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Harvesting the Radial Artery: Does It Affect Early Postoperative Hand Function?

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ABSTRACT

Background: The radial artery (RA) is increasingly being used as a conduit for coronary artery bypass grafting. Previous studies have demonstrated that there is no significant deterioration in hand function in the long term. The aim of this study was to assess whether removal of the RA caused any alteration in the function or power of the hand 5 days postoperatively that would affect the patient's ability for self care on returning home.

Methods: A consecutive series of 37 patients undergoing RA harvesting was assessed over a period of 12 months from August 2000 to July 2001 as part of a prospective controlled trial. Grip power and fine motor skills in the operated hand were assessed preoperatively with an elasticated grip strength tester and an 18-hole peg board. This test was repeated 5 days postoperatively. The results were analyzed with a paired-sample *t* test to assess whether there was a significant difference between preoperative and postoperative hand function.

Results: The analysis showed that there was no statistically significant difference in fine motor function or grip power following surgery to harvest the RA.

Conclusion: This study provides evidence to suggest that the RA can be safely harvested for use as a conduit in coronary artery bypass grafting, with no significant short-term deterioration in hand function.

INTRODUCTION

Complete arterial revascularization is becoming more popular in many cardiothoracic units. This procedure has been prompted by increasing evidence that patients undergoing arterial revascularization have lower perioperative mortality [Royse 1999] and better medium-term outcomes [Silva 2000]. Although a number of different arterial conduits can potentially be used, those used most frequently are the internal mammary artery and the radial artery (RA).

The superiority of the internal mammary artery as a conduit in coronary artery bypass grafting compared with the saphenous vein is well established. However, the superiority of the RA is not so well established, mainly because the widespread adoption of the RA as a conduit has occurred only during the last decade. Nevertheless, there is evidence that shows that the RA is superior to the saphenous vein as a conduit. Posatti and colleagues [Possati 1998] observed a 92% RA graft patency at 5 years postoperatively, compared with 74% for vein grafts.

One proposed reason for this result is that the RA is approximately 20% larger in diameter than the coronary vessels; however, the vein is often at least 50% bigger, thus leading to more relative stasis and an increased chance of occlusion [Chen 1996]. It was also observed that most of the RA grafts occluded in the long term were anastomosed to coronary vessels of less than 70% stenosis, increasing the chance of stasis and premature occlusion.

Apart from superior patency rates, use of the RA instead of the saphenous vein has the advantage of lower wound infection rates and less postoperative pain, which result in shorter hospital stays and lower costs [Brodman 1996, Wolff 1997]. Most infections are treated successfully with oral antibiotics [Saeed 2001]. It is convenient and relatively easy to dissect the artery from the forearm [Royse 1999], and its length means that it can reach all parts of the heart. The RA is also rarely affected by atherosclerosis.

Debate remains as to the effect of RA harvesting on hand function. The aim of the present study was to assess whether RA harvesting influences hand function in the early postoperative period. Our null hypothesis was that there was no short-term effect on hand function following surgery.

MATERIALS AND METHODS

Hand power and fine motor function were assessed in 37 consecutive patients who had their RA harvested as a conduit from their nondominant hand. Tests were performed both preoperatively and on the 5th postoperative day. All patients gave informed consent.

Patient Selection

All patients who were to have their RA used as a conduit as part of their preoperative plan from August 2000 to July 2001 were put forward for the study. Confirmation of the suitability for RA harvest was initially performed with the Allen test with a threshold of 5 seconds for capillary refill.

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Table 1. Preoperative and Postoperative Tests of Hand Function

	Time to Complete Peg Board Test, s (n = 37)		No. of Compressions of Grip Strength Tester in 60 s (n = 36)	
	Preoperative	5 Days Postoperative	Preoperative	5 Days Postoperative
Mean	71.35	78.54	90.83	88.61
Range	16-137	18-220	40-140	39-136
SD	24.0	23.5	30.5	42.9

Second, placing a pulse oximeter on the index finger of the patient, compressing the RA, and checking for the maintenance of a waveform confirmed circulation collateral to the RA. Patients were assessed preoperatively and postoperatively at the same time of day.

The following criteria excluded patients from RA harvesting:

- Renal impairment (possible need for an arteriovenous fistula at a later date);
- Previous surgery to the forearm;
- Failed Allen test or loss of the pulse oximeter waveform;
- Profession reliant on fine motor function.

Methods of Testing Hand Function

Peg Board Test. Using 1 hand only, the patient placed fine pegs into holes in a board as quickly as possible. The time taken to complete this task was recorded. The patient retrieved 1-cm pegs from a tray, oriented them correctly with the same hand, and placed them vertically the correct way up into narrow holes in the board. This procedure assessed fine motor function.

Grip Strength Test. This test assessed power and fatigability. The instrument used 5 rubber bands of identical elasticity and resistance. A squeeze that did not fully compress the strengthener was discounted. The number of compressions performed during a 60-second period was recorded.

