

## **CASE REPORTS**

# **Use of an Electronic Apex Locator on a Cardiac Pacemaker Patient**

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**Modern cardiac pacemakers are complex and heterogeneous devices. The potential effect of electrically powered instruments on a patient's pacemaker function must be carefully evaluated before treatment. Interference with the pacemaker's function by the instrument depends on the specific type of pacemaker placed and the patient's dependence on it. A case is presented in which an electronic apex locator was used on a patient with a pacemaker, despite the manufacturer's written warning to the contrary. The patient's cardiologist was consulted before treatment.**

Endodontists routinely rely on electrical devices to aid in the diagnosis and treatment of endodontically involved teeth. In the case of the patient with a cardiac pacemaker, electrical devices such as vitality testers and apex locators can create a treatment dilemma for the clinician because they may interfere with the function of the pacemaker and place the patient in a life-threatening situation. A case is presented in which an electronic apex locator was used on a patient with a pacemaker with a cardiologist's consent, despite the manufacturer's written warning to the contrary. Guidelines for use of electrical devices in endodontics are also given.

### **CASE REPORT**

A 54-yr-old male was examined on an emergency basis with a chief complaint of severe upper right quadrant pain. His blood pressure (BP) was taken and recorded at RASIT 150/110. He was referred to his cardiologist for evaluation of his elevated BP and significant contributing medical history. The patient had rheumatic heart disease in 1987, aortic valve replacement in 1989, and a history of hypertension. A pacemaker was also placed over 20 yr ago. His current medications were vasotec and coumadin. Evaluation by the cardiologist revealed a BP of RASIT 140/80 and a "clear chest with crisp AV closure sounds." The cardiologist's

written response recommended outpatient emergency treatment with the following precautions. The patient should be premedicated for SBE according to current AHA recommendations and his coumadin therapy discontinued to "let the patient drift to a prothrombin time of 12–14 prior to the procedure, if bleeding was expected to be a problem."

After returning to the dental clinic, the patient described his pain as spontaneous and at a level of 3 on a 1 to 10 scale. He stated, however, that he experienced severe pain to any pressure in the maxillary right premolar region. Upon clinical examination, teeth 28, 29, 30, 3, 4, and 6 responded normally to Endo Ice (Hygenic Co., Akron, OH). Tooth 5 did not respond to the cold test and was extremely sensitive to slight finger pressure. Each of the other teeth responded normal to percussion except tooth 4, which was slightly sensitive. Radiographically, tooth 5 showed a deep composite restoration close to the pulp chamber. No distinguishable periradicular pathosis could be seen on preoperative radiographs (Fig. 1). A diagnosis for tooth 5 of pulpal necrosis with acute periradicular periodontitis was made.

The patient was premedicated with 3 g amoxicillin 1 h before the start of treatment. Subsequent treatment was planned without altering the patient's coumadin schedule. Because he was symptomatic, bleeding was not expected to be a problem, and infiltration anesthesia was to be used.

After administration of local anesthesia (1.8 ml of 2% lidocaine with epinephrine, 1:100,000) and placement of a rubber dam, tooth 5 was accessed. Two canals containing necrotic tissue were located and debrided with files at estimated working lengths and 5.25% NaOCl irrigation. It was difficult to interpret radiographically the apices of the buccal and palatal roots and their relationship to the working length files. Estimated working lengths were recorded, Ca(OH)<sub>2</sub> paste (Calasept, Scania Dental, Scania, Sweden) inserted into the canals, a Cavit (Premier Dental Products Co., Norristown, PA) temporary filling material placed, the rubber dam removed, and patient reappointed. Contacted the next day, the patient stated that his symptoms had significantly decreased.

At his next appointment, the patient was again premedicated. He stated that he had been asymptomatic since the first appointment. Although it was still not possible to confirm radiographically a proper working length for either canal (Fig. 2), the use of a resistance-type electronic apex locator (Neosono-MC, Amadent,



FIG 1. Preoperative radiograph tooth 5.

