TITLE: EFFICACY OF NONINVASIVE TRANSCUTANEOUS CARDIAC PACING IN PATIENTS UNDERGOING CARDIOPULMONARY BYPASS

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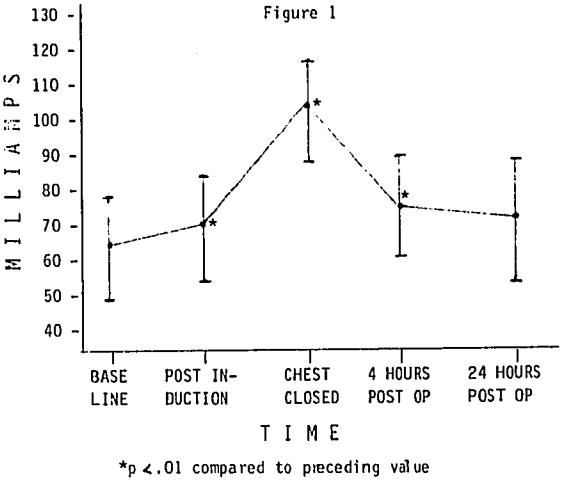
Introduction: Recent technological advances have led to the rebirth of noninvasive transcutaneous cardiac pacing (NTP). NTP is safe, effective, easy to use, well-tolerated by conscious patients, and hemodynamically similar to right ventricular endocardial pacing.[1] Animal studies have not induced ventricular arrhythmias or demonstrated any evidence of myocardial, pulmonary, skeletal muscle, or cutaneous damage.[2] Because NTP has been proven effective in healthy patients undergoing routine general anesthesia,[3] but has not been evaluated perioperatively during cardiac surgery and cardiopulmonary bypass (CPB), the present study was designed to investigate the efficacy and safety of NTP in this setting.

Methods: Ten patients undergoing cardiac surgical procedures utilizing CPB were studied following approval of our institution's Research Practices Committee. Patients were excluded if they were under age 18, unstable, had pre-existing permanent cardiac pacemakers or pacemaker-dependent rhythms postoperatively, or required intraaortic balloon pump assistance. After obtaining informed consent, the Zoll NTP (ZMI Corporation, Cambridge, Massachusetts) utilizing a 40 msec pulse duration and 8 cm^2 high impedance electrodes applied anteriorly and posteriorly as recommended by the manufacturer paced the heart. Pacing thresholds were documented at 5 points during the patient's course: (1) after premedication and institution of standard cardiac surgical monitoring but prior to induction of anesthesia, (2) after high dose narcotic induction, neuromuscular blockade, and endotracheal intubation, (3) immediately after chest wall closure, (4) 4 hours postoperatively, and (5) 24 hours postoperatively. The NTP rate was set at least 10 beats per minute higher than the intrinsic rate, with threshold being defined as the lowest current setting demonstrating electrical capture and palpable pulses for 8 consecutive beats. The mean threshold values (± SD) were plotted against time and compared for significance against baseline readings. Blood pressure, cardiac output, wedge pressure, pump time, ischemic time, body temperature, serum K+, blood gases, chest tube blood loss, chest x-ray, EKG, and body surface area were also recorded.

Results: The mean value ± one standard deviation for milliamperage (MAMPS) is plotted in figure 1 for each time period. A univariate repeated measures analysis of variance revealed a statistically significant difference in mean MAMPS over time ($p = .0001$). Mean MAMPS following induction of anesthesia is significantly greater ($p < .01$) than baseline and mean MAMPS after chest closure significantly exceeded postinduction values ($p < .01$). None of the patients experienced hemodynamic compromise during the study period, although 3 developed postoperative complications that excluded them from further study. One patient experienced intolerable discomfort at 24 hours resulting in discontinuation of NTP at his request.

Discussion: NTP, an effective alternative for patients undergoing CPB, may be used as a temporary backup if epicardial wires become displaced postoperatively. While baseline MAMPS was slightly higher than that of healthy volunteers,[4] MAMPS after chest closure was significantly elevated and approached the maximum output of the unit (140 milliamps) in some patients. Multiple factors such as hypothermia, myocardial edema, pericardial blood accumulation, loss of chest wall integrity, and residual narcotics or neuromuscular blockade may be involved. Further investigation will be necessary to elucidate the relative importance of these variables. No statistically significant difference in MAMPS was noted at 24 hours compared to baseline, demonstrating a gradual return to normal thresholds in the immediate postoperative period.

Figure 1



*p < .01 compared to preceding value

References:
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3. Berliner D, et al: Transcutaneous temporary pacing in the operating room. JAMA 254:84-86, 1985
4. Falk RH, et al: Safety and efficacy of noninvasive cardiac pacing: a preliminary report. N Engl J Med 309:1166-1168, 1983