



**Figure 1.**  
*Magnetic resonance imaging showing bilateral communicating frontal lobe porencephalic cyst.*

BIS monitoring has been largely used to monitor the depth of anaesthesia. However, nothing has been published regarding the role of BIS monitoring and its validity in neurosurgical patients with raised intracranial pressure. Since the BIS algorithm analyses the EEG signals of the patient, it should be expected to vary or else alter the values displayed, to some extent, especially in patients with grossly elevated intracranial pressure.

Schnider and colleagues [4] reported a case in which, due to the patient's EEG amplitude being

genetically very low, the BIS value was 40 during consciousness. This EEG pattern occurs with an incidence of approximately 10% of the population. It has also been suggested that emotional tension may induce low-voltage EEG activity. In our patient, an increase in intracranial pressure as a result of the cyst may have resulted in decreased cerebral perfusion pressure and thereby caused global cerebral ischaemia over a long period. This may have been responsible for the lower BIS values. A large prospective study may be needed to validate the role of the BIS monitor in neurosurgical patients with signs of raised intracranial pressure as in cases of gross hydrocephalus or patients with large intracranial cysts. Lower BIS values in these patients may not reflect the true hypnotic state and could be a result of cerebral ischaemia or even low-voltage EEG signals. To adjust the level of anaesthesia based entirely on BIS could be erroneous and inappropriate.

*H. Prabhakar, Z. Ali, P. K. Bithal, G. P. Rath*  
*Department of Neuroanaesthesiology*  
*All India Institute of Medical Sciences*  
*New Delhi, India*

## References

1. Merat S, Levecque JP, Le Gulluche Y, Diraison Y, Brinquin L, Hoffmann JJ. BIS monitoring may allow the detection of severe cerebral ischemia. *Can J Anaesth* 2001; 48: 1066–1069.
2. Prabhakar H, Rath GP. Change in bispectral index following intraventricular bleed in neuroradiological suite. *Anaesth Intensive Care* 2007; 35: 138–139.
3. Renna M, Handy J, Shah A. Low baseline Bispectral Index of the electroencephalogram in patients with dementia. *Anesth Analg* 2003; 96: 1380–1385.
4. Schnider TW, Luginbuhl M, Petersen-Felix S, Mathis J. Unreasonably low bispectral index values in a volunteer with genetically determined low-voltage electroencephalographic signal. *Anesthesiology* 1998; 89: 1607–1608.

## Perioperative outcome of pacemaker patients undergoing non-cardiac surgery

doi: 10.1017/S0265021508003621

### EDITOR:

There has been a remarkable evolution in the technology of cardiac pacemakers since the first

implantation in the 1950s. Apart from the basic functions of cardiac pacing and sensing, some pacemakers are now able to preserve atrio-ventricular synchronization (dual-chamber pacemaker) and/or to adjust heart rate to metabolic demand (rate-responsive pacemaker). All currently implanted pacemakers have some programmable features that have made pacemaker devices more dependable and more complex [1]. On the

Correspondence to: Emmanuel Samain, Department of Anaesthesiology and Intensive Care Medicine, Jean Minjot Hospital, University of Franche-Comte, 3 Bvd Fleming, 25000 Besançon, France. E-mail: esamain@chu-besancon.fr; Tel: +33 3 81 82 85 94; Fax: +33 3 81 66 90 14

Accepted for publication 1 January 2008 EJA 4825  
First published online 13 February 2008

other hand, population aging, along with broader indications for implantation, has led to growing numbers of pacemaker patients presenting for surgery. Literature regarding the perioperative period in patients with an implanted pacemaker is limited either to review and guidelines for perioperative management or to case reports of pacemaker dysfunctions, mostly related to electromagnetic interferences generated by electrical devices used in the operating theatre [2,3].

