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Expanding the Horizon: Single-port Robotic Vascularized Omentum Lymphatic Transplant

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Summary: Vascularized omentum lymphatic transplant is frequently used for the treatment of lymphedema due to demonstrated efficacy, a reduced complication profile, and, in particular, negligible risk of donor site lymphedema. Historically harvested by open laparotomy, more recent techniques involve laparoscopic omental harvest. Although effective and reproducible, laparoscopy may be limited by reduced visualization, minimal tactile feedback, multiple port sites, and imprecise instrumentation. Therefore, we employed the da Vinci Single-Port (SP) surgical robot system for vascularized omentum lymphatic transplant. A 52-year-old man with a 3-year history of progressive left lower extremity swelling and lymphoscintigraphy and magnetic resonance lymphangiogram consistent with lymphedema of unknown etiology underwent vascularized omentum lymphatic transplant to the left groin. A 2.5-cm infraumbilical incision was used for placement of the primary trocar, through which the camera and operating instruments were passed. Following robotic harvest, the omental lymph node flap was transferred to the left groin for microsurgical anastomosis. The procedure was uneventful, and the patient was discharged on postoperative day 1. At 6 weeks, there were no complications. Here, we show for the first time the safety and feasibility of robotic omental lymph node flap harvest for extremity lymphedema using the da Vinci Single-Port robotic system. The benefits of this technology include a minimally-invasive approach that allows for flap dissection and removal through a single 2.5-cm incision. Further investigation is necessary to characterize the indications and limitations of this technique in plastic surgery. *(Plast Reconstr Surg Glob Open 2021;9:e3414; doi: 10.1097/GOX.0000000000003414; Published online 16 February 2021.)*

INTRODUCTION

Vascularized omentum lymphatic transplant (VOLT) is a common approach for surgical lymphedema treatment.[1] An important advantage relative to other donor options is negligible donor site lymphedema.[2] Traditionally performed via open laparotomy, laparoscopic omental harvest has gained recent popularity. Although laparoscopy can limit the extent of intraabdominal dissection and improve outcomes, it has potential drawbacks, including inferior visualization, limited tactile feedback, multiple port sites, and imprecise instrumentation.[3,4]

To escape such shortcomings, surgeons have recently employed robotic minimally-invasive approaches. Despite successful use of robotics in plastic surgery, its application has been limited.[5–9] We document the first harvest of a free omental lymph node flap using the da Vinci Single-Port (SP) surgical robot system. This platform represents novel technology not previously applied in plastic surgery.

METHODS

A 52-year-old man with primary lymphedema presented after failed conservative management. Confirming the diagnosis with lymphoscintigraphy and magnetic

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Received for publication November 19, 2020; accepted December 10, 2020.

Drs. Teven and Yi contributed equally to this work.

DOI: 10.1097/GOX.0000000000003414

Disclosure: *The authors have no financial interest to declare in relation to the content of this article. The da Vinci Single-Port surgical robotic system (Intuitive Surgical, Sunnyvale, Calif.) is approved by the Food and Drug Administration for certain urology and otolaryngology procedures. Its use in the current report is considered off-label.*

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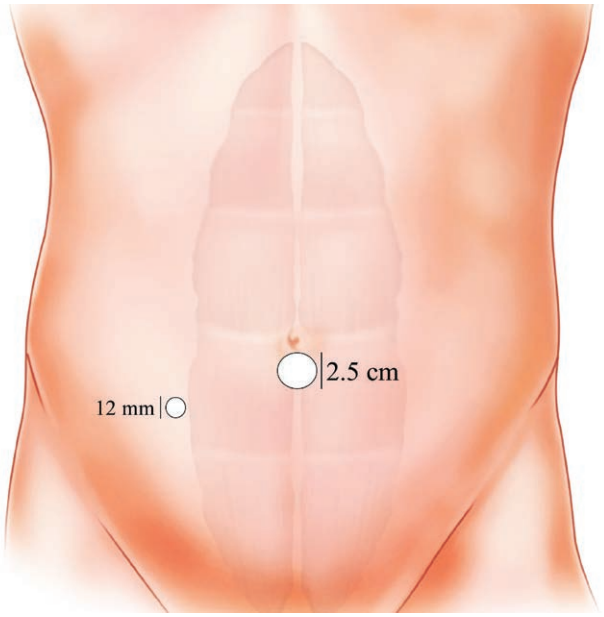

Fig. 1. Schematic representation of cannula positions. Midline: Single port for camera and up to 3 instruments. Lateral: 12-mm accessory port.

resonance lymphography, after informed consent, robotic-assisted VOLT to the left groin was planned.

