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Division of the Brachioradialis Muscle: A Modification of the Current Technique in Endoscopic Radial Artery Harvesting

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ABSTRACT

Background. Utilization of the radial artery as a conduit for coronary artery bypass grafting has increased significantly over the past 8 years. Concurrently, minimally invasive surgical techniques have been increasingly applied resulting in improved aesthetics, less pain, and decreased morbidity and length of hospital stay. Endoscopic radial artery harvesting (ERAH) has been shown to be of benefit to patients undergoing coronary artery bypass grafting. The brachioradialis is a recognized limitation in ERAH. To date, the standard operative techniques for ERAH have included maintaining the integrity of the brachioradialis muscle.

Objective. The aim of this study was to assess the effect of dividing the medial border of the brachioradialis muscle during ERAH.

Methods. We performed ERAH on 9 cadaveric arms using standard endoscopic vein harvesting equipment (30-degree/5-mm endoscope, subcutaneous retractor, and pig-tail vessel dissector) and ultrasonic harmonic coagulating shears. In 5 cadaveric arms, the medial aspect of the brachioradialis muscle was preserved during the dissection. In 4 arms, the medial border of the brachioradialis muscle was divided. All 9 harvests were timed and compared. At the completion of the endoscopic dissection, all 9 arms were opened and examined for neurovascular injury.

Results. In cadaveric arms, modifying the current ERAH technique by dividing the medial border of the brachioradialis muscle resulted in a visible increase in tunnel size. In the group where the brachioradialis muscle was divided, a statistically significant reduction in harvest time of 32% was observed (P = .02). Post-harvest examination revealed no gross neurovascular injury; specifically, no injuries to the superficial branches of the radial nerve or the lateral antebrachial cutaneous nerves were identified.

Conclusion. Division of the medial border of the brachioradialis muscle during endoscopic radial artery harvesting appears to be a safe technique modification that subjectively improves working space and vision of vital structures, facilitating ease of the procedure. Objectively, division of the medial border of the brachioradialis muscle resulted in a statistically significant reduction in harvest time in cadaveric arms when compared with the current technique of ERAH. A clinical pilot study to verify the efficacy and safety of this technique modification is warranted.

INTRODUCTION

The morbidity associated with open-conduit harvesting for coronary artery bypass grafting is significant and has served as a catalyst for the development of less invasive means of harvesting both venous and arterial conduits. Allen et al [1997] first described endoscopic vein harvesting (EVH) in 54 patients. Since its introduction, EVH has conferred considerable benefits to the surgical patient [Crouch 1999] without compromising the quality of the vessel [Lancey 2001] or safety of the patient. The success and popularity of EVH spawned endoscopic radial artery harvesting (ERAH), which was first described by Terada et al [1997] in 5 patients. Since that time, ERAH has been described on numerous occasions [Connolly 2002; Genovesi 2001] and has recently shown to be a superior technique when compared to the open technique of radial artery harvesting [Patel 2004].

One of the biggest challenges associated with endoscopic vessel harvesting is related to the decrease in working space when compared to open vessel harvesting. Specifically, the muscular prominence in the mid-zone of the forearm is a recognized limitation in ERAH [Casselman 2004] that, although not eliminated, is ameliorated by fascial dissection. We hypothesized that division of the medial border of the brachioradialis (BR) muscle may eliminate this limitation.

