CASE REPORT

Sharp cardiac trauma through the sternum caused by an automatic nail gun: A case report

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ABSTRACT

Automatic nail gun injuries to the hand commonly occur with the use of these machines in construction. However, such injuries to the cardiothoracic area are atypical. Herein, we report a case of emergency surgery to remove a nail, which was accidentally shot through the sternum and reached the heart. A 24-year-old man was working in a narrow space at a construction site, where he tripped over the air hose of an automatic pneumatic nail gun. The trigger was accidentally pulled, while the machine was facing his direction, and a nail entered his sternum. The patient felt chest pain, walked to a nearby orthopedic clinic, and then was transferred to our hospital for treatment. On examination, the nail was completely embedded in the midline of the precordial chest. Chest X-ray and computed tomography (CT) images showed a rod-shaped nail penetrating the sternum from the precordial region and reaching the anterior mediastinum. The nail tip was located between the pulmonary artery and the aorta; it was touching the main trunk of the pulmonary artery. Emergency surgery was performed to remove the 45-mm-long nail (2 mm in diameter) on the same day, considering the possibility of massive bleeding and infection. An auxiliary circulatory system was not used, and intraoperative blood transfusion was not required. The patient was extubated on the same day. On post-operative day 7, CT confirmed that there were no issues of concern and no signs of infection. The patient was discharged on post-operative day 8 and returned home on foot. The patient was followed up for 6 months in the outpatient clinic, and there were no signs of infection or abnormal hemodynamics. This case demonstrates the need for careful assessment of nail gun injuries, which may initially appear insignificant.

Keywords: Automatic nail gun; cardiac trauma; penetrating trauma; sternum trauma.

INTRODUCTION

Recently, cases of penetrating trauma have increased with the global use of automatic nail guns during construction.[1–3] Although these injuries commonly affect the hands, several reports of head injury with brain damage have been published in the fields of neurosurgery and oral and maxillofacial surgery.[4–7] However, reports of nail gun injuries in the fields of cardiovascular surgery and orthopedics are rare.[8] We report a case, in which emergency surgery was performed to remove a nail that was accidentally shot through the sternum and reached the heart.

CASE REPORT

A 24-year-old man was referred to our hospital with a nail in his sternum, accidentally shot from a nail gun. The patient was alert and walking. No vital sign abnormalities were noted. He had a medical history of type I diabetes, for which he was receiving NovoRapid (Novo Nordisk, Bagsværd, Denmark) (20 U in the morning, 20 U at noon, and 33 U in the evening) and FlexPen (Novo Nordisk) (20 U in the morning and 20 U before bedtime). No allergies were noted.

On admission, the patient reported pain in the precordial re-

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gion. No murmurs or decreased breath sounds were noted. No other physical findings, such as dyspnea, were observed. Visual assessment revealed that the nail was completely embedded in the midline of the precordial chest, with no bleeding or other abnormal findings (Fig. 1). Laboratory test results only showed a mildly elevated leucocyte count (9120/μL) and glycated hemoglobin level (8.4%).

Electrocardiograms exhibited sinus rhythm and a heart rate of 93 bpm, with no arrhythmia or abnormal waveforms. Chest radiographs showed a cardiothoracic ratio of 52%, no mediastinal enlargement or pleural effusion, and no other obvious lung lesions. An opaque shadow of a foreign body was observed in the sternum and in the area that overlapped with the cardiac shadow (Fig. 2a). Chest computed tomography (CT) showed that the nail had penetrated the sternum from the precordial region and reached the anterior mediastinum. The nail tip was between the pulmonary artery and the aorta, touching the main trunk of the pulmonary artery. Mediastinal hematoma and cardiac tamponade could not be identified on CT (Fig. 2b-d).

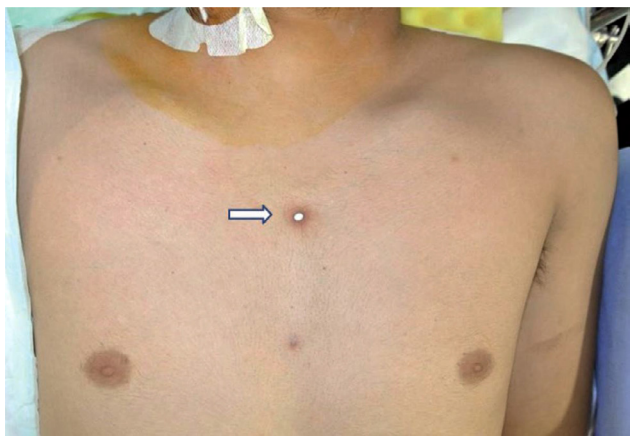

Figure 1. Photograph of the precordial chest on presentation. The nail is completely embedded in the midline of the precordial chest, and there is no bleeding (white arrow).

