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Improvement of atrial pacing spikes visualization on ambulatory ECG monitoring by filter and smoothing disabling

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Βελτίωση της απεικόνισης των αιχμών κολπικής βηματοδότησης στην περιπατητική παρακολούθηση ΗΚΓ με απενεργοποίηση φίλτρου και εξομάλυνση

Περίληψη στο τέλος του άρθρου

Key words: ECG monitoring, Filter, Pacing, Spikes, Vizualization

Identification of pacing spikes on either standard electrocardiography (ECG) or ambulatory ECG monitoring may be challenging.[1] Pacing spike detection is significantly complicated if bipolar pacing is used. In addition, atrial pacing spikes are less obvious than ventricular ones. Pacing spikes are often undetectable on the ECG, and the absence of visible pacing on the ECG does not rule out a paced rhythm.[1] Detection of pacing spikes may provide valuable information and may be essential for correct diagnosis.

Filter correction seems to be a potential feature for better visualization of the atrial pacing spikes. We hypothesized that a low-pass filter and smoothing might make the pacing spikes less obvious. To test this, we analyzed three recordings of 12-lead ambulatory ECG monitoring and one recording of 3-channel ambulatory ECG monitoring in patients with atrial pacing. Atrial pacing was provided by either a single-chamber pacemaker or a dual-chamber pacemaker. Fragments of ambulatory ECG monitoring with atrial pacing were compared with and without applying a low-pass filter of 50 Hz and smoothing.

Figures 1–3 show better visualization of atrial pacing spikes on ambulatory ECG monitoring fragments with a disabled low-pass filter of 50 Hz and smoothing. Figure 4 shows atrial undersensing, which is better seen when the low-pass filter of 50 Hz and smoothing is disabled.

So, the ECG filter and smoothing may affect the detection of atrial pacing spikes. These findings correspond to the data obtained by García-Niebla and Serra-Autonell, who demonstrated that the low-pass filter attenuates ventricular pacing spikes, which are important from a clinical point of view; they showed that a 150-Hz filter is better for the detection of the pacing spike than a 40-Hz filter.[2] Also, Sun et al concluded that a low-pass filter of 300 Hz cut-off improved the detection of pacemaker spikes compared to 40 Hz, 100 Hz, 150 Hz, and 200 Hz.[3] Thus, an increase in filter frequency leads to a better visualization of the pacing spikes. In contrast to these studies, we completely disabled the low-pass filter and smoothing which resulted in significantly better visualization of the atrial pacing spikes.

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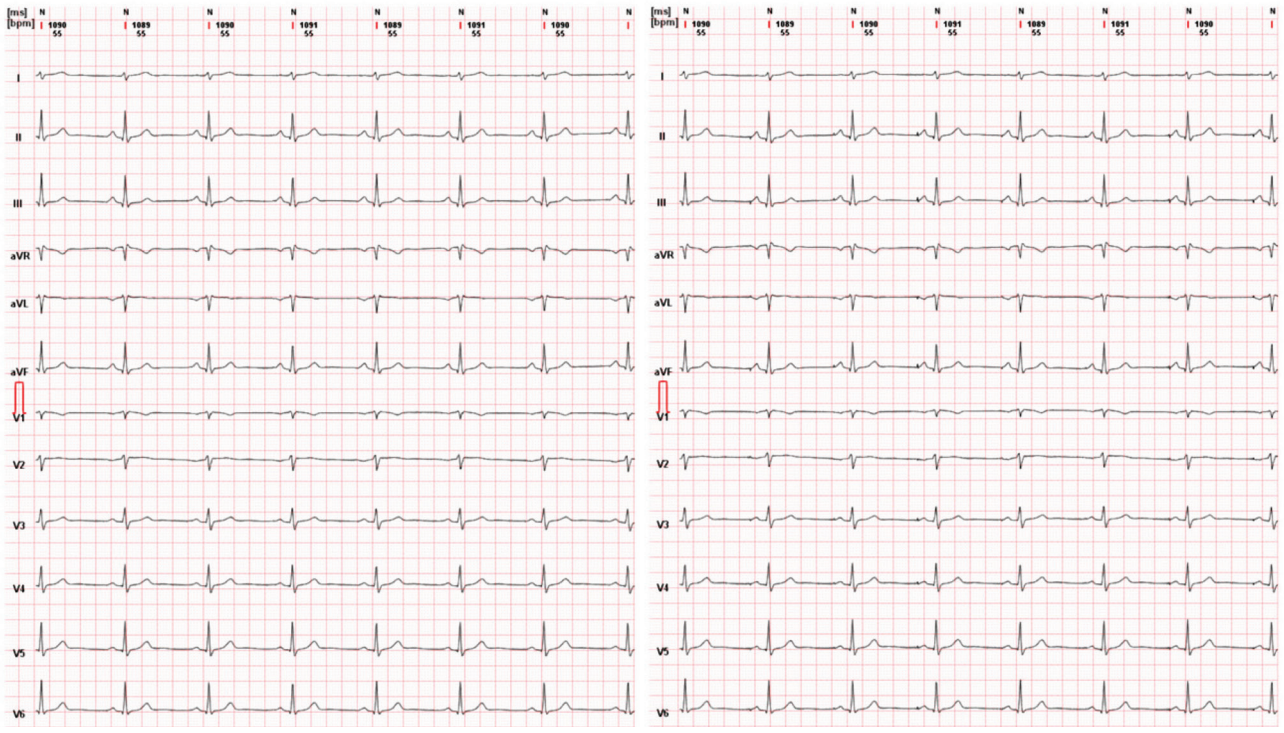

