and Dupuisin 1973 [4] Iselin [5]. The first true second dorsal metacarpal artery flap was by Lister [6]. This flap used a perforator branch between dorsal and palmar system frequently found in the web space [7]. The dorsal metacarpal artery flap is classified as a fascio-cutaneous flap. The dorsal network communicate with the superficial arch via constant anastomoses. These anastomoses form the basis of the reverse metacarpal flaps [8,9] which have further enhanced the versatility of this arterial system. More communicating vessels are found in the web space and the proximal phalanx thereby creating new options of flap design.

Antegrade metacarpal flaps:

The presence of the dorsal metacarpal artery is decreasing from the radial to the ulnar aspect of the hand. The fourth dorsal metacarpal artery may be missing in 17-30% [10]. Therefore, Doppler examination prior to flap elevation is mandatory.

The second dorsal metacarpal artery flap can be raised as a single lobe flap or can be raised as a bi-lobed flap using the branching vessels in the web space [10,11,16,17]. The arc of rotation of all dorsal metacarpal flaps allows for coverage of proximal defects of adjacent fingers and of smaller defects of the dorsum of the hand or the wrist area.

Reversed (extended) metacarpal artery flap:

Anatomical studies by Early [12] and others [19,20] have demonstrated constant arterial anasto-

mosis between the dorsal digital network and the superficial palmar arch at the level of the metacarpal heads. Another anastomosis are found between this network and palmar digital arteries. The reverse metacarpal artery flaps have been based on these findings [9,10,18,21].

Anatomy:

The second to fourth dorsal metacarpal arteries arise from the dorsal carpal arch. Near their origins they anastomose with the deep palmar arch by proximal perforating arteries and, near their bifurcation, with dorsal perforating branches from the palmar metacarpal arteries which pass between the metacarpal necks. They also anastomose distally at the level of the web spaces with dorsal perforating branches from the palmar digital arteries. The third and fourth dorsal metacarpal arteries are much smaller than the first and second.

Cutaneous branches from the dorsal metacarpal arteries supply the dorsal skin as far distally as the proximal interphalangeal joint. At the level of the neck of the second, third and fourth metacarpals, direct cutaneous branch are given off which passes proximally and supplies an area of skin between the two adjacent metacarpals.

These anatomical arrangements permit the surgical elevation of flaps of dorsal skin to be based either proximally on the dorsal metacarpal arteries proper, or distally on the direct cutaneous branch. These flaps may be used for reconstructing areas of missing tissue elsewhere in the hand [32].

The first and second arteries are anatomically constant, making them very safe as a source of pedicle flaps. In the other hand, the third and fourth DMAs are not constant. Therefore, it would be wiser to confirm their presence with Doppler prior to surgery [22].

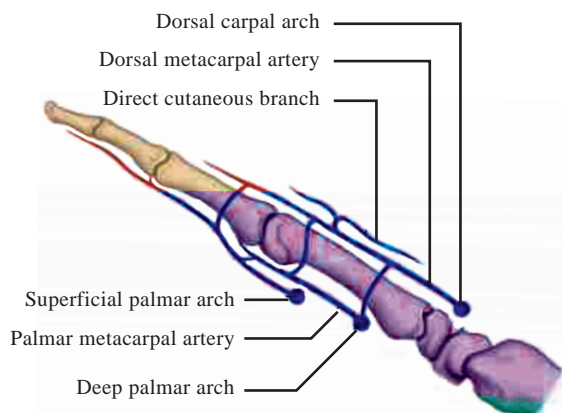


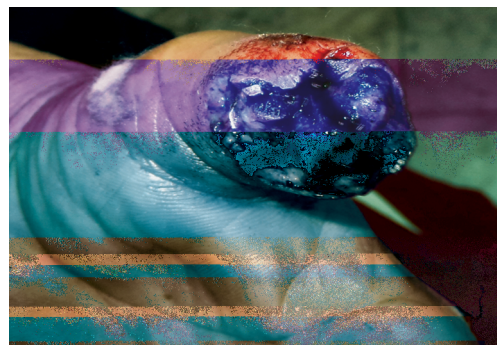
Fig. (1): Dorsal metacarpal artery anatomy (23).

