Permanent Pacemaker Implantation After Isolated Aortic Valve Replacement: Incidence, Indications, and Predictors

Sam Dawkins, MB BS, Alex R. Hobson, MB BS, Paul R. Kalra, MD, Augustine T. M. Tang, DM, FRCS Ed (C-Th), James L. Monro, FRCS, and Keith D. Dawkins, MD, FRCP

Wessex Cardiac Unit, Southampton University Hospital, Southampton, United Kingdom

Background. **Conducting system defects are common in patients with aortic valve disease. Aortic valve replacement may result in further conduction abnormalities and necessitate permanent pacemaker implantation (PPM). We sought to identify the contemporary incidence and predictors for early postoperative PPM in patients undergoing isolated aortic valve replacement.**

Methods. **Data were analyzed from 354 consecutive patients undergoing isolated aortic valve replacement at a referral cardiac unit during a 30-month period; data were unavailable on 4 patients and a further 8 had undergone preoperative PPM. Results for the remaining 342 patients (97%; mean age, 67 ± 14 years), of whom 212 were males, are presented. The major indications for aortic valve replacement were valvular stenosis (n = 224), regurgitation (n = 70), or infective endocarditis (n = 25). Preoperative conducting system disease was present in 26% of patients.**

Results. **In-hospital mortality was 1.8% (6 of 342 patients). Postoperatively 29 patients (8.5%) required early PPM, of which 26 were during the index admission. Patients with preoperative conducting system disease (16% versus 6%; $p = 0.004$) and valvular regurgitation (16% versus 7%; $p = 0.01$) were more likely to require PPM as opposed to those without. Preoperative conducting system disease was the only independent predictor of PPM ($p < 0.01$); the relative risk of PPM requirement in this group was 2.88 (95% confidence interval, 1.31 to 6.33).**

Conclusions. **Permanent pacemaker implantation requirement after aortic valve replacement is a common occurrence, and should be discussed as part of the preoperative consent process. Preexisting conducting disease and preoperative aortic regurgitation were predictors of PPM requirement.**

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Aortic valvular stenosis and regurgitation are associated with abnormalities of conduction, including higher degrees of atrioventricular (AV) block [1, 2]. Aortic valve replacement (AVR) can result in the development of further conduction abnormalities [3], which may be associated with an increased risk of sudden death [4]. Higher degrees of AV block, although often reversible, may also necessitate permanent pacemaker implantation (PPM) [5].

Studies conducted in the late 1970s suggested that early PPM was required in approximately 6% of patients undergoing isolated AVR [6]. Advances in cardiac surgical techniques and improved availability have resulted in surgery being offered to a wider range of patients. Elderly patients, an increasing proportion of the adult population, gain substantial benefits from cardiac surgery [7], and this has resulted in a significant change in the demographics of patients undergoing AVR. Caution is therefore required when extrapolating data from older case series.

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Address correspondence to Dr Dawkins, Wessex Cardiac Unit, Southampton University Hospital, Southampton SO16 6YD, United Kingdom; e-mail: keith@dawkins.org.

The most recent series (reported in 2003) is a prospective cohort study performed in 276 patients (mean age, 57.5 ± 14 years) undergoing AVR in a single center [8]. Patients were included irrespective of whether the primary indication for surgery was severe aortic valve disease or the need for revascularization with concomitant aortic valve disease. Permanent pacemaker implantation was indicated in 3.2% of patients.

Identifying patients at increased risk of developing conduction system abnormalities that are likely to require postoperative PPM would be of substantial clinical benefit, facilitating the planning of postoperative care. It also has important implications in the context of informed preoperative consent. The aim of the current study was to establish the contemporary incidence of early postoperative PPM requirement in patients undergoing isolated AVR. In addition, we sought to identify clinical criteria that might predict the need for early postoperative PPM.