The da Vinci SP surgical robot was used for omental harvest with the patient supine. A 2.5-cm infraumbilical incision was placed 20 cm from the target anatomy. A single-port trocar was introduced, allowing entry of the camera and instruments (advanced bipolar and monopolar scissors) into the abdomen (Fig. 1, midline). With pneumoperitoneum established, an accessory right 12-mm port was introduced to facilitate retraction, and placement of vascular clips across the pedicle (Fig. 1, lateral).

The robot was docked on the left, allowing the assistant to work unobstructed from the right-sided port. (**See figure 1, Supplemental Digital Content 1,** which shows robot docked. http://links.lww.com/PRSGO/B581.). An experienced robotic surgeon performed the dissection. (**See Video [online],** which demonstrates robotic harvest.) The omentum was retracted cephalad to enter the lesser sac. Upon entry, the omentum was detached from the right transverse colon and bivalved in the midline (flap width: 7 cm), while avoiding creation of potential internal hernia sites. The right gastroepiploic pedicle was dissected toward its origin to a sufficient length/caliber for microvascular anastomosis. Critical lymphatic structures were incorporated within the flap. Vessel clips were placed across the pedicle before sharp division. Once separated, the omentum was delivered through the infraumbilical incision in an endocatch bag (**See figure 2, Supplemental Digital Content 2**, which shows removal of the omentum. http://links.lww.com/PRSGO/B582.)

The omentum was microsurgically anastomosed in the groin (**See figure 3, Supplemental Digital Content 3**, which shows anastomosis to the femoral artery [end-to-side, 8-0 nylon] and a saphenous vein branch [end-to-end, 2.5-mm coupler] http://links.lww.com/PRSGO/B583.) Subcutaneous tissue of the thigh was excised to create sufficient space for flap inset. All incisions were closed primarily in layers (Fig. 2A).

RESULTS

The operation lasted 200 minutes (robotic harvest, 80 minutes). Blood loss was 100 mL. The patient was discharged 24 hours after surgery after ambulating and tolerating a regular diet. At 10 weeks, incisions were healed (Fig. 2B) and he reported significant improvement of lymphedema symptoms. (**See figure 4, Supplemental Digital Content 4**, which shows the patient preoperatively. http://links.lww.com/PRSGO/B584.) (**See figure 5, Supplemental Digital Content 5**, which shows 10-week result. http://links.lww.com/PRSGO/B585.)

DISCUSSION

As popularity of minimally-invasive surgery grows, robotic surgery is applied across numerous surgical disciplines. Several advantages are associated with its use,

