The omentum: A unique organ of exceptional versatility

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ABSTRACT

In the past, the omentum was considered to be an inert tissue without much biological significance. But since the beginning of the last century, innumerable studies and trials have been conducted by surgeons and scientists all over the world, which have proven that the omentum is a unique, physiologically dynamic tissue with immense therapeutic potential. We have undertaken the present review to provide a concise account of the variety of applications of the omentum in the various disciplines of surgical practice. An extensive search was carried out on the internet for indexed publications in the English literature using the keywords “omentum, omentoplasty and surgical uses of omentum.” The search revealed about 86 publications. All those publications were systematically reviewed and analyzed. The inferences derived from those publications are methodically summarized. The omentum is indeed an organ of exceptional versatility. This review presented by us will enable the readers to appreciate the fact that, clearly the omentum was placed in the abdomen for a reason.

Key words: Omentoplasty, omentum, surgical uses of omentum

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The greater omentum is nothing but a large fold of peritoneum that hangs down from the greater curvature of the stomach like an apron to a variable extent over the intestinal loops. It appears as a thin fenestrated membrane with varying amount of fat deposition. Apart from serving as a storehouse of fat, it protects the peritoneal cavity from infections by virtue of its “milky spots,” which are nothing but collections of macrophages. It is also said to limit the spread of intraperitoneal infections by moving to the concerned site and sealing it from the nearby area, a function that has made the British surgeon Rutherford Morrison to rightly name it as “The policeman of the abdomen” in the early 20th century. In spite of all these valuable functions, the omentum is often forgotten.

SPECIAL PROPERTIES OF THE OMENTUM

Certain special attributes of the omentum favor its innumerable applications in day-to-day surgical practice. Basically, it is a highly vascular organ with a rich source of angiogenic factors that promote the growth of blood vessels into whatever tissue it is placed close to. The potent lymphatic system of the omentum can absorb enormous amounts of edema fluids and remove metabolic wastes and toxic substances. Recent studies have revealed that the omentum, apart from being a great source of various growth factors, neurotransmitters, neurotrophic factors and inflammatory mediators, also contains omnipotent stem cells that can differentiate into a variety of cell types. It provides an excellent plastic material against inflammation and irradiation. Anatomically, the attachments of the omentum and the arrangement of the vascular arcades are in such a way that it can be lengthened to an unbelievable extent at a vascular pedicle, exteriorized or detached using microvascular techniques for various intra-abdominal and extra-abdominal procedures. The arterial and venous...
supply to the omentum are derived from the branches of the right and left gastroepiploic vessels that course along the greater curvature of the stomach. Division of the right or left gastroepiploic artery and the vasa recta along the greater curvature of the stomach with mobilization of the omentum from the transverse colon allows the development of a vascularized omental pedicle flap. The following is an account of the various ways by which the omentum can be put into use in the modern surgical field.

**GASTROINTESTINAL SURGERY**

The most common use of omentum is as an adjunct to intestinal surgery, wherein it is often wrapped around the sites of anastomosis. The omentum fills in small gaps between the sutures and provides a good source of blood vessels and inflammatory cells for healing. Anastomotic leakage is the most feared complication in the surgery of cancer of cardia and esophagus. The incidence of leakage is more common in cervical anastomoses, while it is virtually fatal when it occurs in intrathoracic anastomoses. Due to its capacity of localizing infection and sealing microperforations, most authors strongly recommend omentoplasty in every case of radical surgery for cancer of cardia and esophagus.[1] For the management of perforated gastric ulcer, omental patch closure and ulcer excision are as effective as gastrectomy.[2] For perforated duodenal ulcers, the Graham omental patch closure is a well known and commonly performed procedure. Cellan-Jones omental patch is a simple, timesaving and dependable procedure even for closure of large duodenal perforations up to 3 cm in size. The omental plug can be reliably used for occluding large duodenal defects, wherein it promotes healing through a combined process of inflammation, granulation, vascularization and fibrosis, eventually providing a normal duodenal mucosal cover to the perforation site.[3] During pancreaticoduodenectomy, wrapping an omental flap around the dissected splanchic vessels reduces postoperative intra-abdominal bleeding and infection.[4] Surgery is the cornerstone in the management of echinococcosis. Omentoplasty of the hydatid cyst cavity, if feasible, is preferred to tube drainage.[5] Omentoplasty of the abscess cavity can be useful for patients with both complicated and noncomplicated amebic liver abscesses. This procedure may be used for managing liver abscess complicating perforative colonic diverticulum.[6] Arrest of severe liver hemorrhage in victims of blunt injury abdomen by tamponade with a viable omental pack is an almost uniformly successful technique. In pediatric splenic trauma, omentoplasty can be combined with splenorrhaphy or partial splenectomy as a valuable spleen-saving procedure. The omental lipid fraction has been shown to contain a factor that induces good regeneration of splenic transplants.[7] In colorectal anastomosis also, omentoplasty appears to contain the severity of leakage. Omentoplasty and possible drainage may be considered in rare prohibitive cases of colonic diverticular disease with adhesions and conditions that prevent effective segmental resection, peritoneal lavage and proximal fecal diversion. In majority of patients undergoing abdominoperineal resection for adenocarcinoma of lower rectum, sutured perineal omentoplasty merits consideration and is associated with excellent primary perineal wound healing.[8] Vascularized omental pedicle flap can be used to prevent the small intestine from entering the pelvis after abdominoperineal resection, thus preventing radiation enteritis during radiation therapy for rectal carcinoma. A new procedure has been devised for abdominal rectopexy, wherein the omentum can be used to support the rectum below the rectopexy, to reconstruct the anorectal angle and to avoid the need for synthetic meshes.[9] The omentum’s rich vascularity and high content of thromboplastin is an excellent feature for treating difficult-to-handle abdominal or pelvic abscesses and for inducing hemostasis.

