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Endoscopic Radial Artery Harvesting: Results of First 300 Patients

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Background. With the expanded use of the radial artery as a bypass conduit in patients undergoing coronary artery bypass grafting, an endoscopic radial artery harvesting method was used to improve esthetics and patient acceptance, and possibly, to decrease hand neurologic complications.

Methods. After informed consent and confirmation of adequate ulnar collateral blood flow, 300 consecutive patients undergoing coronary artery bypass grafting had their nondominant radial artery endoscopically removed through a small 3-cm incision just proximal to the radial styloid prominence. Standard endoscopic vein equipment (30-degree 5-mm endoscope, subcutaneous retractor, and vessel dissector) with ultrasonic harmonic coagulating shears were used. After radial artery isolation, the radial artery was proximally clipped and transected 1 to 2 cm distal to the visualized ulnar artery origin to the inferior end of the wrist incision.

Results. The mean age was 62.2 years; 23% of the patients were women, 39% had diabetes mellitus, and 28% had peripheral vascular disease. All 300 endoscopic radial arteries were grossly acceptable and used for grafting. Early in the series, 29 patients (9.7%) required a second 3-cm incision proximally for vascular control. Only one wrist incision was required at the last 200 cases. The conduit length varied between 18 and 24 cm. Occurring early in the series, hospital complications were two tunnel hematomas requiring drainage and one brachial artery clipping repaired primarily without sequela. At 30 days postoperative follow-up, 5 patients (1.6%) had been treated with oral antibiotics for incisional cellulitis and 26 patients (8.7%) had objective dorsal thenar sensory numbness. No ischemic hand complication, perioperative myocardial infarction, reintervention in radial artery graft distribution, or numbness in the lateral forearm occurred. All patients expressed marked satisfaction with the small incision and cosmetic result.

Conclusions. In our initial experience, endoscopic radial artery harvesting can be performed safely, with minor, infrequent complications. A full-length radial artery conduit can be obtained with improved esthetics and patient satisfaction and acceptance. Late dorsal thenar paresthesias, although infrequent, continue to be a problem as with the open method.


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ing, and, possibly, decrease the incidence of neurologic and wound complications caused from the open harvest technique. Initial experience with our first 300 ERAs is described.

Material and Methods

Patients
From February 2000 to September 2001, 300 patients undergoing coronary artery bypass grafting had ERA performed in the nondominant hand. Informed consent was obtained in all patients. The mean age of the patients was 62.2 ± 11.1 years with 70 women (23.3%), 116 patients (38.7%) with diabetes mellitus, and 84 patients (28.0%) with peripheral vascular disease.

Operative Technique
Before ERA adequate collateral circulation from the ulnar artery to the palmar arch was tested using a noninvasive Doppler by the Allen method [14]. The entire arm from fingertips to axilla is prepared with Betadine-alcohol solution and draped with a sterile stockinette. Care is taken not to overextend the arm above 90 degrees to prevent brachial plexus injury.

A 3-cm incision is made over the palpated radial artery beginning 1 cm superior to the radial styloid prominence. The distal radial artery is dissected and isolated from surrounding tissue under direct vision. The distal radial artery is dissected and isolated from surrounding tissue under direct vision. The brachioradialis and flexor carpi radialis muscles is divided anterior to the radial artery with the Harmonic LCS/CS Shears to allow more space for proximal insertion of the subcutaneous Ultra-Retractor. Particularly, in muscular, male forearms, the space under the anterior muscle bundle can be limiting, making forward, proximal unroofing of the radial artery difficult. By dividing the brachioradialis and flexor carpi radialis fascia, adequate anterior space is created and the subcutaneous retractor can be easily advanced proximally.

Segmental division of side branches with the Harmonic LCS/CS Shears is continued toward the antecubital space until the ulnar artery origin is visualized. A pigtail Vessel Retractor (Ethicon Endo-Surgery, Somerville, NJ) is advanced from the distal incision proximally under endoscopic vision to verify complete isolation of the conduit. The proximal radial artery is clipped (Ligaclip, Allport; Ethicon Endo-Surgery, Cincinnati, OH) just distal to the visualized ulnar artery branch, transected with endoscopic Endopath curved scissors (Ethicon Endo-Surgery, Cincinnati, OH), and pulled out through the incision. The distal end is ligated proximal to the superficial radial artery with sutures. The incision is irrigated with saline solution and closed with 4-0 absorbable subcuticular suture. A bandage and forearm gauze wrap is placed for 12 to 24 hours. Figure 1 shows the operator using endoscopic equipment during ERA.

