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EuroSCORE: Useful in Directing Preoperative Intra-Aortic Balloon Pump Placement in Cardiac Surgery?

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ABSTRACT

Background. The placement of preoperative intra-aortic balloon pumps (IABP) in high-risk patients has been described, although controversy remains regarding the appropriate selection of these patients. The EuroSCORE is a proven predictor of operative mortality for coronary artery bypass surgery (CABG). Our objective was to assess whether patients with a preoperative IABP had a 30-day mortality consistent with their predicted mortality.

Methods. Sixty-six patients who had had an IABP sited while undergoing CABG were retrospectively identified. The additive EuroSCORE was calculated with omission of the IABP preoperative placement score of 3 points. Patients with a EuroSCORE <5 were considered low risk, and those ≥5 as high risk.

Results. High-risk patients with preoperative IABP placement had a significantly lower mortality (1/16, 6.25%) than predicted. The predicted versus actual mortality was 12.6% versus 6.25%.

Conclusion. Correct identification of appropriate patients who would benefit from pre-emptive placement of IABP could potentially be performed using the EuroSCORE.

INTRODUCTION

There is much interest in the pre-emptive placement of an intra-aortic balloon pump (IABP) in patients undergoing cardiac surgery procedures. Prophylactic placement in high-risk patients offers many advantages. Cases presenting for cardiac surgery are increasingly complex with patients having more advanced cardiac disease with greater myocardial ischemia and energy depletion. An IABP reduces myocardial workload while improving coronary perfusion. This reduces myocardial ischemia, left ventricle diastolic pressures, and mitral regurgitation and results in increased stroke volume and cardiac output. Early use of an IABP in a vulnerable patient may also avoid the use of high-dose inotropic agents. However, IABP placement can be associated with significant complications such as aortic dissection, thrombocytopenia, infection, and lower limb vascular complications with a reported rate of 0% to 8.3%.[Christenson 1997, 1999; Briguori 2003] Therefore, the selection of patients who are likely to gain the most from this intervention is critical.

The most common causes of postoperative low cardiac output syndromes in cardiac surgery are pre-existing myocardial dysfunction, suboptimal myocardial protection, and a perioperative myocardial infarction. There is gathering evidence for the beneficial effects of prophylactic placement of an IABP prior to cardiac surgery. Case series comparing the outcomes of patients receiving preoperative IABP placement to the outcomes of those receiving intraoperative or postoperative placement show that the outcomes in the preoperative placement group are superior to the mortality predicted by the Parsonnet score, whereas the actual mortality with intraoperative or postoperative IABP placement was higher then predicted [Kang 2001]. Randomized studies of preoperative elective IABP placement have utilized a combination of variables such as poor left ventricular fraction, left main stem disease, unstable angina, and reoperation for the determination of preoperative placement of an IABP (Table 1). Preoperative IABP placement has been used to extend the range of suitable candidates for off-pump coronary artery bypass surgery (CABG) [Craver 2001; Kim 2001; Suzuki 2004]. Coronary angioplasty is also associated with fewer laboratory events and improved survival when an IABP is placed prior to the procedure in high risk patients [Brodie 1999; Briguori 2003]. However this practice has not been universally adopted. This is partly due to difficulty in objectively identifying the group of patients who would benefit from preoperative IABP placement.

The EuroSCORE is an established scoring system used for calculating operative mortality in CABG patients [Nashaf 1999]. The EuroSCORE includes many of the factors previously used by other studies such as left ventricle function, reoperation, age, unstable angina, and emergency procedures. We hypothesized that the EuroSCORE would be a useful, objective method of selecting patients for preoperative IABP

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Table 1. The Experience of a Number of Prospective Randomized Trials of Preoperative Intra-Aortic Balloon Pump (IABP) Placement*

Study	N	Criteria for IABP Placement	Preoperative Outcome	Control Outcome	IABP Complication Rate
[Christenson 1997]	52	Any 2 of: LVEF <40%, reoperation, unstable angina, left main stenosis >70%	6% Mortality, lower incidence of low cardiac output syndrome, shorter ICU time	25% Mortality	0%
[Christenson 1999]	60	Any 2 of: LVEF <30%, reoperation, unstable angina, left main stenosis >70%	1/30 Deaths, higher CI, shorter ventilation time, shorter ICU time	5/30 Deaths	8.3%
[Marra 2002]†	60	LVEF <30%	6% Mortality, lower inotrope requirements	23% Mortality	5%

*LVEF indicates left ventricular ejection fraction; ICU, intensive care unit; CI, cardiac index.

†Control IABP placed prior to weaning from cardiopulmonary bypass.

placement in CABG-related procedures. To evaluate the usefulness of the EuroSCORE we examined how the actual mortality in patients with preoperative placement of an IABP compared to the mortality in patients with post–aortic cross clamp IABP placement and whether the mortalities matched what was predicted by the patients' EuroSCORE.