Cherry Hill, NC) was considered to confirm the estimated working lengths. The instruction manual, however, clearly warned that **THIS DEVICE SHOULD NOT BE USED ON PATIENTS UTILIZING A PACEMAKER.** The patient's cardiologist was contacted by phone, given a brief description of the apex locator's function, and informed that it was powered by a 9-V battery. The cardiologist recommended using the apex locator, if necessary, because its voltage and current were not high enough to interfere with the patient's pacemaker (fixed rate), and the patient had an escape heart beat. The patient would still have an underlying functional heart beat if the pacemaker totally shut off.

Treatment on the patient was completed uneventfully. Working lengths for the buccal and palatal canals were established using the apex locator. The canals were shaped with a step-back, flaring technique and obturated with laterally condensed gutta-percha and Roth's 801E sealer. Final radiographs also did not show the exact apical extent of the gutta-percha fill (Fig. 3).

### DISCUSSION

Cardiac pacemakers were introduced over 30 yr ago primarily for the treatment of bradycardia. The early devices were relatively simple, electrical timers that provided the heart with a timed stimulus to maintain a minimum heart rate (1). Many pacemakers are now commercially available and are currently used to treat an array of arrhythmias, including bradycardia. Basically, a pacemaker consists of a pulse generator, lead wires and electrodes, and functions by firing its electrodes that are the uninsulated portions



FIG 2. Working length radiograph.

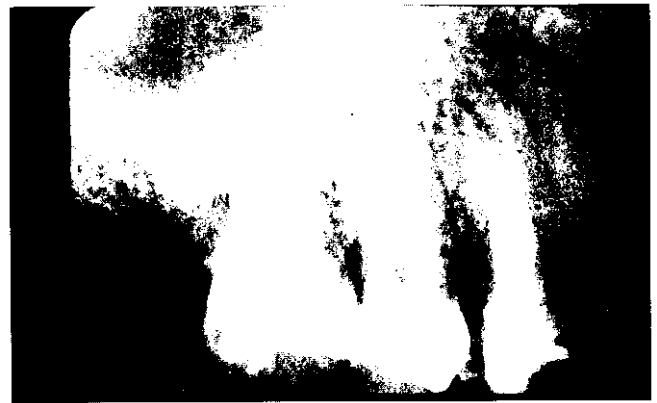


FIG 3. Postobturation radiograph.

of the lead wires that come in direct electrical contact with the tissue to be stimulated.

Pacemakers differ in several parameters, including the area of stimulation (atria, ventricle, etc.) and the mode of function (fixed rate vs. demand) (2). Fixed rate (asynchronous) pacemakers stimulate the heart regularly and continually irrespective of the heart's own rhythm. These devices are rarely used now, and interference with their action is unlikely with any apparatus used in dentistry today. Demand pacemakers stimulate the heart when needed. They do not interfere with or compete with the patient's inherent rhythm.

An artificial electrical stimulus, delivered during the vulnerable period following a heart beat, can induce ventricular arrhythmias and even lethal ventricular fibrillation. The patient's life can also be threatened if a demand pacemaker malfunctions and delivers a stimulus during the vulnerable period—the period following a heart beat during the repolarization phase (3). In addition to current leaks from electrical equipment, the application of electrical stimuli to pacemaker patients through the use of pulp testers, electro-surgical instruments, and desensitizing equipment can interfere with pacemaker function (4). Therefore, devices that generate an electrical current must be used with caution on patients with artificial pacemakers. Each cardiac pacemaker patient must be carefully evaluated before using an electrically powered device.

Woolley and coworkers (4) tested four electric pulp testers for their effect on a pacemaker implanted in a dog for 19 months. Results suggested that any dental device that applied an electric current directly to a patient could interfere with a pacemaker. Current leakage from electrical appliances and equipment can also interfere with pacemaker function (5). It is, therefore, important that all equipment in the dental operator be checked for electrical leakage and proper grounding, and only experienced electronic technicians make electrical repairs (6). Woolley and coworkers (4) also emphasized that electrical leakage can be a great hazard, because the leak may be entirely unsuspected by the dentist.