A prospective study was undertaken over a 30-month period to evaluate the perioperative outcome of pacemaker patients undergoing non-cardiac surgery in one university institution. In accordance with French Bioethics Law, all patients gave informed consent to participate in the study, but as it was only observational and did not modify current diagnostic or therapeutic strategy, written consent was not mandatory. All pacemaker patients undergoing non-cardiac surgery or invasive diagnostic or therapeutic procedure unrelated to the cardiac device, performed under general or regional anaesthesia, were included. Exclusion criteria included refusal to participate or age less than 18 yr.

Patients were managed according to the same clinical protocol that is currently being used for pacemaker patients at our institution. Data regarding patient characteristics and past medical history were collected prospectively. Preoperative evaluation focused on underlying cardiac disease, indication for pacing, and pacemaker characteristics and set up. Physical signs of pacemaker dysfunction were assessed, and a resting 12-lead surface electrocardiogram (ECG) was performed preoperatively. Except for case of emergency surgery, the cardiac device was checked preoperatively by telemetry, by either the patient's attending cardiologist or a cardiologist at our institution. Program changes were made if necessary to optimize cardiac pacing, but no change was done specifically for the perioperative period. Choice of the anaesthetic technique and agents were left to the decision of the anaesthetist in charge of the patient. Intraoperative monitoring included at least ECG for cardiac rhythm, non-invasive arterial pressure measurement, pulse oximetry and capnography in case of general anaesthesia. Invasive monitoring of arterial pressure was undertaken in cases of high-risk surgery. Postoperatively, cardiac adverse events were assessed by daily clinical examination until hospital discharge, and both 12-lead surface ECG and plasma cardiac troponin I (cTnI) assays (automated immunoenzymatic assay, Access Cardiac Troponin-I; Beckman Instrument, Chaska, MN, USA) were performed on postoperative day 1 and 3 or when

clinically indicated. Telemetric check of the pacemaker was carried out before hospital discharge. The primary end-point was a composite of death from cardiac causes, non-fatal acute myocardial infarction, congestive heart failure and arrhythmia requiring antiarrhythmic therapy during hospitalization. Death was considered to be of cardiac cause if the patient died from myocardial infarction, cardiac arrhythmia or congestive heart failure. The diagnosis of myocardial infarction required elevated cTnI concentration above the normal upper value, set as  $0.1 \mu\text{g mL}$ . Quantitative variables are presented as mean  $\pm$  SD or median (interquartile range) for variables not normally distributed.

In all, 65 patients aged  $76 \pm 11$  yr (36 male, 29 female) were enrolled in the study. Past medical history of coronary artery disease, congestive heart failure and diabetes mellitus were present in 37%, 32% and 12% of the patients in each of those groups, respectively. Previous coronary artery revascularization had been performed in 12.3% of the patients. A pacemaker device, of which 69% were dual-chamber, had been implanted  $1.7$  ( $3.1$ ) yr before surgery (data available in 61 cases). Thirty-six percent of the pacemakers were rate responsive. Indications for pacing were symptomatic sinus bradycardia, sinus node disease and symptomatic atrio-ventricular block in 39%, 11% and 38% of the cases, respectively. Preoperative pacemaker dysfunction was noted in seven of the 60 devices tested: dual-chamber DDD pacing mode was found inadequate because of atrial fibrillation in three patients, leading to reprogramming in either VVI (two cases) or DDI (one case) mode [4]. Pacemaker output amplitude was modified in three cases and sensing parameters in one. A low-voltage battery was noted in three cases, but preoperative device change was not considered mandatory by the cardiologist.

Vascular, orthopaedic, intra-abdominal surgery, neurosurgery and miscellaneous procedures were performed in 34%, 25%, 18%, 9% and 14% of the patients, respectively. Emergency surgery was performed in 23% of the patients. General anaesthesia, regional anaesthesia and combined general and regional anaesthesia were used in 83%, 14% and 3% of the cases, respectively. No major dysfunction of the pacemaker device occurred in the perioperative period. Composite adverse outcome was met in 11 patients, including postoperative myocardial infarction in seven patients, left ventricular failure in two and arrhythmia in two. Two patients died of cardiac causes during hospitalization.