Patients and Methods

Patients

Data were analyzed from 354 consecutive patients undergoing isolated AVR at the Wessex Cardiac Unit (a referral

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Table 1. Characteristics of 342 Patients Undergoing Isolated Aortic Valve Replacement

Characteristic	All Patients (n = 342)	PPM Subset (n = 29)	No PPM (n = 313)	*p* Value (PPM vs. No PPM)
Age (y)	67 ± 14	66 ± 13		NS
Sex (male)	212 (62%)	19 (65%)	193 (62%)	NS
Conduction abnormalities	89 (20%)	14 (48%)	75 (22%)	0.004
Indications for AVR				
AS	224 (66%)	16 (55%)	208 (61%)	NS
AR	70 (20%)	11 (38%)	59 (17%)	0.01
Mixed	20 (6%)	0 (0%)	20 (6%)	NS
Endocarditis	25 (7%)	2 (7%)	23 (7%)	NS
Others	3 (1%)	0 (0%)	3 (1%)	NS
Elective/emergency	283/80	25/4	258/76	NS
Bioprosthetic/mechanical	195/147	16/13	179/134	NS
Prosthetic AV diameter (mm)		24 ± 4	23 ± 3	0.03
Cross-clamp time (min)		54 ± 23	51 ± 20	NS
Bypass time (min)		72 ± 34	66 ± 25	NS
Lowest operative temperature (°C)		30.6 ± 1.9	31.2 ± 2.5	NS

AR = aortic regurgitation; AS = aortic stenosis; AV = aortic valve; AVR = aortic valve replacement; NS = not significant; PPM = permanent pacemaker.

cardiac center) during a 30-month period from January 2000 to July 2002. Patients were identified from a custom-designed cardiac surgical database (based on FoxPro), which is maintained by a dedicated data clerk.

Eight patients had undergone preoperative PPM, and data were not available in a further 4 patients. The remaining 342 patients (mean age, 67 ± 14 years [± standard deviation]) formed the study population; 212 (62%) were males. Baseline demographic details are shown in Table 1. The major indications for AVR were predominant valvular stenosis (n = 224, 66%), predominant regurgitation (n = 70, 20%), or infective endocarditis (n = 25, 7%). The majority of surgical procedures were performed on an elective basis (90%), and only one was a redo. Comprehensive perioperative data were collected from the database and from surgical or anesthetic notes. One hundred ninety-five patients (57%) received bioprosthetic valves, of which four were stentless (three homograft, one Toronto stentless porcine valve). The standard approach for myocardial protection within the unit includes intermittent, cold, anterograde blood cardioplegia supplemented with topical cooling. The mean length of follow-up was 114 ± 192 days (range, 2 to 938 days).

All patients underwent standard 12-lead resting electrocardiography before surgery. Analyses of the recordings were performed by one of two experienced cardiologists. Preoperative conducting system disease was defined by the presence of at least one of the following abnormalities: first-degree AV block (PR interval >200 milliseconds), left bundle-branch block, right bundle-branch block, or left anterior hemiblock (mean QRS axis, −30 degrees, or greater). Postoperatively, resting electrocardiographs were repeated and interpreted using the same criteria. The first electrocardiograph in the notes after day 1 was used.

The requirement for PPM was determined by the attending cardiologist and was based on the general policy of waiting until at least the fifth postoperative day. Uniformly accepted indications within the department are the continued presence of complete heart block, symptomatic bradycardia, or the need to prevent undue bradycardia while controlling tachyarrhythmias at day 7. The actual decision and timing of PPM was, therefore, determined on an individual patient needs basis. All systems were implanted using a transvenous approach.

Preoperative clinical characteristics thought likely to influence the conducting system and several operative variables were analyzed to determine whether any were predictive of postoperative PPM requirement.

This audit was approved by the Southampton & South West Hampshire Research Ethics Committee.

Statistical Analysis

All results are presented as mean ± standard deviation. Data were analyzed using Stat View 4.5 (Abacus Concepts Inc, Berkeley, CA). Analysis of variance and χ^2 were used as appropriate. The receiver-operating characteristic curve for prosthetic aortic valve diameter was drawn (MedCalc 5.0, MedCalc Inc, Mariakerke, Belgium). The cutoff level that resulted in the highest product of sensitivity and specificity was considered the optimum for predicting PPM requirement. Logistic regression analysis was performed to determine independent predictors of PPM requirement. A probability value of less than 0.05 was considered significant.

Results

Preoperative Electrocardiographic Findings

A preoperative resting electrocardiograph demonstrated that the majority of patients were in sinus rhythm (n = 300, 88%); atrial fibrillation was present in 40 patients (12%) and complete AV block in a further 2. Other