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Radial Artery as Secondary Conduit for Coronary Revascularisation in Diabetic Patients

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Abstract

Coronary revascularistion using left internal mammary artery for the left anterior descending artery has been conclusively proven to have best outcome. However the choice of secondary conduit is still unclear. The right internal mammary artery has shown increased complication rate in diabetic patients. Radial artery has been proposed as alternative but uncommonly used. With the increasing incidence of diabetes need for choosing an optimal secondary conduit is clear. *Aims:* The aim of this study was to investigate the effectiveness of Radial artery for coronary revascularisation in diabetic patients. *Settings and Design*: A single unit prospective study. *Methods and Material*: A total of 132 patients with Diabetes underwent CABG by single unit with radial artery as second arterial conduit. Suitability of radial artery was determined preoperatively. Patients were followed up and underwent CT-CAG at the end of five years. *Results:* One patient suffered MI in immediate postop period and on reopening was secondary to Radial artery spasm requiring revision. Two patients died in perioperative period. We had 125 patients for follow up. At the end of one year, 123 patients survived amounting to 98.3% survival rate. Among the 15 patients who have crossed five years of follow up, we had single mortality with five year survival rate of 93%. All these patients underwent CT-CAG, revealing patent LIMA and RADIAL artery grafts but two patients had their vein grafts blocked. *Conclusions:* The Radial artery maybe recommended as second arterial conduit (in conjunction with the LIMA) for achieving arterial revascularisation in diabetic patients.

Keywords: Coronary Artery Disease; Diabetes; Radial Artery Graft; Revascularization.

Introduction

The aim of coronary artery bypass grafting (CABG) is the durable relief of symptoms of myocardial ischemia and restored life expectancy of patients with coronary atherosclerosis to age-matched population without coronary disease. The current paradigm for this strategy is complete myocardial revascularisation with a maximum number of arterial grafts.

The use of left internal mammary artery (LIMA) to revascularise the left anterior descending coronary artery has been, unambiguously, shown to improve survival and minimize recurrent symptoms requiring re-interventions postoperatively [1].

Increasing the number of arterial grafts via the use of bilateral IMA was shown to carry an incremental survival benefit, particularly in the second decade post CABG [1-4].

Harvesting the right internal mammary artery (RIMA), however, results in an increased incidence of sternal wound infections in diabetic patients and in obese patients, as well as in patients with chronic obstructive pulmonary disease, a growing proportion of patients undergoing surgery [5]. The RIMA is also

frequently used as a free or T graft owing to its limitations reaching target arteries as an insitu graft. These drawbacks have resulted in only a 4% use of bilateral IMA CABG as reported in The Society of Thoracic Surgeons (STS) database [6].

The radial artery (RA) is an excellent alternative to the RIMA [7]. It is readily harvested [8] while the LIMA is being taken down. It easily reaches any vessel on the heart and is a better size match to the native coronary arteries than the SV. Sequential or Y grafting increases the number of arterial grafts per patient. There are several studies showing the benefits of RA grafts compared with SV grafts in CABG patients receiving a LIMA graft [9 –11]. Despite very encouraging short and intermediate outcomes, RA grafting is used in only 9% of patients undergoing CABG as noted in the STS database [6]. Thus, the vast majority of patients presently undergoing CABG in the world receive only one arterial graft, the LIMA, and SV grafts.

Diabetes is an increasingly common risk factor in the CABG population approaching 40% in some patient series, and increased morbidity and mortality in this CABG cohort is well established including diminished long-term survival [12-14].

Surgical revascularization (CABG) remains the best evidence based treatment for atherosclerotic multivessel coronary artery disease in patients with diabetes, despite improvements in percutaneous interventional techniques (PCI) and medical therapy [15]. The long term survival benefit of CABG depends on the graft patency, and hence the type of conduit [16,17].

In our unit we share the usual concerns in diabetic patients about using both internal mammary arteries which can compromise blood supply of the sternum and interfere with wound healing. Failure of saphenous vein grafts is known to occur more often in diabetics, and such vein graft failure might reduce long term survival in these patients [18].