These tests were chosen in conjunction with the occupational therapists who specialize in cardiac rehabilitation at the hospital. The peg board test is widely used as a measure of fine motor function. For the purposes of this study it was thought that an instrument to assess strength and, more importantly, fatigability would expose the effects of a reduction in perfusion to the hand. The commonly used static dynamometer was therefore discounted as an appropriate instrument for our purposes.

Table 2. Statistical Analysis of Preoperative and Postoperative Hand Test Data

	Time to Complete Peg Board Test	No. of Compressions of Grip Strength Tester in 60 s
Mean difference	−7.19 s	2.22
SD	23.861 s	14.061
t	−1.833	0.948
df	36	35
P	.075	.350

Operative Method

A surgeon harvested the RA at the same time as a second surgeon harvested the internal mammary artery. The RA was harvested with sharp dissection, and the side branches were clipped with Liga clips. Once disconnected from the forearm, the RA was kept in a calcium antagonist solution until it was anastomosed as a conduit. The forearm wound was closed in layers over a drain, which was removed 12 hours postoperatively.

RESULTS

There were 37 patients included in the study, 33 men and 4 women (89.2% and 10.8%, respectively). The mean age of the patient sample was 68.5 years (range, 48-81 years). Thirty-four patients (91.9%) were right-hand dominant; 3 (8.1%) were left dominant. In each case the nondominant RA was harvested.

The mean times to complete the 2 tasks preoperatively and postoperatively are shown Table 1.

The results were analyzed for significance at the 5% level with the 2-tailed Student *t* test for paired samples with SPSS software (SPSS, Chicago, IL, USA). Table 2 provides a summary of the analysis comparing the means of the preoperative and postoperative data.

The evidence suggests that there is no significant difference in power and fatigue or in fine motor function of the hand after harvesting the RA ($P = .075$, peg board; $P = .35$, grip strength tester). There were, however, 2 patients who displayed extreme differences in the times taken to complete the peg board test preoperatively and postoperatively. Both patients took considerably longer to complete the test after their operation (125 seconds preoperatively versus 217 seconds postoperatively; 126 seconds preoperatively versus 220 seconds postoperatively). Such large increases in time to complete the task were not observed with the remaining patients.

There were no incidences of wound infection, hematoma, or hand ischemia.

DISCUSSION

The present literature provides limited evidence about the effects of removing the RA and how removal may influence the power and fine motor function of the forearm and hand. In addition, there are no articles that report short-term changes in function of the hand following surgery. It is critical for patients to fully recover hand function in the first few days following surgery, because they are often expected to be completely self-caring after discharge to the home.

Dumanian and colleagues did assess several criteria, including grip strength, digital 2-point discrimination, and 9-hole peg tests, in patients who had undergone RA harvesting and found no significant differences postoperatively [Dumanian 1998]. Grip strength was measured with a calibrated dynamometer. This test measures explosive power and does not take into account fatigability due to reduced blood flow. A grip strengthener used in the present study fatigued the patient's forearm over 60 seconds, thereby revealing the effects of potentially altered perfusion.

Only 67% (n = 28) of Dumanian's patients returned for follow-up at 5 to 17 months postoperatively. We chose to assess patients at 5 days postoperatively because this is the time at which they are expected to be self-caring.

Sadaba and colleagues evaluated 20 patients by measuring forearm strength and function clinically and also by using technetium Tc 99m serum albumin to assess tissue perfusion [Sadaba 2001]. Follow-up was carried out to at least 12 months postoperatively. Again, power grip was measured with a dynamometer (Jamar, Preston, Jackson, MI, USA), and pinch grip was measured with a pinch gauge (Jamar). Although these investigators described testing both hands, they published only data that compared the operated hand to normalized British data. They therefore did not use the preoperative hand as a control. They reported a significant fall in perfusion without any significant deterioration in function.

There were 2 patients in the present study who displayed a large increase in time taken to complete the peg board test postoperatively. This result was not reflected in these patients' abilities to perform the grip strength exercise. It is difficult to know whether these individuals were more affected by a general anesthetic and the hospital stay than the others or whether the harvesting of the RA had a profound effect on their fine motor abilities. Both patients did take a long time to complete the test preoperatively and therefore may have had an already poor hand function that was exacerbated by the surgery.

Certain studies show that up to 10% of patients complain of paresthesia or numbness of the forearm after RA harvesting, and it is usually only temporary [Brodman 1996, Wolff 1997]. There have also been reported cases of hand ischemia secondary to harvesting the RA (less than 0.1% in a series of over 2000 RA conduits) [Nunoo-Mensah 1998, Royse 1999] and a case of compartment syndrome [Hayes 1998]. One case of hand ischemia was due to an anatomical absence of the ulnar artery. A study of 50 cadaveric arms showed a radioulnar anastomosis in 100% of hands [Ruengsakulrach 2001]. Therefore ischemic complications are extremely uncommon and usually due to poor patient selection. Jarvis and colleagues have suggested that the Allen test is unreliable for assessing collateral blood flow [Jarvis 2000]. They advocate Doppler ultrasound as the gold standard for preoperative assessment of patient suitability.