Figure 1. Comparison between enabled (left) and disabled (right) filter of 50 Hz and smoothing in a patient with an implanted single-lead atrial (AAI) pacemaker. *Note*: Atrial pacing spikes are more obvious (especially in leads II, III, and aVF) when the filter of 50 Hz and smoothing are disabled.

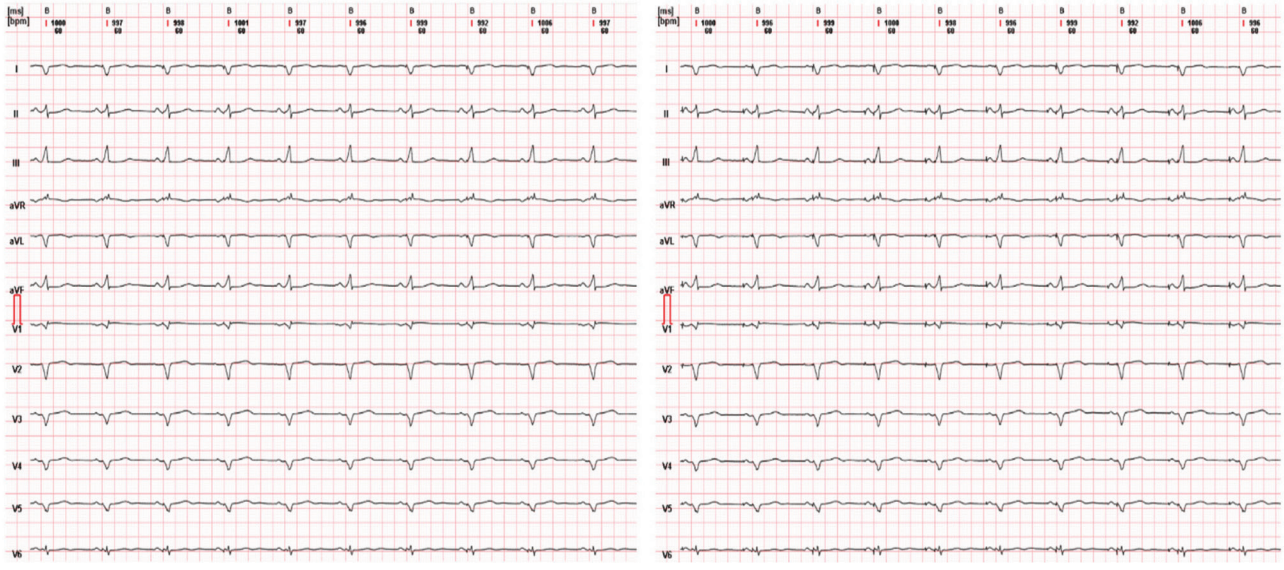

Figure 2. Comparison between enabled (left) and disabled (right) filter of 50 Hz and smoothing in a patient with an implanted dual-chamber (DDD) pacemaker. *Note*: Atrial and ventricular pacing spikes precede each P wave and QRS complex, respectively. Atrial pacing spikes are more prominent (especially in leads II, III, aVR, aVF, V1, and V2) when the filter of 50 Hz and smoothing are disabled.

Thus, disabling low-pass filter and smoothing on ambulatory ECG monitoring software may be considered in patients with implanted pacemakers with presumed atrial pacing to improve visualization of atrial pacing spikes. This may be particularly important when pacemaker troubleshooting is suspected.