We aim in this present study to examine whether use of the RA as a second arterial conduit improves survival after CABG for diabetic patients.

Subjects and Methods

All diabetic patients undergoing CABG since 2010 in our unit, fulfilling following criteria were included in the study

- *Inclusion Criteria*

- Age ≤ 70 years,
- Negative Allen's test
- Normal radial artery Doppler,
- EF ≥ 40%,
- Target coronary lesion above 80% on left side and above 90% on right side
- All patients who received LIMA – LAD graft

- *Exclusion Criteria*

- RA size < 2mm
- Allen's positive
- Diseased / calcific RA by Doppler
- CKD patients
- Peripheral vascular disease
- Rayanaud's disease
- Emergency cases

Surgical Technique

Radial artery was harvested atraumatically from the non-dominant hand of the patient by two skip incisions along its course in the forearm. Skin bridge was left in between two incisions. It was harvested as a pedicle with accompanying veins by no touch technique. The harvested radial artery was stored until use in a solution of patient's heparinized venous blood mixed with 1% Papaverine. Heparinized blood is injected gently into the lumen of radial artery. Only topical Papaverine was used in all patients. Aorto coronary conduit was made in all cases.

CABG was performed by off pump technique in all cases, unless intraoperative events warranted conversion to on pump technique. Postoperatively all patients were started on Diltiazem infusion which was continued for 24 hours.

At discharge all patients were put on dual antiplatelets and Diltiazem for 1 year, after which only Ecosprin was continued along with Beta blockers, Statins, and Diuretics (depending on EF).

Glycaemic control was achieved with Insulin and OHA.

Follow up Protocols

- After discharge patients were followed up at 2weeks, 1month, 3months, 6 months and thereafter every 6 months to assess functional class and Glycaemic control(was also maintained by patients personal physician).

- Echo was done at discharge and thereafter at 6 month intervals.
- ECG was done at every visit.
- Symptomatic patients underwent TMT.
- CAG was done for those who were TMT positive/ new RWMA.
- At end of five years all patients were subjected to CT CAG.

Results

A total of 132 patients with Diabetes underwent CABG with radial artery as second arterial conduit

Majority of patients were in the age group of 40–60 years (90%). 47% of patients were in 41-50 years and 43% of patients in 51-60 years group. Mean age of our study population was 49.3 years (33-68 years).In our study group 78% (n=104) of patients were males and 22% (n=28) were females.

In our study group 65% (n=86) of patients were smokers, 77% (n=102) were hypertensive, 59% (n=78) had Dyslipidaemia and 39% (n=51) had uncontrolled diabetes. 16% (n=21) of our patients had additional carotid stenosis which did not warrant any surgical intervention. 71% (n=94) of our patients had history of previous MI and additional 9% (n=12) of our patients had renal dysfunction.

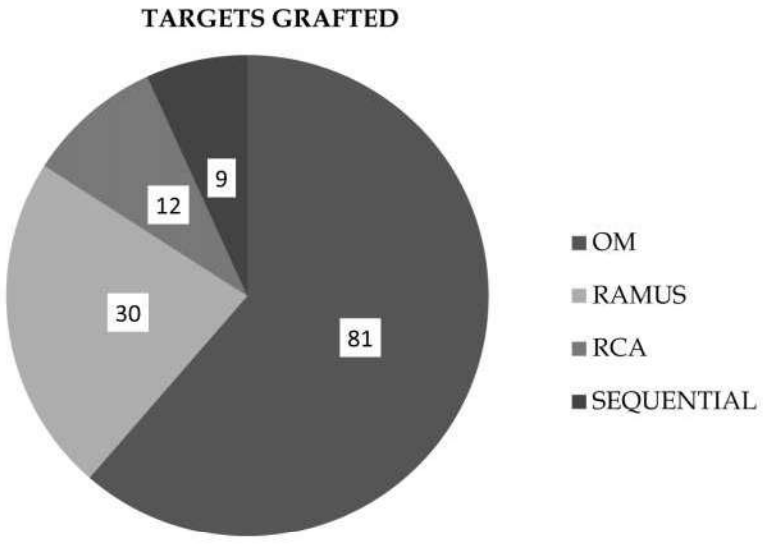
In our study group 40% (n=53) of our patients had EF less than 50%, 37% (n=49) had EF between 50-59% and the remaining 23% (n=30) of patients had normal EF. Mean EF of patients in our study group was 48%.