MATERIALS AND METHODS

In this study, 9 cadaveric arms were utilized to prospectively determine the effect of dividing the medial border of the BR muscle during ERAH. One operator performed all

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Descriptive Statistics

Brachioradialis Muscle–No Division	N	Mean	SD
Harvest Time, sec	5	1132.2	152.98
Arm Weight, kg	5	1.9	0.73
Conduit length, cm	5	18.7	0.64
Brachioradialis Muscle–Division	**N**	**Mean**	**SD**
Harvest Time, sec	4	764.3	121.40
Arm Weight, kg	4	1.7	0.39
Conduit length, cm	4	19.2	0.96

9 harvests. In 5 arms, a standard ERAH surgical approach was used with standard endoscopic vein harvesting equipment consisting of a 30-degree/5-mm endoscope (Karl-Storz, Tuttlingen, Germany), subcutaneous Ultra-Retractor and pig-tail vessel dissector (CardioVations, Sommerville, NJ, USA), and 5-mm Ultracision Harmonic Scalpel coagulating shears LCS/CS (Ethicon Endo-Surgery, Cincinnati, OH, USA). In 4 arms, a standard ERAH surgical approach was again used with standard EVH equipment. In this group, however, the medial border of the BR muscle was divided during the ERAH procedure. All 9 harvests were timed and recorded. Harvest times were defined as from time of the initial insertion of the endoscope into the arm until the time the radial artery pedicle was removed from the arm. On completion of the harvests, all 9 arms were opened and inspected under 2.0 loupe magnification by a board certified hand surgeon inspecting for evidence of neurovascular injury.

The arm was secured to the table both proximally and distally. A rolled surgical towel placed beneath the hand at the wrist was used to slightly hyperextend the wrist. A 2.5-cm horizontal incision was made 1 cm proximal to the radial styloid. Local sharp dissection with Metzenbaum scissors was performed under direct vision to locate the distal end of the radial artery and create a plane anterior to the radial artery and posterior to the fascial layer of the BR and flexor carpi radialis muscles. The Ultra-Retractor, with inserted endoscope and 15 lpm of CO_2 insufflative assistance, was advanced 4 cm proximally over the radial artery, exposing it from its surrounding tissue. The Ultra-Retractor was then withdrawn and re-advanced 4 cm, anterior to the fascial plane, into the subcutaneous tissue. With the Harmonic scalpel coagulating shears, the remaining fascial layer was divided. The process was repeated until the muscular borders of the BR and flexor carpi radialis were encountered. The Ultra-Retractor was again advanced 4 cm anterior to the radial artery and posterior to the medial border of the BR muscle. Careful inspection of the posterior/medial aspect of the BR muscle through the transparent hood of the Ultra-Retractor was performed, ensuring the absence of the superficial branch of the radial nerve (SBRN). The Ultra-Retractor was then withdrawn and re-advanced 4 cm slowly over the anterior surface of the BR muscle, inspecting for the exit of the SBRN from the BR muscle and for the lateral antebrachial cutaneous nerve (LABCN). This 2-part dissection demonstrated the potential added anterior working space (Figure 1). With the Harmonic Scalpel coagulating shears, the remaining muscular layer was divided (Figure 2). The process was repeated until the curvature of the medial border of the BR muscle no longer traveled over the radial artery in the mid to proximal zones of the arm. In the proximal zone of the arm, the Ultra-Retractor was advanced along the anterior portion of the radial artery to further unroof the artery in its proximal portion until the recurrent branch of the radial artery was identified. Maintaining the radial artery's accompanying veins, the Harmonic Scalpel coagulating shears were then inserted and advanced proximally along the lateral and medial borders of the radial artery to divide the tributaries of the radial artery and free it from the surrounding tissue. The pigtail vessel dissector was then inserted and used to cradle the artery and was advanced proximally to ensure that all branches and surrounding tissue were divided and free from the artery. A nonabsorbable 3-0 suture was then used to ligate the artery in its most distal portion. A