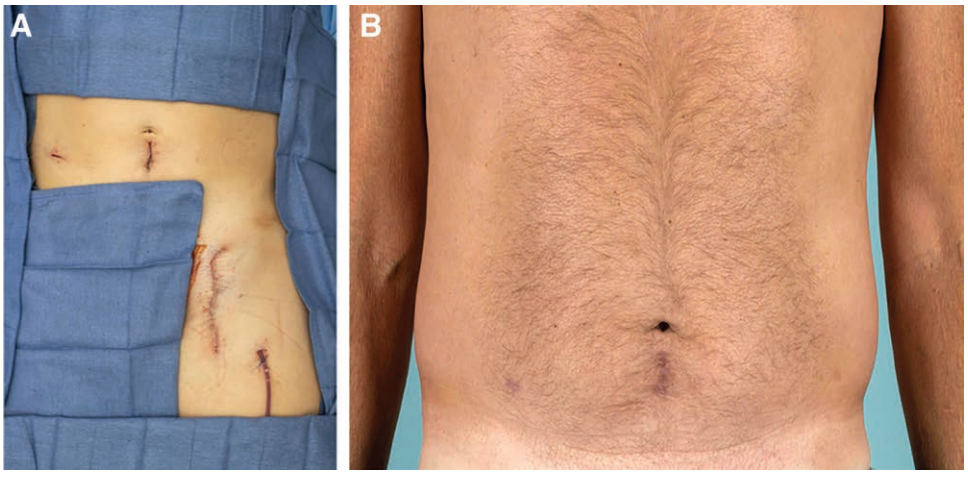

Fig. 2. Postoperative incisions: (A) immediate and (B) 10 weeks after surgery.

Table 1. Cases of Robotic Omental Free Flap Harvest

Author	Reference Number	Indication	da Vinci Platform	No. Incisions	Largest Incision (cm)	Successful Outcome	Follow-up (wk)
Ozkan et al	8	Nonhealing LE wound	Xi	6	5	Yes	0
Ciudad et al	15	LE lymphedema	Si	4	NR	Yes	0
Teven et al	Current	LE lymphedema	SP	2	2.5	Yes	6

LE, lower extremity; NR, not recorded.

including safety and reliability in various clinical settings.[10] Compared with laparoscopy, it facilitates clearer 3-dimensional visualization, improved instrument articulation, and reduced tremor. Robotic technology may also improve speed, precision, and ergonomics.[11,12] Recently, high-volume robotic centers have shifted surgical practices to incorporate robotics in abdominal surgeries, fostering collaboration with robotic surgeons and innovation of minimally-invasive approaches to flap harvest and reconstruction.

First introduced in plastic surgery for oropharyngeal defect reconstruction[5] and latissimus dorsi harvest,[6,7] authors suggest that robotic surgery is technically superior to endoscopy and aesthetically superior to traditional techniques. Other robotic applications in plastic surgery include peripheral nerve surgery,[11] intraperitoneal flap harvest,[13] and microsurgery.[14] Two previous cases of robotic omental harvest exist (Table 1).[8,15] Utilizing 4 ports, Ciudad et al harvested a right gastroepiploic lymph node flap for leg lymphedema using the da Vinci Si system.[15] Follow-up beyond the perioperative period was unavailable. Additionally, Ozkan et al used the da Vinci Xi for free omental harvest for coverage of a nonhealing pretibial wound, requiring 5 ports.[8] The flap, mobilized on the right gastroepiploic vessels, was removed from the abdomen through an additional 5-cm incision. Follow-up was unreported. Nevertheless, the authors highlighted the reliability and reproducibility of their technique.

The current study is only the second report of robotic free omental harvest for lymphedema, and the first using the SP platform. Although SP shares some features with older da Vinci systems (S, Si, and Xi), it is unique in its use of a single surgical arm for placement of an articulating camera and three instruments.[16] In addition to the primary arm, we positioned an accessory port for safe placement of vascular clips across the pedicle. Unlike earlier platforms, which typically require 4–6 incisions, only 2 were required. Having gained experienced with this first case, we recently successfully performed this operation with only 1 port, further supporting the effectiveness of this approach. Further, this system facilitated flap removal through a 2.5-cm incision, the smallest reported to date. An incision of this size is suitable for VOLT, whereas removal of a larger or less pliable flap may require an extension.

The current report supports the existing literature on the safety and feasibility of robotic flap harvest. Compared with laparoscopy, we found the SP system to offer superior visualization and more precise instrumentation. This is important in lymphatic surgery, as preservation of lymphatic tissue during dissection is paramount. Although longer than prior reports, this study is limited by short follow-up and small sample size. Ongoing clinical trials are in progress. Finally, although it is unlikely that robotic omental harvest is less effective than laparoscopy, comparative studies are needed to show benefit.

CONCLUSIONS

Omental harvest with the da Vinci SP robot is novel and effective, offering technical and aesthetic advantages over laparoscopic, open, and prior robotic techniques. Further investigation is necessary to characterize indications, limitations, and outcomes of the SP platform in plastic surgery.

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