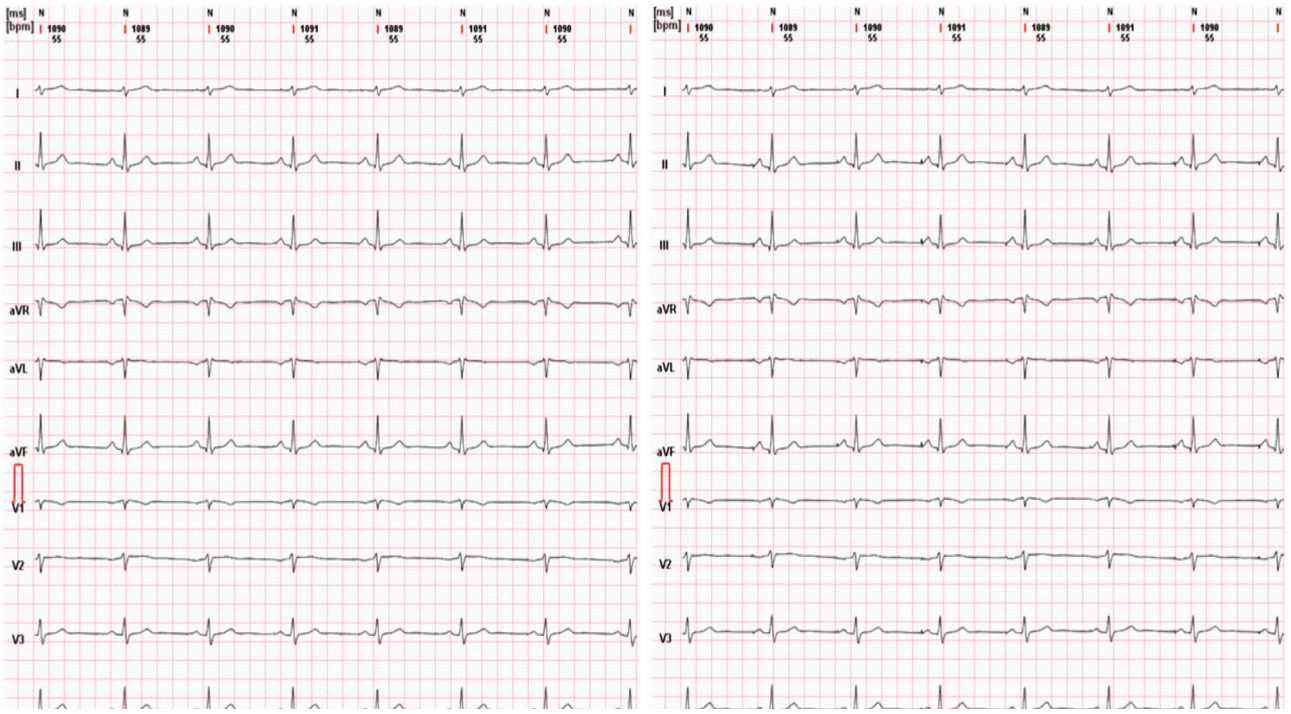

Figure 3. Comparison between enabled (left) and disabled (right) filter of 50 Hz and smoothing in a patient with an implanted dual-chamber (DDD) pacemaker. *Note*: Atrial pacing occurs only after blocked premature atrial contractions. Each QRS complex is paced. Atrial pacing spikes are more obvious (especially in leads III, aVL, aVF, V1, and V2) when a filter of 50 Hz and smoothing are disabled.