Pola and colleagues studied the patency of upper limb arteries with Doppler ultrasound before and after RA harvesting [Pola 1996]. Only patients with patent collateral circulation went on to have the RA removed. Postoperative Doppler studies showed a significant increase in blood flow velocities in the ulnar artery, and no patients went on to suffer ischemic sequelae.

Harvesting of the RA remains a controversial area with respect to its effect on hand function. However, the present study of 37 consecutive patients in the immediate postoperative period after RA harvesting provides evidence to suggest that there is no significant reduction in the function and power of the hand. The present patient sample size was small, and 2 patients did have large deteriorations in the peg board test. So, much larger patient numbers need to be evaluated in the future to increase the power and significance of these findings.

REFERENCES

Brodman RF, Frame R, Camacho M, Hu E, Chen A, Hollinger I. 1996. Routine use of unilateral and bilateral radial arteries for coronary artery bypass graft surgery. J Am Coll Cardiol 28:959-63.

Chen AH, Nakao T, Brodman RF, et al. 1996. Early postoperative angiographic assessment of radial grafts used for coronary artery bypass grafting. J Thorac Cardiovasc Surg 111:1208-12.

Dumanian GA, Segalman K, Mispireta LA, Walsh JA, Hendrickson MF, Wilgis EF. 1998. Radial artery use in bypass grafting does not change digital blood flow or hand function. Ann Thorac Surg 65:1284-7.

Hayes EC, L'Ecuyer KM. 1998. A standard of care for radial artery grafting. Am J Crit Care 7:429-35.

Jarvis MA, Jarvis C, Jones P, Spyt T. 2000. Reliability of Allen's test in selection of patients for radial artery harvest. Ann Thorac Surg 70:1362-5.

Nunoo-Mensah J. 1998. An unexpected complication after harvesting of the radial artery for coronary artery bypass grafting. Ann Thorac Surg 66:929-31.

Pola P, Serricchio M, Flore R, Manasse E, Favuzzi A, Possati GF. 1996. Safe removal of the radial artery for myocardial revascularization: a Doppler study to prevent ischemic complications to the hand. J Thorac Cardiovasc Surg 112:737-44.

Possati G, Gaudino M, Alessandrini F, et al. 1998. Midterm clinical and angiographic results of radial artery grafts used for myocardial revascularization. J Thorac Cardiovasc Surg 116:1015-21.

Royse AG, Royse CF, Shah P, Williams A, Kaushik S, Tatoulis J. 1999. Radial artery harvest technique, use and functional outcome. Eur J Cardiothorac Surg 15:186-93.

Royse AG, Royse CF, Tatoulis J. 1999. Total arterial coronary revascularization and factors influencing in-hospital mortality. Eur J Cardiothorac Surg 16:499-505.

Ruengsakulrach P, Eizenberg N, Fahrer C, Fahrer M, Buxton BF. 2001. Surgical implications of variations in hand collateral circulation: anatomy revisited. J Thorac Cardiovasc Surg 122:682-6.

Sadaba JR, Conroy JL, Burniston M, Maughan J, Munsch C. 2001. Effect of radial artery harvesting on tissue perfusion and function of the hand. Cardiovasc Surg 9:378-82.

Saeed I, Anyanwu A, Yacoub M, Amrani M. 2001. Subjective patient outcomes following coronary bypass using the radial artery: results of a cross-sectional survey of harvest site complications and quality of life. Eur J Cardiothorac Surg 20:1142-6.

Silva J, Malillos S, Villasenor M, et al. 2000. Midterm results of coronary bypass surgery exclusively with arterial revascularization. Rev Esp Cardiol 53:1201-8.

Wolff CA, Scott C, Banks TA. 1997. The radial artery: an exciting alternative conduit in coronary artery bypass surgery. Crit Care Nurse 17:34-9.

REVIEW AND COMMENTARY

1. Editorial Board Member IG23 writes:

There is evidence that removing the radial artery does not affect the ability to perform the grip test. Concerning the peg board test: the mean post-pre difference is –7.19 seconds with a $P = .075$, suggesting that, in fact, there is a difference.

As correctly noted, the power of the test is very poor and with an n of 37 patients. The authors can put a 45% confidence on this estimate. If there were a true difference, they would need 116 patients to reach a 90% confidence with a .05 alpha level. It is therefore important to know if the outliers have been included or not.

The main interest is therefore to detail the characteristics of these 2 outliers compared with the larger group of normal respondents. The authors should try to comment on the characteristics of the 2 outliers. They tell us they were slower patients to start with. How much did they differ from the rest of the group? Were there differences in sex, age, scholarity, working ability, preoperative Doppler, post-clamping oxygen saturation, and so forth?

Authors' response by Dr. Andrew Sankey:

The 2 outliers commented on in the paper have been included in the data analysis. In the comparison of the results of the peg board test data preoperatively and postoperatively, a *P* value of .075 does not reach significance. If the 2 outliers are excluded from the data (sample size now 35), then analysis of this smaller data set confirms the fact that there is no significant difference: $t = -1.124$; $P = .269$.

The outliers are men aged 67 and 75 years. They are both retired from work and indeed are dependent on family living with them to help with activities such as shopping and cooking. No formal cognitive testing or neurologic assessment was performed on any of the patients in the study.