

INCIDENCE OF PERMANENT PACEMAKER IMPLANTATION AFTER CARDIAC SURGERY: A SINGLE CENTRE EXPERIENCE

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Permanent pacemaker implantation (PPI) after open heart surgery is required in 0.4–8.5% of patients. The aim of our study was to determine the incidence of PPI after cardiac surgery at Pauls Stradiņš Clinical University Hospital and to assess its influence on intrahospital outcomes. This was a single-centre retrospective study. We reviewed all patients who underwent either open heart surgery or transcatheter aortic valve implantation (TAVI) between the years 2015 and 2017. Included were all patients with PPI postoperatively before discharge. We compared the patient demographics, and perioperative state, incidence of PPI and intrahospital stay among groups. After cardiac surgery a total of 135 (4.2%) patients received a PPI. The PPI incidence was highest in the tricuspid valve intervention group — 8.8% followed by aortic valve replacement (AVR) patients with 3.3%. After TAVI incidence of PPI was 4.0% after Sapien valve and 8% after CoreValve implantations, respectively. Incidence of PPI after TAVI with the Sapien valve was not significantly higher when compared to conventional AVR, but it was significantly higher after TAVI with CoreValve. Regardless of the initial procedure a need for PPI significantly increased the total length of hospital stay.

Key words: permanent pacemaker, aortic valve replacement, TAVI, cardiac surgery.

INTRODUCTION

Cardiac conduction abnormalities after heart surgery are observed in 17% to 34% of patients. Transient bradyarrhythmias resolve themselves in the first days after surgery, but persistent conduction disturbances requiring permanent pacemaker implantation (PPI) occur in 0.4–8.5% of patients undergoing conventional heart surgery, depending on surgery type and can reach even higher frequencies after TAVI (Meimoun *et al.*, 2002; Berdajs *et al.*, 2008; Merin *et al.*, 2009; Moraca *et al.*, 2009; Schurr *et al.*, 2010; Al-Ghamdi *et al.*, 2016; Mangieri *et al.*, 2018).

The incidence of postoperative PPI has a tendency to decrease, because of better understanding of the mechanisms of possible injury to the conduction system of the heart during surgery. Certain technological improvements to the procedures and to the design of implantable devices have facilitated this reduction (Nardi *et al.*, 2010; Al-Ghamdi *et al.*,

2016). On the other hand, the overall number of PPI after cardiac procedures has increased due to the advent of TAVI. PPI after TAVI is reported in even up to > 20% patients depending on the prosthesis used (Mangieri *et al.*, 2018). Unfortunately, in contrary to some beliefs, PPI is not a harmless procedure as it may increase morbidity and postoperative hospital stay (Merin *et al.*, 2009).

The aim of our study was to determine the incidence of PPI after conventional cardiac surgery and to compare the incidence of PPI after various conventional open-heart surgical procedures and TAVI, as well as to assess its influence on intrahospital outcomes.

MATERIALS AND METHODS

This is a single-centre retrospective study. We reviewed all patients who underwent open heart surgery at Pauls Stradiņš

Clinical University Hospital between the years 2015 and 2017, in total 3242 patients. Included in this study were all patients with PPI postoperatively before discharge. Also, all patients undergoing transfemoral TAVI using either the Edwards Sapien or Medtronic Corevalve systems were assessed — a total of 174 and 50 patients, respectively. We compared the patient demographics, and perioperative state, incidence of PPI and intrahospital stay among groups of patients undergoing isolated CABG, aortic valve replacement, any tricuspid valve intervention and TAVI. For statistical analysis, the Chi-Square or Fisher's Exact Test, normal approximation (Wald) was used; *p* values < 0.05 were considered as statistically significant. The study was conducted after it was approved by the research ethics board in our hospital.

RESULTS

From the 3242 patients after conventional cardiac surgery, 135 (4.2%) patients received a PPI. The mean age of PPI patients was 68.5 ± 10.5 years. The most common indication for PPI was complete atrioventricular block in 59 (43.7%), sick sinus syndrome with symptomatic bradycardia in 25 (18.5%), and atrial fibrillation (AF) with a slow ventricular rate in 41 (30.4%). Other causes for PPI were recorded in 10 (7.4%) patients — six having second-degree atrioventricular block and four ventricular tachycardia and receiving an implantable cardioverter defibrillator (Fig. 1). It has to be noted that sick sinus syndrome with significant bradycardia in these patients was not diagnosed before surgery.