Emergency surgery was performed by our cardiovascular surgeon (day 1) to remove the nail, considering the possibility of massive bleeding and infection. Before surgery, an antibiotic (cefazolin, 3 g/day) and anti-tetanus human immunoglobulin (250 IU) were administered, and tetanus toxoid (0.5 mL) was injected intramuscularly. With the patient under general anesthesia, a skin incision was made at the nail insertion site, and a sternum saw was used to perform a midline sternotomy from the cranial aspect. The nail was positioned to the left of the sternum. The sternum's posterior surface was observed to confirm that the nail tip was buried in the anterior mediastinal thymus tissue. The nail had reached the heart, and the nail tip remained between the pulmonary artery and the aorta (Fig. 3). After confirming the absence of a hematoma in the mediastinum, the nail was

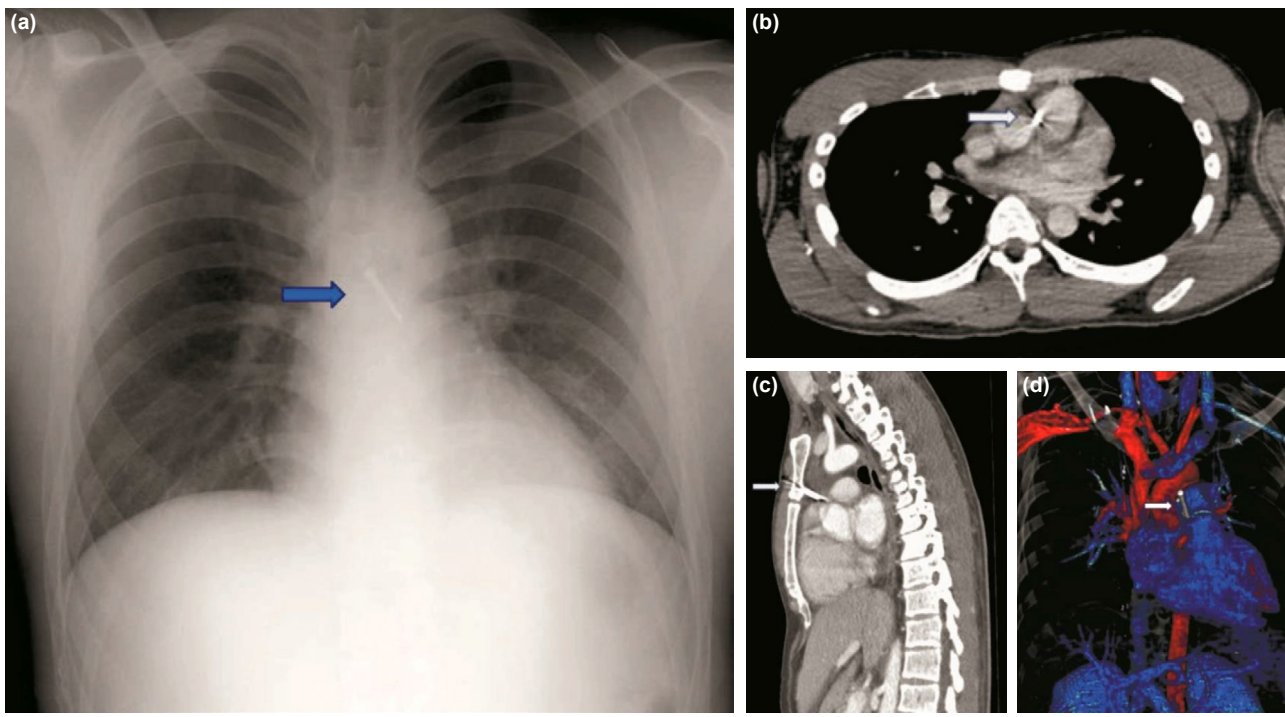

Figure 2. (a) Chest radiograph taken on admission. The chest radiograph reveals a cardiothoracic ratio of 52%, no mediastinal enlargement or pleural effusion, and no other obvious lung lesions. An opaque shadow of a foreign body is observed in the sternum and in the area overlapping the cardiac shadow (blue arrow). Axial **(b)**, sagittal **(c)**, and three-dimensional computed tomography **(d)** images obtained on admission show a rod-shaped nail penetrating the sternum from the precordial region to the anterior mediastinum. The nail tip is between the pulmonary artery and the aorta and is in contact with the main trunk of the pulmonary artery. Mediastinal hematoma and cardiac tamponade are not identified (white arrows).

