Egypt, J. Plast. Reconstr. Surg., Vol. 46, No. 1, January: 29-36, 2022

A Case Series of Microvascular Omental Flap: Indications and Outcomes

SUHAEL ZAHUR, M.Ch. (Plastic Surg)

Aesthetica Plastic Surgery Clinic, Narwal Bypass, Jammu, Jammu and Kashmir India

ABSTRACT

Background: Omental flap has the distinction of being the foremost flap to be applied in the field of reconstructive microsurgery. Despite the keen initial interest, the drawback of a harvest laparotomy led to gradual loss of favour in this flap. It was the path breaking application of minimal access surgery for flap harvest, which led to a renewed interest in omental flap in its new incarnation. In this case series of laparoscopically harvested microvascular omental transfers, we explore the flap's unique immunologic and tissue regenerative properties and resulting outcomes in challenging reconstructive situations and limb salvage.

Patients and Methods: A retrospective analysis of microvascular reconstructions with laparoscopically harvested omental flaps in ten challenging situations. The study evaluated the indications, procedural details such as operative technique and time, length of flap vascular pedicle achieved, complications and outcome.

Results: Provision of vascularized and stable soft tissue cover with swift resolution of infection in chronic wounds was achieved in all cases leading to reduced long term morbidity with negligible complications.

Conclusion: Microvascular omental flap provides large pliable tissue with characteristic vascular anatomy and unique set of immune and stem cells that has immense application in situations of complex three-dimensional reconstruction and limb salvage. Together with the laparoscopic-assisted harvest to avoid the morbidity of laparotomy, it presents an effective solution for those challenging situations that demand more than the routine options.

Key Words: *Microvascular reconstruction – Omental flap – Laparoscopic harvesting.*

Disclosures: None declared.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

INTRODUCTION

The omentum has the distinction of being the foremost flap in the field of microsurgery [1,2]. Though historical applications of pedicle omental flap are well known in literature, it was the microvascular transfer (Mclean and Buncke) that popularized its role in reconstructive surgery [3-15]. However, in spite of the unique attributes of pliability, vascular architecture, stem cells and angiogenic factors [16-18], the drawback of a harvest laparotomy hindered its routine use until laparoscopic-assisted harvest technique renewed interest and acceptability of this flap.

In this case series, we explore the current indications of laparoscopically harvested omental flap in reconstructive microsurgery and discuss with outcomes the impact of the flap's immunologic and tissue regenerative properties in complex reconstructions and limb salvage.

Anatomy:

The greater omentum is a four-layered fold of peritoneum hanging like an apron from the greater curvature of the stomach. Supplied by the right (Rt) and left (Lt) gastroepiploic vessels with an arterial diameter of 1.5 to 3.6mm, its rich framework of blood vessels, lymphatics, fat pads, mesothelial cells, and lymphoreticular bodies promote neovascularization by releasing polypeptide growth factors and activated macrophages into the recipient bed [19,20]. Recent studies also indicate that omentum is a rich source of omnipotent stem cells having the ability to differentiate into a variety of cell types [17].

These unique attributes make microvascular omental transfer a potent and reliable option for complex soft tissue reconstructions.

PATIENTS AND METHODS

This is a retrospective analysis of ten microvascular omental transfers for complex soft tissue reconstructions and limb salvage performed between January 2013 and March 2016. The study evaluated the surgical indications, operative technique with duration, pedicle lengthening, complications and outcome. The size of the defect and duration of follow-up were recorded.

All procedures were approved and in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 **[5]**.

Informed consent was obtained from all patients and legal guardians in case of minors.

Surgical technique:

The two team approach starts with a diagnostic laparoscopy by the laparoscopic surgery/general surgery team to assess the status of omentum for transfer. Once confirmed, the plastic surgery team joins by dissecting the recipient vessels and preparing the bed for flap transfer while the flap is being harvested. We had to modify this approach in case no. 3 & 5 where flap harvest preceded recipient vessel dissection for operative ease. The vascular pedicles are identified and retrogradely dissected to their origins from the splenic and gastroduodenal arteries. The branches going to the stomach are sealed with harmonic scalpel. In this study, all flaps were pedicled on the (Rt) gastroepiploic vessels due to its preferable calibre. After dissection of the (Rt) gastroepiploic vessels and division of the left, the omentum is delivered by a small upper-midline incision. At this stage, a template of the defect with the desired pedicle length helps in flap customization. Also, lengthening of the vascular pedicle is achieved by selective ligation of the middle omental vessels **[21,22,23]**. This is done before the ligation of (Rt) gastroepiploic vessels and flap detachment to reduce ischemia time. Once detached, the flap is immediately transferred to the plastic surgery team for microvascular anastomosis. In this study, the reperfused flaps were covered with split thickness skin graft (STSG) harvested from thigh and immobilized with skin staples. The post-operative monitoring for the first 72 hours involved hourly monitoring by the nursing staff of the flap's colour, temperature and vascular pulsations through the windows kept in the skin graft. When required, the findings were corroborated with a hand held doppler examination by the operating surgeon. In addition, the patients in the study were put on intravenous Dextran for 3 days.

RESULTS

The case series comprises of ten patients, eight males and two females with an age range of 7-60 years. The main indications being provision of stable soft tissue coverage to chronically exposed and infected fracture sites with and without underlying bony osteomyelitis, obliteration of post-sequestrectomy bony cavities and resurfacing of severely infected wounds with exposed tendons and nerves.

Case (1):

A 60 year male referred with 12 weeks old Gustilo type 3b fracture both bones distal 1/3 left leg immobilized in an external fixator with a discharging wound (Fig. 1A). Sequestrectomy of the in-fected tibia resulted in 8 x 6cm bony cavity which was obliterated with microvascular omental flap (Fig. 1B). The (Rt) gastroepiploic vessels were anastomosed to the (Lt) posterior tibial vessels in middle third of leg. The osteomyelitic bone and fracture site healed well in a remarkably short span of time. There was a shortening of the affected limb by around 2cm that was not bothering to the patient and he could ambulate without support with modified footwear after removal of fixator. Another observation in late follow-up was swelling in the flap on prolong ambulation (Fig. 1C). This was a result of vascular stasis as visualized on post-op CT Angiography (Fig. 1D) and resolved with compression stocking. The patient was given the option of flap debulking which he refused.

Fig. (1A): Post-debridement bony cavity with exposed fracture site.

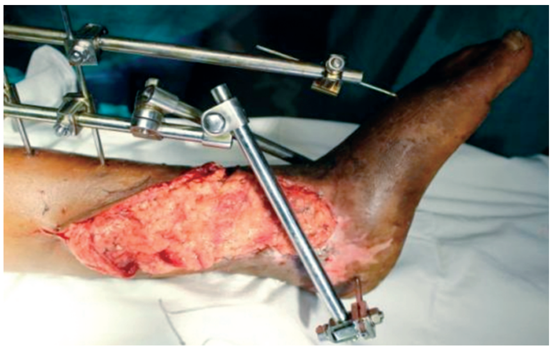

Fig. (1B): Intra-operative obliteration of cavity with flap.

Fig. (1C): Late post-op view of well settled flap and graft.

Fig. (1D): Post-operative CT Angiography.

Case (2):

A 25 year old female polytrauma patient referred with cerebral contusion, pelvic fracture, right hip dislocation, bladder rupture, multiple rib fractures with right-sided hemothorax besides mangled left foot. She had to undergo emergency laparotomy for bladder repair, tube thorocostomy, pelvic fixator and closed hip reduction followed by prolonged stay in ICU. Serial bedside debridements of foot resulted in circumferential loss of the hind and midfoot skin with exposed calcaneum and necrotic tendons. Once deemed fit, the foot was salvaged with microvascular omental flap and STSG (Fig. 2A). The vascular anastomosis was performed in the middle third of the leg between the (Rt) gastroepiploic and posterior tibial vessels (Fig. 2B). In this case, preliminary laparoscopic examination revealed extensive omental adhesions from previous laparotomy precluding safe harvest and resulting in conversion to open harvest. Subsequently, both the flap and graft healed without complications. (Fig. 2C).

Fig. (2A): Post-traumatic skin defect (Lt) foot with cover with exposed calcaneum and tarsals.

Fig. (2B): Inta-operative view of soft tissue microvascular omental flap.

Fig. (2C): Early post-operative view of flap with graft.

