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Nanoscale Radiofrequency Control Technology for Endoscopic Radial Artery Harvesting: A Case Report

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ABSTRACT

A recent revival in the use of the radial artery for bypass surgery stimulated the development of minimally invasive harvesting techniques since the endoscopic approach has several advantages when compared to the open technique. A novel nanoscale radiofrequency-controlled device has been recently introduced in the surgical armamentarium as a vessel-sealing system, albeit to date it has been mainly used in the urological setting. To our knowledge, this is the first report in the literature about the use of such an innovative device for endoscopic harvesting of the radial artery, along with a stainless steel resterilizable retractor conventionally used for endoscopic vein harvesting.

INTRODUCTION

The recent revival in the use of the radial artery (RA) for bypass surgery stimulated the development of minimally invasive harvesting approaches. Endoscopic procedures required the development of new technology for vascular control of side branches, because the use of conventional titanium clips is cumbersome during video-assisted RA dissection; in particular, energy sources such as ultrasonic coagulating shears and bipolar radiofrequency (BR) energy devices gained increasing popularity [Connolly 2002; Patel 2004].

The SurgRx EnSeal System (Palo Alto, CA, USA) is a FDA-approved (approval No. K031133), nanoscale BR-controlled device intended for vascular sealing on vessels up to 7 mm and allows surgeons to seal and transect side branches of the RA during endoscopic harvesting of the conduit.

CASE REPORT

A 68-year-old woman scheduled for coronary artery bypass graft (CABG) surgery and left ventricular remodeling was enrolled and signed an informed consent form for the procedure. The patient was suffering from a coronary disease affecting the left anterior descending (LAD) and posterior descending arteries and also had evidence of an apical aneurysm of the left ventricle. The patient was therefore scheduled for myocardial revascularization of the LAD with the left internal thoracic artery and the posterior descending artery with the RA (in a composite Y-graft fashion with the left internal thoracic artery) and left ventricle remodeling.

Endoscopic harvesting of the RA was performed by means of the EnSeal Forceps (SurgRx) and the Storz Endoscopic Vein Retractor (Karl Storz, Tuttlingen, Germany) as a dissector system. The Storz Endoscopic Vein Retractor, a stainless steel resterilizable device, is a dissector conventionally used for minimally invasive harvesting of saphenous vein grafts along with a 45°, 5-mm endoscopic camera. The EnSeal System is a 5-mm, 35-cm long forceps with a high compression jaw (Figure 1); the length of the jaws is 2 cm. This innovative BR device allows the adjustment of tissue-dynamic energy delivery at the electrode-tissue interface according to the specific tissutal impedance. The electrode consists of millions of nanometer-sized conductive particles embedded in a temperature-sensitive material. Each particle acts as a discrete thermostatic switch to regulate the amount of current passing through the tissue grasped between the jaws. To prevent the temperature from rising to potentially damaging levels and causing charring, each particle interrupts current flow to its specific tissue area. When the temperature dips below the optimal sealing level, the individual particle switches back on, reinstating current flow and heat deposition. The vessel walls are sealed through compression, protein denaturation, and then renaturation; an audible tone alerts the surgeon that tissue sealing is complete. Finally, transection is accomplished thanks to the cutting mechanism of the EnSeal; high compression is maintained as the blade is advanced from the proximal to the distal end of the jaw. Despite the device's regulation of energy delivery according to the specific tissutal impedance, every application usually requires 3 to 6 seconds to seal and divide the tissue.

A 2- to 2.5-cm longitudinal incision of the volar surface of the forearm is performed beginning 1 cm proximal to the radial styloid prominence; the fascia between the brachioradialis and the flexor carpi muscles is then divided and the dissection of the RA as a pedicled graft is started with the EnSeal system under direct vision. Once enough space is cre-

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Figure 1. The SurgRx (Palo Alto, CA, USA) EnSeal Tissue Sealing and Hemostasis System is similar to forceps used for endoscopic maneuvers.

ated, the Storz Endoscopic Vein Retractor is inserted into the subcutaneous tissue and advanced toward the antecubital fossa; during these maneuvers, the fascia is divided and the RA visualized. A careful dissection around the pedicled RA is then carried out by means of just the EnSeal system, similarly to the technique previously reported [Connolly 2002]. Once the full length of the RA has been harvested, an additional 1.5-cm incision is performed near the antecubital space for proximal ligation. Following full heparinization, the RA is divided distally, gently dilated by means of intraluminal injection of papaverine, clipped at the distal end, and plunged into wet gauzes with warm papaverine outside the forearm.

During the endoscopic procedure no bleeding was observed either from side branches of the RA or from any incidental damage to minor vessels in the subcutaneous tissue. Smoke production was almost absent throughout the procedure. The RA could be harvested for the full length without any macroscopic damage. No charring or sticking was observed over the arterial pedicle. No spasm of the RA occurred. Total harvest time was 35 minutes. No significant complication was observed in the early postoperative period, and the patient did not suffer any neurological impairment, vascular compromise, or hematoma to the hand. A complete healing of the surgical wounds was observed 15 days postoperatively (Figure 2).