The harvested radial artery conduit is cannulated and gently dilated with heparinized saline solution. Side vascular branches are checked for hemostasis, then the conduit is placed into a papaverine solution. Early in the series, intravenous diltiazem was administered continuously during the perioperative period to prevent vasospasm. Presently, intravenous nitroglycerin is used based on recent reports [15]. The harvested radial artery was most commonly used as a bypass conduit for single or sequential diagonal, intermediate ramus, and obtuse marginal coronary arteries.

Wound complications, infection, hand and arm numb-
ness and paresthesias, hand ischemia, and perioperative cardiac events (myocardial infarction and reinterventions) were evaluated before discharge and at 30 days follow-up. Postdischarge follow-up was performed by office visit or telephone survey by clinical research nurses. Follow-up was 98% complete, with 6 patients dying within 30 days.

Results

All radial artery conduits were successfully removed endoscopically and used for coronary artery bypass grafting. All conduits were grossly acceptable and appeared visibly equal to radial arteries harvested using our open technique, also performed with the Harmonic Scalpel. The length of the ERA conduit ranged from 18 to 24 cm depending on the patient’s forearm length.

Of the 300 ERA patients, 29 (9.7%) required a second proximal 3-cm incision near the antecubital space to obtain visualization or to control venous bleeding. In the last 200 cases, no second proximal incision has been required. For the first 50 cases, the average time for harvest and closure of the skin incision was 40 to 60 minutes. In the last 250 cases, total harvest time including skin closure has been 15 to 25 minutes.

Significant in-hospital complications were one brachial artery clipping, which was repaired primarily without sequelae, and two tunnel hematomas requiring drainage through the wrist incision. The above in-hospital complications occurred early in the series (first 50 patients). At 30-day follow-up, 5 patients (1.6%) had received oral antibiotics for incisional cellulitis and 26 patients (8.7%) complained of objective dorsal thenar numbness on examination of the distribution of the superficial radial nerve. No patients complained of forearm numbness or paresthesias in the distribution of the lateral antebrachial cutaneous nerve. No early or late ischemic complications of the hand occurred. At 30-day follow-up, no myocardial infarction or revascularization reinsertion occurred in the distribution of radial artery grafting.

When surveyed, all patients expressed marked satisfaction with ERA and the small incision (Fig 2), compared with the possible full-length forearm incision used for the open method. No patient complained of functional loss, inability to perform tasks, or return to work because of hand paresthesias.

Comment

Owing to poor, long-term saphenous vein graft failure [9], many surgeons are performing more arterial conduit grafting in patients undergoing coronary artery bypass grafting. Midterm results of the radial artery as an alternative conduit to the saphenous vein has been encouraging [3–8]. Presently, the radial artery is used in 60% of our patients, with 80% receiving more than one arterial graft. The endoscopic saphenous vein harvesting technique has demonstrated significant reductions in wound infections, earlier ambulation, and improved patient satisfaction compared with open longitudinal saphenectomy [16]. Although wound infection and functional loss are infrequent after open radial artery harvesting, hand and forearm numbness or paresthesia, scar hypersensitivity, and patient dissatisfaction are not uncommon. Tatoulis and colleagues [17] reported objective sensory loss in 10% and forearm scar discomfort in 33% of patients undergoing open radial artery harvest. Eight percent of patients thought their work performance was affected, and 6.5% were undergoing forearm rehabilitation. Denton and associates [12] reported 30% early sensory hand dysfunction. Saeed and coworkers [13]
reported 51% of patients having subjective radial artery harvest describing numbness on phone interview.

Although not reported in other series, scabbing, superficial skin edge erythema or separation, or keloid formation are not uncommon in the open method, particularly in diabetic patients. In the small 3-cm ERA wrist incision, these superficial wound complications rarely occurred. In our series, significant wound infection was low (1.6%), similar to other reported open method series [6–8].

