

## CASE REPORT

# Triboelectric simulation of pacemaker malfunction

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We report the occurrence of a triboelectric phenomenon (static electricity) that mimicked malfunction of a contemporary pacemaker by creating an electrocardiographic artifact virtually identical to the pacemaker stimuli. The diagnosis was established by observing a subtle overshoot of the questionable deflection that was absent from pacemaker stimuli.

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**Key Words:** Pacemaker, triboelectric interference, pacemaker failure.

Significant confusion can occur when unusual artifacts are seen in the electrocardiogram of a paced patient. There are many potential sources including static electricity. The term ‘triboelectric phenomena’ is often used to describe high-voltage deflections generated by static electricity. This type of interference may create artifacts that resemble pacing stimuli and may potentially cause pacemaker inhibition<sup>[2–5]</sup>.

We report a case with a triboelectric phenomenon that caused difficulty in electrocardiographic interpretation.

## Case

A 74-year-old female with a VVI pacemaker implanted 4 years earlier presented March 2001 for routine pacemaker evaluation. The pacemaker was programmed to a bipolar pacing and sensing configuration. An electrocardiographic rhythm strip was obtained during magnet application (Fig. 1). The tracing reveals an initial artifact that appears to be a pacemaker stimulus with failure to capture. Subsequently, appropriate ventricular capture occurs with each stimulus delivered whenever the ventricle is not refractory from intrinsic depolarization. The initial artifact clearly occurs at a time when the ventricle is not refractory and raised the question of possible intermittent failure to capture. However, the interval from the initial artifact to the subsequent stimulus measures approximately 1120 ms. At the time, the paced

cycle length with magnet application was 1000 ms (60 ppm). When the baseline of the electrocardiogram is inspected closely there is a definite difference between the ‘overshoot’ after the initial artifact (Fig. 2A) and the subsequent pacing stimuli (Fig. 2B).

Subsequent evaluation demonstrated completely normal pacemaker function and excellent chronic thresholds of 1.0 V at 0.2 ms pulse duration and a lead impedance of 600 ohms. At the programmed settings of 2.5 V and 0.2 ms pulse duration, the patient had a 2.5:1 margin of safety. Subsequent follow-up has revealed completely normal pacemaker function.

## Discussion

Triboelectric phenomena are rarely considered in the differential diagnosis of pacemaker interference or artifacts in the standard electrocardiogram<sup>[1]</sup>. Static electricity or triboelectric phenomena occur more commonly during very cold weather and very low relative humidity. In the case presented the month was March and the weather unseasonably cold and dry even for the northeastern United States. The occurrence of the disturbance as the magnet was being applied favours an electrostatic discharge from the operator’s hand.

Previous work involving<sup>[2–5]</sup> triboelectric phenomena was conducted with implanted unipolar pacemakers which demonstrated occasional sensing of the generated voltage by either the atrial or ventricular channels of single or dual chamber pacemakers. Old external

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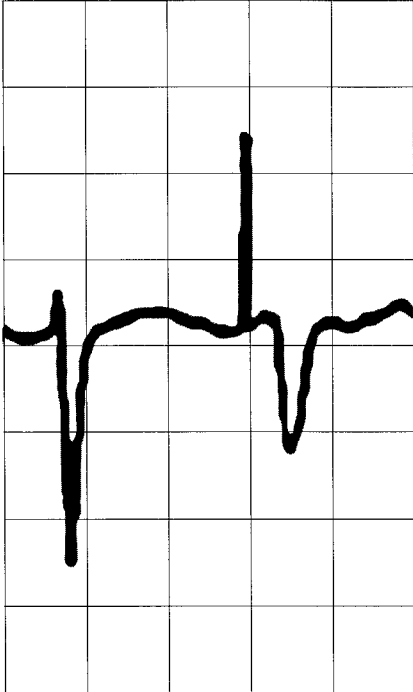


*Figure 1* Electrocardiographic rhythm strip obtained during magnet application. The magnet was applied when the artifact in question was produced (arrow).

2a



2b



*Figure 2* A: Left: Close-up of the initial artifact showing the characteristic overshoot of the triboelectric deflection. Right: The pacemaker stimulus does not produce a discernible overshoot.

temporary bipolar pacemakers were sensitive to static electricity. One publication recorded a pause of 4 s in a hospitalized pacemaker dependent patient which occurred when the patient was asked to rub his heels against the bed sheets. Improved shielding of external devices has eliminated this problem.

Triboelectric signals are usually wider and more irregular than pacemaker stimuli and often recognizable as artifacts. Occasionally as in our case, the diagnosis depends on finding subtle differences from the pacing stimulus. Magnification of the questionable artifact clearly revealed a relatively prolonged overshoot not present with pacemaker stimuli. Such an overshoot is typical of electrostatic discharge (triboelectric signals) and should be sought in the evaluation of artifacts mimicking pacemaker stimuli to avoid the diagnosis of pacemaker malfunction. Electrocardiographically a rhythmic pattern to this phenomenon is not usually seen. The diagnosis may be more difficult when the isolated artifact is insulated.

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