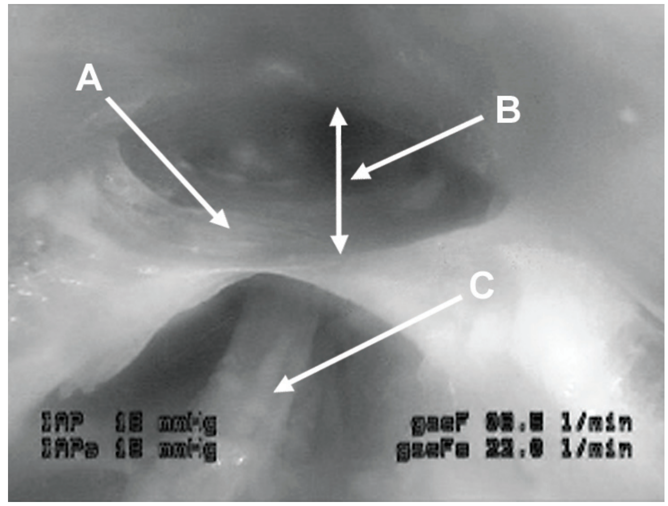

Figure 1. A, Medial border of brachioradialis muscle. B, Potential added workspace. C, Radial artery.

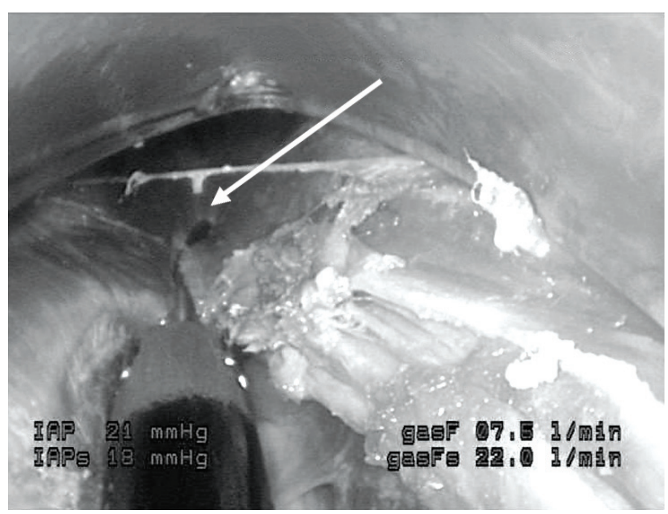

Figure 2. Division of brachioradialis muscle.

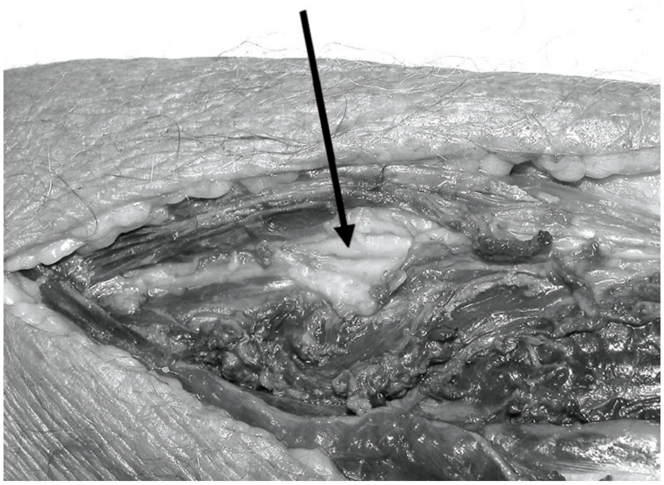

Figure 3. Intact superficial branch of the radial nerve.

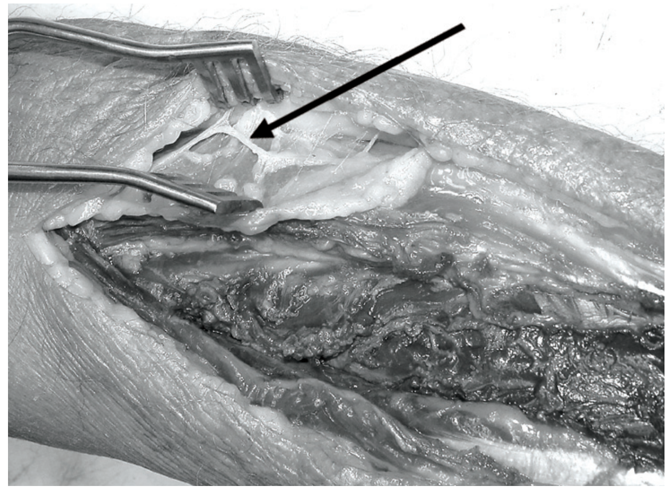

Figure 4. Intact lateral antebrachial cutaneous nerve.

