Emergence and resolution of the electrocardiographic spiked helmet sign in acute noncardiac conditions

Abstract

Patients with acute abdominal or acute thoracic events occasionally develop a curious electrocardiographic ST-segment elevation, where the upward shift of the baseline starts before the onset of the QRS complex. The shape of the complexes resembles a German military spiked helmet. It has been previously postulated that the “spiked helmet” sign is the result of an acute rise in intraabdominal or intrathoracic pressure causing pulsatile epidermal stretch that is in concert with the cardiac cycle. Here, we present 2 cases, where recognition of the spiked helmet sign led to immediate discovery of the underlying pathology. Removal of a large epigastric content resulted in the prompt resolution of the spiked helmet sign in the inferior leads, whereas suctioning of a large pneumothorax lead to the gradual disappearance of the spiked helmet sign in the chest leads. These cases provide the first definitive proof of a mechanical, noncardiac etiology of the spiked helmet sign.

A few years ago, a new electrocardiographic (ECG) finding has been described, which was characterized by a dome and spike-patterned apparent ST-segment elevation, where the upward shift of the baseline started before the onset of the QRS complex [1]. The morphology of the complexes resembled the shape of a German military spiked helmet. The presence of this “spiked helmet” sign was found to be associated with critical noncardiac illness and high risk of in-hospital death [1]. In the original report as well as in subsequent publications, acute abdominal events were usually associated with the spiked helmet sign in the inferior leads, whereas acute intrathoracic events caused the spiked helmet sign in the chest leads [1-6]. The purpose of this communication is to present the first documented cases, where prompt recognition and management of underlying acute noncardiac conditions resulted in resolution of the spiked helmet sign.

An 83-year-old woman with recent abdominal surgery and ongoing sepsis was noted to have ST-segment elevation in telemetry. In the 12-lead ECG, the interpretation software indicated acute inferior infarct (Fig. 1A). The morphology was consistent with the spiked helmet sign (Fig. 1, insert). The patient denied any chest pain but complained of severe epigastric distension. A nasogastric tube was placed, and 850 mL of bilious gastric fluid was suctioned. The ECG just 40 minutes later demonstrated complete resolution of the spiked helmet sign (Fig. 1B). Cardiac serum markers were negative; the patient ruled out for myocardial infarction.

A 56-year-old woman with acquired long QT syndrome and episodes of torsade de pointes ventricular tachycardia underwent an unsuccessful attempt at temporary pacemaker insertion via the right subclavian vein. A few hours later, she developed respiratory distress. A 12-lead ECG showed apparent ST-segment elevation in 5 of 6 chest leads (Fig. 2A). Here too, the morphology was consistent with the spiked helmet sign (Fig. 2, insert). Chest x-ray demonstrated a large right-sided pneumothorax with complete collapse of the right lung. With low pressure suctioning, the right lung gradually expanded. Simultaneously, the extent of the spiked helmet sign decreased (Fig. 2B). Three days later, the lung expanded completely, and the apparent ST elevation disappeared (Fig. 2C). Cardiac serum markers were negative; the patient ruled out for myocardial infarction.

ST-segment elevation can occur in many conditions other than acute myocardial infarction including left bundle branch block, left ventricular hypertrophy, acute myocarditis and pericarditis, severe hyperkalemia, Prinzmetal angina, pulmonary embolism, and the Brugada syndrome [7]. Less commonly, ST-segment elevation has been shown to accompany acute abdominal and thoracic events such as pancreatitis, pancreatic cancer, pneumomediastinum, and pneumothorax [8-13]. In most reported cases, the ST-segment elevation appeared to be real and may have reflected acute cardiac injury. The “spiked helmet” sign, however, is unique in that the upward shift of the ECG baseline starts before the onset of the QRS complex, and therefore, it cannot signify a true repolarization abnormality.

The exact cause of the spiked helmet ECG pattern is uncertain. The most likely mechanism is pulsatile epidermal stretch resulting from an acute rise in intracavitary pressure [1,11,14]. When seen in the inferior leads, this curious ECG pattern should raise the possibility of an acute abdominal event, and one should suspect an intrathoracic pathology if it shows up in the precordial leads [1-6]. In human cardiac tissue, there are stretch-activated ion channels, which change conductivity under different stretch conditions [15]. In addition, human fibroblasts in general have stretch-activated cation channels [16]. These channels show significant adaptation of activity, when stretch is maintained over a period of several seconds, with a static component persisting for much longer periods [16]. In the 2 presented cases, the prompt resolution of the spiked helmet sign in the inferior leads after removal of a huge gastric content in the first case and the gradual resolution of an anterior spiked helmet sign with resolution of the pneumothorax in the second case further support a mechanical, noncardiac etiology of this type of apparent ST-segment elevation.

ST-segment elevation in the intensive care unit setting is a relatively common but nonspecific condition; most such patients are found not to have acute ST-elevation infarct [17,18]. When the apparent ST elevation takes the form of the spiked helmet sign, it should prompt providers to actively search for a possible acute intrathoracic or intraabdominal pathology. Although the spiked helmet morphology of ST-segment elevation can suggest a non-ST-segment elevation (non-STEMI) event, the clinician should strongly...
consider the presence of STEMI if other clinical variables suggest the possibility. The presence of the spiked helmet sign has not been proven to be either sensitive or specific for STEMI and non-STEMI diagnoses.

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http://dx.doi.org/10.1016/j.ajem.2014.06.023

References
Fig. 2. Spiked helmet sign in the chest leads in a patient with pneumothorax. A, The chest x-ray shows complete collapse of the right lung (arrows). In the ECG, a spiked helmet pattern is present in leads V2 to V6. B, Improvement of pneumothorax is associated with a decrease in the extent of the spiked helmet sign, which is now only evident in lead V2. C, Three days later, the pneumothorax has resolved and the ECG normalized.