Case (3):

A 7 year girl, with high voltage electric injury, resulting in deep burns; involving 25% body surface area. The deep burn to the forehead resulted in 8x10cm full thickness skin loss with exposed frontal bones. The scattered nature of the burns made all the routine flap sites unavailable. The defect was resurfaced with microvascular omental flap and STSG. The vascular pedicle had to be lengthened to 12cms for anastomosis in the neck between (Rt) gastroepiploic vessels and (Rt) facial Artery & Vein as there were no local recipient vessels available due to deep burns. The flap and the graft healed well except a few subcentric losses that healed with conservative management.

Case (4):

A 25 year male with Gustilo type 3b fracture both bones left forearm (Fig. 3A) following a road side accident. Initially, the fracture was stabilized with external fixator and overlying skin lacerations repaired. Subsequently, the degloved skin overlying the fracture site necrosed and the patient presented 6 weeks later with a discharging wound with exposed fracture site. The coverage was provided with microvascular omental flap and STSG. The (Rt) gastroepiploic artery and vein were anastomosed to the (Lt) radial artery and cephalic vein (Fig. 3B). The wound healed remarkably well within a couple of weeks and fractured bones fixed as a secondary procedure (Fig. 3C,D).

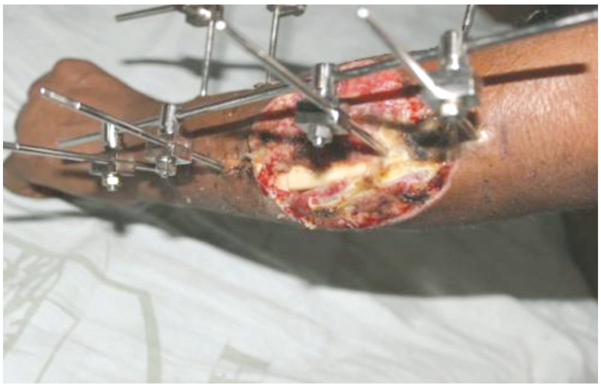

Fig. (3A): Post-traumatic skin defect with exposed and fracture site.

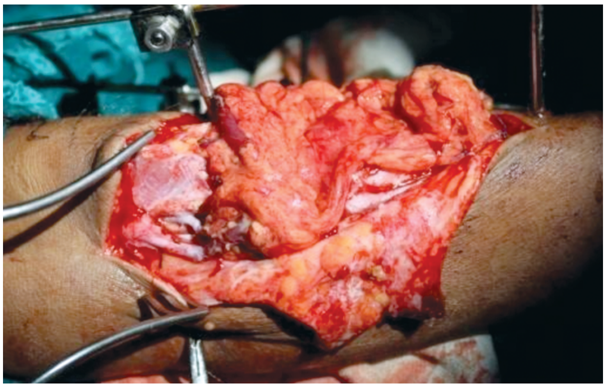

Fig. (3B): Intraoperative view of flap.

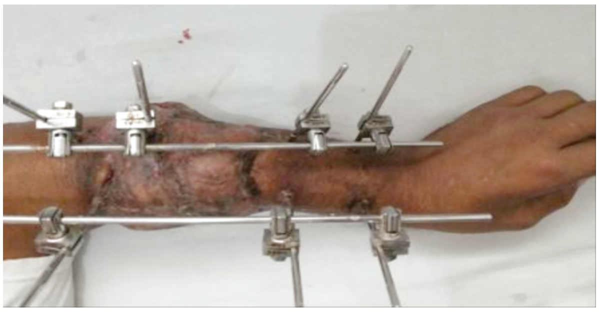

Fig. (3C): Well settled flap and graft in late post-op.

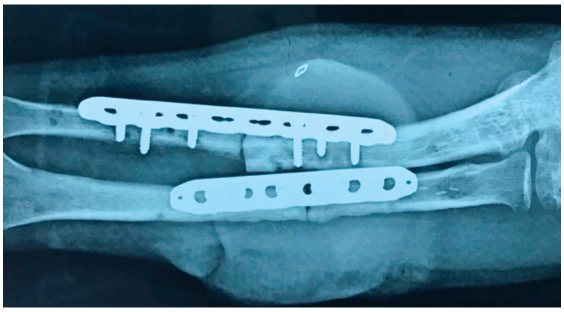

Fig. (3D): Fracture site fixed with plates.