As expected, the lowest incidence of PPI was observed in the group of patients undergoing isolated CABG with only two cases (0.2%; CI 0.0–0.8%). The incidence of PPI in the group of conventional AVR patients was 3.3% (CI 2.0–4.6). Among conventional surgery patients, the PPI rate was higher only in the tricuspid valve intervention group — 8.8%; CI 6.9–10.9%. In all patients receiving PPI the total length of hospital stay was significantly longer compared with the patients not requiring PPI. The longest hospital stay was for the patients having a tricuspid valve procedure. For them it also took the longest until PPI after the initial surgery. These results with additional data on patient groups can be seen in Table 1.

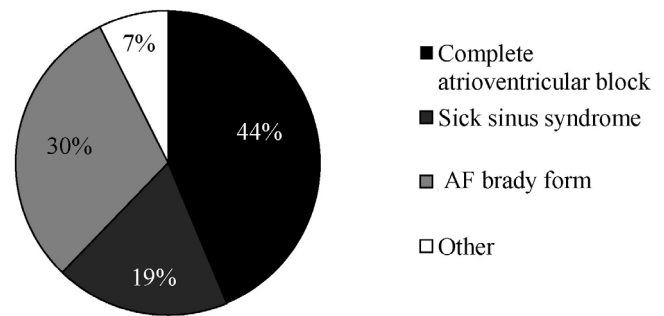


Fig. 1. Most common indications for permanent pacemaker implantation after conventional open cardiac surgery.

After TAVI, 11 patients received PPI, seven of them after Edwards Sapien implantation with a PPI incidence of 4.0% and four after Medtronic Corevalve, with an incidence of 8%. In both of these groups patient mean age was significantly older than that in the conventional AVR group: 82.6 ± 5.8 in Corevalve and 83.2 ± 4.3 in Sapien groups, respectively. The length of hospital stay in these groups increased from 10.4 days to 16.4 in the Sapien group and from 8.2 days to 14.1 in the Corevalve group if receiving PPI (Table 1).

For all surgical procedures combined mean time from initial surgery to PPI when developing a complete AV block was significantly shorter — 5.0 ± 3.4 days compared to 7.7 ± 3.2 days for other indications (*p* < 0.05). Analysis of most common indications for PPI in studied surgical groups is summarised in Table 2. As complete AV block altogether was the most common indication for PPI, we performed a risk analysis to determine patient and procedure factors increasing the likelihood of an AV block in our series. The factors having the most significant impact were preoperative right bundle branch block (OR 2.86 [1.12 – 7.27], *p* = 0.02), intervention on the aortic valve (OR 2.93 [1.16 – 7.43], *p* = 0.02) and heavy calcinosis of the aortic valve annulus (OR 2.53 [1.03 – 6.23], *p* = 0.04).

DISCUSSION

In our series the overall intrahospital PPI rate after open heart surgery was 4.2%, which is similar to published results from other institutions and registries (Al-Ghamdi *et al.*, 2016). We observed the highest need for pacemaker im-

Table 1

PROPORTION OF PATIENTS RECEIVING PERMANENT PACEMAKER IMPLANTATION, THEIR AGE, TIME UNTIL PACEMAKER IMPLANTATION AND TOTAL LENGTH OF STAY IN STUDIED SURGICAL AND TAVI PATIENT GROUPS

	CABG	TV procedure	AVR	TAVI Sapien	TAVI CoreValve
Patients: total/ with PPI	1006/2	803/38	722/24	174/7	50/4
Age at the time of the surgery, mean values \pm SD	68.4 ± 10.4	69.4 ± 8.7	69.5 ± 11.4	83.2 ± 4.3	82.6 ± 5.8
Days to PPI after surgery, mean values \pm SD	7.1 ± 7.3	7.8 ± 4.8	5.7 ± 3.4	3.2 ± 1.8	4.3 ± 2.5
Total length of stay in days, patients without PPI/with PPI	9.4/17.6	10.3/17.8	9.2/16.2	10.4/16.4	8.2/14.1

AVR, aortic valve replacement; CABG, coronary artery bypass grafting; PPI, permanent pacemaker implantation; SD, standard deviation; TAVI, transcatheter aortic valve implantation; TV, tricuspid valve. For total length of stay Student's t-test showed *p* < 0.05 for all analysed patient groups.