DISCUSSION

Following the revival of the RA as the second conduit of choice for total arterial myocardial revascularization [Acar 1992; Muneretto 2004], the development of minimally invasive harvesting techniques of the RA gained new interest. Other authors demonstrated the advantages of the endoscopic approach when compared to the open techniques in terms of neurological impairment, vascular compromise to the hand, development of hematomas. and improved aesthetics. To date, the techniques adopted have been based on 2 energy sources, ultrasound and BR [Connolly 2002; Patel 2004].

To our knowledge, this is the first report about the use of the EnSeal system for endoscopic RA harvesting; to date its use

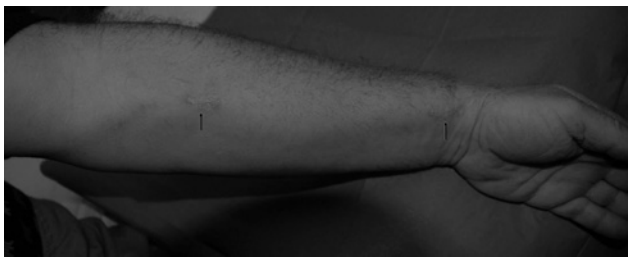

Figure 2. The mini-incisions (arrows) for endoscopic radial harvesting, depicted 15 days postoperatively.

has been limited to other types of surgery [Denes 2003]. The systems currently available for RA harvesting are using conventional BR or ultrasonic energy. and these devices require a process of protein denaturation leading to the formation of an amorphous mass of protein, finally causing the tissue to divide and resulting in 2 sealed ends. Conversely, the EnSeal system is the first BR device to allow a more peculiar adjustment of tissue-dynamic energy delivery leading to collagen denaturation first and then renaturation. The highly focused heat applied within the jaws allows the use of the minimum energy required to complete the sealing and division, and because tissue temperature is prevented from reaching potentially damaging levels, there is virtually no sticking, charring, or smoking. The bipolar electrode configuration restricts the electromagnetic field within the jaw, thereby minimizing the collateral RF thermal effect on adjacent tissue. Sealed vessels are capable of withstanding mean burst pressures up to 1000 mmHg [Denes 2003]. Moreover, several experimental studies using real-time infrared thermography on porcine vessels demonstrated that there was negligible lateral thermal spread beyond 1 mm of the device when the EnSeal device was used, which is less than other currently available systems using bipolar RF energy [Turner 2003; Brill 2004; Damani 2005].

The patient who underwent this procedure did not suffer any ischemic or neurological hand impairment and had prompt wound healing. At a 3-month follow-up, the patient did not show any residual sign of myocardial ischemia in the territory revascularized with the RA.

This study reports only a single experience with this novel device and a clinical trial is currently being performed to confirm the safety and efficacy of such a device by means of clinical and histological evaluation of samples from the RAs. This trial is meant to especially to rule out potential vasospasm resulting from the endoscopical harvesting technique. It should also be stressed that we adapted instruments that have not been specifically designed for endoscopic RA harvesting (eg, the endoscopic saphenous vein retractor), and we therefore foresee that this procedure could be further improved once more dedicated instruments have been designed.

REFERENCES

Acar C, Jebara VA, Portoghese M, et al. 1992. Revival of the radial artery for coronary artery bypass grafting. Ann Thorac Surg 54:652-60.

Brill AI. 2004. Mapping the thermal gradient of a new radiofrequency bipolar vessel sealing device, EnSeal, using real-time thermography. J Am Assoc Gynecol Laparosc 11(Suppl 3):S7.

Connolly MW, Torrillo LD, Stauder MJ, et al. 2002. Endoscopic radial artery harvesting: results of first 300 patients. Ann Thorac Surg 74:502-6.

Damani T, Advincula A, Way LW. 2005. Comparative thermal spread of three bipolar radiofrequency vessel sealing devices. Annual Congress of the Society of American Gastrointestinal Endoscopic Surgeons, April 13-16, 2005, Ft. Lauderdale, FL, USA.

Denes BS, de la Torre RA, Krummel TM, Oleson LSM. 2003. Evaluation of a vessel sealing system in a porcine model. 21st World Congress of Endourology—Moderated Poster Session, Endourology/Laproscopy: Laboratory & Teaching, September 2003, Montreal, Canada.

Muneretto C, Bisleri G, Negri A, et al. 2004. Left internal thoracic artery–radial artery composite grafts as the technique of choice for myocardial revascularization in elderly patients: a prospective randomized evaluation. J Thorac Cardiovasc Surg 127:179-84.

Patel AN, Henry AC, Hunnicutt C, Cockerham CA, Willey B, Urschel HC. 2004. Endoscopic radial artery harvesting is better than the open technique. Ann Thorac Surg 78:149-53.

Turner DJ, Denes BS, de la Torre RA, Krummel TM, Oleson LSM. 2003. Thermal effects and effectiveness of a new vessel sealing system in a porcine model. Global Congress of Gynecologic Endoscopy, November 19-22, Las Vegas, NV, USA.