Surgical revascularization after acute myocardial infarction in patients with end-stage renal disease

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Abstract

**Objective:** Cardiovascular disease accounts for over 50% of deaths in patients with end-stage renal disease (ESRD). After acute myocardial infarction (AMI), hospital mortality exceeds 25%, and survival beyond 2 years is < 20% for patients with ESRD. The role of coronary artery bypass grafting (CABG) in the setting of an AMI in patients with ESRD remains undefined.

**Methods:** Three hundred and forty-two patients had preoperative ESRD (serum creatinine $\geq 2.0$ mg/dl or dialysis dependence) between 1995 and 2000. One hundred and nineteen patients had an AMI ($\leq 7$ days) and 223 patients had a remote myocardial infarction (RMI) ($> 7$ days) at the time of CABG. The study group, AMI, was compared to the RMI group, which served as a comparison group.

**Results:** The age (69 vs. 67 years), males (68 vs. 67%), creatinine (3.18 vs. 3.76 mg/dl, $P = 0.06$), and preoperative dialysis (19 vs. 22%, $P = 0.52$) were similar in either the AMI or RMI group, respectively. The frequency of diabetes, hypertension, dyslipidemia, previous myocardial infarction were common, yet not different between groups ($P = $NS).

For either AMI or RMI group, multivessel CABG (96 vs. 94%, $P = 0.73$), off-pump CABG (OPCAB) (22 vs. 18%, $P = 0.67$), and arterial conduits (71 vs. 78%, $P = 0.42$) were similar. Among postoperative events, only pulmonary complications (33.8 vs. 14.7%, $P = 0.049$) and atrial fibrillation (48 vs. 29%, $P < 0.001$) were more common in the AMI group. Hospital mortality was no different between the AMI and RMI groups (10 vs. 8.5%, $P = 0.88$).

**Conclusions:** Although patients with ESRD that have an AMI or RMI represent high risk groups, perioperative outcomes suggest that patients selected for CABG as an early treatment strategy in the setting of an AMI represents a viable therapeutic option.

Keywords: Renal failure; Myocardial infarction; Coronary artery bypass grafting

1. Introduction

Chronic kidney disease (CKD) or end-stage renal disease (ESRD) is a worldwide public health problem. In the US, there are more than 300,000 patients receiving some form of renal replacement therapy [1,2]. There is an even higher prevalence of people with early stages of CKD, with estimates affecting 10.8% of the US population [1]. With the increasing age of the population and associated prevalence of diabetes in patients with ESRD, it is estimated that over 650,000 patients will require renal replacement therapy by 2010 [1,2]. Unfortunately, although the mortality rate for patients with ESRD on the first year of dialysis has declined, it is still 19% per year [2,3]. Cardiac disease, and in particular cardiovascular disease (CVD) or ischemic heart disease (IHD) account for 44–50% of all cause related death in patients with ESRD [1–4].

The mortality due cardiovascular disease is 10–30 times higher in dialysis patients than in the general population [1]. Of significance, is that up to 25% of cardiac death is related to acute myocardial infarction (AMI) [2–4]. After an AMI, the in-hospital mortality for all patients with ESRD exceeds 26%, and is 60% at 1 year, and fewer than 10% are alive at 5 years [4]. These mortality rates are worse for older patients and those with diabetes that are receiving dialysis [4].
Despite advances in early reperfusion strategies, including thrombolitics and percutaneous interventions (PCI), the hospital and short or long-term outcomes in patients with ESRD after an AMI, remain dismal [1,4–7]. Although more patients with ESRD or dialysis are being referred for coronary artery bypass grafting (CABG) due to the potential long-term survival advantage over medical or PCI therapy [6–9,10–16] the role of CABG as an early revascularization strategy in the setting of an AMI remains undefined. We reviewed our experience with CABG in patients with ESRD after an AMI to determine if this is a viable therapeutic option.

