The “Spiked Helmet” Sign A New Electrocardiographic Marker of Critical Illness and High Risk of Death

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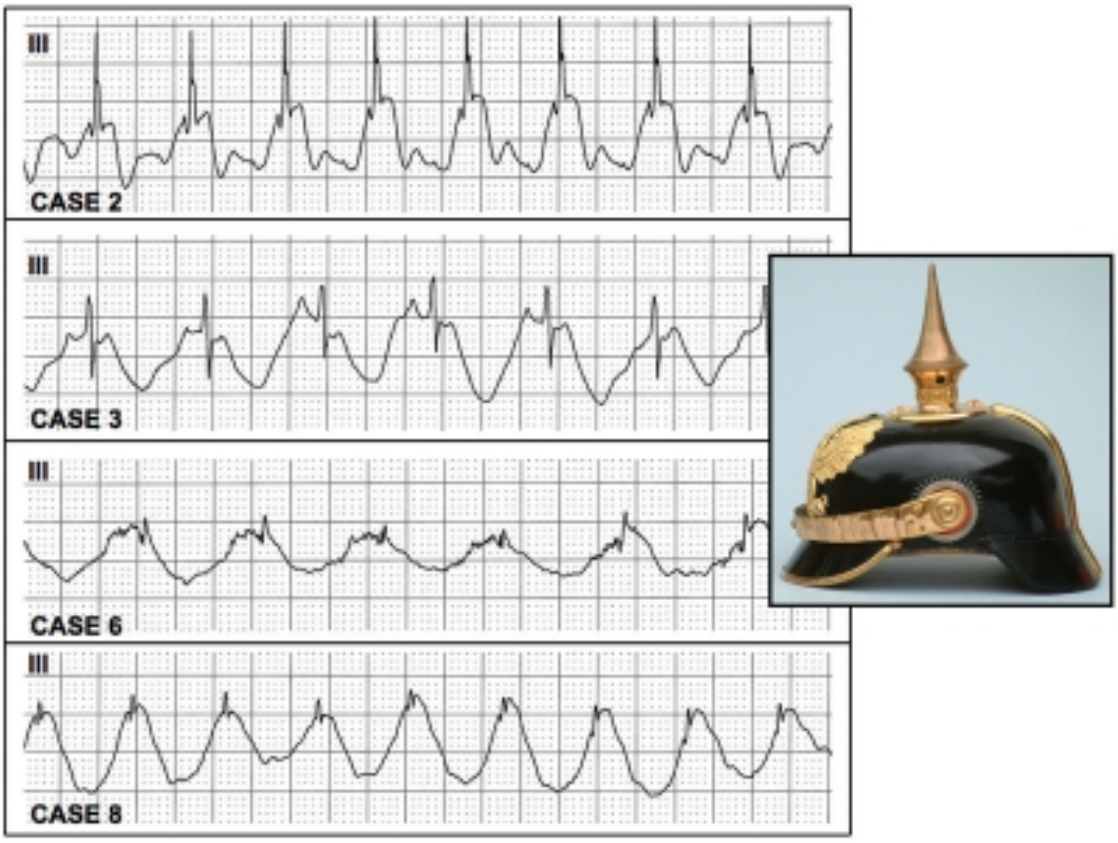
To the Editor: In critically ill patients, ST-segment elevation myocardial infarction (STEMI) is a relatively common finding on the electrocardiogram (ECG). However, many such patients do not have STEMI.[1] One of the rare causes of ST-segment elevation is artifact. The purpose of this case series is to present a new, unique pattern of apparent STEMI whose presence was found to be associated with critical illness and very high risk of in-hospital death.

During the routine interpretation of ECGs of hospitalized patients, we collected 8 cases in which the ECG showed apparent ST-segment elevation but with the upward shift starting before the onset of the QRS complex (Figure). In each case, the ECG showed a dome-and-spike pattern, giving the appearance of Pickelhaube, the German military spiked helmet introduced in 1842 by Friedrich Wilhelm IV, King of Prussia (Figure).



Figure

Left, representative electrocardiograms of 4 patients showing the “spiked helmet” sign. Right, Pickelhaube, the German military spiked helmet. Note the similarity of the electrocardiogram waveforms in lead III to the shape of the spiked helmet.

We were actively involved in the care of the most recent case, case No. 8 (Table). A 58-year-old woman was hospitalized for diarrhea, nausea, vomiting, and dehydration. On hospital day 2, she experienced severe abdominal pain but no chest pain. She had tachycardia, tachypnea, and diffuse abdominal tenderness. Telemetry suggested ST-segment elevation, and a subsequent 12-

lead ECG with computer interpretation indicated inferior STEMI. Careful analysis of the ECG revealed that the upward baseline shift started before the onset of the QRS complex (Figure, last strip), which would be inconsistent with STEMI. Furthermore, an emergent echocardiogram demonstrated no wall motion abnormality, and cardiac serum markers were negative. A repeat ECG 2 hours later showed no ST-segment elevation. Within 12 hours, the patient had evidence of acute abdomen. Emergent laparotomy revealed perforated bowel with extensive bowel necrosis. Despite aggressive surgical and medical management, the patient died 24 hours after the ECG was obtained that exhibited the “spiked helmet” sign.