Objective dorsal thenar numbness occurred in 8.7% of patients at 30 days. No patient in our series complained of functional loss or activity limitation from ERA. Furthermore, no patient experienced paresthesia or numbness in the distribution of the lateral antebrachial cutaneous nerve. Because the lateral antebrachial cutaneous nerve traverses over the brachial muscle fascial sheath, contusion or damage to this nerve is unlikely during the ERA technique. In the open longitudinal harvest method, the lateral antebrachial cutaneous nerve can be injured from excessive traction, transection, or suturing during wound closure.

Damage to the superficial radial nerve continues to be a problem for both the open and this less invasive endoscopic method. Recently, one ERA was aborted as the superficial radial nerve was traversing anteriorly over the radial artery. Anatomic superficial radial nerve variation and proximity to the radial artery increase the susceptibility of this sensory nerve to injury. Because endoscopic vein retractors developed for leg saphenectomy were used in this ERA series, the development of smaller, arm-specific endoscopic equipment, presently in progress, may further decrease neurologic complications.

Ultrasonic harmonic coagulation and cutting shears are the mainstay of this less-invasive, closed-space endoscopic procedure. No lateral spread of potential damaging energy to the radial artery pedicle or surrounding structures occurs. Vascular side branches are easily coagulated and transected. Others have described the use and advantages of the Ultrasonic Harmonic Scalpel for open radial artery harvest [18–20].

Undoubtedly, our extensive experience with endoscopic vein harvesting contributed to our success in adapting ERA. We recommend proficiency in endoscopic vein harvesting before ERA is attempted.

In conclusion, ERA is a safe, reproducible procedure. The most significant, although infrequent, late postprocedure complication is injury to the superficial radial nerve producing dorsal thenar numbness. No hand ischemia or functional loss occurred.

All patients were satisfied with their less invasive incision, and patient preoperative acceptance for radial artery harvesting has increased. Future investigation comparing histology, vasoreactivity, electron microscopy, and angiographic patency to the open method are presently in progress.

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References


DISCUSSION

DR HENDRICK B. BARNER (St. Louis, MO): Others have reported small series of endoscopic radial artery harvests, but this is the first substantial report to date. We have harvested 1,600 radial arteries by the open method since 1993, and in the last 4 years, use of the Harmonic Scalpel for dissection and branch control has been routine. Our wound complications are not substantially different from those reported today, with 8 patients receiving antibiotics for cellulitis and approximately a 10% incidence of dorsal thenar sensory loss at 1 year. A few women have complained of the incisional scar, but acceptance of the incision has been surprisingly good, and patients have volunteered a preference for it over a leg incision, whether they were male or female.

Clearly, the cosmesis associated with a 3-cm incision is far better than a full forearm incision, which we usually use to obtain maximal radial artery length for T grafting.

You have obviously used care in harvesting so that conduit spasm and branch bleeding have not been a problem. Although you were able to harvest 18 to 24 cm of radial artery in your patients, which is what we generally attain, too, the video that you showed suggests that there was loss of proximal length of the radial artery.

Surgical assistants have always harvested our radial arteries. In the two hospitals in which I work, they have tried endoscopic vein harvest but found it difficult and did not continue with that approach, so that they will be reluctant to try endoscopic radial artery harvesting.

Mark, did you harvest all the radial arteries yourself? If not, who else harvested them? Can surgical assistants be trained in this technique? A final question, is an assistant required for radial artery harvesting?

This is an excellent experience and we all should consider this approach.

DR CONNOLLY: Doctor Barner, the authors would like to commend you not only for your strong support for the use of the radial artery, but also your investigation into its harvesting methods.

To answer your two questions, actually I did not harvest any of these radial arteries. It was our physician assistants. We had a vast experience with endoscopic vein harvesting, more than 3,500 procedures, and our physician assistants actually do the conduit harvesting. Our more talented physician assistants became interested in using this endoscopic technique, and they were the ones who are proficient with it. I recommend to anybody embarking on this less invasive endoscopic method that the people who are doing it have experience with the endoscopic vein method. Addressing the second question, there is no second assistant that is required. It is a stand-alone, single operator procedure.

To make a comment about one of your other comments, many people who describe the use of the open method recommend taking the radial artery up to the radial recurrent artery. We actually commonly transect that arterial branch and obtain extra length, as you are probably doing with your open method.
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