MATERIAL AND METHODS

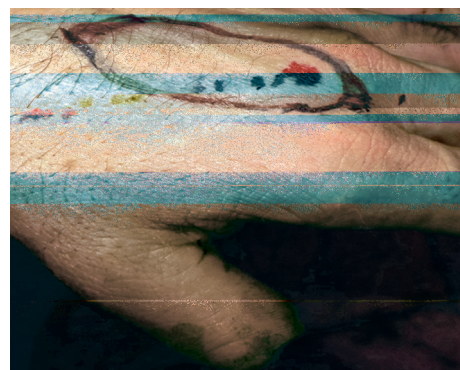
A total number of twelve cases of various types of dorsal metacarpal artery flaps were done in Shebin El-Kom Teaching Hospital from March 2013 to March 2015 with age ranges from 2 years till 65 years with mean age was 30.3y. Ten cases were males and two cases were females. Seven cases were second dorsal metacarpal artery flap. Two cases were double pivot for thumb reconstruction after trauma and first web space reconstruction and three cases were classic type for dorsal hand reconstruction. Other two cases of extended second dorsal metacarpal artery flap for reconstruction of the fingers. Three cases of the third dorsal metacarpal artery were done. One case of Boomerang flap from the dorsum of the fourth finger dorsum to reconstruct the third finger tip. Another two cases of classic third dorsal metacarpal artery flaps for reconstruction of the dorsum of the hand were done. Two cases of fourth dorsal metacarpal artery flap for reconstruction of the dorsum of the hand and little finger. All flaps survived completely with adequate postoperative results. Follow for at least 3 months.

RESULTS

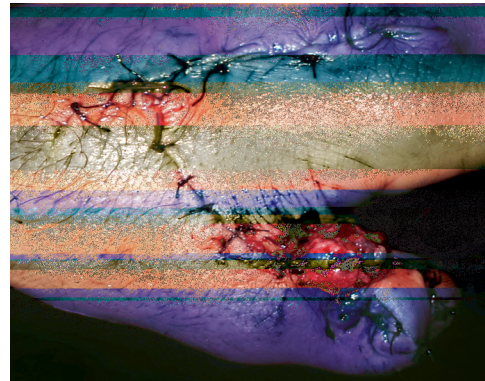
All flaps survived with good functional results and acceptable cosmetic appearance. Donor site of all dorsal metacarpal flaps were closed directly except one case which was grafted. Functional and cosmetic results were acceptable.



(2-A): Preoperative.



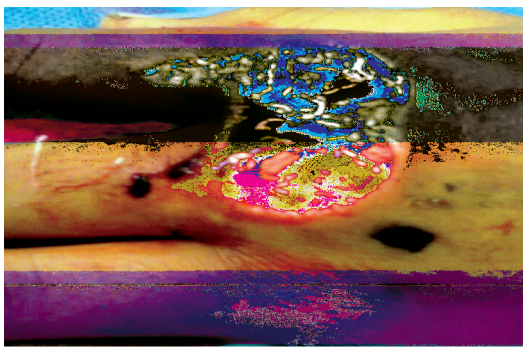
(2-B): Design.



(2-C): Intraoperative.

(2-D): Postoperative.

Fig. (2): Second dorsal metacarpal artery flap Double pivot (Case 1).

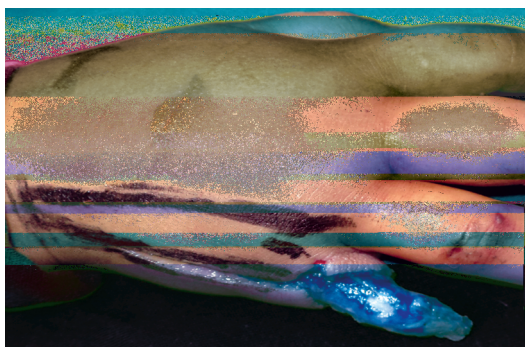


(3-A): Preoperative.

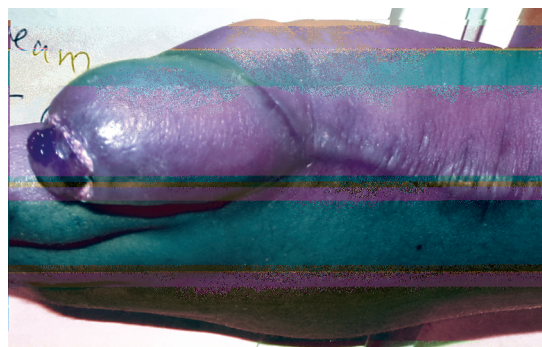


(3-B): Postoperative.

