Invest Clin 64(4): 533 - 538, 2023 https://doi.org/10.54817/IC.v64n4a10

Evaluation of myocardial infarction by a 12-lead routine electrocardiogram: a case report of an ST-segment elevation.

Huayong Jin, Lijiang Ding, Binglei Li and Jianming Zhang

Department of ECG Room, Shaoxing People's Hospital, Zhejiang Province, China.

Keywords: electrocardiogram; spiked helmet sign; ST-segment elevation; myocardial infarction.

Abstract. The spiked helmet sign (SHS) is a type of ST-segment elevation associated with critical cardiac disease and a high risk of death. We report a case of SHS caused by an ECG artifact. A 60-year-old male patient presented to the clinic after suffering an electric shock. The initial 12-lead routine electrocardiogram showed an SHS. The patient received appropriate intravenous fluid replacement therapy, and after 30 minutes, the ST-T changes of the 12-lead electrocardiogram were all restored to normal. The patient was discharged after a 24-hour observation period in the emergency room. Recent studies have pointed out that there may be two different types of SHS. One is the mechanical factor, and the other is the significant prolongation of the QT interval. The two types have different clinical significance. In our report, the radial artery of the patient's right wrist pulsed strongly, and after the occurrence of SHS, the SHS disappeared after adjusting the contact position of the electrode in his right arm. This SHS caused by mechanical traction was an ECG artifact. Although the SHS may be an essential indicator of critical illness, there are mechanical factors that lead to the appearance of ECG artifacts. Therefore, in clinical work, obtaining a complete medical history and primary conditions of the patient at the time of ECG sampling is necessary to help the diagnosis and thus avoid erroneous treatment.

Corresponding author: Jianming Zhang. Department of ECG Room, Shaoxing People's Hospital, Shaoxing 312000, Zhejiang Province, China. E-mail: zjsxzjm@163.com

Evaluación del infarto de miocardio mediante un electrocardiograma de rutina de 12 derivaciones: reporte de un caso de elevación del segmento ST.

Invest Clin 2023; 64 (4): 533 – 538

Palabras clave: electrocardiograma; signo del casco prusiano; elevación del segmento ST; infarto del miocardio.

Resumen. El signo del casco prusiano (signo del casco con púa-SHS) es un tipo de elevación del segmento ST asociado con enfermedad cardíaca crítica y un alto riesgo de muerte. Presentamos un caso de SHS causado por un artefacto del ECG. Un paciente varón de 60 años acudió a la clínica tras sufrir una descarga eléctrica. El electrocardiograma de rutina inicial de 12 derivaciones mostró un SHS. El paciente recibió una terapia de reposición de líquidos por vía intravenosa adecuada y, después de 30 minutos, los cambios ST-T del electrocardiograma de 12 derivaciones se normalizaron. El paciente fue dado de alta después de un período de observación de 24 horas en la sala de emergencias. Estudios recientes han señalado que puede haber dos tipos diferentes de SHS. Uno debido a un factor mecánico y el otro es la prolongación significativa del intervalo QT. Los dos tipos tienen un significado clínico diferente. En nuestro reporte, la arteria radial de la muñeca derecha del paciente pulsaba con fuerza, y después de la aparición del SHS, este desapareció después de ajustar la posición de contacto del electrodo en su brazo derecho. Este SHS causado por tracción mecánica era un artefacto del ECG. Aunque el SHS puede ser un indicador esencial de enfermedad crítica, existen factores mecánicos que conducen a la aparición de artefactos en el ECG. Por lo tanto, en la práctica clínica, es necesario obtener una historia clínica completa y observar las condiciones primarias del paciente en el momento de la toma de muestras del ECG para ayudar al diagnóstico y así evitar un tratamiento erróneo.

Received: 19-06-2023 Accepted: 05-08-2023

INTRODUCTION

The ST-segment elevation is typical in acute myocardial infarction. In 2011, Littmann et al. reported a particular type of ST-segment elevation, which presented as ST-segment inferior oblique elevation with baseline superior oblique elevation of the QRS wavefront and a sharp R wave. Because of its graphic characteristics similar to the shape of the pointed helmet used by German soldiers, this electrocardiogram (ECG) finding was named the spiked helmet sign (SHS) [1]. In the existing literature, SHS is usually associated with critical illnesses such as acute myocardial infarction and predicts very poor clinical outcomes, including death[2,3]. However, the mechanism and clinical significance of SHS is still unclear.

