

Recognition of ventricular fibrillation concomitant with pacing artifacts

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ABSTRACT

Introduction. In pre-hospital settings recognition of underlying rhythm in patients with ventricular stimulation can be difficult especially when a 3-lead electrocardiogram (ECG) is analyzed. This fact is particularly important in patients with life-threatening cardiac dysrhythmias. The pacing spikes in the ECG of a patient with cardiac arrest due to ventricular fibrillation may be misdiagnosed as QRS complexes.

Aim of the study. The aim of this study was to assess emergency medical care students' accuracy in recognizing ventricular fibrillation when pacing spikes are present.

Material and methods. The study group consisted of 39 emergency medical care students, 16 males and 23 females, aged 21 - 23. Subjects were at the midpoint of their 3-year university healthcare professional education. Subjects were asked to interpret electrocardiograms presenting ventricular fibrillation with concomitant pacing artifacts, ventricular fibrillation and atrial fibrillation with ventricular pacing, respectively. Students were trained in recognition of ECG tracings presenting ventricular stimulation, atrial fibrillation and ventricular fibrillation. They were instructed that the duration of the QRS complex in adults is at least 0.06s and that pacemaker stimuli are shorter. Prior to the examination, an electrocardiogram similar to the abovementioned, with ventricular fibrillation and pacemaker stimuli, was not presented.

Results. Only one student (out of 39) recognized ventricular fibrillation with pacemaker stimuli present; the majority of students (92%) incorrectly interpreted the rhythm as atrial fibrillation or atrial flutter. The ECG with isolated ventricular fibrillation was correctly interpreted by all but two students who recognized polymorphic ventricular tachycardia and 62% of students correctly recognized ventricular pacing whereas none of them recognized atrial fibrillation.

Conclusions. 1. The skills of recognizing ventricular fibrillation in patients with concomitant ventricular pacing are poor among emergency medical care students.

2. The ECG tracing showing concomitant ventricular fibrillation and pacing stimuli should be included in teaching programs for emergency medical care students. An ongoing quality improvement program may reduce the rate of mistakes in ECG analysis in rare cases with life-threatening emergencies.

Key words: ventricular fibrillation, cardiopulmonary resuscitation, training, cardiac pacing

Introduction

The total number of patients who wear an implanted pacemaker is growing. (1) In pre-hospital settings recognition of underlying rhythm in patients with ventricular stimulation can be difficult especially when a 3-lead electrocardiogram (ECG) is analyzed. This fact is particularly important in patients with life-threatening cardiac dysrhythmias. (2) The pacing spikes in the ECG of a patient with cardiac arrest due to ventricular fibrillation may be misdiagnosed as QRS complexes. The consequence of an erroneous diagnosis would be incorrect treatment and delay or even omission of defibrillation which in these circumstances might mean a dramatic decrease in patients' chances of survival. (3) Little is known about the misinterpretation of ECGs presenting with ventricular fibrillation and concomitant pacing spikes.

Aim of the study

The aim of the study was to assess emergency medical care students' accuracy in recognizing ventricular fibrillation when pacing spikes are present.

Material and methods

This study presents the results of an examination conducted in 2008.

The study group consisted of 39 emergency medical care students, 16 males and 23 females, aged 21 - 23. Subjects were at the midpoint of their 3-year university healthcare professional education. The total duration of emergency medical care students' practical and theoretical training is 3800 hours. ECG interpretation is included in emergency medicine training. Before the study, subjects had already been trained in ECG interpretation by university teachers –cardiologists and emergency physicians. Subjects were asked to interpret electrocardiograms presenting ventricular fibrillation with concomitant pacing artifacts, ventricular fibrillation and atrial fibrillation with ventricular pacing, respectively (figures 1,2,3). Students were trained in recognition of ECG tracings present-

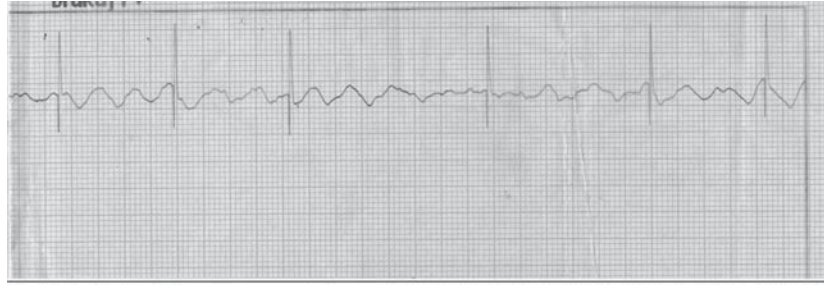


Figure 1. Ventricular fibrillation and pacemaker spikes.

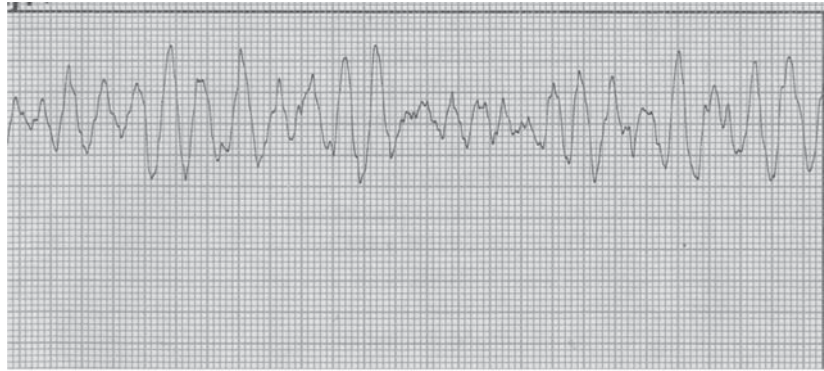


Figure 2. Ventricular fibrillation.