Fig. (3): Third dorsal metacarpal artery flap (Case 2).



(4-A): Preoperative.



(4-B): Postoperative.

Fig. (4): Fourth dorsal metacarpal artery flap (Case 3).

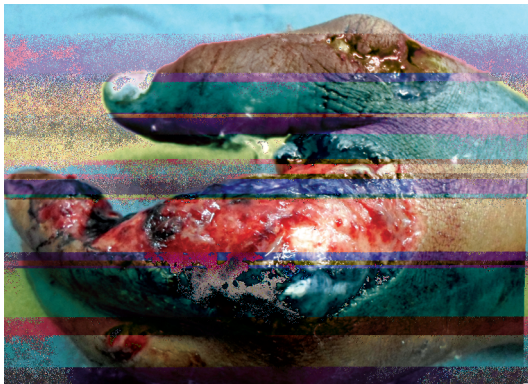


(5-A): Preoperative.



(5-B): Postoperative.

Fig. (5): Second dorsal metacarpal artery flap (Case 4).



(6-A): Preoperative.



(6-B): Intra-operative.



(6-C): Immediate post-operative.



(6-D): Late Post-operative.

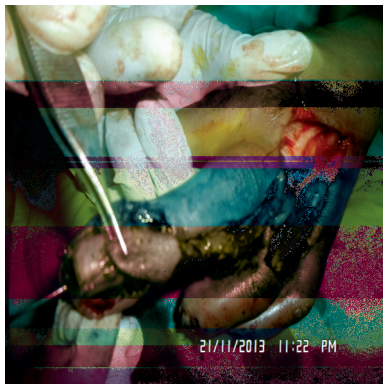
Fig. (6): Extended second dorsal metacarpal artery flap (Case 5).



(7-A): Preoperative.



(7-B): Intra-operative.



(7-C): Intra-operative.



(7-D): Postoperative.

Fig. (7): Boomerang third dorsal metacarpal artery flap (Case 6).

Table (1): Summary of cases.

No.	Age	Sex	Etiology	Site & size	Procedure	Follow-up	Result
1	44	M	Trauma	Dorsum of the hand & 2 nd finger skin 5x4 cm	Classic 2 nd	5M	Good
2	19	M	Trauma	3 rd fingertip injury	Boomerang flap 3 rd metacarpal	5M	Good
3	42	M	Trauma	Web space 5x3	2 nd metacarpal Quaba flap	7M	Good
4	55	M	Trauma	Dorsum of the hand 4x3	Classic 3 rd metacarpal	3M	Good
5	2	F	Trauma	Degloved left little finger	Classic 4 th metacarpal	3M	Small raw area healed conservatively
6	12	F	Trauma	Dorsum of the hand 5x4	Classic 2 nd metacarpal	4M	Good
7	65	M	Tumor excision	Dorsum of the 3 rd finger 4x3	Classic 3 rd metacarpal	4M	Partial necrosis healed conservatively
8	40	M	Trauma	Dorsum of the hand 5x4 cm	Classic 4 th metacarpal	3M	Good
9	30	M	Trauma	Dorsum of the hand 5x5 cm	Classic 2 nd metacarpal	6M	Good
10	19	M	Trauma	Dorsum of the hand & index finger 5x2	Extended 2 nd metacarpal	4M	Good
11	39	M	Trauma	Dorsum of the hand & 2 nd finger skin 10x4 cm	Extended 2 nd metacarpal+STSG	6M	Small raw area healed conservatively
12	48	M	Trauma	Dorsum of the hand 4x5	Classic 2 nd metacarpal	3M	Good

DISCUSSION

The dorsal metacarpal artery perforator flap is a versatile solution for resurfacing soft-tissue defects of fingers, web spaces, thumb and the dorsum of the hand. The cause of these defects may be trauma with, contracture release or tumor excision.

Many modalities are used for covering and reconstruction of these areas including skin grafting [24,25], local random flaps e.g. rotation flap, z plasty 5 flap, MV flap and VY flap [26,27,29,30], local pedicled flap from the hand eg dorsal metacarpal flaps [31,32,34-39], moberg flap [40,41], island flap [42], cross finger flap, dorsal turnover flap [43,44,45], regional pedicled flaps from the forearm, abdominal wall and groin flaps [46,47,48] and free flaps [49].