Case (5):

A 17 year male with left fronto-parietal scalp defect from a bear maul injury. The multiple scalp lacerations were repaired and area of scalp loss covered at the primary hospital with split thickness skin graft (STSG). For unspecified reasons, the skin graft was partially lost and the patient presented to us three months after injury with bare fronto-parietal skull (Fig. 4A). The scalp was reconstructed with laparoscopically harvested omental flap with a vascular pedicle length ened to 14cm for anastomosis in the neck (Fig. 4B,C) between the (Rt) gastroepiploic and the (Lt) facial vessels. The flap and STSG settled well without any complication (Fig. 4D).

Fig. (4A): Post-traumatic scalp defect with exposed frontal bone.

Fig. (4B): Inta-operative view with desired length of vascular pedicle.

Fig. (4C): Intra-operative view of flap.

Fig. (4D): Late post-operative view with well settled flap and graft.

Case (6):

A 17-year old male presented with crush injury to left foot following a road side accident. The degloved skin of the dorsum of the foot necrosed resulting in exposure of the extensor tendons. There was associated vascular injury to the distal anterior tibial vessels in the lower third of the leg. Laparoscopically harvested omental flap was used to cover the dorsum of foot and 1st web space with the anastomosis between (Rt) gastroepiploic and anterior tibial vessels at the junction of middle and distal 1/3rd of the leg. The flap settled well except a small area around the ankle with graft loss due to shearing. This healed well with dressings and the patient achieved normal foot function and ability to bear weight in routine footwear.

Case (7):

A 28 year old male presented to the hospital with old electric injury resulting in soft tissue loss over right forearm and hand with exposed flexor tendons. Following initial debridement skin coverage was provided with microvascular omental transfer and STSG. The anastomosis was performed between (Rt) gastroepiploic vessels and radial artery and venae comitantes in middle of the forearm. The flap and graft settled well with acceptable hand function after physiotherapy.

Case (8):

A 14 year old boy presented with old type IIIB injury to the distal third of right leg following fall from height. The necrosed degloved skin had been debrided and the exposed fracture site stabilized in an external fixator. The skin cover was provided with microvascular omental flap and STSG with the (Rt) gastroepiploic vessels anastomosed end to side with the posterior tibial vessels in the proximal leg. The flap and graft healed well with no complications.

Case (9):

A 45 yr old male presented with high voltage electric injury resulting in extensive deep burns to the right upper limb. The patient underwent initial fasciotomy of the right forearm and hand followed by serial debridements of the burnt area resulting in extensive soft tissue defect involving distal forearm, dorsum of the hand and first web space. The soft tissue coverage was provided with microvascular omental flap covered with STSG. The vascular anastomosis was performed in the proximal forearm between the (Rt) gastroepiploic vessels and the radial artery and venae comitantes. The flap and the graft healed exceptionally well with good hand function.

Case (10):

A 25 year old male presented with firearm injury resulting in amputation of all the fingers of left hand at the metacarpophalangeal level. After debridement, the bare metacarpal bones were wrapped around with microvascular omental flap and STSG. The vascular anastomosis was performed in the mid forearm between the (Rt) gastroepiploic vessels and the radial artery and venae comitantes. The flap and graft healed without complications.

Table (1): Patient table with operative details, defect size, operative time, length of vascular pedicle, follow-up and outcome.

