Original Article

Assessment of the clinical outcomes and patient satisfaction when using bilateral radial artery as surgical conduits in coronary artery bypass grafting

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Abstract

Introduction

The need for use of the bilateral radial artery has emerged since we faced patients in our institute with severe uncontrolled diabetes, bilateral leg elephantiasis, and left main disease that needs surgical revascularization.

Patients and methods

We reviewed the outcomes from our institute with retrospective analysis of prospectively collected clinical data from our local clinical database and identified 30 consecutive patients who underwent coronary artery revascularization requiring the use of bilateral radial harvest. Patient satisfaction was assessed using a quality-of-life questionnaire with the descriptors on a Likert Scale (table A). The patients were followed up both clinically and by ECG and echocardiography every 6 months for 2 years postoperatively to follow up their ejection fraction and for the assessment of any new segmental wall motion abnormalities.

Results

Only three (12.5%) patients out of 24 reported 'rarely' or sometimes arm pain or discomfort, while all the others (87.5%) were asymptomatic. The median score for arm and sensory and neurological complications was 5. Three (12.5%) patients reported long-term permanent sensory deficit, while six (25%) patients had some other less-significant sensory loss. Only one (4.2%) patient reported significant motor dysfunction, while five (20.8%) patients reported milder forms of motor deficit. Thirteen (54.1%) patients considered the appearance of radial harvest site as excellent, while 23 (95.8%) patients considered it to be at least acceptable. One (4.2%) patient reported a 'moderate' functional change otherwise, the remaining patients reported 'minimal' (12.5%) or 'no change' (83%). The functional outcomes from our series of patients remain favorable with minimal functional decline in the majority of our patients. Both clinical ECG and echocardiographic follow-up revealed stability of all followed patients without the need for CCU admission or repeat revascularization in this time period.

Conclusions

Using bilateral radial artery as surgical conduits in coronary artery bypass grafting is acceptable to patients when alternatives are not favorable for surgical revascularization.

Keywords: CABG, ECG, LIMA

Background

Coronary artery bypass graft surgery remains an effective treatment strategy for complex advanced atheromatous coronary disease. Carpentier *et al*. [1] were the first to use the radial artery as a surgical conduit, but subsequently abandoned due to high failure rates [2]. Anatomically, the radial artery has a thin continuous intima of endothelial cells, a single internal elastic lamina, and a relatively thick media of tightly packed smooth muscle cells, which

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predispose to spasm, occlusion, and thrombosis [3]. Histopathologically, distal radial artery segments have significantly reduced luminal diameter with increased internal hyperplasia if compared with the proximal segment [4]. Still, the radial artery has a low rate of atherosclerosis (5.3 vs. 0.7% if compared with left internal mammary artery) [3]. Even so, the radial artery still has a relatively low rate of atherosclerosis at around 6% [5]. Acar *et al*. [6] repopularized the use of the radial artery when they reported a series of 56 radial artery grafts with 100% patency. However, there is a relative paucity of comparative trial data regarding the use of bilateral radial artery conduits with wound, neurological, and functional complications following surgical revascularization [7].

Aim

To assess the clinical outcome and patient satisfaction after bilateral radial artery harvest for surgical coronary revascularization.

Patients and methods

We reviewed the outcomes from our institution with retrospective analysis of prospectively collected clinical data from our local clinical database. Between April 1, 2015 and November 1, 2017, we identified 30 consecutive patients who underwent coronary artery revascularization requiring the use of bilateral radial harvest. Patient satisfaction was assessed using a quality-of-life questionnaire during outpatient clinic follow-up [7], with the descriptors on a Likert Scale (Table A, supplemental material). Data were entered into an Excel spreadsheet for statistical analysis.

Results

Patient characteristics are listed in Table 1. Follow-up was completed in 24 out of 30 patients (six patients were uncontactable or declined to participate).

The mean duration of follow-up was 24.8 ± 5.7 months. The mean age of patients was 49.0 ± 10.8 years at the time of surgery. The indications for the use of bilateral radial artery conduits are given in Table 2.

The most common indications were leg elephantiasis, existing bilateral varicose veins, or previous bilateral vein surgery (combined 74% of all cases) precluding venous conduit use.

There were two deaths within 30 days of surgery (operations: double valve and CABGx2 for infective endocarditis, CABGx3 with severe left ventricular dysfunction). Twenty-eight patients were ultimately discharged to home.

The selection of coronary targets and anastomoses is given in Table 3. After left internal mammary artery– left anterior descending (LAD) grafts (97% of all cases), the radial arteries were most commonly anastomosed to the obtuse marginal (63%) and right coronary (47%) arteries, respectively, with the fewest grafts to the intermediate coronary artery (13%).