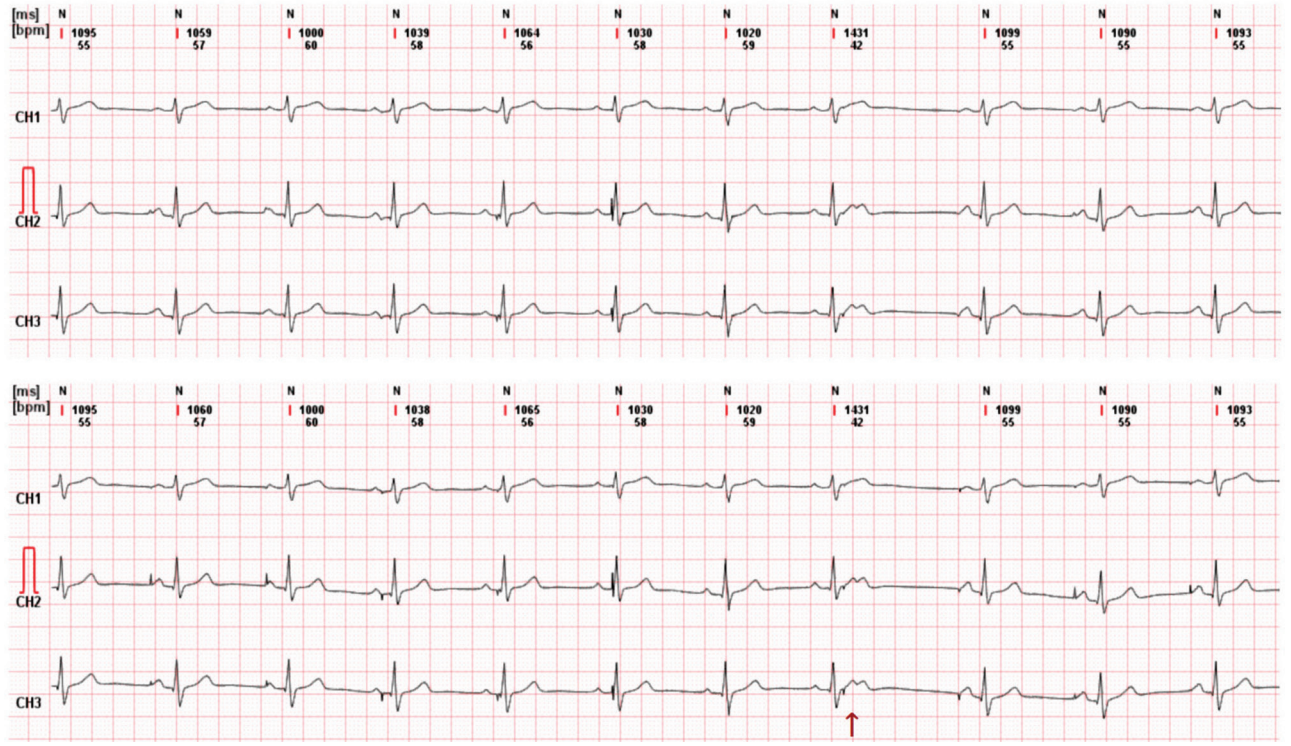

Figure 4. Comparison between enabled (top) and disabled (bottom) filter of 50 Hz and smoothing in a patient with an implanted single-lead atrial (AAI) pacemaker. *Note*: Atrial pacing spikes are better apparent in channels 2 and 3. The bottom strip facilitates the identification of atrial undersensing (some atrial pacing spikes are registered after P waves and even QRS complex). Atrial undersensing causes blocked premature atrial contraction (arrowed).

ΠΕΡΙΛΗΨΗ

Βελτίωση της απεικόνισης των αιχμών κολπικής βηματοδότησης στην περιπατητική παρακολούθηση ΗΚΓ με απενεργοποίηση φίλτρου και εξομάλυνση

Η αναγνώριση των αιχμών βηματοδότησης στην περιπατητική παρακολούθηση του ηλεκτροκαρδιογραφήματος (ΗΚΓ) ενδέχεται να είναι μερικές φορές δύσκολη, αλλά μπορεί να είναι απαραίτητη για τη σωστή διάγνωση. Παρουσιάζονται τμήματα περιπατητικού ΗΚΓ παρακολούθησης που καταγράφηκαν σε 4 διαφορετικούς ασθενείς, με και χωρίς φίλτρο χαμηλής διέλευσης 50 Hz και εξομάλυνση. Οι αιχμές της κολπικής βηματοδότησης είναι πλέον εμφανείς σε τμήματα περιπατητικής παρακολούθησης ΗΚΓ με απενεργοποιημένο φίλτρο χαμηλής διέλευσης και εξομάλυνση σε σύγκριση με ενεργοποιημένο χαμηλότερο φίλτρο και εξομάλυνση. Έτσι, η απενεργοποίηση του φίλτρου και η εξομάλυνση στο λογισμικό παρακολούθησης περιπατητικού ΗΚΓ μπορεί να ληφθούν υπ' όψιν σε ασθενείς με εμφυτευμένους βηματοδότες με κολπική βηματοδότηση για τη βελτίωση της απεικόνισης των αιχμών της κολπικής βηματοδότησης. Αυτό φαίνεται να είναι ιδιαίτερα σημαντικό όταν υπάρχει υποψία αντιμετώπισης προβλημάτων βηματοδότη.

Λέξεις ευρετηρίου: Αιχμές, Απεικόνιση, Βηματοδότης, ΗΚΓ, Παρακολούθηση

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