MOST COMMON INDICATIONS FOR PPI IN STUDIED SURGICAL AND TAVI PATIENT GROUPS

Indication	AVR	CABG	TV procedure	TAVI Sapien	TAVI CoreValve
Complete AV block, n (%)	16 (66.7%)	0	26 (36.6%)	4 (57.1%)	3 (75%)
Sick sinus node syndrome, n (%)	5 (16.7%)	1 (50.0%)	5 (7.2%)	0	0
AF brady form, n (%)	0	1 (50.0%)	34 (49.3%)	3 (42.9%)	1 (25%)

AF, atrial fibrillation; AV, atrioventricular; AVR, aortic valve replacement; CABG, coronary artery bypass grafting; PPI, permanent pacemaker implantation; TAVI, transcatheter aortic valve implantation; TV, tricuspid valve.

plantation in the group of patients undergoing tricuspid valve interventions, reaching even 8.8%. This can be explained by the proximity of the AV node to the fibrous annulus of the tricuspid valve and hence high likelihood to damage while passing through surgical stiches in order to repair or replace the tricuspid valve (Fig. 2), even though this is a well-known anatomical fact and has been taken in to account when developing valve repair techniques and devices. Annuloplasty rings are incomplete rings, trying to avoid the area with the highest risk to damage the conduction system. Still, the risks cannot be fully mitigated, because the conduction system is invisible to the surgeon's eye and there exist anatomical variations of the location of the AV node. Hence, avoiding stitches at a certain area does not 100% prevent from developing a complete AV block. The next procedure most commonly requiring PPI is AVR, with 3.3% of cases, which corresponds well to the results published elsewhere (Limongelli *et al.* 2003; Schurr *et al.* 2010). With aortic valve procedures the situation is similar, as making sutures for aortic valve replacement or repair can directly damage elements of the conduction system, which are located in the area of the right coronary sinus, passing through the membranaceous septum (Fig. 2). The same mechanism works with TAVI; here damage to the conduction may be caused by the radial force of the TAVI valves pushing against LVOT, against septum and hence damaging atrio-ventricular signal conduction (Mangieri *et al.*, 2018). As TAVI valves rely on their radial force as the only mechanism of fixation in the aortic annulus, this is an in-born problem of the procedure. The risk of PPI in TAVI can be reduced only by avoiding to implant the valve too deep ventricle-wise. As for some of the valves the stents are very long and designed to be located partially in the LVOT, this is a serious problem. One of the valves with a very tall profile and long stent is the Medtronic CoreValve. This valve has been reported to have high PPI rates. Our study showed similar results to previously reported ones, and patients with CoreValve implantations demonstrated significantly higher PPI rates of 8% when compared both to conventional AVR with 3.3% and TAVI with Edwards Sapien valve with 4% PPI rates, respectively. This data corresponds well with previously published results, where the PPI incidence after CoreValve ranged between 6% and even as high as 30% (Erkagic *et al.*, 2012; Mangieri *et al.*, 2018).

The most common indication for PPI in our series was complete AV block both for conventionally operated and TAVI patients (see Table 2). As mentioned previously, patients

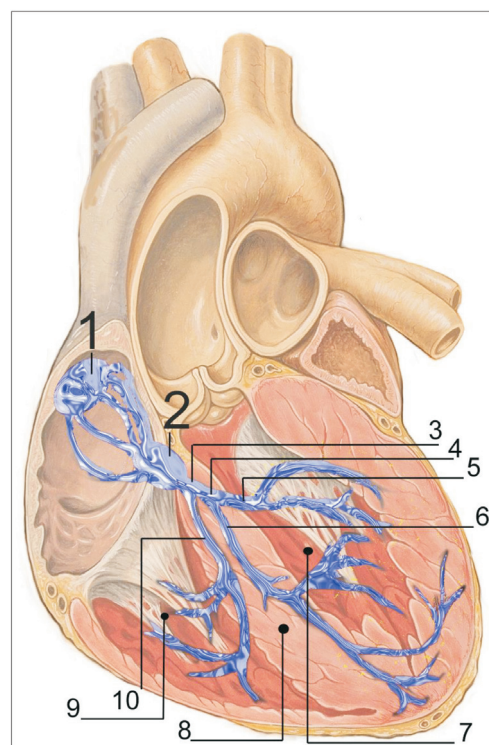


Fig. 2. Electrical conduction system of the heart: 1) Sinoatrial node; 2) Atrioventricular node; 3) Bundle of His; 4) Left bundle branch; 5) Left posterior fascicle; 6) Left-anterior fascicle; 7) Left ventricle; 8) Ventricular septum; 9) Right ventricle; 10) Right bundle branch.