MATERIALS AND METHODS

Patient Population

Patients undergoing CABG-related procedures from January 2000 to December 2001 who required an IABP were retrospectively identified. Departmental activity and outcome data are available at www.mater.ie/depts/cardiothoracic/department/data.htm. Data collection was approved by the Hospital Ethics Committee. A total of 66 patients operated on with cardiopulmonary bypass (CPB) were evaluated. Their case records were examined to calculate the additive EuroSCORE [Nashaf 1999]. This time frame was chosen because it predates the routine application of the EuroSCORE at this center. Preoperative placement of an IABP adds 3 points to the EuroSCORE, but for the purpose of this study these 3 points were not included, to enable comparison with the predicted risk of the postoperative IABP placement group. Using this criterion, patients with a preoperative score >5 were considered high risk. The primary outcome measure was 30-day mortality. Predicted mortality was assessed using the logistic EuroSCORE [Roques 2003]. Patients were divided into 4 groups: group 1A (low EuroSCORE/preoperative IABP), group 1B (low EuroSCORE/postoperative IABP), group 2A (high EuroSCORE/preoperative IABP), group 2B (high EuroSCORE/postoperative IABP).

IABP Placement

Preoperative placement of IABP was defined as placement prior to the commencement of CPB, while all placements during weaning or following separation from CPB were considered to be postoperative. A percutaneous technique was used in each case for IABP placement with or without a sheath. The IABP used in all cases was either an 8-F or 9.5-F, 40-mL balloon catheter (Datascope, Montvale, NJ, USA). Patients with an IABP in situ were treated with intravenous heparin with a target activated partial thromboplastin time >70 sec. IABP support was terminated when hemodynamic support was restored with minimal pharmacological support.

Surgical Technique

Surgery was carried out by median sternotomy using standard CPB techniques and mild systemic hypothermia. The left internal mammary artery was used routinely and was the only arterial graft in this series. The remaining grafts were performed with the saphenous vein. Antegrade crystalloid cardioplegia was used in 34 cases and antegrade/retrograde blood cardioplegia in 32. No significant differences were observed in survival ($P = .183$), timing of IABP placement ($P = .67$), or EuroSCORE (additive $P = .499$, logistic $P = .64$) between the 2 methods.

Statistical Analysis

Normal data were initially evaluated with a 1-factor analysis of variance (ANOVA). Where permitted, post-hoc analysis was performed with a Student t test. A chi-square test was used to compare proportions. Correlations were analyzed using a Spearman rank correlation coefficient. Alpha was set at 0.05. Data are presented as means with standard deviations.

RESULTS

Patient Details

There were 51 male and 15 female patients with mean ages of 65 (±9.03) years and 70 (±7.14) years, respectively. The number of grafts per case was 2.9 (±0.77), with an average myocardial ischemic time of 71 (±22) minutes. There were 10 CABG cases with an intracardiac component: 3 mitral valve replacements, 1 mitral repair, 1 aortic valve replacement,

Table 2. Patient Data

	Group				
	1A	1B	2A	2B	*P*
Patients, n	1	11	16	38	
Male	1	9 (81%)	12 (75%)	31 (76%)	.921
Age, y	54	60 (±6.5)	65 (±10)	69 (±8)	.007
Diabetes	1	1	3	7	.163
Family history of cardiac disease	0	7	5	19	.279
Hyperlipidemia	0	5	4	16	.514
Smoking	1	5	9	14	.384
Ischemic time	45	68 (±18)	66 (±28)	75 (±20)	.391
No. of grafts	4	2.9 (±0.8)	2.9 (±0.5)	3 (±0.8)	.570

*Group 1A included patients with low-risk/preoperative intra-aortic balloon pump (IABP) placement; 1B, low-risk/postoperative IABP; 2A, high-risk/preoperative IABP; 2B, high-risk/postoperative IABP. *P* values for normal data were generated with a 1-factor analysis of variance; for analysis of proportions, a chi-squared test was used.

1 aortic and mitral replacement, 2 ventricular septal defect repairs, and 2 left ventricular aneurysm repairs. The characteristics of the individual groups are shown in Table 2. There were no significant differences in sex, myocardial ischemic time, or number of grafts performed. A 1-factor ANOVA demonstrated a significant difference in age among the groups. Posthoc analysis with a Student *t* test demonstrated no significant differences between groups 1A and 1B ($P = .433$) or between 2A and 2B ($P = .147$). However, group 1B had a significantly younger population then group 2B ($P = .006$). This is consistent with inclusion of age as a factor in the calculation of the EuroSCORE.

Mortality

Overall there was a positive correlation between the additive EuroSCORE and 30-day mortality (correlation coefficient, 0.281; $P = .022$). There were a total of 14 deaths, 13 of which were in the high-risk group. There was no difference in mortality between groups 1A and 1B ($P = .75$). However, patients in group 2A had a significantly lower mortality (1/16, 6.25%) than patients in group 2B (12/38, 31%) ($\chi^2 = 3.952$, df = 1, $P = .047$). The predicted versus actual mortality was 12.6% versus 6.25% for group 2A and 11.2% versus 31% for group 2B.

