Review

Off-pump Coronary Artery Bypass Grafting in Elderly and High-risk Patients – A Review

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Elderly and high-risk patients are increasingly being considered for myocardial revascularisation. Most trials comparing the various options for revascularisation exclude elderly and 'high-risk' patients. We have reviewed the options for myocardial revascularisation for elderly patients, and for patients with a number of common 'high-risk' co-morbidities – diabetes mellitus, renal insufficiency, poor left ventricular ejection fraction, peripheral vascular disease, left main coronary artery disease and chronic obstructive pulmonary disease – with a focus on coronary artery bypass grafting without the use of cardiopulmonary bypass and aortic manipulation.

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Introduction

Improved life expectancy in developed countries will continue to increase the proportion of the population that reaches an advanced age. In Australia, the proportion of octogenarians increased by 26% in the past decade alone [1]; in the USA, the number of people aged over 75 years old is projected to quadruple in the next 50 years [2]. Accordingly, the number of elderly patients with symptomatic coronary artery disease (CAD) [1] being considered for surgical revascularisation is increasing.

Elderly patients (>75years) have considerably more co-morbidities and reduced end-organ reserve [3]. Studies investigating invasive revascularisation techniques frequently exclude this group of patients and there is a perception that surgery for the treatment of CAD in this group may be too "high-risk". There are relatively few trials that compare the various options for myocardial revascularisation in the elderly and high-risk patient – it is difficult (and indeed inappropriate) to extrapolate the results of trials including younger, low-risk patients to the high-risk group. We have reviewed studies comparing optimised medical therapy, percutaneous coronary intervention (PCI), coronary artery bypass grafting with cardiopulmonary bypass (CABG) or off-pump coronary artery bypass (OPCAB) in high-risk patient subgroups (Table 1).

The Role of OPCAB in Myocardial Revascularisation of the High-risk Patient

Avoiding use of the cardiopulmonary bypass circuit significantly reduces the diffuse systemic inflammatory response during and after cardiac surgery [4], reduces platelet activation and changes to coagulation and fibrinolytic systems [5]. The use of cardioplegic arrest and the associated ischaemia-reperfusion injury is avoided [6]. However, perhaps the biggest benefit of OPCAB is the ability to avoid aortic manipulation (aortic no-touch/anaortic), which when used in conventional CABG, is a potential source of atheroemboli that can cause significant neurologic complications [6,7]. Puskas and Al-Ruzzeh argue that high-risk patients have the most to gain from anaortic OPCAB surgery. Most trials comparing OPCAB with CABG have excluded high-risk patients–by excluding this group from trials, the full potential of OPCAB is yet to be realised [8,9].

Puskas et al. retrospectively analysed 14,766 patients (OPCAB $n = 7083$; CABG $n = 7683$) and divided them into quartiles based on their Society of Thoracic Surgeons Predicted Risk of Mortality (PROM). The study revealed that whilst there was no survival benefit between OPCAB and

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Table 1. *Summary of Revascularisation Options for Each High-Risk Subgroup.*

Sub-group	Risk	Medical Versus Intervention	CABG Versus PCI	OPCAB Versus CABG
Elderly and very elderly patients	Considerably more co-morbidities and reduced end-organ reserve [3]	Intervention (versus medical) = 1 year mortality [13] ↑ 4 years survival rates CABG and PCI [12] ↑ quality of life ↓ anti-anginal medications [13]	CABG =or slightly ↓ short term survival [13,15,16] ↑ longer term survival (ref)	OPCAB = or ↓ 30-day mortality [17,18,19] ↓ stroke [17,18,19] ↓ peri-operative complications [19]
Diabetes mellitus	Two-thirds of mortality due to cardiovascular disease, with approximately 75% of these deaths directly related to CAD [20]	Intervention = death, myocardial infarction or stroke [24] CABG: ↑ survival free of MACCE events [24]	CABG ↓ 5-year mortality [27] ↓ 1 year composite MACCE versus DES [25]	OPCAB = mortality [28,29] ↓ peri-operative complications (↓ AF [28], ↓ renal failure [28], ↓ stroke [29], ↓ blood transfusion ↓ hospital stay [29])
Renal insufficiency	Renal dysfunction and the physiological changes that result are independent risk factors for cardiovascular disease	CABG ↓ mortality ↑ event-free survival [32]	CABG ↓ mortality ↑ event-free survival [32]	Unclear whether OPCAB reduces post-operative renal failure [36,37,33]
Left ventricular dysfunction (LVD)	LVD often secondary to CAD LVD with CAD has poor prognosis [85]	Intervention ↑ survival [40–43]	CABG = 30 day mortality [47] = 36-month survival [46,47] ↑ complete revascularisation ↑ 3-year freedom from cardiac events [47] ↑ ejection fraction [47]	OPCAB = or ↓ mortality [29–48] ↓ post-op complications [29–48] ↓ post-op complications [50,51]
Peripheral vascular disease (PVD)	PVD is a greater significant predictor of mortality following surgery than a previous myocardial infarction or angina severity [54,55] PVD patients more likely to have peri- and post-op complications [55]	N/A	CABG ↑ survival to 3 years [59] (HR 0.63, $p = 0.063$) [59]	OPCAB = in-hospital mortality rates [60] ↓ post-op stroke ↓ length of hospital stay [60]
Left Main coronary artery disease (LMCD)	Exists in 5–7% of patients undergoing coronary angiography [61,62] Poses significant management issues due to the large territory at risk during revascularisation	CABG ↑ median survival [64]	CABG recommended by consensus statement [44] SYNTAX: ↓ MACCE when LMCD and 2 or 3-vessel disease [67] One meta-analysis reported ↑ MACCE [66]	OPCAB = or ↓ mortality [68,69] ↓ post-op renal failure [68] ↓ inotropic support [69]
Chronic obstructive pulmonary disease (COPD)	Strong link between COPD and CAD [71,72] Smoking and systemic inflammation important factors in atheromatous plaque formation [74]	N/A	N/A	OPCAB = mortality [84] trend towards ↓ post-op respiratory complications [82,83] and a ↑ PaO2/FIO2 ratio [83] ↓ post-op ventilator requirements [4]

AF: atrial fibrillation; CABG: coronary artery bypass graft; CAD: coronary artery disease; COPD: chronic obstructive pulmonary disease; DES: drug-eluting stent; LMCD: left main coronary artery disease; LVD: left ventricular dysfunction; MACCE: major adverse and cardiac and cerebrovascular event; SYNTAX: synergy between percutaneous coronary intervention with taxus and cardiac surgery; OPCAB: off-pump coronary artery bypass; PVD: peripheral vascular disease.