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with complete AV block received PPI significantly earlier in comparison to patients with other indications — 5.0 ± 3.4 days compared to 7.7 ± 3.2 , respectively. This can be explained by the higher risk of managing these patients without a PPI, because in case of temporary pacemaker lead failure these patients would be left with a risk of asystole, compared to other forms of bradyarrhythmias with at least some if even very slow base heart rate. It has to be noted that there is a wide variation in regard to recommended timing of PPI after cardiac surgery procedures, which ranges from 3 to 21 days after appearance of an AV block (Schurr *et al.*, 2010). This wide variety in the time to PPI can be explained by observations that the rhythm disturbances are temporary and potentially due to postoperative edema of cardiac tissue, which may resolve with time. Hence, in some situations with lower degree of AV blockade or slow sinus rhythm, it is reasonable to postpone PPI. In contrast, it has been shown that complete AV block, especially after

aortic valve procedures resolves very rarely (Schurr *et al.*, 2010) and can be a serious risk for the patients after cardiac surgery, justifying earlier PPI. We report time to PPI as low as 3.2 ± 1.8 days after TAVI with the Sapien valve ranging till 7.8 ± 4.8 days after tricuspid valve interventions. This certainly marks a well pronounced tendency to implant a permanent device earlier in the TAVI cohort, which compares well with previously published data (Nazif *et al.* 2015; Tichelbäcker *et al.* 2018).

CONCLUSIONS

In our centre, patients undergoing heart surgery required a PPI in approximately 4.2% of all cases. The risk of PPI was particularly higher after procedures where TV was involved, followed by AVR. Incidence of PPI after TAVI with the Sapien valve was not significantly higher when compared to conventional AVR, but it was significantly increased after TAVI with CoreValve. Regardless of the initial procedure, a need for PPI significantly increased the total length of hospital stay.

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PASTĀVĪGA ELEKTROKARDIOSTIMULATORA IMPLANTĀCIJAS BIEŽUMS PĒC SIRDS ĶIRURĢIJAS OPERĀCIJĀM: VIENA CENTRA PIEREDZE

Pastāvīga elektrokardiostimulatora (EKS) implantācija pēc atvērtām sirds operācijām nepieciešama vidēji 0,4–8,5% pacientu. Šī pētījuma mērķis bija noteikt pastāvīga EKS implantācijas biežumu pēc atvērta tipa sirds operācijām Latvijas Kardioloģijas centrā, kā arī novērtēt tā ietekmi uz intrahospitalajiem rezultātiem. Šis ir viena centra retrospektīvs pētījums. Mēs apskatījām visus pacientus, kuriem tika veikta vai nu atvērta sirds operācija, vai transkatetra aortas vārstuļa implantācija (TAVI) no 2015. līdz 2017. gadam. Tika iekļauti visi pacienti ar no jauna implantētu EKS pirms izrakstīšanās no stacionāra. Mēs salīdzinājām pacientu demogrāfiskos datus, perioperatīvo stāvokli, EKS implantācijas biežumu un intrahospitalālās uzturēšanās ilgumu starp pacientu grupām. Pēc sirds ķirurģijas kopā 135 (4,2%) pacientiem bija nepieciešama EKS implantācija. Vislielākā pastāvīga EKS incidence bija trikuspidālā vārstuļa intervences grupā — 8,8%, kam sekoja aortas vārstuļa protezēšanas (AVR) pacienti ar 3,3% incidenci. Pēc TAVI pastāvīga EKS implantācija bija nepieciešama 4,0% gadījumu pēc Sapien protēzes un 8,0% gadījumu pēc CoreValve implantācijas. Salīdzinot ar konvencionālu AVR, pastāvīga EKS implantācijas incidence pēc Sapien protēzes nebija nozīmīgi lielāka, savukārt, pēc CoreValve incidence bija nozīmīgi lielāka. Neatkarīgi no iniciālās procedūras, nepieciešamība pēc EKS implantācijas pēcoperācijas periodā nozīmīgi pagarināja kopējo hospitalizācijas laiku.