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Laparoscopic harvesting of omental pedicle flap for cerebral revascularization in children with moyamoya disease

Matias Bruzoni [a], Gary K. Steinberg [b], Sanjeev Dutta [a,*]

[a] Division of Pediatric Surgery, Department of Surgery, Stanford University School of Medicine, Stanford, CA
[b] Department of Neurosurgery, Stanford University School of Medicine, Stanford, CA

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ABSTRACT

Introduction: An abundance of angiogenic and immunologic factors makes the omentum an ideal tissue for reconstruction and revascularization of a variety of extraperitoneal wounds and defects. Omental harvesting was historically performed through a large laparotomy and subcutaneous tunneling to the site of disease. Several complications of the open procedure including abdominal wound infection, fascial dehiscence, ventral hernia, and postoperative ileus have been described. The use of laparoscopy to harvest the omentum has the potential to reduce such complications. We describe the surgical technique and outcomes of a series of patients undergoing laparoscopic pedicled omental flap mobilization for cerebral revascularization in moyamoya disease.
Methods: A retrospective chart review of all patients undergoing laparoscopic omental cerebral transposition for moyamoya disease between 2011 and 2014 was performed. Clinical indication, surgical technique, operative times, complications, and outcomes at follow-up were reviewed.
Results: A total of 7 children underwent the procedure. The general surgery team performed laparoscopic omental mobilization, extraperitonealization, and subcutaneous tunneling, while the neurosurgical team performed craniotomy and cerebral application of the graft. The patients were followed postoperatively with clinic visits and angiography. There was one intraoperative complication (colon injury) and one postoperative complication (intermittent omental hernia at fascial defect for pedicle). All patients had partial to complete symptomatic resolution and demonstrated adequate intracranial revascularization on angiography.
Conclusion: Laparoscopic omental pedicle flap mobilization and subcutaneous transposition is feasible in children who require salvage cerebral revascularization for moyamoya disease. The procedure should be considered for other conditions requiring extraperitoneal revascularization.

An abundance of angiogenic and immunologic factors makes the omentum an ideal tissue for reconstruction and revascularization of a variety of extraperitoneal wounds and defects. Just like any other adipose tissue, the omentum serves as the primary site for a number of critical biologic functions including fatty acid metabolism and lipoprotein lipase synthesis. A number of polypeptide growth factors that possess potent angiogenic properties have been identified in the omentum. For example, the levels of vascular endothelial growth factor (VEGF) protein were found to be high in the omentum and even increased in hypoxic conditions. Augmented expression of VEGF by omental cells under hypoxic conditions may reflect the mechanism responsible for enhancing the angiogenic activity of omentum in the setting of ischemia [1].

Current applications include repair of massive sternotomy wounds, complex head and neck defects post oncologic surgery, hemifacial atrophy, and bronchopleural fistula. Neurosurgeons have used the omentum as salvage therapy for moyamoya disease, a condition characterized by cerebral ischemia from progressive stenosis of the internal carotid arteries, when more established therapies such as superficial temporal artery to middle cerebral artery bypass have failed [2–4]. Omental harvesting has historically been performed through a large laparotomy and subcutaneous tunneling to the site of disease. However, Hultman et al. [5] described an 18.5% complication rate in a series of 135 open omental flaps, the majority of which consisted of abdominal wound infection, fascial dehiscence, ventral hernia, and postoperative ileus.

The use of laparoscopy to harvest and tunnel omentum has the potential to avoid these complications by reducing incision length, handling of hollow viscus, and postoperative pain. In an effort to assist our neurosurgical colleagues in treating patients with moyamoya disease, we developed a systematic approach to laparoscopic omental flap harvesting that we believe can be useful as a minimally invasive adjunct to a variety of reconstructive procedures. We previously described in the neurosurgery literature [6] the neurological outcome of three patients that underwent this procedure. This study represents a larger series of patients and places greater emphasis on the general surgical technique. We describe the minimally invasive approach to omental flap harvesting, potential complications, and outcomes in seven patients undergoing laparoscopic omental pedicle flap for moyamoya disease.

* Corresponding author at: 1027 Riverside Dr., Los Altos, CA 94024. Tel.: +1 650 387 1670.
E-mail address: sdutta@mac.com (S. Dutta).

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Table 1
Clinical characteristics and follow up of patients.

n	Age	Indications	Follow up	6 m follow up angiogram
1	5	Recurrent TIAs s/p direct revascularization	Resolution of symptoms at 1 year. 2 year follow up showed 7 episodes of TIA	Patent extra and intracranial omental graft
2	6	Recurrent TIAs s/p direct revascularization	No symptoms at 6 months	Patent intracranial collaterals with occluded omental graft
3	12	Recurrent TIAs s/p direct revascularization	No symptoms at 6 months, mild symptoms at 1 year (left arm weakness), no new TIAs	Patent intracranial collaterals with occluded omental graft
4	8	Recurrent TIAs s/p direct revascularization	Mild TIAs at 1 year	Patent intracranial collaterals with occluded omental graft
5	13	Recurrent TIAs s/p direct revascularization	No symptoms at 6 months, mild TIA at 1 year	Patent intracranial collaterals with occluded omental graft
6	7	Recurrent TIAs s/p direct revascularization	No symptoms at 6 months	Patent intracranial collaterals with occluded omental graft
7	12	Recurrent TIAs s/p direct revascularization	Recurrent TIAs at 6 months	Patent intracranial collaterals with occluded omental graft

Ref: TIA – transient ischemic attack.