2. Material and methods

Between 1995 and 2000, 10,291 consecutive patients underwent isolated CABG at the Washington hospital center (WHC). Of these, 342 (3.3%) patients had chronic renal disease or ESRD defined in accordance to The Society of Thoracic Surgeons (STS) as serum creatinine (Cr) > 2.0 mg/dl or dialysis dependence. There were 119 (35%) patients who had an AMI (< 7 days) and 223 (65%) patients who had a remote myocardial infarction (RMI) (> 7 days) at the time of CABG.

All data was prospectively collected and captured through the WHC cardiac surgery database. However, patient inclusion was non-randomized, and analysis was retrospective. Patient inclusion was based on referral for CABG and deemed an operable candidate by the operating surgeon. The AMI, or study group, was compared to the RMI group, which served as a comparative group for the same period. Analysis was performed on group demographics, clinical variables, operative data, and hospital outcomes.

Operative technique was uniform for all surgeons, although the choice for off-pump (OPCAB) was based on the individual surgeon. All participating surgeons were experienced in OPCAB techniques. For patients undergoing conventional CABG, mean arterial pressure was maintained > 70 mmHg, the temperature was allowed to drift, but not below 32 °C, and a hemoconcentrator was used in the cardiopulmonary bypass (CPB) circuit for dialysis patients. For the OPCAB technique, a vessel stabilizer, usually suction type was used, and vessel loops (not circumferential), and not occluders controlled coronary blood flow. An apical suction device was used as a heart positioner. Postoperatively, the renal service was an active participant in the management of all patients.

Statistical analysis was performed by chi-square for categorical variables, and continuous variables were by Student t test. All differences with a two-tailed P value < 0.05 were considered statistically significant.

The WHC Cardiac Surgery Research Committee under the Director of Cardiac Surgery, and the Executive Director of Washington Heart approved this study. No author has any financial disclosures.

### Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>AMI</th>
<th>RMI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>69.4</td>
<td>67.2</td>
<td>0.85</td>
</tr>
<tr>
<td>Male</td>
<td>68%</td>
<td>67%</td>
<td>1</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>3.18±2.6</td>
<td>3.74±3.8</td>
<td>0.06</td>
</tr>
<tr>
<td>Dialysis</td>
<td>23 (19%)</td>
<td>51 (22%)</td>
<td>0.52</td>
</tr>
<tr>
<td>Previous MI</td>
<td>35 (29%)</td>
<td>71 (32%)</td>
<td>0.73</td>
</tr>
<tr>
<td>Diabetes</td>
<td>42%</td>
<td>55%</td>
<td>0.089</td>
</tr>
<tr>
<td>Hypertension</td>
<td>75.6%</td>
<td>81.6%</td>
<td>0.39</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>52%</td>
<td>52%</td>
<td>1</td>
</tr>
<tr>
<td>CHF</td>
<td>26 (22%)</td>
<td>62 (28%)</td>
<td>0.41</td>
</tr>
<tr>
<td>COPD</td>
<td>16%</td>
<td>10.3%</td>
<td>0.29</td>
</tr>
</tbody>
</table>

AMI, acute myocardial infarction; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; MI, myocardial infarction; RMI, remote myocardial infarction.

3. Results

The patient characteristics and demographics are profiled in Table 1. For either the AMI or RMI group, over 70% of patients were between 61 and 99 years old. In each group, there were equal distributions of non-dialysis dependent and dialysis dependent ESRD. There was a high prevalence of diabetes, hypertension, and elevated cholesterol (dyslipidemia) in all patients. Nearly 25% of patients had a component of heart failure, and about 30% of all patients had a history of prior myocardial infarction.

The comparative operative data is listed in Table 2. Only 4% in the AMI group and 6% in the RMI group (P=0.73) received a single bypass. Therefore, multivessel coronary artery disease was prevalent in all patients, and in the AMI 86% and in the RMI 72% received three to five grafts. Arterial conduits, mostly utilizing an in situ left internal mammary artery to the left anterior descending artery, constituted over 70% of all grafts. Saphenous vein grafts were used preferentially at other vessel sites. Intraoperative complications were low, although about 10% of all patients had an intraoperative intraaortic balloon pump (IABP) placed.