second nonabsorbable 3-0 suture was then used to ligate the artery 0.5 cm proximal to the first ligation. The artery was then transected with Metzenbaum scissors between the 2 sutures. An 18-inch Ethicon PDS Endoloop (CardioVations) was then advanced to the proximal zone of the arm and used to ligate the radial artery slightly distal to the recurrent radial artery branch. Endoscopic scissors (Ethicon Endo-Surgery) were used to transect the radial artery distal to the deployed Endoloop. The artery was then withdrawn from the arm.

Statistical Methods

Simple descriptive statistics were used to summarize the data. Due to the range of harvest time values, a Wilcoxon rank sum test was used to compare the 2 groups. Assessments of the impact of arm weight, sex, and conduit length on the harvest times were made. Statistical testing was conducted using 2-sided alternatives with a significance level of 0.05.

RESULTS

The Table displays the descriptive statistics. In addition, there were a total of 4 women and 5 men that were evenly distributed between the 2 groups.

Mean harvest times for arms 2, 4, 6, and 8, where the BR muscle was left intact, was 18.8 minutes with a mean conduit length of 18.7 cm. Harvest times for arms 1, 3, 5, 7, and 9, where the medial border of the BR muscle was divided, was 12.7 minutes with a mean conduit length of 19.2 cm. Dividing the medial border of the brachioradialis muscle in arms 1, 3, 5, 7, and 9 resulted in an objective 32% reduction in harvest time when compared to arms 2, 4, 6, and 8 where the medial border of the BR muscle was left intact (P = .02). Postharvest inspection of all arms revealed no identifiable injury to the superficial branch of the radial nerve (Figure 3) and the lateral antebrachial cutaneous nerve (Figure 4).

DISCUSSION

ERAH is the newest addition to the armamentarium of endoscopic vessel harvesting techniques. The presence of the BR significantly reduces working space in the distal and mid-harvesting zones during ERAH and can serve as a considerable obstacle for operators, especially during the learning curve. Our modification of the current technique involves dividing the medial border of the BR muscle utilizing ultrasonic coagulation technology. Although this experiment was performed on nonperfused tissue, we believe that given the utilization of ultrasonic coagulation in liver resections [Treska 2002; Vyhanek 2002] and nephrectomies [Lapointe 2002; Helal 1997], it is more than capable of performing forearm muscle division with good hemostasis.

Potential neurofunctional compromise to the arm as a result of muscular division was considered prior to the undertaking of this study. Review of the orthopedic literature reveals evidence of routine utilization of the BR as a donor muscle in tendon transfers [Burkhalter 1974; Freehafer 1988; Friden 2001]. Analysis of the biomechanics and role of the BR muscle as an accessory elbow flexor reveal its redundant function in forearm flexion, thus making it an acceptable donor in tendon transfer [Vyhanek 2002]. Therefore, in our modification where only partial muscle division is performed, leaving the majority of the architecture and function of the BR muscle intact, and where the SBRN and LABCN are left intact, neurofunctional compromise as a result of this modification is believed to be unlikely.

The radial artery is being increasingly applied in myocardial revascularization procedures. The learning curve associated with ERAH is steep and can dissuade new users. Modifications of its technique that result in increased efficiency and ease of the procedure may decrease the learning curve and increase the ease of technique for experienced operators. Both of these benefits have the potential to increase the overall acceptance and utilization of ERAH in cardiac surgery. A pilot study to verify the efficacy and safety of this technique modification is warranted.

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