Postoperative pacemaker control, performed in 52 patients, revealed no change in pacemaker

program, but allowed for optimization of cardiac pacing in five cases (change in pacing mode in two cases, pacing or sensing parameters changes in three cases).

The results of this observational study showed that severe cardiac complications were frequent in pacemaker patients, but that these complications were mainly related to underlying cardiac disease, and not directly to the pacemaker device. Because of unique characteristics of cardiac diseases that lead to cardiac pacing, we found it impossible to perform a case-control study to compare outcome between patients that differ only by cardiac pacing. However, as current data available on pacemaker patients are limited to case reports of intraoperative dysfunction, we think that our results may help to have a global view on perioperative risk in these patients.

Preoperative pacemaker dysfunction was frequent in our series, and in 12% of the cases pacemaker programming was modified, some of these changes being major alterations, indicated because of evolution of the underlying cardiac disease. Whether a complication linked to a pacemaker dysfunction would have occurred in the absence of reprogramming is not known, but our results reinforce the current recommendation, based on a simple assumption, to check pacemaker program before surgery.

The incidence of cardiac complications was high in our series. Two patients died of cardiac causes, but no death was related to a dysfunction of the cardiac pacemaker device. This is in accordance with the fact that cardiac pacing was not identified as an independent risk factor of cardiac complication in the perioperative period. This also suggests that preoperative evaluation should not only focus on pacemaker evaluation but also consider recent guidelines for preoperative optimization of underlying cardiac disease.

Postoperative pacemaker check revealed that adaptation of pacing mode or parameters were necessary in five patients. In two cases, this was related to alteration in the patients' cardiac rhythm, but in three cases, ventricular output amplitude was changed. The precise mechanism of these alterations was unclear and may require further investigation. This finding is in accordance with the study by Rozner [5], which showed a postoperative increase in pacing output threshold in 4.3% of pacemaker patients exposed to intraoperative electromagnetic interference.

In conclusion, this study showed a poor perioperative outcome of pacemaker patients, mainly related to the underlying cardiac disease, and confirmed the necessity to check the cardiac device in both the preoperative and postoperative period.

S. Pili-Floury, E. Farah, E. Samain  
Department of Anaesthesiology and Intensive Care Medicine  
Jean Minjot Hospital  
University of Franche-Comte  
Besançon, France

F. Schawliege  
Department of Anaesthesiology  
Beauvais Hospital  
Beauvais, France

J. Marty  
Department of Anaesthesiology and Intensive Care Medicine  
Henri Mondor Hospital  
Assistance Publique-Hôpitaux de Paris  
University Paris XI  
Créteil, France

## References

1. Practice advisory for the perioperative management of patients with cardiac rhythm management devices: pacemakers and implantable cardioverter-defibrillators: a report by the American Society of Anesthesiologists Task Force on Perioperative Management of Patients with Cardiac Rhythm Management Devices. *Anesthesiology* 2005; 103: 186–198.
2. Zipes DP, Camm AJ, Borggrefe M *et al.* ACC/AHA/ESC 2006 Guidelines for Management of Patients With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death: a report of the American College of Cardiology/American Heart Association Task Force and the European Society of Cardiology Committee for Practice Guidelines (writing committee to develop Guidelines for Management of Patients With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death): developed in collaboration with the European Heart Rhythm Association and the Heart Rhythm Society. *Circulation* 2006; 114: e385–e484.
3. Samain E, Marty J, Souron V *et al.* Intraoperative pacemaker malfunction during shoulder arthroscopy. *Anesthesiology* 2000; 93: 306–307.
4. Bernstein AD, Daubert JC, Fletcher RD *et al.* The revised NASPE/BPEG generic code for antibradycardia, adaptive-rate, and multisite pacing. North American Society of Pacing and Electrophysiology/British Pacing and Electrophysiology Group. *Pacing Clin Electrophysiol* 2002; 25: 260–264.
5. Rozner M. Pacemakers and implantable cardioverter defibrillators. *Crit Care Med* 2004; 32: 1809–1812.