removed. The nail was 45-mm long and 2-mm in diameter (Fig. 4). After removal, a small amount of exudative bleeding into the mediastinum was observed. With pericardiotomy, the heart was lifted, and holes were observed in the fatty tissue anterior to the pulmonary artery. The fatty tissue was peeled off, and the pulmonary artery's anterior surface was observed to confirm that the blood vessel wall, aorta, and other surrounding tissues were not damaged. After careful confirmation of hemostasis, the chest cavity was washed with 10,000 mL of normal saline, and drains were placed. The operation was completed with the closure of the pericardium, sternum, and skin. The operative time was 1 h and 57 min. No auxiliary circulatory system was used, intraoperative blood loss was 218 mL, and no intraoperative blood transfusion was required.

Post-surgery, the patient returned to the intensive care unit and was extubated the same day. The central venous catheter was removed on day 2, and the pericardium and anterior pulmonary drains were removed on day 3. Subsequently, the patient was transferred to the general ward. Intubation time was 3 h, and the intensive care unit stay lasted 3 days. The substernal drain was removed on day 4. Repeat CT on day 7 confirmed no issues and no signs of infection; thus, the antibiotic therapy (cefazolin, 3 g/day) was terminated. The patient was discharged and walked home on day 8. No signs of infection or abnormal hemodynamics were observed during 6 months of outpatient follow-up.

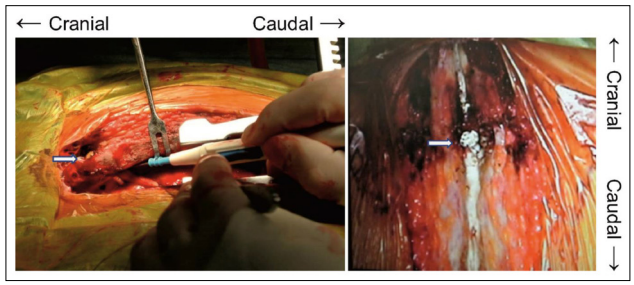

Figure 3. Photograph of the cranial and caudal operative field. The nail is on the left side of the sternum. The posterior (caudal) surface of the sternum reveals that the nail tip is buried in the anterior (cranial) mediastinal thymus tissue. The nail has reached the heart, and the tip of the nail is between the pulmonary artery and the aorta (white arrows).

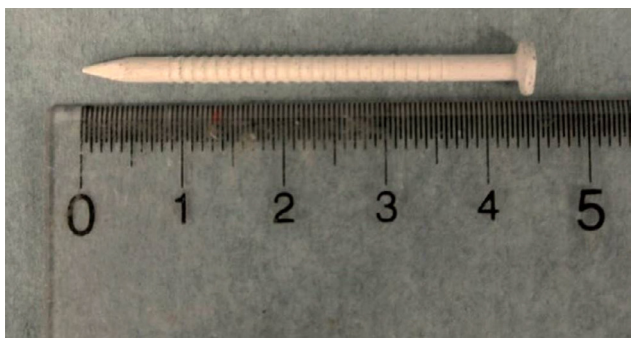

Figure 4. Photograph of the extracted nail. The nail is 45 mm long and 2 mm in diameter.

DISCUSSION

In our patient with an accidental automatic nail gun injury to the sternum, no significant symptoms except pain were noted, and he was able to walk unassisted to a nearby doctor. The automatic nail gun is designed to minimize damage to the object during nailing to avoid destroying areas outside the punctured region. Therefore, unlike a gunshot wound, a nail gun wound is unlikely to crush the bone, and as it is an instantaneous injury, the damage may be limited.[9] Given that the symptoms may be minimal, as they were in this case, the patient may consider the damage to be at the surface level and may not recognize it as a serious internal injury. However, serious internal injury can occur, as shown in the case reported by Koçak et al.,[3] wherein a nail perforated the entire sternum and the pericardium, entering the right atrium, and missing the right coronary artery by 5 mm. Hence, examining physicians must pay close attention when diagnosing and treating such patients to avoid missing a serious injury. Indeed, a case has been reported, in which a nail from an automatic nail gun was left in the temporal fossa for 3 years, because the wound was very small and hard to see on the outer surface and symptoms were limited.[10] Collectively, our findings and previous findings underscore the importance of fully assessing the situation of the injury and the tools involved (such as nail length and diameter) to ensure proper diagnosis and treatment.