Figure 3. Atrial fibrillation and ventricular pacing.

ing ventricular stimulation, atrial fibrillation and ventricular fibrillation. They were instructed that the duration of the QRS complex in adults is at least 0.06s and that pacemaker stimuli are shorter. Prior to the examination, an electrocardiogram

similar to the abovementioned, with ventricular fibrillation and pacemaker stimuli, was not presented.

Results

Only one student (out of 39) recognized

ventricular fibrillation with pacemaker stimuli presented in figure 1. (table1); the majority of students (92%) incorrectly interpreted the rhythm as atrial fibrillation or atrial flutter (table 2). The ECG with isolated ventricular fibrillation, presented in figure 2, was correctly interpreted by all but two students who recognized polymorphic ventricular tachycardia, and 62% of students correctly recognized ventricular pacing in figure 3 whereas none of them recognized atrial fibrillation (table1).

Discussion

The ECG tracings showing ventricular fibrillation with concomitant spikes due to stimulation, presented in figure 1, appeared to be difficult to interpret for emergency medical care students. Ventricular fibrillation waves were considered to be atrial fibrillation waves whereas the pacing spikes were assumed to be QRS complexes. The most common misdiagnosis was atrial fibrillation probably due to irregular spike occurrence. The pacing spikes are irregular because of the occasional sensing of ventricular fibrillation waves by the stimulator and pacing inhibition. The apparent "QRS" complexes are very narrow (they last less

than 40ms) which indicates that they are pacing artifacts. The recognition of polymorphic ventricular tachycardia in figure 2 might have no impact on the treatment in a patient with cardiac arrest because it is also an indication for defibrillation but concerns regarding amiodarone use might have ensued. The result of our study stresses the necessity to include analysis of electrocardiogram with ventricular fibrillation and pacing artifacts into emergency medical care students' curricula. It was also reported that automated external defibrillators (AED) in the presence of pacemaker spikes could fail to recognize ventricular fibrillation. (4,5) It should also be stated that modern ECG monitors and defibrillators can filter out spikes and they are not shown on a display, but can be printed out. The above presented underdiagnosis of ventricular fibrillation and pacing artifacts may be related to poor availability of similar images in the training materials. The image presented in figure 1 is not available in the majority of textbooks on electrocardiography and emergency medicine known to us. The incidence of the events of ventricular fibrillation and pacing spikes is difficult to be assessed but probably is rare. Only one fifth of all

deaths occurring suddenly and unexpectedly are treated by providers of emergency medical services. Taking into account that the prevalence of cardiac pacing in Poland is about 100 000 in the whole population of near 40mln inhabitants (2.5 patients per 1000) and cardiac arrest occurs in 1-2 per 1000 people per year, even if the risk of the pacemaker recipient is 5%, the estimated number of cardiac arrests is 13 per year in the pacemaker recipients of the population of 100 000. However, devices are more and more frequently implanted in patients with heart failure in whom cardiac arrests are more common. On the other hand, the number of ventricular fibrillations in cardiac pacemaker recipients may be lower than expected because of higher co-morbidity which favors pulseless electrical activity as the mechanism of cardiac arrest. The underdiagnosing of ventricular fibrillation and concomitant pacing spikes may be related to the low incidence of such an event and the shortage of relevant information in the available sources. (4,6-8)

Limitations

Lack of provided clinical scenarios might have contributed to the decrease in the accuracy of ECG interpretation but it could be assumed that during cardiac arrest, pulseless electrical activity would be recognized and defibrillation which is crucial in the treatment of patients with ventricular fibrillation might have been abandoned or delayed.

Conclusions

1. The skills of recognizing ventricular fibrillation in patients with concomitant ventricular pacing are poor among emergency medical care students.

Table 1. Percentage of correct electrocardiogram (ECG) diagnosis.

	Correct ECG diagnosis N (%)
Ventricular fibrillation and pacing artifacts (figure 1)	1 (3%)
Ventricular fibrillation (figure 2)	37 (95%)
Atrial fibrillation (figure 3)	0 (0%)
Ventricular pacing (figure 3)	24 (62%)

Table 2. Students' interpretations of electrocardiogram (ECG) which presented ventricular fibrillation and pacing artefacts (figure 1). Each student could give more than one ECG diagnosis.

	Atrial fibrillation	Atrial flutter	AV block	Pacing artifacts	VF and pacing artifacts	VF without pacing spikes	Sinus rhythm
Number and percentage of students N (%)	29 (74%)	7 (18%)	3 (8%)	3 (8%)	1 (3%)	1 (3%)	1 (3%)

2. An ECG tracing showing concomitant ventricular fibrillation and pacing stimuli should be included in teaching programs for emergency medical care students. An ongoing quality improvement program may reduce the rate of mistakes in ECG analysis in rare cases with life-threatening emergencies.

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