ECG artifacts caused by various interferences are often encountered in clinical work [4]. Although common interferences can be identified in combination with ECG morphology and clinical manifestations of

patients, some can also manifest as severe heart diseases, such as acute myocardial infarction, which is difficult for even experienced clinicians to identify. This case reports the ECG manifestations of a patient who initially developed false SHS after an electric shock.

CASE DESCRIPTION

A 60-year-old man with no previous history of critical illness presented with head, chest, hip, and left elbow pain one hour after a fall. The patient was found lying on the ground at work one hour before. The patient's co-workers claimed that he was injured due to a fall. The patient recalled the scene then and claimed that an electric shock caused it. The patient had an episode of transient coma and recovered spontaneously without nausea, vomiting, convulsions, or dyspnea. At the time of presentation, the patient's temperature was 36.6 ℃, heart rate was 90 beats per minute, blood pressure was 150/70 mmHg, and oxygen saturation was 95%. The results of the physical examination were mild respiratory sounds in both lungs, normal heart sounds, no evident murmur, warm limbs, about 1% of a third-degree burn area on the forearm of the left upper limb, movable limbs, and palpable *dorsalis pedis* artery pulsation. A CT scan of the skull revealed swelling of the right scalp soft tissue. Creatine kinase and creatine kinase-MB were 953.7U/L and 27U/L, respectively, which were higher than normal values. A 12-lead electrocardiogram (Fig. 1) revealed an SHS: lead (I, II, AVL, and AVF) showed an ST elevation of 0.05–0.1 mV with T-wave inversion, the lead AVR showed an ST depression of 0.05mm with T-wave bidirectional changes, and QT interval extended to 460 ms. During this period, the radial artery of the patient's right wrist pulsated strongly, and the SHS phenomenon disappeared after adjusting the contact position of the right arm electrode. After that, the patient received appropriate intravenous rehydration therapy. After 30 minutes, the 12-lead electrocardiogram (Fig. 2) was reviewed, and all the ST-T changes in the electrocardiogram returned to normal. The patient was discharged without any abnormality after 24 hours of observation in the emergency department.

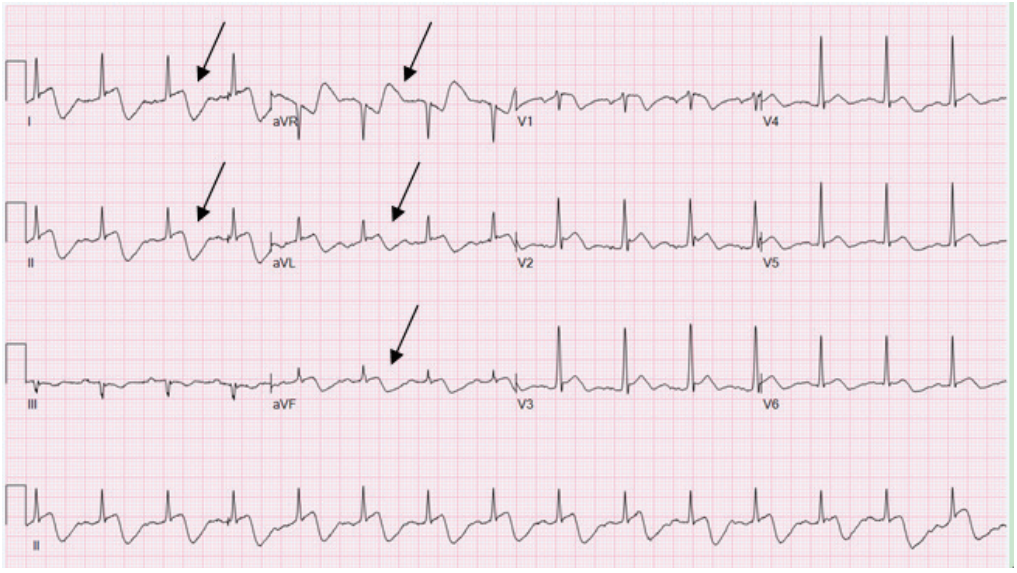

Fig. 1. The patient presented with a 12-lead routine ECG. Arrows indicate ST elevation of 0.05-0.1mv with T-wave inversion in leads I, II, AVL, and AVF, and ST depression of 0.05mv in lead AVR with bidirectional changes in T-wave.