Summary results of the quality-of-life reporting are given in Table 4. Three (12.5%) out of 24 patients reported arm pain or discomfort 'rarely' or 'sometimes,' while all the others (87.5%) were asymptomatic. The median score for arm and sensory and

Table 1: Patient characteristics

Parameters	Number
Sex	
Male	21 (70)
Female	9 (30)
Previous cardiac surgery	
No previous surgery	29 (97)
Valve surgery	1 (3)
Diabetes status	
Not diabetic	23 (77)
Oral therapy	5 (17)
Insulin dependent	2 (7)
Extracardiac arteriopathy	
No	27 (90)
Yes	3 (10)
LV function	
Good	19 (63)
Fair	11 (37)
Operative urgency	
Elective	18 (60)
Urgent	12 (40)
Log Euroscore	5.9±8.0%

Absolute numbers are presented with percentages in parentheses. LV, left ventricular.

Table 2: Indications for radial harvest

Documented indication	Number
Bilateral varicose veins	11 (37)
Previous varicose-vein surgery	11 (37)
Young age (<45 years)	2 (7)
Obesity	1 (3)
Poor veins	1 (3)
Severe pitting edema	1 (3)
Elephantiasis	3 (10)

Absolute numbers are presented with percentages in parentheses.

Table 3: Indications for radial harvest

Coronary anastomosis performed	Number
LIMA – left anterior descending	29 (97)
RA – obtuse marginal	19 (63)
RA – posterior descending artery	20 (43)
RA– distal right coronary artery	16 (30)
RA – distal circumflex	5 (17)
RA – intermediate	4 (13)

Absolute numbers are presented with percentages in parentheses. LIMA, left internal mammary artery; RA, radial artery.

neurological complications was five. However, three (12.5%) patients reported long-term permanent sensory deficit with a further six (25%) patients having some other less-significant sensory loss. Significant motor dysfunction was reported in one (4.2%) patient, while five (20.8%) reported milder forms of motor deficit. About 95.8% of patients considered the esthetic outcome of the radial harvest site appearance to be at least acceptable (54.1% rated the appearance as excellent). One (4.2%) patient reported a 'moderate' functional change otherwise, the remaining patients reported 'minimal' (12.5%) or 'no change' (83%).

The patients were followed up both clinically, by ECG, and by echocardiography every 6 months for up to 2 years postoperatively.

Clinically

All followed-up patients (24 patients) remained clinically stable on their medical treatment during the follow-up period with no need for CCU admission or repeat angiographic study.

ECG changes

None of the patients had or developed new ischemic changes or arrhythmia at baseline or at study's end visit.

Nonsignificant changes were seen in corrected QT over study visits ($P > 0.05$) (Table 5).

Echocardiographic findings

None of the patients had developed new echocardiographic regional wall-motion abnormalities at baseline or after 2 years of follow-up.

Systolic-function parameters (End diastolic dimension (EDD), End systolic dimension (ESD), and Ejection fraction (EF)) showed minute nonsignificant changes over study visits ($P > 0.05$).

Similarly, diastolic-function parameters (E/A ratio, deceleration time, and E/Ea ratio) showed nonsignificant changes between baseline and the end visits ($P > 0.05$) (Table 6 and Fig. 1).

Table 4: Reported scores

	Arm pain or discomfort	Mobility	Sensory	Arm cosmesis	Functional change
Mean	4.8±0.5	4.5±1.0	4.1±1.4	4.4±0.9	4.7±0.7
Median	5	5	5	5	5
Mode	5	5	5	5	5

Values reported are mean±SD or as indicated on the Likert item.

Table 5: ECG changes

	Baseline (day 0) [*n* (%)]	Month 24[*n* (%)]	*P*
Ischemia yes : no	0: 24 (100)	0: 24 (100)	NA
Arrhythmia yes: no	0: 24 (100)	0: 24 (100)	NA
Corrected QT (mean±SD)	0.388±0.023	0.387±0.020	0.7566

Table 6: Echo changes

	Baseline (day 0) (mean±SD)	Month 24 (mean±SD)	*P*
Systolic function			
EDD	4.88±0.35	4.87±0.39	0.6090
ESD	2.87±0.37	2.86±0.38	0.8574
EF	54.80±4.01%	54.71±3.28%	0.8146
Diastolic function			
Doppler E velocity	0.848±0.045	0.847±0.043	0.7683
Doppler A velocity	0.596±0.066	0.595±0.068	0.9084
E/A ratio	1.440±0.181	1.439±0.164	0.9732
Deceleration time	191.647±10.111	191.746±9.009	0.9008
Tissue Doppler Ea velocity	0.348±0.020	0.348±0.019	0.1129
E/Ea ratio	2.445±0.191	2.444±0.170	0.9580
RWMA yes : no [*n* (%)]	0: 24 (100)	0: 24 (100)	NA

RWMA, regional wall-motion abnormalities; EDD, end diastolic dimension; ESD, end systolic dimension; EF, ejection fraction.