Skin grafting is an easy technique but it is only limited to small defects without exposed bone or tendons. Applying full thickness graft to the injured finger can be done successfully when there are small gaps in the tendon sheath, but not after more extensive flexor tendon exposure. Full thickness graft reconstruction will cover intact nerves, arteries and the flexor tendon sheath well [25].

Local random flaps are good option in small defects and contractures in the presence of supple nonscarred skin but not suitable in the presence of scar tissue and in tissue loss.

Moberg flap is a good sensate flap in volar thumb defects but has no rule in dorsal hand or web space reconstruction.

Cross finger flap needs another operation for flap separation and island flap needs extensive dissection.

Turnover flap is adequate only for dorsal finger defects.

Forearm flaps, and free flap need leaning curve and has many complications. Groin flap and abdominal flaps need another operation for flap separation.

First dorsal metacarpal artery flap is a good sensate flap for reconstruction of dorsum of the hand, 1st web space and thumb in one stage operation. Donor site graft is acceptable.

Second, third and fourth dorsal metacarpal artery flaps has wide range of resurfacing for soft-tissue defects of fingers, web spaces, thumb and distal portion of the dorsum of the hand technique of harvesting is easy and donor site is closed directly in most of cases. The only disadvantage is that it is nonsensate.

Conclusion:

The dorsal metacarpal artery flaps are good alternative for reconstruction of soft-tissue defects of the fingers, thumb, dorsum of the hand and web

space. Its advantages are simple technique, thin tissue, minimal donor site morbidity, and a good appearance without bulk.