Early diagnosis is also critical for cardiac trauma. Previous reports support that subxiphoid pericardial fenestration and transthoracic echocardiography are optimal diagnostic methods for cardiac injury patients with and without hemodynamic instability, respectively.[11,12] Ultrasound is considered the most effective method for early diagnosis in cardiac trauma patients.[13] However, in our patient, the nail had penetrated the sternum, and transthoracic echocardiography was difficult. Moreover, transesophageal echo would have been highly invasive and would require extensive device preparation. Hence, a CT examination was performed immediately after the patient's arrival, and we were able to assess the state of damage accurately, especially with three-dimensional CT. If the patient is hemodynamically stable, a CT scan is ideal to understand the positional relationship between the foreign object and each organ.

Penetrating damage caused by a nail gun is more likely to result in infection than a gunshot wound since the penetration speed with a nail gun injury is slower, and there is less of a temperature increase.[9,14] As our patient also had type I diabetes, we were hyperattentive to potential infection. We administered cefazolin, an anti-tetanus human immunoglobulin, and an intramuscular tetanus toxoid injection before surgery; a large volume of normal saline was used to wash the cardiac cavity; and the antibiotic (cefazolin, 3 g/day) course was continued postoperatively. Routine blood tests and wound examinations were also performed. After observing wound healing

and decreased levels of inflammatory markers on blood tests, the patient was discharged 8 days post-surgery. No infection was observed after discharge.

Conclusion

In this unusual case, a nail from an automatic nail gun penetrated the sternum and caused a sharp cardiac trauma. This case highlights the importance of careful assessment of nail gun injuries, as their external presentation may not reflect the extent of internal damage.

Informed Consent: Written informed consent was obtained from the patient for the publication of the case report and the accompanying images.

Peer-review: Internally peer-reviewed.

Authorship Contributions: Concept: R.F.; Design: R.F.; Supervision: R.F.; Data: R.F.; Analysis: R.F.; Literature search: R.F.; Writing: R.F.; Critical revision: R.F., Y.I.

Conflict of Interest: None declared.

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OLGU SUNUMU - *ÖZ*

Otomatik çivi tabancasının neden olduğu sternumdan geçen penetran kardiyak travma: Olgu sunumu

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Otomatik çivi tabancasının neden olduğu el yaralanmaları, bu makinelerin inşaatlarda kullanılmasıyla yaygın olarak ortaya çıkar. Bununla birlikte, kardiyotorasik bölge yaralanmaları atipiktir. Bu yazıda, bir çiviyi çıkarırken yanlışlıkla sternumdan kalbe ulaşılan acil cerrahi müdahale olgusunu sunmaktayız. Yirmi dört yaşındaki bir erkek, bir şantiyede dar bir alanda çalışırken, otomatik havalı çivi tabancasının hava hortumuna takılıp düştü. Alet kişiye doğru bakarken yanlışlıkla tetik çekilmiş ve sternuma bir çivi girmiş. Göğsünde ağrı hisseden hasta, yakındaki bir ortopedi kliniğine yürümüş ve ardından tedavi için hastanemize sevk edildi. Muayenede çivi prekordiyal göğüs orta hattına tamamen gömülüydü. Akciğer grafisi ve toraks bilgisayarlı tomografi görüntülerinde prekordiyal bölgeden sternuma giren ve anterior mediastene ulaşan çubuk şeklinde bir çivi görüldü. Çivi ucu pulmoner arter ve aort arasında durmaktaydı; pulmoner arterin ana gövdesine dokunuyordu. Masif kanama ve enfeksiyon olasılığı düşünülerek aynı gün, 45 mm uzunluğundaki (2 mm çapında) çivinin çıkarılması için acil cerrahi uygulandı. Yardımcı dolaşım sistemi kullanılmadı ve intraoperatif kan transfüzyonu gerekmedi. Hasta aynı gün ekstübe edildi. Ameliyat sonrası yedinci günde çekilen bilgisayarlı tomografi, endişe verici bir durum olmadığını ve enfeksiyon belirtisi olmadığını doğruladı. Hasta ameliyat sonrası sekizinci gün taburcu edildi ve yürüyerek evine döndü. Hasta poliklinikte altı ay takip edildi; enfeksiyon durumu veya anormal hemodinamik bulgu saptanmadı. Bu olgu, başlangıçta önemsiz görünebilecek çivi tabancası yaralanmalarının dikkatli bir şekilde değerlendirilmesi gerektiğini göstermektedir.

Anahtar sözcükler: Kardiyak travma; otomatik çivi tabancası; penetran travma; sternum travması.

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