Case	Defect size	Omental flap harvest	Anastomosis	Length of pedicle (cm)	Operative time (hours)	Follow-up	Outcome
1	8x6 cm post-sequestrectomy bone cavity distal tibia	Laparoscopic-assisted	End to end anastomosis between (Rt) gastroepiploic and posterior tibial vessels in middle third of leg	6cm	3.45	18 months	Flap and STSG healed well, rapid resolution of infection, good limb function with complete weight bearing without secondary bone procedure.
2	20x16 cms skin defect with exposed tarsal bones	Laparoscopic-assisted converted to laparotomy	End to end anastomosis between (Rt) gastroepiploic and Posterior tibial vessels at the junction of middle and distal 1/3rd of the leg.	12cm	4.0	1yr	Flap and STSG healed well without complication.
3	8x10 cm skin defect with exposed frontal bone	Laparoscopic-assisted	End to end anastomosis between (Rt) gastroepiploic vessels and facial A&V. in neck.	12cm	4.50	1 yr	The flap and STSG healed, a few subcentric areas of flap necrosis leading to graft loss that healed with conservative methods.
4	10x12cm skin defect with exposed fracture both bones forearm	Laparoscopic-assisted	End to end anastomosis between (Rt) gastroepiploic vessels and radial artery and cephalic vein in proximal forearm	6cm	3.50 hours	1 yr	Flap and STSG healed well, internal bone fixation after 6-weeks by orthopaedics, good limb function
5	8x12cm skin defect with exposed fronto-parietal bone	Laparoscopic-assisted	End to end anastomosis between (Lt) gastroepiploic and facial vessels in neck	14cm	4.30 hours	1yr	The flap and STSG healed well without complications.
6	16x12 cms skin defect with exposed tendons	Laparoscopic-assisted	End to end anastomosis between (Rt) gastroepiploic and Anterior tibial vessels in distal third leg	8cm	3.45 hours	1yr	The flap and STSG healed well without major complications except a small area around the ankle with graft loss due to shearing.
7	16x8cm skin defect with exposed flexor tendons	Laparoscopic-assisted	End to end anastomosis between (Rt) gastroepiploic vessels and radial artery and venae comitantes in mid forearm	8cm	3.45	1yr	The flap and STSG healed well without complications.
8	20x10 cm skin defect with exposed tibia	Laparoscopic-assisted	End to side anastomosis between (Rt) gastroepiploic vessels and Posterior tibial vessels in proximal leg	10cm	3.50	18 months	The flap and STSG healed well without complications.
9	16x12cm skin defect with exposed tendons	Laparoscopic-assisted	End to end anastomosis between (Rt) gastroepiploic vessels and radial Artery and venae comitantes in proximal forearm.	8cm	3.30	1yr	The flap and STSG healed well without complications.
10	12x8cm skin defect with exposed metacarpals	Laparoscopic-assisted	End to end anastomosis between Rt gastroepiploic vessels and radial artery and venae comitantes in mid forearm	8cm	3.30	1 yr	The flap and STSG healed well without complications.

DISCUSSION

The selection of a flap in reconstructive surgery is guided by the size, location and etiology of the defect as well certain patient variables such as past and existing medical and surgical illnesses. Though application of microvascular omental flap for routine reconstructive situations can be debatable, it's unique set of attributes make it a natural choice for certain peculiar and challenging situations where the regular flaps either don't suffice or are unavailable. These special qualities include:

1- A host of immune cells that help in swift resolution of infection and expedite healing.

2- A vascular pedicle **[21,22,23]** that can be customized to need for microvascular anastomosis outside the zone of injury and as flow-through flap.

3- Pliable tissue with characteristic vascular architecture that enables simultaneous transfer of multiple omental segments in complex three-dimensional reconstructions.

4- A rich lymphatic system that ameliorates edema.

In this study, we explored omentum's rich vascularity with its immunologic, reparative and regenerative properties in a variety of severely infected and chronic wounds **[17,24,25,26]**. The pliability of the flap enabled obliteration of post-sequestrectomy bony cavities characteristic of chronic osteomyelitis. The results were swift resolution of indolent infection, shorter hospital stay, significant reduction in secondary surgical procedures and long term morbidity. The resurfaced tendons demonstrated good function as the flap provides a stable gliding surface essential for normal kinetics. Though there was no incidence of secondary tendon procedures like tenolysis in this study. When required, that could be easily done due to the peculiar vasculature of the flap that allows safe access through it.

Some of the complex wounds in this study (Cases 2,3,5,8) needed a flap with a long vascular pedicle in order to have the microvascular anastomosis outside the zone of injury. Such "Customized" vascular pedicles (range 6-14cm) were achieved by extrapolating the principle of omental lengthening by selective division of the arcade branches. This technique allowed us to avoid the need of vein grafts, thereby reducing operative time and possible morbidity.

Laparoscopic assisted flap harvest, by doing away with laparotomy, significantly reduces morbidity **[4,27,29,30,31]** with less post-operative pain and shorter time to resumption of bowel function. This was clearly demonstrable in this study as all the patients were allowed oral intake and ambulation after 24 hours of the procedure. The only exceptions to early ambulation were the cases with lower limb reconstruction.