**NEUROSURGERY**

The omentum finds its application in the field of neurosurgery due to the fact that it is the best tissue to provoke revascularization and through these vessels the underlying and adjacent brain receives increased blood flow, oxygen, omental neurotransmitters (dopamine, noradrenaline and acetylcholine) and neurotrophic factors (nerve growth factor and gangliosides).[10] The conventional surgical procedures for epilepsy include surgical ablation of the epileptogenic zone, disconnection procedures and vagus nerve stimulation. Placing the omental tissue directly upon the epileptic focus (medial temporal lobe structures) and neighboring areas (posterior hypothalamus, subcommissural region and extreme anterior perforated substance) as well as underlying and adjacent brain receives increased blood flow can provoke revascularization and through these vessels the underlying and adjacent brain receives increased blood flow, oxygen, omental neurotransmitters (dopamine, noradrenaline and acetylcholine) and neurotrophic factors (nerve growth factor and gangliosides).[10] Omental transplantation on the optic chiasma, carotid bifurcation and the anterior perforated substance can improve the symptoms of Alzheimer’s disease.[11] Application of vascularized omental graft has been shown to benefit patients with ischemic cerebrovascular diseases.[12] Intracranial transplantation of omentum can help patients with cerebrovascular moyamoya disease. Cerebrospinal fluid fistulas are a major source of morbidity after pericranial surgeries. Free microvascularized omental flap can be used in an intracranial position for the management of chronic CSF rhinorrhea.[13] Similarly, pedicled or free omental graft can be transposed to the lumbar subarachnoid space to resorb CSF. Though there are only a few published reports with detailed outcomes, numerous claims are being made in favor of omental transposition in chronic spinal cord injury.[14] However, this procedure may have a definite role in the
management of acute spinal cord injury as an adjunct to neural grafting and reconstruction using collagen bridges and neurotrophic factors.\textsuperscript{16}

**CARDIOTHORACIC SURGERY**

The omentum, apart from being a well vascularized tissue, is also a good source of angiogenic factors like vascular endothelial growth factor. CD 34 + cell population of human omentum is supposed to be responsible for the clinical benefit of omental transplantation by promoting angiogenesis.\textsuperscript{17} Omentopexy has been recently shown to promote myocardial angiogenesis, the so-called Hybrid surgical angiogenesis, wherein it enhances the angiogenesis induced by autologous bone marrow derived mononuclear cell transplantation.\textsuperscript{18} Omentopexy and cell patch cardiomyoplasty (impregnation of skeletal myoblasts from autologous rectus muscle into the infarcted myocardium) in conjunction with coronary artery bypass surgery may stimulate myogenesis and angiogenesis in the avascular, dyskinetic scar tissue of the left ventricle, resulting in improved functional capacity.\textsuperscript{19} In this era of cardiac valve replacement and coronary bypass surgeries, there are an increasing number of sternal wound infections and mediastinitis. In such conditions when the usual modalities of treatment like appropriate antibiotics, early debridement and transposition of muscle flaps prove unsatisfactory, transposition of the greater omentum is particularly well suited as it contains a large number of immunologically active cells with anti-infective activity.\textsuperscript{20} In thoracic surgery, omentum is being widely used for filling up of the dead spaces at chronic empyema, for chest wall reconstruction after extensive resections and to strengthen a main bronchus stump in cases of failure after pneumonectomy.\textsuperscript{21} While managing chronic empyema, omental flap transposition should be considered when both thoracic tube drainage and thoracostomy prove to be ineffective. Due to the plastic and immunological features of the omentum, intrathoracic omentoplasty is an effective means of treatment of pleural cavity secondary to a stabilized bronchial fistula.\textsuperscript{22} During surgical attempts at curing lung tumors with carinal proximity, omentum can be used to protect tracheobronchial anastomoses. Omentoplasty also prevents bronchial dehiscences following lung transplantation.