TABLE.

Clinical and Electrocardiographic Characteristics of Patients with the “Spiked Helmet” Sign[a]

Case No./ age(y)/sex	Clinical diagnose	Interventions	ECG leads with thew “spiked helmet” sign
1/46/M	Pneumonia, sepsis, hypothermia, DKA, ARF, respiratory failure	I/MV, RHC, pressors, CPR	II,III
2/54/F	ESRD, PAD, cellulitis, sepsis	I/MV, RHC, hemodialysis, Pressors, CPR	II, III, aVF
3/71/F	ALS, respiratory failure, altered mental status, fever, diarrhea, VAP, empyema	MV, chest tube	II, III, aVF
4/22/M	Trauma, sepsis, cardiac tamponade, anoxic brain damage, seizure	I/MV, pericardiocentesis, chest tube, pressors, CPR	II, III, aVF
5/44/M	MIDCM, cardiac arrest, anoxic brain injury, sepsis, DVT, ARF seizures	4/22/M, pressors, CPR	II
6/66/M	SDH, SAH, anoxic brain damage	I/MV, craniotomy	II, III, aVF
7/55/F	AIDS PCP, respiratory failure, pneumothorax	I/MV, chest tube	III, aVF
8/55/F	Bowel perforartion, Bowel ischemia, sepsis, shock	I/MV, pressors, abdominal surgery, drain	I/MV,

Width of pseudo-ST elevation (mm/ms)	Height of pseudo-ST elevation (mm/mV)	Admission to ECG(d)	ECG to death (d)
8.5/3.40	5.0/0.5	0	4.5
6.5/260	58/0./0.5	15	2
8.5/3.40	4.0/0.4	7	NA
8.0/320	3.0/0.3	4	NA
14.0/560	7.0/0.7	0	8.5

AKS= Amyotrophic lateral sclerosis; ARF= acute renal failure; CPR= cardiopulmonary resuscitation; DVT= deep venous thrombosis; ECG= Electrocardiogram; ESRE= end stage renal disease I/ intubation and mechanical ventilation; MV= mechanical ventilation; NA= not applicable (patient was alive when discharged from the hospital); NIDCM = no ischemic dilated cardiomyopathy; PAD= peripheral arterial disease; PCP; Pneumocystis carini pneumonia; RHC: right heart catheterization; SAH: subarachnoid hemorrhage; SDH : subdural hematoma; VAP: ventilator associated pneumonia * Measured in the lead exhibiting the tallest pseudo ST elevation: averaged for 5 consecutive cycles.

We think that the pseudo-ST segment elevation possibly occurred at the time and may have been a reflection of the bowel perforation. On the basis of this experience, we decided to review all other cases in our collection in which the ECG showed a similar spiked helmet pattern and found the following similarities (Table). First, each patient had critical noncardiac illness. Second, despite the ECG interpretation software indicating STEMI, acute MI was uniformly ruled out by cardiac serum markers. Third, the spiked helmet sign was present exclusively in the inferior leads (II, III, aVF). Fourth, 7 of the 8 patients had ECGs recorded before and/or after the index ECG, but none

showed ST elevation. Finally, 6 of the 8 patients died 1 to 10 days after the index ECG (mean, 5.5 days), corresponding to a mortality of 75% (95% confidence interval, 34.9%-96.8%; SAS, version 9.2; Cary, NC). Only 2 patients were discharged from the hospital, both debilitated—one to a rehabilitation center and one to a skilled nursing facility.

The exact mechanism of the spiked helmet ECG pattern and its association with critical illness is uncertain, but several observations point to the possible role of the diaphragm. Certain pathological conditions can rarely result in repetitive contraction of the diaphragm that is in concert with the cardiac cycle.[2,3] Postulated mechanisms of this pulsatile diaphragmatic motion include direct stimulation of the diaphragm by the inferior wall of the left ventricle or triggering of the left leaf of the diaphragm by the left phrenic nerve.[2,3] Such diaphragmatic contractions may result in alteration of the ST segment, which is best seen in the inferior leads.[2,3] A possible mechanism to explain pseudo-ST segment elevation is repetitive epidermal stretch in association with nearby pulsatile flow or due to an acute rise in the intrathoracic or intra-abdominal pressure.[4,5] From this perspective, it may be of significance that 7 of the 8 patients in our series were intubated and undergoing mechanical ventilation at the time of the ECG recording,

and 4 of 8 had documented free air, fluid, or mechanical tubes and drains in either the thorax or the abdomen (Table).

The spiked helmet sign is a potential novel ECG marker of a very high risk of impending death, but the prevalence, mechanism, and clinical applicability remain uncertain at this time. Repetitive signals in the ECG that are not generated by cardiac depolarization or repolarization have previously been shown to provide important clues to patients' clinical conditions and guidance on their treatment. [6] Further experience is needed to determine whether the spiked helmet sign will eventually change clinical management or just remain an electric curiosity.

References

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