The postoperative events, and hospital outcomes, and perioperative mortality are detailed in Table 3. In general,
although intensive care unit (ICU) and hospital stay did not differ between groups, the duration of care was more prolonged than the typical non-ESRD patient. New dialysis requirement occurred only in four patients with an AMI, and in only eight patients with a RMI ($P = 1$). New onset renal insufficiency, defined as a $>50\%$ rise above baseline serum creatinine was no different in either group ($P = 0.086$). The incidence of new myocardial infarction, cerebrovascular accident, or reoperation for bleeding was low. However, composite pulmonary events (ventilation $>48$ h, tracheostomy, and pneumonia) were significantly higher in the AMI group vs. the RMI group ($33.8$ vs. $14.7\%$, $P = 0.049$). Most of this difference was attributed to the development of pneumonias. Also, the frequency of atrial fibrillation was nearly doubled in the AMI vs. the RMI group ($48$ vs. $29\%$, $P < 0.001$). The 30 day, or in-hospital mortality was $10\%$ in the AMI group and $8.5\%$ in the RMI group ($P = 0.88$).

4. Conclusions

Both in the US and in Europe, the incidence and prevalence of ESRD or failure is rising, with poor outcomes and high cost [1,2]. For all stages of progressive ESRD, cardiovascular problems are the most important cause of death, and account for over $50\%$ mortality among these patients [1–4]. Over $20\%$ of cardiac causes of death are from myocardial infarction [1–4]. The in-hospital outcome in patients with ESRD after an AMI, is extremely dismal at over $25\%$, and is worse for older patients and in patients with diabetes [4]. This finding is similar to the high-mortality rate seen in Europe, with mortality after myocardial infarction being $16$–$19$ times as high among patients with renal failure as in the general population [2]. What also is worrisome, is that this poor survival persists after myocardial infarction, even in the era of aggressive reperfusion strategies, with mortality at $59\%$ at 1 year, $73\%$ at 2 years, and $90\%$ at 5 years [1,4]. A treatment strategy that has been demonstrated to have a $13\%$ risk reduction of death after myocardial infarction, and reduced subsequent death after revascularization in patients with ESRD or dialysis is CABG [4,5,7,12,15]. However, the role of CABG as an early treatment option after AMI in patients with ESRD remains undefined.

As demonstrated in this study, patients with ESRD and myocardial infarction who had subsequent CABG have significant CVD risk factors, including older age, diabetes, hypertension, previous myocardial infarction and multivessel coronary artery disease. This risk profile is similar to other data that showed at angiography or after acute coronary syndromes, patients with ESRD were found to have a high prevalence of significant coronary artery disease (at least one vessel $>50\%$ lumina narrowing), a high number of patients with multivessel coronary artery disease, previous myocardial infarctions, and heart failure [1,3,5–9]. Moreover, in our study, the degree of ESRD was quite profound in either the AMI or RMI group with estimated creatinine clearance (CrCl) being $21.7$ and $18.9$ ml/min, respectively. Historically, patients with this degree of ESRD and coexisting clinical characteristics typically have had an early and long-term survival benefit from surgical revascularization [11–16]. This treatment benefit is in contrast to the poor results after medical therapy or percutaneous intervention for acute coronary syndromes and myocardial infarction for patients at all stages of ESRD [4–9].

Although there have been documentation that supports an advantage of early percutaneous intervention in ACS in patients with ESRD, especially compared to medical therapy, the long-term durability of these procedures remains questionable. After percutaneous therapy, there are high incidences of post procedure acute renal failure [5,8,9], and major adverse events including myocardial infarction and emergent CABG and death [8]. While current debulking or stent strategies seem to improve target vessel lesion procedural success rate (at $89\%$), there is a high early and midterm recurrence of symptoms (freedom only $55\%$ at 1 year) [8], increased need for repeat revascularization (reintervention), greater number of repeat hospitalizations, earlier time to subsequent surgical revascularization, and an increased need for subsequent CABG at a rate of $20\%$ at 2 years and $25\%$ at 5 years [5,7–9].