Morbidity

Overall there was no correlation between EuroSCORE, length of intensive care (0.488 d), and length of inpatient stay ($P = .174$). There was no significant difference in intensive care or inpatient stay among the groups (Table 3). There were 2 thromboembolic complications related to IABP usage, both from group 2A, resulting in an IABP-related complication rate of 3%. In both cases the IABP was removed. In one case a surgical thromboembolectomy was required, but the second case was resolved with intravenous heparin. Both patients survived to discharge, were mobilizing prior to discharge, and had no residual problems at 2-month outpatient follow-up.

DISCUSSION

The ability of an IABP to improve myocardial demand and supply balance may benefit these high-risk patients by optimizing their myocardium prior to the ischemic challenge of cardiac surgery with CPB. Studies have shown that in patients with preoperative IABP placement, the cardiac index (CI) was improved [Christenson 1997]. In addition, although the CI was improved in all patients postoperatively, the improvement was greater in the preoperative IABP groups and continued to improve with time following surgery, while the non-IABP control group reached a plateau or declined [Christenson 1997]. The timing of the preoperative placement of the balloon has been evaluated in a prospective randomized trial. In a comparison of results when IABP was placed 2, 12, and 24 hours prior to aortic cross clamping, there was no significant difference among the preoperative IABP groups. However, all 3 had a better survival and shorter intensive care unit stay than the control group [Christenson 1999]. Another prospective randomized study has shown that there is a significant survival benefit in placing the IABP preoperatively compared to placing an IABP just prior to weaning [Marra 2002].

IABP placement is not without risk, however, particularly in patients with peripheral vascular disease. The reported complication rates with IABP have been a significant factor in

Table 3. Outcomes

	Group				
	1A	1B	2A	2B	*P*
Patients, n	1	11	16	38	
EuroSCORE	2	2.45 (1)	7.5 (2.3)	7.5 (1.3)	—
Intensive care unit stay, d	5	3.9 (±1.1)	8.5 (±5.1)	7.8 (±8.6)	.065
Inpatient stay, d	11	11.1 (±4.4)	21.8 (±12)	22.9 (±25)	.054
30-Day mortality, n*	0	1	1	12	1A versus 1B, .75; 2A versus 2B, .047

*The mortality in group 2B was significantly higher than in group 2A.

the reluctance to use elective preoperative IABP in routine practice. We report a vascular complication rate of 3%. Vascular complications have been reported by contemporary studies to be as high as 8.3% [Christenson 1999]. These rates mean that correct identification of the patients likely to benefit most from elective IABP placement is of particular importance for risk benefit analysis. Despite these complications, an increasing majority of IABP use in North American cardiac surgery is in preoperative placement, although it is unknown what proportion is elective [Baskett 2003]. An alternative strategy for managing these high-risk patients, particularly those with systemic atherosclerosis, is the utilization of off-pump techniques. However, while IABP use has been reported to extend the number of patients suitable for off-pump surgery [Craver 2001; Kim 2001; Suzuki 2004], any benefits to survival from preoperative IABP placement in off-pump surgery have not yet been evaluated.

Although the benefits of preoperative IABP placement in high-risk patients is recognized, selection of the ideal patient for preoperative IABP placement has proven challenging. Trials to date have utilized a limited number of variables such as left ventricular function, left main stem disease, reoperation, and unstable angina as the selection criteria. Comparisons of outcomes following preoperative IABP placement with Parsonnet score show that these patients achieve better than expected survival rates [Kang 2001]. While the EuroSCORE has established itself as a predictor of CABG-related mortality, other applications of the EuroSCORE are under study. To date, the EuroSCORE has been demonstrated to predict intensive care stay and hospital costs [Nilsson 2004]. The outcome measure in all the studies of preoperative IABP placement is hospital mortality. Because the EuroSCORE is an established predictor of hospital mortality, it is intuitive that it could be used to select high-risk patients for IABP application preoperatively. The EuroSCORE also includes variables previously used by allocating a score for degrees of left ventricle function, reoperation, and unstable angina. The EuroSCORE does not allocate a score for critical left main stem disease, although this has been part of the criteria for a number of trials. However, in no trial to date has critical left main stem disease been the sole criterion.

This report has demonstrated that patients with a high-risk EuroSCORE profile have a better outcome with preoperative IABP placement than is predicted by the EuroSCORE, and that their outcome is significantly better than the outcome of patients having an IABP placed postoperatively. There are a number of limitations to this retrospective observational study, however. The criteria for placement of a preoperative IABP were not standardized, and in the majority of cases an IABP was required to manage an unstable patient preoperatively rather than placed electively. The patient requiring a postoperative IABP is a vulnerable patient and therefore would be expected to have a high mortality rate. However, the mortality rate among patients with a low EuroSCORE having a postoperative IABP was very low in comparison to patients with a high EuroSCORE. A prospective randomized trial is required to definitively evaluate the utility of the EuroSCORE as a selection tool for preoperative IABP placement. This study provides some justification for such an endeavour and offers a potential cut-off point on the EuroSCORE scale for IABP placement.

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