The patient in the case presented was at low risk for pacemaker interference in the dental operator, because he had a fixed-rate type pacemaker and an adequate escape heart beat. Fixed-rate pacemakers are less sensitive to disturbances than demand type and are influenced only by a very intense electromagnetic field (7). Pacemakers that have proper shielding reduce the possibility of interference. The exact type of pacemaker and quality of shielding, however, are generally not known to the dentist (8). Safety in treating a patient with a demand-type pacemaker may be increased by temporarily converting it to a fixed mode by applying a magnet over the pulse generator during treatment. This must be done with

extreme caution, because most pacemakers in use today are programmable. Cases have been reported in which use of a magnet to induce fixed-rate pacing during electrocautery surgery caused an erroneous reprogramming of the pacemaker. Only the magnet specified by the manufacturer for a specific pacemaker should be used (9). In those cases where the use of a magnet may be necessary, dental treatment should be provided in a hospital environment with resuscitative equipment available (7).

Adams and coworkers (3) found that some models of ultrasonic scalers can interfere with the function of more sensitive pacemakers. The effects were produced when the handle of the scaler came within 6 cm of the pacing lead. Keeping the scaler as far away as possible from the pacing leads decreased the risk of interference. Dentists and dental hygienists should use caution when using an ultrasonic scaler if they themselves wear a pacemaker (3).

Modern pacemakers represent a complex and heterogeneous group of devices. In the case presented herein, an electronic apex locator was used despite a manufacturer's warning to the contrary. There are no strict guidelines covering the use of electrical devices on pacemaker patients. Most electrical equipment can be used safely. At a minimum, a patient's cardiologist must be consulted before beginning any treatment that will involve the use of electrical equipment. This will help the dentist determine the patient's overall risk status and what treatment precautions need to be followed. These factors may depend on the specific pacemaker placed and if the patient is totally pacemaker dependent. The dentist should also make sure that all electronic equipment used during the procedure is properly grounded and not placed in close proximity to the pacemaker leads.

The assertions contained herein are those of the authors and are not to be construed as official or as reflecting the views of the Department of the Navy, Department of Defense, or the United States Government.

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#### References

1. Miura DS. A new concept in pacemaker therapy: rate-responsive pacing. *Cardiovasc Rev Rep* 1987;8:40-4.
2. Morse DP. How a pacemaker functions. In: Morse D, Steiner RM, eds. *The pacemaker and valve identification guide*. Medical Examiners Publishing Company, Inc., 1978:1-15.
3. Adams D, Fulford N, Beedhy J, MacCarthy J, Stephens M. The cardiac pacemaker and ultrasonic scalers. *Br Dent J* 1982;152:171-3.
4. Woolley LH, Woodworth J, Dobbs JL. A preliminary evaluation of the effects of electrical pulp testers on dogs with artificial pacemakers. *J Am Dent Assoc* 1974;89:1099-1101.
5. Starmer CR, McIntosh HD, Whalin RE. Electrical hazards and cardiovascular function. *N Engl J Med* 1971;284:181-6.
6. Schram PJ. Guidelines for electrical safety in the dental office. *J Am Dent Assoc* 1972;85:365-71.
7. Rezai FR. Dental treatment of patient with a cardiac pacemaker. *Oral Surg* 1977;44:662-5.
8. Council on Dental Materials and Devices. Possible electromagnetic interference with cardiac pacemakers from dental induction casting machines and electrosurgical devices [Abstract]. *J Am Dent Assoc* 1973;86:426.
9. Sager DP. Current facts on pacemaker electromagnetic interference and their application to clinical care. *Heart and Lung* 1987;16:211-21.

#### A Word for the Wise

The classic observation on the limits of bravado and self-illusion may well have been made by Francis Iles. "However superior to any number of cats a mouse may feel in its own hole, it requires a good deal of self-suggestion to maintain this opinion in the presence of the cat."

*Ann Wiley*