**VASCULAR SURGERY**

Omental pedicled flaps are commonly interposed between aortic reconstructions and the nearby small bowel to prevent erosion, graft infection and aortoenteric fistula formation. Buerger’s disease is a progressive disabling disease of unpredictable course affecting young smokers. Omentopexy by free or pedicled omental transfer is an attractive option for these patients. Many published series have shown marked improvement of intermittent claudication and rest pain, healing of ischemic ulcers and delaying of progression of gangrene.\textsuperscript{23} Patients with buerger’s disease of the upper extremities can also be benefited by omentopexy. Pedicled omentum, prepared through midline laparotomy, can be placed through a subcostal incision to the subcutaneous space of the forearm and the affected fingers.\textsuperscript{24} When arterial reconstructions are fashioned in the femoral region, at times, achieving soft tissue coverage of the reconstruction may be challenging. This is especially true when radical and wide debridement has removed the nearby tissues normally used for this purpose. In such circumstances, omentum reached from behind the inguinal ligament and transposed over the femoral triangle can help by obliterating the dead space and providing a surface for skin coverage.\textsuperscript{25}

**PLASTIC AND RECONSTRUCTIVE SURGERY**

The omentum continues to be a versatile reconstructive tool with increasing applications in the field of plastic and reconstructive surgery. It can be used to correct a variety of defects of the face and scalp. Full thickness defects of the cheek can be repaired by so-called “omental sandwich technique,” wherein a flap of omentum brought to the neck through a subcutaneous tunnel is used to cover the defect, followed by skin grafting.\textsuperscript{26} Laparoscopically harvested omental flaps can be used for head and neck reconstructions. In patients with a devascularized temporoparietal region, particularly when there is unavailability of the contralateral temporoparietal fascia, total ear reconstruction has been carried out using omental free flaps.\textsuperscript{27} Following extensive surgeries for pharyngoesophageal malignancies, tubed gastro-omental free flaps can be used for pharyngoesophageal reconstruction.\textsuperscript{28} The omentum can be safely harvested and reliably used to reconstruct a diverse range of extraperitoneal wounds and defects. It has a trophical effect on the surrounding tissues, making it very useful in reconstructive procedures. Advanced breast cancer is associated with pain, ulceration and bad odor. In such patients with uncontrolled chest wall disease, radical chest wall surgery with omental flap transposition serves as a good palliative procedure and a means of local control, provided they have an expectation of at least moderate-term survival.\textsuperscript{29} Omental transfer restores epithelial cover after radical surgery and is especially useful after previous irradiation injury. Omental flaps may be used for abdominal wall oncologic defect reconstruction also, on account of their large size and good vascularity. Especially when materials like Gore-Tex are used for large defect reconstructions, omentum serves as an interpositional flap over the Gore-Tex repair, preventing exposure in the event of infection or flap breakdown.\textsuperscript{30} Transposed greater omentum can serve as a vascularized base for split-thickness skin grafts.
during reconstruction of soft tissue defects of groin and axilla. Extensive soft tissue defects of both the lower limbs can be resurfaced with free hemiflaps harvested from the omentum. Pedicled omentoplasty has been shown to prevent the formation of lymphedema after pelvic lymph node dissection. This procedure is also useful in reducing the formation of lymphedema in the lower limbs following radiotherapy, by favoring the absorption of lymph fluids. Omentoplasty done through a midline laparotomy and transferred to the thigh either through the lower end of the laparotomy incision or through a separate stab and placed subcutaneously in the upper third of the thigh has been tried as a primary procedure as well as after failed lymphonodo-venous shunt to reduce the edema in patients with unilateral filarial lymphedema.

The high vascularity of the omentum, coupled with its rich content of microvascular endothelial cells and adipocytes that produce large amounts of vascular endothelial growth factor, paves way for its usefulness in soft tissue augmentation procedures. Transplantation of fragmented omental tissues or co-transplantation with preadipocytes promises a new and exciting horizon for soft tissue augmentation. Omentum can be used to vascularize skin, a skin flap or a bone graft to obtain secondary island flaps. The clinical applications of these flaps are immense in the field of reconstructive surgery.

Wrapping the median nerve with vascularized omentum is a viable option for the treatment of severe recalcitrant carpal tunnel syndrome. This is especially helpful while dealing with a carpal tunnel that has earlier undergone multiple operations with diffuse scar and adherence over an extended length of the median nerve.