In our study 97% (n=128) of our patients underwent surgery by off pump technique and in remaining 3% (n=4) of patients, conversion to on pump technique was warranted due to unstable haemodynamics intraoperatively.

In our study radial artery was used to graft OM's in 61% (n=81) of patients, RAMUS in 23% (n=30), RCA in 9% (n=12) and as sequential grafts in 7% (n=9) of patients. As sequential grafts radial artery was used to graft D1 - OM in 4 patients and OM1 – OM2 in remaining 5 patients. Mean number of grafts received by patients in our study was 3.6.

Table 1: Risk factors

Type of Risk Factors	No. of Patients
Smoking	86
Hypertension	102
Dyslipidaemia	78
$Hba_{1c} > 9$	51
Carotid stenosis	21
Previous MI	94
Renal dysfunction	12



Graph 1:

Table 3: Perioperative events

Periop Events	No. of Patients
MI	1
Death	2
CVA	1
Superficial Wound Infection	6
Deep Sternal Infection	0
Tracheostomy	1
Re-Exploration	2
Graft Redo	1
IABP	4

In our study group of 132 patients one patient suffered MI in immediate postop period, who was reopened and found to have spasm of radial graft to OM. The graft was revised and subsequently patient improved with IABP, prolonged ventilation requiring tracheostomy and long ICU stay. Two mortalities occured in our study group in periop period, one patient had extensive CVA and subsequently succumbed on second postop day inspite of stable cardiac condition, other patient had femoral embolism warranting embolectomy but finally died due to renal dysfunction. Two patients required re-exploration due to bleeding. Four patients required IABP insertion intraoperatively due to unstable haemodynamics. Six patients in our series had superficial wound infection which was managed conservatively with sensitive antibiotics. None of the patients developed deep sternal wound infection.

Complications of Radial Artery Harvest

In our study group of 132 patients for whom radial artery was harvested, 6% (n=9) of patients developed minor degree of parasthesia of left forearm and about 5% (n=6) of patients had numbness. None of the patients had wound infection, motor weakness or gangrene of the radial artery in harvested limb.

Follow Up

In our study group of 132 patients 7 patients lost follow up and remaining patients are in various levels of follow up. All patients in our study group had minimum 1 year of follow up. We have about 123 patients who have completed first year follow up, 92 patients in second year, 64 patients in third year and 38 patients who have completed fourth year of follow up. 14 patients in our study group have completed five years of follow up.

In our group of 132 patients after leaving the dropouts we had 125 patients for follow up. At the end of one year we had 123 out of 125 patients surviving amounting to 98.3% survival rate. None of the surviving patients had any excertional Angina, drop in EF, or onset of new RWMA. 89% (n=110) of our patients had their $HBA_1C < 8$ suggesting good glycaemic control.

Among the 15 patients who have crossed 5 years of follow up, we had single mortality with 14 (93%) surviving patients at the end of 5 years, with a 5 year survival rate of 93%. All these 14 patients underwent CT CAG as per the study design, CT CAG revealed patent LIMA and RADIAL artery grafts in all these patients, but 2 patients had their vein grafts blocked one being to D1and other to RCA. These patients had RWMA in these territories before and hence did not have new RWMA nor drop in EF. The above 2 patients had poor glycaemic control and poor target vessels.

Discussion

Diabetes is a global epidemic. In patients with diabetes, abnormal glucose levels and injected insulin subject the vascular tissues to conditions that can inflict potent injury and impede repair [19]. Patients with diabetes experience early and more diffuse atherosclerosis, producing a greater disease burden, unfavourable anatomic distribution, and impairment of the ability to develop collateral circulation.