The two-team approach significantly reduced the operative time of the procedure (Average 4hrs) as confirmed in this study. We believe this factor can have major implication for centers with huge load of reconstructive microsurgery patients but limited resources particularly operative facilities.

Not with standing these advantages, this procedure does have its own limitations. First, the availability of trained minimal access surgeon is imperative which may not be possible everywhere. Second, any previous upper abdominal surgery or co-morbid condition that precludes safe laparoscopic harvest is considered a relative contraindication. A CT-angiography may be considered for evaluating the status of the flap and its vascular pedicle. In our study, all procedures proceeded with initial diagnostic laparoscopy to confirm the feasibility of flap harvest. If found other-wise, as in Case (2) of the series with extensive adhesions, a decision must be taken for conversion to open technique or an alternate flap should be considered.

We did not come across any major flap related or donor site complication including flap congestion or loss. However, we did experience minor graft loss in two cases. One in Case (3), where the delicate omentum of child together with handling trauma during harvest led to few sub-centric areas of flap and graft loss. Other is Case (6), where graft shearing during early ambulation resulted in an area of minor loss around the ankle. All these areas of graft loss healed conservatively with dressings in a couple of weeks.

Another limitation is the short number of cases in this series. We believe a larger series with extended follow-up is required to further validate the results.

Conclusion:

Microvascular omental flap with its unique set of stem cells, exceptional wound healing and tissue reparative properties with minimum donor site morbidity deserves to be in the armamentarium of every reconstructive surgeon. However, the utility of this flap should be reserved for selected complex situations that require it's unique attributes for salvage or when as a salvage flap when the routine skin and muscle flap options are unavailable.

REFERENCES

1- O'Shaugnessy L.: An experimental method of providing a collateral circulation to the heart. Br. J. Surg., 2: 665-70. doi: 10.1002/bjs.1800239122, 1936.

2- Casten D.F. and Alday E.S.: Omental transfer for revascularization of extremities. Surg. Gynecol. Obstet., 132: 301-4, 1971.

3- Jurkiewicz M.J. and Nahai F.: The omentum: Its use as a free vascularized graft for reconstruc-tion of the head and neck. Ann. Surg., 195: 756-65, 1982.

4- Hultman C.S., Carlson G.W., Losken A., Jones G., Culbertson J., Mackay G., et al.: Utility of the omentum in the reconstruction of complex extraperitoneal wounds and defects: Donor-site complications in 135 patients from 1975 to 2000. Ann. Surg., 235: 782-95, 2002.

5- Hultman C.S., Culbertson J.H., Jones G.E., Losken A., Kumar A.V., Carlson G.W., et al. Thoracic reconstruction with the omentum: Indications, complications, and results. Ann. Plast. Surg., 46: 242-9, 2001.

6- Rand R.P., Amerhauser A., Justicz A. and Jurkiewicz M.J.: Enhancement of intestinal absorptive capacity with omental flaps. Ann. Plast. Surg., 33: 611-4, 1994.

7- Rand R.P. and Jurkiewicz M.J.: Formation of independently revascularized small-bowel segments using pedicled omental flaps. Ann. Plast. Surg., 33: 606-10, 1994.

8- Bostwick J., Stevenson T.R., Nahai F., Hester T.R., Coleman J.J. and Jurkiewicz M.J.: Radiation to the breast. Complications amenable to surgical treatment. Ann. Surg., 200: 543-53, 1984.

9- Bostwick J. 3rd, Vasconez L.O. and Jurkiewicz M.J.: Breast reconstruction after a radical mastectomy. Plast. Reconstr. Surg., 61: 682-93, 1978.

10- Jurkiewicz M.J. and Arnold P.G.: The omentum: An account of its use in the reconstruction of the chest wall. Ann. Surg., 185: 548-54, 1977.

11- Arnold P.G., Hartrampf C.R. and Jurkiewicz M.J.: One-stage reconstruction of the breast, using the transposed greater omentum. Case report. Plast. Reconstr. Surg., 57: 520-2, 1976.

12- Kiricuta I.: [Plastic surgery using part of the epiploon. Prior vascularisation of the trans-plant on the dorsal surface of the hand (author's transl)]. Nouv Presse Med., 7: 4295-7, 1978.