1. Methods

A retrospective chart review of all children undergoing laparoscopic omental-cerebral transposition for moyamoya disease between 2011 and 2014 was performed. This was an IRB exempt study.

Clinical indication, surgical technique, operative times, complications, and outcomes were reviewed. All patients were followed on an ongoing basis for resolution of transient ischemic attacks (TIAs). Cerebral angiography and selective gastroduodenal arterial angiography were performed at 6 months postop (Table 1).

1.1. Anatomic considerations and surgical technique

1.1.1. Anatomy (Fig. 1)

The greater omentum is divided into two parts: the gastrocolic ligament (lesser omentum) connecting the greater curvature of the stomach and the transverse colon; and the fat apron, or "greater omentum", which hangs from the transverse colon to the free peritoneal cavity. The gastrocolic ligament is composed of that part of the greater omentum that extends between the first part of the duodenum and greater curvature of the stomach to the transverse colon.

The greater omentum extends downward to the transverse colon, fusing with it and the transverse mesocolon to a varying degree. Continuing inferiorly, it overlies loops of the small bowel and pelvic organs. There is great variation in the length of the omentum. It extends about 14–36 cm below the xiphoid.

The omentum is a transparent network with an excellent blood supply from the gastroepiploic arteries. The right and left gastroepiploic vessels are contained between the leaflets of the gastrocolic ligament. Both of these arteries anastomose and form the arc of Barkow through their branches (right and left epiploic) in the posterior omental layer. The arc of Barkow is reinforced by anterior epiploic arches, which branch from the right and left gastroepiploic arteries and from posterior epiploic branches from the pancreatic vessels.

The attachments of the greater omentum and its free edges are extremely variable. It is unusual to find the greater omentum "floating free" in the peritoneal cavity; more often there are additional attachments to the spleen, the stomach and the duodenum, which have to be lysed for its full mobilization.

1.1.2. Surgical technique

All procedures were performed collaboratively between a pediatric general surgeon (S.D.) and a neurosurgeon (G.S.) with extensive experience in the care of children with moyamoya disease. Under general anesthesia and endotracheal intubation, the patient is positioned supine and in modified lithotomy position (Fig. 2). The head is placed on a gel donut and turned contralateral to the affected hemisphere. The patient is neurologically monitored. The target area of the cranium is shaved, the umbilicus is cleaned with alcohol swabs, and the patient is

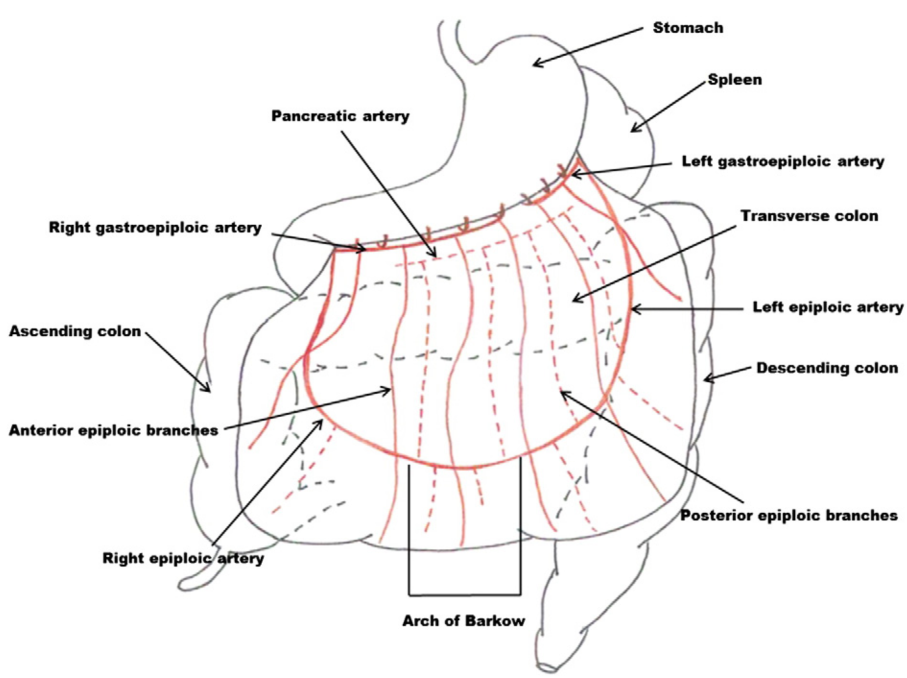

Fig. 1. A schematic of the omentum depicts the typical vascular anatomy.