

SHORT REPORT

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Simple Techniques to Manage the Patent Internal Mammary Artery in Redo Cardiac Surgery

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Abstract: The presence of a patent internal mammary artery (IMA) represents a well-known technical challenge in redo cardiac surgery. Dissection of the IMA and controlling its flow during cardioplegic delivery has thus been considered essential steps. This maneuver however, is associated with the risk of damaging the IMA. Herein, we report a technique, which involves no attempts to dissect, or clamp the IMA in 44 consecutive redo cardiac surgery procedures. The results demonstrate that this technique is simple, safe, and reduces the chance of IMA injury.

Keywords: cardiac reoperation; CABG, arterial grafts; surgery, complications

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Introduction

The use of IMA for coronary artery bypass grafting (CABG) is widely accepted. The IMA is known to be the ideal conduit for revascularization of the left anterior descending artery (LAD). This is mainly because, the use of the IMA confers a survival advantage versus vein conduits, likely due to the fact that the long term patency rate of IMA grafts is higher than that of other conduits (10 year IMA patency = 90–95%). However, in the context of re-operative cardiac surgery, a patent IMA graft presents a well-known technical challenge. Traditionally, a standard and essential principle in redo surgery is to dissect the IMA and control its flow, to prevent cardioplegia washout during the period of aortic cross clamping. However, identification and dissection of the patent IMA graft can be technically challenging, time consuming, and more importantly, is associated with the risk of damaging the IMA with resultant ischemic myocardial injury.

Several techniques have been described to protect against injuring a patent IMA graft. These usually involve either a prophylactic approach in which the IMA is displaced and/or protected during the original CABG surgery or an alternative approach to the redo sternotomy (i.e. Left or Right Thoracotomy).^{1–3} In this paper we describe a safe and simple technique in which IMA dissection and clamping are completely avoided in various redo cardiac surgery procedures. To our knowledge, others have, only addressed this technique, in the context of redo aortic valve replacement (AVR) surgery.^{4–6}

Patients/Methods

The described technique was applied in 44 consecutive cases with different redo cardiac procedures (described in Table 1). The surgery was done at a university center; patients consented for the procedure after explanation of the operation by the surgical

Table 1. Types of redo cardiac surgery procedure.

Total Number 44 Patients	CABG 20 Patients (45%)
	AVR 13 Patients (30%)
	MVR 4 Patients (9%)
	CABG & Valve Replacement 7 Patients (16%)

team. All patients were operated on electively except 4 patients who were emergency CABG cases.

Describing each procedure in detail is outside the scope of this paper, however there were a few essential steps characterize the technique in all patients: Firstly, and most notably was that no attempts were made to dissect or clamp the IMA. Secondly in all patients, continuous retrograde cold blood cardioplegia (at 6–10 °C) was used, The continuous flow of the retrograde cardioplegia was kept at 100 cc/minute and increased to 200 cc/minute for 2 minutes every 15 minutes intervals. Coronary sinus pressure was monitored and kept below 35 mmhg. The flow of the cardioplegia was interrupted during the distal graft anastomoses to help in visualization. In addition, cardioplegia was also given in at a rate of 50 cc/minute in each vein graft after constructing the distal anastomoses. Thirdly, body systemic temperature was kept at 25 °C while the aorta was clamped. Clamp time range was (43–126 minutes). At this temperature the heart, developed low voltage ventricular fibrillation, giving the heart an electrical shock at 10 Joules converted the fibrillation to a systole in most of the cases.

Intra operative Trans-esophageal Echocardiogram (TEE) assessment of ventricular function, the Inotropic support and Intra aortic balloon pump (IABP) requirement as well as post operative recovery were monitored, recorded and used as indicators for success and safety of the technique. The results were compared with those results in the literature that described similar operations but with LIMA dissection and clamping.

Results

There was no evidence of regional ventricular wall motion changes in 28 (64%) patients. Sixteen (36%) patients developed various degrees of right and left ventricular hypokinesia and required inotropic support. Two patients (4.5%) required IABP: one patient had AVR/CABG and the second one had Mitral valve replacement (MVR)/CABG. (Table 2)

Two patients (4.5%) required reoperation for bleeding. One patient (2.3%) developed sternal dehiscence. One patient (2.3%) developed right leg ischemia from IABP (AVR/CABG).

Two patients (4.5%) died, both from the AVR/CABG group, one patient died of stroke 7 days post operatively, and one patient with the ischemic leg died after 16 days with generalized sepsis (Table 2).

**Table 2.** Post –op Cardiac function, complications and mortality.

LV Function	No RWMA	28 Patients (64%)
	Different degrees of hypokinesia	16 Patients (36%)
	IABP	2 Patients (4.5%)
Complications	Reexploration for bleeding	2 Patients (4.5%)
	Sternal dehiscence	1 Patient (2.3%)
	Leg ischemia	1 Patient (2.3%)
Mortality		2 Patients (4.5%)

Discussion

With the number of redo cardiac operations increasing, and the fact that these reoperations have higher morbidity and mortality, it is important to employ all available measures to decrease this risk.² Although it is known that IMA to LAD grafting increases long-term survival as well as decreases the need for further cardiac interventions, it is also important to recognize the danger of injuring a patent IMA graft during redo cardiac surgeries. Reports in the literature of damaged patent IMA grafts range anywhere from 5% to 40% at cardiac reoperation.^{2,3} Furthermore, it is reported that mortality may be as high as 50% when the IMA is injured,² Largely due to the resultant ischemic injury of the myocardium supplied by the patent graft.

As mentioned above, other techniques have been described which attempt to protect the patent IMA (i.e. prophylactically or lateral thoracotomies), however these have associated with shortcomings which can be avoided with the described technique. Namely, thoracotomies can not be used for the majority of redo CABG procedures because multiple areas are usually affected and they do not afford full exposure of the heart. Using off pump surgery might be attractive in redo CABG where the LIMA clamping as well as the cardiopulmonary bypass can be avoided all together. In our experience to minimize the unnecessary heart manipulation and to avoid any damage or crashes prior or during the revascularization, we had been adopting the strategy of trying to get on cardiopulmonary bypass as soon as possible after the resternotomy. The rest of the dissection is done on an empty heart with protected systemic circulation. Therefore,

to optimize the procedure safety we do not use off pump technique in Redo CABG.

The described technique, besides avoiding the LIMA injury, theoretically should provide optimum protection of the LAD territory by leaving the LIMA opened and protecting the rest of the myocardium by using retrograde cardioplegia continuously. The use of moderate systemic hypothermia, protects the myocardium from warming up due to the unclamped LIMA.

Bar-El et al⁴ Byrne et al⁵ as well as Savitt et al⁶ support this concept of avoiding IMA dissection and clamping in redo cardiac surgery in the AVR literature. In this paper, however, we have described the use of this technique not only for AVR after CABG with patent LIMA but also for a variety of redo cardiac surgeries including CABG, MVR, AVR and combined CABG/Valve surgeries.

The results, in terms of post-operative wall motion analysis, need for inotropic and IABP support, complications and mortality are comparable to the results of the reported technique in which the patent LIMA is identified and clamped.⁷ Therefore the simplicity and the safety of the described technique are reflected by not going after the patent IMA to clamp and by avoiding its injury respectively.

Disclosure

This manuscript has been read and approved by all authors. This paper is unique and is not under consideration by any other publication and has not been published elsewhere. The authors and peer reviewers of this paper report no conflicts of interest. The authors confirm that they have permission to reproduce any copyrighted material.

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