13- Liebermann-Meffert D. and White H.: The greater omentum: Anatomy and physiology, pathology, surgery with an historical survey. New York: Springer, p. 1-369, 1983.

14- Goldsmith H.S.: Omental transposition for peripheral vascular insufficiency. Rev. Surg., 24: 379-80, 1967.

15- McLean D.H. and Buncke H.J.: Autotransplant of omentum to a large scalp defect with micro-surgical revascularization. Plast. Reconstr. Surg., 49: 268-74. doi:10.1097/00006534-197203000-00005, 1972.

16- Shimotsuma M., Shields J.W., Simpson-Morgan M.W., Sakuyama A., et al.: Morpho-physiological function and role of omental milky spots as omentum-associated lymphoid tissue (OALT) in the peritoneal cavity. Lymphology, 26 (2): 90-101, 1993.

17- Singh A.K., Patel J., Litbarg N.O., et al.: Stromal cells cultured from omentum express pluripotent markers, produce high amounts of VEGF, and engraft to injured sites. Cell Tissue Res., 332 (1): 81-8. doi:10.1007/s00441-007-0560-x, 2008.

18- Williams R. and White H.: The greater omentum: Its applicability to cancer surgery and cancer therapy. Curr. Probl. Surg., 23 (11): 789-865. doi:10.1016/0011-3840(86)90007-9, 1986.

19- Liebermann-Meffert D.: The greater omentum. Anatomy, embryology, and surgical applications. Surg. Clin. North Am., 80 (1): 275-93. doi: 10.1016/S0039-6109(05)70406-0, 2000.

20- Minakawa M., Fukuda I., Wada M., Kaiqiang J., Daitoku K., Itoh K., et al.: Preoperative evaluation of the right gastroepiploic artery using abdominal ultrasonography. Ann. Thorac. Surg., 82 (3): 1131-3. doi:10.1016/j.athoracsur.2005.09.018, 2006.

21- Alday E.S. and Goldsmith H.S.: Surgical technique for omental lengthening based on arterial anatomy. Surg. Gynecol. Obstet., 135: 103-7, 1972.

22- Das S.K.: The size of the human omentum and methods of lengthening it for transplantation. Br. J. Plast. Surg., 29: 170-4. doi: 10.1016/0007-1226(76)90045-X, 1976.

23- Sarlak A.Y., Tosun B., Buluc B., et al.: A comparison of two omental lengthening techniques by the pedicled omentum to close a knee disarticulation defect: A case report. Eur. J. Plast. Surg., 30: 239-43. doi:10.1007/s00238-007-0173-3, 2008.

24- Piano G., Massad M.G., Amory D.W., et al.: Omental transfer for salvage of the moribund lower extremity. Am. Surg., 64: 424-7, 1988.

25- Goldsmith H.S.: The evolution of omentum transposition: from lymphedema to spinal cord, stroke and Alzheimer's disease. Neurol. Res., 26 (5): 586-93. doi:10.1179/016164104225017622, 2004.

26- Karasawa J., Touho H., Ohnishi H., et al.: Cerebral revascularization using omental trans-plantation for childhood moyamoya disease. J. Neurosurg., 79: 192-6, 1993.

27- Saltz R., Stowers R., Smith M. and Gadacz T.R.: Laparoscopically harvest edomental-free flap to cover a large soft tissue defect. Ann. Surg., 217 (5): 542-546, discussion 546-547, 1993.

28- Saltz R.: Endoscopic harvest of the omental and jejunal free flaps. Clin. Plast. Surg., 22 (4): 747-754, 1995.

29- Zaha H., Onomura M., Nomura H., Umekawa K., Oki M. and Asato H.: Free omental flap for partial breast reconstruction after breast-conserving surgery. Plast. Reconstr. Surg., 129 (3): 583-587, 2012.

30- Kamei Y., Torii S., Hasegawa T. and Nishizeki O.: Endoscopic omental harvest. Plast. Reconstr. Surg., 102 (7): 2450-2453, 1998.

31- Zaha H., Inamine S., Naito T. and Nomura H.: Laparoscopically harvest edomental flap for immediate breast-reconstruction. Am. J. Surg., 192 (4): 556-558, 2006.