As a result, more patients with symptomatic ischemic coronary disease and ESRD or dialysis are being referred for CABG, based on the data that suggest better long-term survival over medical therapy or percutaneous interventions [5,7,11–16]. Although patients with ESRD are higher risk, and operative mortality for cardiac operations, not in the setting of an AMI, ranges between 6 and $13\%$, the durability of the operation in terms of symptom control (freedom from angina), quality of life, and survival compare favorably to other treatment options and parallels the survival of dialysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>AMI Value</th>
<th>RMI Value</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU (days)</td>
<td>3.5</td>
<td>3.9</td>
<td>1</td>
</tr>
<tr>
<td>Postoperative stay (days)</td>
<td>11.2</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>New dialysis</td>
<td>4 (3.3%)</td>
<td>8 (3.5%)</td>
<td>1</td>
</tr>
<tr>
<td>Renal failure</td>
<td>14 (11.8%)</td>
<td>13 (5.8%)</td>
<td>0.086</td>
</tr>
<tr>
<td>MI</td>
<td>1 (0.8%)</td>
<td>1 (0.4%)</td>
<td>1</td>
</tr>
<tr>
<td>CVA</td>
<td>5%</td>
<td>4.9%</td>
<td>1</td>
</tr>
<tr>
<td>Pulmonarya</td>
<td>29 (33.8%)</td>
<td>33 (14.7%)</td>
<td>0.049</td>
</tr>
<tr>
<td>Reoperation for bleeding</td>
<td>2.5%</td>
<td>5.4%</td>
<td>0.49</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>56 (48%)</td>
<td>64 (29%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Death (30 days)</td>
<td>12 (10%)</td>
<td>19 (8.5%)</td>
<td>0.88</td>
</tr>
</tbody>
</table>

AMI, acute myocardial infarction; CVA, cerebrovascular accident; ICU, intensive care unit; MI, myocardial infarction; RMI, remote myocardial infarction.

a Pulmonary complication included composite events of prolonged ventilation $>48$ h, tracheostomy, and pneumonia.

Table 3

Hospital events
patients without CVD [1,11–16]. For patients with acute coronary syndromes or after AMI, CABG, therefore, may be the only potential viable therapeutic option for these patients [5–7]. For patients with ESRD who sustained an AMI or RMI, as demonstrated in this report, the early hospital outcome and mortality (10%) in the setting of AMI after CABG compares favorably to elective cardiac operation in similar groups of patients (6–13%) [10–16] or after PCI for ACS in patients with ESRD [4–7], and is profoundly less than the 26% hospital mortality for conventional therapy after AMI [4]. From our analysis, an early surgical revascularization strategy for selected patients after AMI seems to be a prudent and viable treatment strategy, given the high in-hospital mortality of 26%, and dismal 1 (40%) and 5 year (10%) survivals for conventional management strategies. We firmly believe, especially based on the pattern of atheroma and coexistence of diabetes in patients with ESRD, liberal use of the internal mammary artery to the left anterior descending artery is an important factor for early survival, and perhaps long-term quality of life and relative survival benefit in these patients [17].

Whether off-pump coronary bypass grafting (OPCAB) allows for a safer outcome compared to conventional CABG for these high-risk groups, cannot be completely answered from our study. In either AMI or RMI groups who had an OPCAB, the hospital mortality was similar to the conventional CABG groups (10 vs. 11.5% in the AMI group or 8.5 vs. 4.9% in the RMI group). Perioperative events, including pulmonary complications and atrial fibrillation were equally high, although there was a trend toward shorter ICU and hospital stays in the OPCAB patients. In the OPCAB group, for either an AMI or RMI, nearly 20% received a single bypass compared to only 4% with standard bypass grafting. Other groups [10,18,19], including ours [20], have reported the potential benefits of OPCAB in patients with non-dialysis dependent renal failure or dialysis dependence with regard to postoperative events and mortality, and potential renal protective effects of OPCAB techniques in the setting of non-AMI or elective CABG. In our current study, certain postoperative events, especially those involving pulmonary complications and atrial fibrillation are frequent with either technique, yet more prevalent in the AMI group. This likely is more reflective of the urgency nature of the case, and less optimization in terms of fluid and electrolyte balance, and renal management prior to the operation in the AMI group. Regardless, for patients with ESRD and dialysis, the 5-year survival even after a cardiac operation is only between 35 and 55%; [14–16] thus, emphasizing the relentless and progressive natural disease course of renal failure.