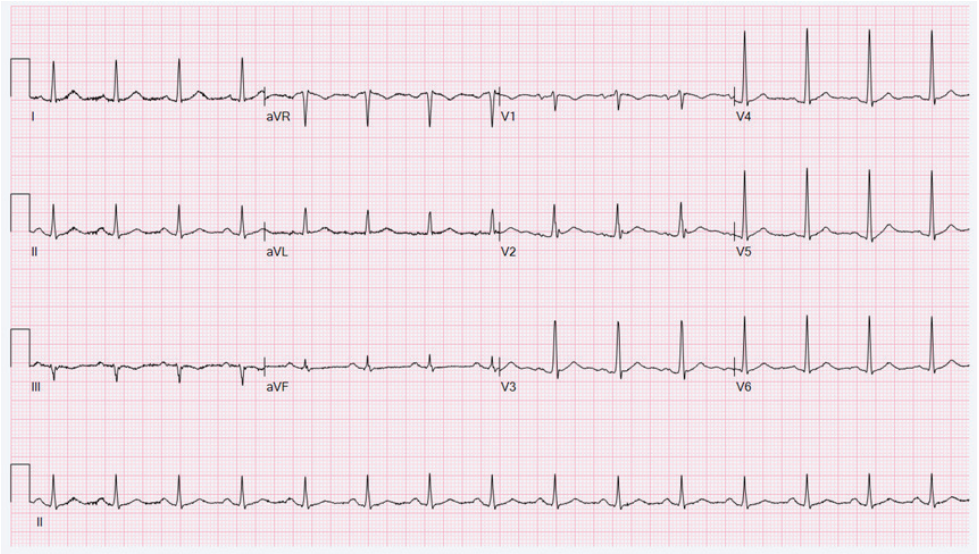

Fig. 2. The patient's ECG reviewed after 30 minutes. ST-T in leads I, II, AVR, AVL, and AVF returned to normal.

DISCUSSION

In the twelve years since the SHS was first reported in 2011, several communications have portrayed the SHS as an indicator of critical illness and poor prognosis, with an alarming post-emergence mortality rate of 59% [5]. However, recent studies have divided the SHS into two types. The prolongation of the QT interval causes one, and the other is caused by the superposition of mechanical factors, which may be an ECG artifact [6].

Experimental data show that physical stretching of the skin can produce a voltage of several millivolts [7]. The conductivity of ion channels in the heart will be changed under the pull of different tensions, affecting myocardial cells' action potential and changing the ECG pattern [8]. In addition, recent studies support the conclusion that mechanical factors contribute to the SHS. When Tomcsányi et al. placed the ECG lead over the arteriovenous fistula in the left arm of a hemodialysis patient, the ECG showed SHS, whereas when the electrodes were placed further on the normal epidermis, the SHS disappeared, meaning that SHS was caused by pulsatile epidermal stretching [6]. Agarwal *et al.* reported that an SHS appeared in the ECG of a 77-year-old male patient who used mechanical ventilation when the pressure in the chest cavity increased, obviously due to excessive positive end-expiratory pressure, but disappeared after reducing positive end-expiratory pressure [9]. In this case, when compared with the ECG image in Fig. 1, we found no dynamic changes in ST-T in Lead III. According to Einstein's triangle theory, Lead III was the potential difference between the left arm and left leg. When the artifact came to the right arm, there was an interference artifact in leads I and II, and Lead III remained normal. The patient's right wrist radial artery was beating strongly, and the ECG showed SHS, whereas the ECG disappeared after adjusting the position of the right arm electrode contact, similar to the case reported by Tomcsányi [10]. Therefore, in our case, the SHS was an ECG artifact caused by mechanical traction.