Discussion

Our observational study has revealed reduced incidence of pain in our patients postsurgery compared with the 76% reported in the literature with similar cosmetic satisfaction but with higher incidence of sensory and motor deficits in patients undergoing bilateral radial harvest [8]. This increased incidence of neuromotor dysfunction may be a reflection of the doubling of the number of radial arteries harvested. Moreover, the functional outcomes from our series of patients remain favorable with minimal functional decline in the majority of our patients. However, this study was limited due to the retrospective observational nature of the data without a direct comparative group and a relatively small population of patients. The study was also based on patient-reported outcomes without objective measurement or assessment of the precise degree of neurosensory or motor function. Despite these limitations, we believe that our study is the first series to report the functional and patient-satisfaction outcomes in bilateral open radial artery harvest. These patients represent surgical challenges, given the limited options for conduit use, and it is of note that one of the mortalities in our series had poor-quality radial conduits. Endoscopic harvest may be an option to minimize the comorbid effects of radial extraction and may be a consideration in future studies.

Both patients and cardiologists accepted the radial artery as a surgical conduit as there was an early postoperative ambulation with less pain. This was also accompanied with a shorter hospital stay that reached a median of 7 days in such patients. Only few patients experienced postoperative forearm complications, while none required a second hospital admission or increased length of hospital stay.

The use of radial artery as a surgical conduit is used to supplement the internal thoracic artery for coronary artery bypass grafting allowing an opportunity to perform total arterial revascularization. This is more applicable in diabetic and obese patients with

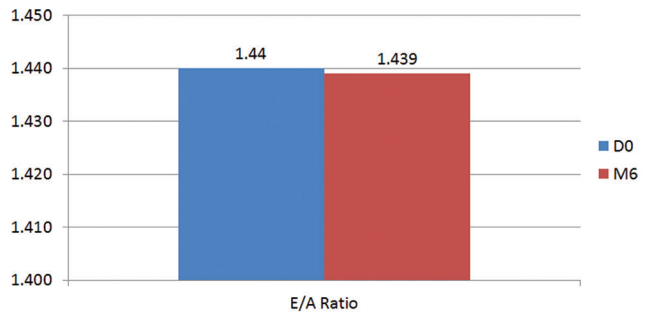

Figure 1: E/A ratio changes in the patients over study visits.

peripheral vascular disease [9]. The thick wall and large diameter of the radial artery gave it the advantage to be used as an excellent arterial conduit as it can withstand the systemic pressure. Also, the average harvested length of the radial artery permitted its use as a surgical conduit for any coronary artery as well as its proximal aortic anastomosis. The long-term patency of the bilateral radial artery enabled the patients to persist symptom free for a long time as evidenced by clinical, ECG and echocardiographic follow-up for up to 2 years with improved long-term survival and omitting the need for repeat revascularization.

Conclusions

Open bilateral radial artery is acceptable to patients as a conduit choice when alternatives are not favorable for surgical revascularization.

It provides a better chance for total arterial revascularization, especially those with severe diabetes mellitus and obesity where bilateral internal mammary carries significant risk of mediastinitis.

In the future, endoscopic harvesting of the radial artery may give better patient satisfaction, regarding sensory and motor complaints, however, we may face financial problems regarding the endoscopic tools used in each patient.

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Conflicts of interest

None declared.

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Supplementary Material

Supplementary Material Table A: Assessment of patients satisfaction after the use of bilateral radial arteries as surgical conduits

	1	2	3	4	5
Arm pain or discomfort	Always	Often	Sometimes	Rarely	Never
Mobility					
Do you have problems with performing hand normal activities? (e.g. work, drive, ride a bicycle, write, washing yourself, and housework)	Always	Often	Sometimes	Rarely	Never
Sensory: arm sensory and neurological complications					
Do you have problems of sensitivity? (e.g. numbness, hand anesthesia/paraesthesia)	Always	Often	Sometimes	Rarely	Never
Arm cosmesis					
How do you consider the cosmetic result of the wound on your arm?	Extremely poor	Poor	Barely acceptable	Good	Excellent
Functional change	Severe change	Moderate	Mild	Minimal	No change

Table A: Likert scale.