Coronary disease causes three in four diabetes-related deaths [20]. Revascularization is the established, evidence-based treatment for complex coronary disease and diabetes; the FREEDOM trial [21], the latest in a long series of major trials, has confirmed the superiority of CABG over percutaneous intervention for such patients [22]. Nevertheless, the outcomes in diabetic patients are not as good after CABG as in comparable patients without diabetes [23]. Vein grafts in diabetics remain more vulnerable to atherosclerosis [24].

Enhancing long-term outcomes after CABG for diabetic patients is imperative; all-arterial revascularizations improved survival for a subgroup of diabetic patients [25], and the multiple arterial graft strategy is attractive. The mechanisms of endothelial activity that protect arterial grafts have been partly elucidated [26]. Bilateral IMA grafts confer a survival advantage for diabetic patients [27]. The relative performance of LIMA and BIMA is the subject of an ongoing randomized trial [28]. The RA yields better patency than does SVG, and it offers an attractive alternative arterial conduit to RIMA [29].

Hoffmann et al reported reduction in mortality (>30%) for diabetic patients revascularized with LIMA plus RA as opposed to LIMA plus vein [30]. In another propensity matched comparison of RA and RITA, survival in the subgroup of diabetic patients was not significantly different (HR 0.86; 95% CI 0.57–1.29; p ¼ 0.474); however, major adverse events were reduced with RA use (OR 0.32; 95% CI 0.15–0.68; p ¼ 0.003) [31].

Although multiple arterial grafts improve survival, DSWI is increased with the use of BIMA in diabetic patients. Taggart [29] reported increased DSWI especially among diabetic patients in the ongoing randomized trial (BIMA vs SIMA). Puskas and colleagues [32] reported, from their registry subgroup of diabetic patients with BIMA, an 85% increase in DSWI, although this did not achieve statistical significance (compared with the DSWI rate in their diabetic patients who received one IMA). Superimposed on the particular vulnerability of diabetic individuals to infection, DSWI causes major morbidity and mortality.

CABG is increasingly needed in diabetic patients, who more often are obese and have other comorbidities. With the concern about wound complications in the devascularized sternum, it is not surprising that most surgeons avoid BIMA; therefore, despite the evidence of survival benefit, BIMA use in the Society of Thoracic Surgeons database is below 6% [6] (and presumably even lower in diabetic patients). Evidence that skeletonized harvest can mitigate the increased risk of DSWI from BIMA in diabetic patients is suggestive [33] but not yet conclusive. The lower rates of DSWI and respiratory failure in RA cohort suggest cautious use of BIMA in diabetic patients, and they support, instead, a wider use of RA to achieve the benefits of multiple arterial graft revascularization.

Lin and colleagues [34] reported significant survival benefit from RA (over SVG) in their subgroup of diabetic patients at 12 years (HR 0.59).

Results of our study are in par with other published studies in similar subset of patients. All patients in our study group have completed one year of follow up, limitation of the study being only 15 patients have completed 5 years of follow up and our 5 year survival rate is based on this subset. We require further follow up of our patients to comment on actual long term survival benefits.

Table 4:

Study	1 Year Survival	5 Year Survival
SINGH et al RAPS study	98%	
HOFFMANN et al. Beth Israel study	98%	89%
Lin et al Cedars- sinai study, NY	98%	87%
Our study	98%	93%

Conclusion

Either the RA or the RIMA may be used to achieve the documented survival benefit of multiarterial coronary bypass in diabetic patients. However, RIMA use as per literature is attended by increased adverse events plausibly related to harvest, namely, deep sternal wound infection and respiratory failure, which increase the total of major adverse events in RIMA patients to a statistically significant extent. The RA offers the advantage of lower morbidity and therefore may be recommended as second arterial conduit for use (in conjunction with the LIMA) to extend to most diabetic patients the established benefits of multiple arterial graft revascularization while minimizing adverse events.

Key Messages

Radial artery can be a viable second alternative graft in diabetic patients for coronary revascularisation with a good outcome

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