The SHS phenomenon can be produced when limb lead electrodes are placed on the radial artery, indicating acute ST-segment elevation muscular infarction (STEMI). Although an SHS may be an essential indicator of critical diseases, we must identify other

conditions that can cause SHS and remain vigilant. Obtaining a complete medical history and the patient's basic situation during ECG sampling can help clarify the truth of ECG performance, thus avoiding wrong diagnosis and over-treatment.

Conflict of competence

The authors declare no conflict of interest.

Funding

The research is supported by 2022 Zhejiang Provincial Health Science and Technology Plan, Promotion and Application of ECG Remote Intelligent Network Transmission and Report Writing Standards in Grassroots Hospitals (No.: 2022ZH061).

Authors' Orcid Number

- Huayong Jin (HJ): 0009-0008-2326-5884
- Lijiang Ding (LD): 0009-0006-1889-1384
- Binglei Li (BL): 0009-0005-5803-120X
- Jianming Zhang (JZ): 0009-0007-1433-8087

Contribution of authors to the papers

Substantial contributions to conception and design: HJ, LD. Data acquisition, data analysis, and interpretation: BL, JZ. Drafting the article or critically revising it for important intellectual content: HJ, LD. Final approval of the version to be published**:** All authors. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of the work are appropriately investigated and resolved: Huayong Jin, Lijiang Ding, Binglei Li, Jianming Zhang. Huayong Jin and Lijiang Ding contributed equally to this work as co-first authors.

REFERENCES

1. **Littmann L, Monroe MH**. The "spiked helmet" sign: A new electrocardiographic marker of critical illness and high risk of death. In: *Mayo Clin Proc 2011;*86:1245-1246. *https://doi.org/10.4065/mcp.2011.0647*.
2. **Hamade H, Jabri A, Yusaf A, Nasser MF, Karim S**. The spiked helmet sign: a concerning electrocardiographic finding. JACC Case Reports 2021; 3(11): 1370-1372. *https://doi.org/10.1016/j.jaccas.2021.04.048*.
3. **Oluyadi F, Theetha Kariyanna P, Jayarangaiah A, Celenza-Salvatore J, M. McFarlane I**. Helmet sign on EKG: a rare indicator of poor prognosis in critically ill patients. Am J Med Case Reports 2019; 7(10): 260-263. *https://doi.org/10.12691/ajmcr-7-10-9*.
4. **Littmann L**. Electrocardiographic artifact. J Electrocardiol 2021; 64: 23-29. *https://doi.org/10.1016/j.*jelectrocard.*2020.11.006*.
5. **Mahmoudi E, Hui JMH, Leung KSK, Satti DI, Athena Lee YH, Christien Li KH, Hei Lau DH, Ming Kot TK, Ciobanu A, Bazoukis G, Kai Chan JSh, Baranchuk A.** Spiked helmet rlectrocardiographic sign-A systematic review of case reports. Curr Probl Cardiol 2023; 48(3): 101535. *https://doi.org/10.1016/j.cpcardiol.2022.101535*.
6. **Tomcsányi J, Bózsik B**. Two forms of the spiked helmet sign are caused by two separate mechanisms. J Electrocardiol 2022; 73: 129-130. *https://doi.org/10.1016/j.jelectrocard.*2019*.07.012*.
7. **Edelberg R**. Local electrical response of the skin to deformation. J Appl Physiol 1973; 34(3): 334-340. *https://doi.org/10.1152/jappl.1973.34.3.334*.
8. **Weise LD, Panfilov AV.** Correction: A discrete electromechanical model for human cardiac tissue: Effects of stretch-activated currents and stretch conditions on restitution properties and spiral wave dynamics. PLoS One 2013; 8(6): e59317. *https://doi.org/10.1371/*annotation*/9ceadf50-eb8f-4051-9e41-772884d47385*.

9. Agarwal A, Janz TG, Garikipati N V. Spiked helmet sign: An under-recognized electrocardiogram finding in critically ill patients. Indian J Crit Care Med 2014; 18(4): 238-240. *https://doi.org/10.4103/0972-5229.130576*.

10. Tomcsányi J. EKG-gyöngyszem: akut coronaria szindróma gyanúját keltő EKG-műtermék–poroszsisak-jel. Orv Hetil 2021; 162(34): 1383-1385.