The number of patients with chronic kidney disease are becoming prevalent, and even in the continuum of ESRD, patients with only mild reduction of renal function, a decreased GFR or creatinine clearance, have an independent risk factor for cardiovascular disease. Because of the high incidence of coexisting CVD risks factors in patients with ESRD, such as age, hypertension, and diabetes, the likely hood of atherosclerosis to develop early on or at young ages is quite high. This is supported by the high incidences of myocardial infarction after the institution of dialysis [1,4] and by prevalence of coronary calcifications in asymptomatic young patients (19 ± 7 years) undergoing dialysis [21]. It would seem prudent, that for this high risk population aggressive screening strategies targeting early diagnosis of CVD should be performed, so that appropriate medical therapy or surgical intervention can be instituted in a timely manner, since once symptoms are manifested by an acute coronary syndrome or myocardial infarction, long-term survival is poor. If proven successful treatment strategies like CABG could be offered before an AMI in patients with documented objective evidence (myocardial stress imaging or cardiac magnetic resonance) of obstructive coronary artery disease, perhaps risk reduction strategies and therapy could also be added to improve long-term quality and survival in patients with ESRD.

Acknowledgements

This manuscript is dedicated to the memory and in tribute to Albert J. Pfister M.D. Dr Pfister was a graduate of the George Washington University Thoracic Surgery Program, and spent his subsequent years of practice in Washington, DC, educating and training those of us who followed.

References


Appendix A. Conference discussion

Dr M. Ruel (Ottawa, Canada): Perhaps what many of us would like to know as well is what happens to patients who have ESRD and have an acute MI with hemodynamic instability? I presume that those patients would have a high mortality. Should we operate on them or should we not; do you have an answer to that from your data?

Dr Trachiotis: There were patients that were selected to be able to get from the catheterization lab to the operating room table under emergent conditions, about 6% in this report. In our experience, patients who have hemodynamic instability during these instances are not good candidates for immediate surgical revascularization, and indeed, these are the patients that have the extreme high mortalities that have been reported in the literature, and that goes even for percutaneous interventions, and of course, medical failure has nearly a 100% mortality. These patients are best temporized by aggressive medical management including anticoagulation, intraaortic balloon pump, antianginal therapy, and optimization of fluid status by dialysis.

Dr A. Moritz (Frankfurt, Germany): There are papers out showing that the acute mortality in patients operated on within three days of AMI is extremely high related to later on. Did you diversify your patient group into this, because this would also be a very interesting question, and you have quite a large number of patients?

Dr Trachiotis: We have not found that in our experience. In our practice we are tending, as long as the patients have hemodynamic stability, to operate earlier in the period, particularly if there is no significant wall motion abnormality. There are approximately 10% of patients in the AMI group that were operated on within six hours of AMI, and although that subgroup of numbers is small, that particular group did not represent the patients that had any significant complication.

Dr S. Wojcik (Krakow, Poland): How many patients were on dialysis, and after the operation, did the number of patients on dialysis increase or stay the same?

Dr Trachiotis: In the presentation, as noted, there were about 26% in each group on dialysis and not statistically significantly different between the two groups. The new dialysis was infrequent between the two groups. There was a tendency for more onset of renal insufficiency in the AMI group as defined as a greater than 50% rise of creatinine, but this was not a significant problem.

As a corollary to that, I might say that the perioperative events, the pulmonary complications and atrial fibrillation which were more frequent in the AMI group, might be more related to factors related to their renal failure, and therefore, due to urgency of CABG, perhaps not optimized for the operating room.

Dr A. Schachner (Holon, Israel): In the off-pump surgery group, did you have any different results either in the acute or in the remote group?

Dr Trachiotis: We did look at that subgroup. The only difference, and the numbers are small, there is approximately 30 in one group and 43 in the other group, was that there was a tendency towards shorter ICU stay, shorter hospital stay, but perioperative events were actually just as common. The results for OPCAB in AMI with renal failure or in patients with renal failure is an important issue, and we are currently detailing that issue for future reports.