**UROLOGICAL AND GENITAL SURGERY**

Omentum is also being used in the field of urological surgery. Open insertion of the peritoneal dialysis catheters is the conventional method adopted during continuous ambulatory peritoneal dialysis (CAPD), an effective treatment modality for patients with end-stage renal diseases. Instead, laparoscopic omental fixation to the parietal peritoneum and then extraperitoneal placement of the straight portion of the catheter, helps to avoid many complications like catheter tip migration, pericatheteral leakage and severe abdominal pain caused by periodic catheter movement. Following renal transplantation, lymphoceles form in about 5-15% of the cases in spite of meticulous surgical techniques. Peritoneal fenestration of the lymphoceles combined with interposition of greater omentum is a procedure that merits consideration in managing this complication. Omental interposition has also been used for prevention of urinary fistulas in cases of lower pole renal artery lesions and feared ureteral necrosis as well as for protection of pyeloureterostomies and pyelovesicostomies. In diseases where the renal artery and hence the circulation of the kidney is affected, omentum may be used to provide alternative blood supply to the kidney so as to preserve renal function. Following lymphorenal disconnection for chyluria, the omentum can be wrapped around the renal pedicle to minimize the chances of postoperative lymphatic drainage and recurrence. Because of its good absorptive capacity, the omentum is likely to absorb any lymphatic ooze. Omentovesicopexy is a simple and efficient technique for the treatment of neurogenic dysfunctions of the urinary bladder. In this technique, the greater omentum helps in the reinnervation and revascularization of the bladder.

A new composite gastric seromuscular and omental pedicle flap has been described to provide immediate watertight and airtight closure in the repair of complex defects of urethra. This flap was used to repair defects of urethra, scrotum and abdominal wall in a patient with Fournier’s gangrene. During the surgical management of high undescended testes, omentotesticulopexy has been recommended either before or concomitant with spermatic vessel division, so as to improve the vascular supply and reduce the rate of testicular atrophy.

**GYNECOLOGICAL SURGERY**

Following radical abdominal hysterectomy, the omental J-flap is a rapid and effective means of minimizing surgical morbidity and reducing postoperative complications like pelvic infection, abscess or intestinal obstruction and merits consideration for routine placement at the end of the surgery. Following radical pelvic exenteration for gynecological malignancies, neovaginal reconstruction can be done using an omental cylinder flap lined with a split-thickness skin graft. This procedure has distinct advantages over reconstruction with myocutaneous flaps, by providing support for the pelvic floor with primary healing along with potential for sexual function with minimal morbidity. Obstetric trauma, radiotherapy and radical gynecological surgeries can lead to a variety of vesicovaginal fistulae. Surgical procedures using omentum merit consideration in the management of these fistulae. Omental flaps can reach well into the pelvis through the retrocolic route and therefore can be used for perineal reconstruction following radical vulvectomy.

**ORTHOPEDIC SURGERY**

Osteoradionecrosis, earlier described as “osteomyelitis secondary to radiation,” refers to the fibrosis of the underlying bony structures in irradiated sites. Pedicled omentoplasty and split-thickness skin grafting has been successfully tried for infected osteoradionecrotic ulcers that fail to respond to antibiotics and as a palliative
procedure for control of pain and bleeding. This modality is very impressive for the elderly and the debilitated patients. Greater omentum can be used as a plastic and disinfecting material in combination with laser radiation in the management of chronic osteomyelitis of the ribs and sternum. Omentoplasty is the method of choice in surgical treatment of purulent lesions of costal cartilage and sternum. The omentum can be used as a gliding material to prevent re-adhesions following tenolysis after major forearm replantations.[46] Omental free-tissue transfer employing microsurgical techniques has been used in the management of brachial plexus injury pain.[47]

CONCLUSION

Until the 1800s, the role and functions of the omentum continued to be a mystery. Since the early 1900s, the surgical world started recognizing and appreciating the great potentials of this ‘wonder’ organ. The extra-abdominal uses of omentum were first addressed in the 1930s. The omental lengthening procedures described by Ross and Pardo in dog were great contributions to this field. Now, by a simple procedure, the omentum can be converted into a vascularized pedicle graft, which can be put to use throughout the body. The omentum is undoubtedly the most versatile organ in that it finds wide applications in almost all branches of surgery. Its various special attributes make it an extremely useful adjunct in several difficult surgical situations. Hence, we strongly recommend that in this fast growing surgical field, the wise operating surgeon constantly and adequately keeps updating his knowledge on these useful concepts and makes the best use of them as and when applicable.

REFERENCES