REFERENCES

- 1- Hilgenfeldt O.: Operativer D aumenersaltzs, t ed. Stuttgart, Enke Verlag, 1950.
- 2- Goffin D., Brunelli F., Galbiatti A., SammDut and Gilbert A.: A new flap based on the distal branches of the radial artery. *Ann. Hand Surg.*, 11: 217-225, 1992.
- 3- Fouche Gr. and BraunJ B.: A new island flap transfer from the dorsum of the index to the thumb. *Plast. Recon. Surg.*, 6 (3): 344-34, 1979.
- 4- Chen C.L., Chiu H.Y., Lee J.W. and Yang J.T.: Arterialized tendocutaneous venous flap for dorsal finger reconstruction. *Microsurgery*, 15: 886-890, 1994.
- 5- Vilain R. and Dupuis J.F.: Use of the flag flap for coverage of a small area on a finger or the palm. 20 years experience. *Plast. Recon. Surg.*, 51: 397-401, 1973.
- 6- Lister G.D.: Skin flaps. In: *Operativem Hand Surgery*, 3rd Ed, Churchill Livingstone, New York, 1741-182, 1993.
- 7- Yousif N., Zhong Y., Sanger J.R., Arria P., Gilbert A. and Matloub H.S.: The versatile metacarpal and reverse metacarpal artery flaps in hand surgery. *J. Hand Surg.*, 21B: 222-22, 1996.
- 8- Maruyam Y.A.: The reverse dorsal metacarpal flap. *Br. J. Plast. Surg.*, 43: 24-27, 1990.
- 9- Quaba A.A. and Davison P.M.: The distally based dorsal metacarpal artery flap. *Br. J. Plast. Surg.*, 43: 28-32, 1990.
- 10- Early M.J. and Milner R.H.: Dorsal metacarpal flaps. *Br. J. Plast. Surg.*, 40: 333-341, 1987.
- 11- Early M.J.: The second dorsal metacarpal artery neurovascular island flap. *J. Hand Surg.*, 14B: 434-440, 1989.
- 13- Inoue T., Ueda K., Kurihara T., Harada T. and Harashina T.: A new cutaneous flap: Snuff-box flap. *Br. J. Plast. Surg.*, 252-254, 1993.
- 14- Williams R.L., Nanchaha J.L., Sykes P.J. and O'Shaughnes Msy: The provision of innervated skin cover for the injured thumb using dorsal metacarpal artery island flaps. *J. Hand Surg.*, 20B: 231-236, 1995.
- 15- Stice C. and Wood M.B.: Neurovasculair land skin flaps in the hand: Functional and sensibility evaluations. *Microsurgery*, 8: 162-167, 1987.
- 16- Karacalar A. and Ozcan M.: Second dorsal metacarpal artery neurovascular island flap: Clinical applications. *Eur. J. Plast. Surg.*, 18: 153-156, 1995.
- 17- Onishi K., Maruyam Ya and Yoshitake M.: Transversely designed dorsal Metacarpal V-Y advancement flaps for dorsal hand reconstruction. *Br. J. Plast. Surg.*, 49: 165-169, 1996.
- 18- Del Bene M., Petrolati M., Raimond Pi, Tremolada C. and Muset A.: Reversendorsal digital island flap. *Plast. Recon. Surg.*, 93: 552-557, 1994.
- 19- Mancho C.T.: *The cutaneous rteries of the human body*, Springer Verlag New York, 1983.
- 20- Ozcan M., Murat T., Ramaza Kn, Erhahn S. and Selcuk A.: A new flap from the dorsum of the first intermetacarpal area: The first dorsal inter-metacarpal flap. *Proc. EURAPS*, 131-132, 1996.
- 21- Schools M., Chambo En, Leps P., Millot F., Bahm J. and Lambert F.: The reverse metacarpal flap from the first web. *Europ J. Plast. Surg.*, 16: 26-29, 1993.
- 22- Marcelo Rosa de Rezende, Rames Mattar Júnior, Álvaro Baik Cho, Oswaldo Hideo Hasegawa and Samuel Ribak: Anatomic study of the dorsal arterial system of the hand *Rev. Hosp. Clin.*, Vol. 59 No. 2, 2004.
- 23- Loukas M., Holdman D. and Holdman S.: *Folia Morphol (Warsz)*, 64 (2): 78-83, 2005.
- 24- Caleffi E., Bocchi A., Toschi S. and Ghillani M.: Surgical treatment of post-burn contractures of the hand. *Annals of the MBC*, Vol. 3 - n' 1 - March 1990.
- 25- David Elliot and Thomas Giesen: Treatment of unfavourable results of flexor tendon surgery: Skin deficiencies. *Indian J. Plast. Surg.*, 16 (46): 325-32, 2013. Volume: 46 Issue: 2 Page: 325-332, 2013.
- 26- Chao J.D., Huang J.M. and Wiedrich T.A.: Local hand flaps. *J. Am. Soc. Surg.*, 1 (1): 25-44, 2001.
- 27- Hurren J.S. and Cormack G.C.: The application of the rotation flap to the dorsum of the hand. *Br. J. Plast. Surg.*, 53: 491-4, 2000.
- 28- Paulo Morais Cardoso, Paulo Santos and Filomena Azevedo: Rotation flap for closure of surgical defect on the dorsum of the hand. *Surg. Cosmet. Dermatol.*, 3 (4): 348-9, 2011.
- 29- Quataibah Abdullah Al-Kandari, M.D.: 'X-Plasty' for Post Burn Flexion Contractures of Interphalangeal Joints of All Five Digits of Hand and Adduction Contractures of Axilla. *Egypt, J. Plast. Reconstr. Surg.*, Vol. 32, No. 1, January, 67-69, 2008.
- 30- Lewis R.C1., Nordyke M.D. and Duncan K.H.: Web space reconstruction with a M-V flap. *J. Hand Surg. Am. Jan.*, 13 (1): 40-3, 1988.
- 31- Sherif M.M.: First dorsal metacarpal artery flap in hand reconstruction. *Anatomical study. J. Hand Surg. [Am.]*, 19: 32-8, 1994.
- 32- Sokol Isaraj: Use of Dorsal Metacarpal Artery Flaps in Post Burn Reconstruction – Two Cases Report. *Macedonian Journal of Medical Sciences. Jun.*, 15; 4 (2): 180-184, 2011.
- 33- Ayan Gulgonen, M.D. and Kagan Ozer, M.D.: The Correction of Postburn Contractures of the Second Through Fourth Web Spaces. *J. Hand Surg.*, 32A: 556-564, 2007.
- 34- Rami M. Makkar, Wael Naemm, Joseph Naeem and Tamer M. Nabil: The Innervated 1st Dorsal Metacarpal Artery Island Flap for Reconstruction of Post Traumatic Thumb Defect Egypt, *J. Plast. Reconstr. Surg.*, Vol. 36, No. 2, July, 147-152, 2012.
- 35- Mahesh Prabhu1, Rajesh Powar1 and Sanjitsingh R. Sulhyan1*FDMA flap: A versatile technique to reconstruct the thumb. *Int. J. Pharm. Med. & Bio. Sc.*, Vol. 2, No. 4, October 2013 p 8.
- 36- Xu Zhang, Yajie He, Xinzhong Shao, Yanchuang Li, Shumin Wen and Hongwei Zhu: Second Dorsal Metacarpal Artery Flap From the Dorsum of the Middle Finger for

- Coverage of Volar Thumb Defect. *Journal of Hand Surgery*, Volume 34, Issue 8, Pages 1467-1473, October 2009.
- 37- Sebastin, Sandeep J., Mendoza, Romina T., Chong, Alphonsus K.S., Peng, Yeong P. Ono, Shimpei, Chung, Kevin C., Lim and Aymeric Y.T.: Application of the Dorsal Metacarpal Artery Perforator Flap for Resurfacing Soft-Tissue Defects Proximal to the Fingertip Plastic & Reconstructive Surgery Vol., 128 Issue 3, p 166e, 2011.
- 38- Perera, Nisal K. M.B.B.S.; Rozen, Warren M. M.B.B.S., Ph.D.; Niumsawatt, Vachara M.B.B.S. and Ek, Edmund F.R.A.C.S.: First Web Space Reconstruction Using a Dorsal Metacarpal Artery Perforator Flap: A Further Application of the Quaba Flap Plastic & Reconstructive Surgery, Volume 133 - Issue 1 - p 74e-76e, 2014.
- 39- Yuan F1, Yu G. and Zhang S.: (Applied anatomy of the second dorsal metacarpal artery island flap with double pivot points). *Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi*. Aug., 19 (8): 622-5, 2005.
- 40- Macht S.D. and Watson H.K.: The Moberg volar advancement flap for digital reconstruction. *J. Hand Surg. Am.* Jul., 5 (4): 372-6, 1980.
- 41- Steffen Baumeister, Henrik Menke, Michael Wittemann and Günter Germann: Functional outcome after the Moberg advancement flap in the thumb, *Journal of Hand Surgery*, Volume 27, Issue 1, Pages 105-114, 2002.
- 42- Yan-Feng Li and Shu-Sen Cui: Innervated Reverse Island Flap Based on the End Dorsal Branch of the Digital Artery: Surgical Technique. *The Journal of Hand Surgery*, Vol. 30A No. 6 November 2005.
- 43- Jefferson Braga-Silva, M.D., Ph.D.; Carlos R. Kuyven, M.D.; Porto Alegre, Brazil, Walter Albertoni, M.D., Ph.D.; Flávio Faloppa, M.D., Ph.D. and São Paulo, Brazil: The Adipofascial Turn-Over Flap for Coverage of the Dorsum of the Finger: A Modified Surgical Technique. *J. Hand Surg.*, 29A: 1038-1043, 2004.
- 44- Sabah Hassan Naji Dorsal Adipofascial Turnover Flap for Dorsal Defects of Finger Injury *Medical J. of Babylon* Vol 8 No 1 p1, 2011.
- 45- Jeffrey B. Friedrich, M.D.; Leonid I. Katolik, M.D. and Nicholas B. Vedder, M.D.: Soft Tissue Reconstruction of the Hand *J. Hand Surg.*, 34A: 1148-1155, 2009.
- 46- McGregor I.A. and Jackson I.T.: The groin flap. *Br. J. Plast. Surg.*, 25: 3, 1972.
- 47- Shaw D.T. and Payne R.N.: One-stage tubed abdominal flaps. Single pedicle tubes. *Surg. Gyn. Obstet.*, 83: 205, 1946.
- 48- Magdy A.: Reconstruction of the Beverley contracted first web space using the posterior interosseous artery flap. *Egypt J. Plast. Reconstr. Surg.*, Vol 27, No 1, 53-60, 2003.
- 49- Roberto Adani, M.D., Luigi Tarallo, M.D., Ignazio Marcoccio, M.D. and Umberto Fregni, M.D.: First Web-Space Reconstruction by the Anterolateral Thigh Flap. *J. Hand Surg.*, 31A: 640-646, 2006.