

# A large foreign body removal from the anterior mediastinum using a minimally invasive method after a shrapnel wound to the neck: a case report

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This case report describes the diagnosis and surgical management of a shrapnel wound to the neck with a retained foreign body (metal fragment) in the anterior mediastinum. A 44-year-old male service member was wounded in the neck during an air raid. Thirty minutes after sustaining the injury, the patient reached a forward surgical team, exhibiting hemodynamic instability responsive to resuscitation. After initial stabilization, the forward team performed primary surgical treatment of the wound, including hemostasis, irrigation and debridement, and drainage. Twelve hours later, the patient was transported by ground to the Military Medical Clinical Center of the Northern Region of the Military Medical Center of the Armed Forces of Ukraine and hospitalized in the surgical department. Diagnostic evaluation included computed tomography of the head, chest, abdomen, and pelvis along with esophagogastroduodenoscopy, which demonstrated fracture of left ribs 1 and 2, a 40×15-mm metal fragment in the anterior superior mediastinum with pneumomediastinum and hemomediastinum, and metal fragments in the soft tissues of the neck without contrast extravasation. Esophagogastroduodenoscopy revealed no evidence of esophageal injury. Surgical management included left video-assisted thoracoscopic surgery with opening of the anterior mediastinum and removal of the foreign body (metal shrapnel fragment) using a magnetic surgical instrument. The patient was discharged 2 weeks postoperatively. Gunshot wounds of the neck with a large foreign body in the anterior mediastinum are rare. The use of minimally invasive surgical techniques and modern magnetic surgical instruments can reduce surgical morbidity and may be used at tertiary care centers.

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## INTRODUCTION

For centuries, the proportion of combat neck injuries recorded at treatment facilities remained essentially unchanged at approximately 1% to 2%. This figure was largely affected by survival bias due to the high rate of battlefield deaths from neck injuries. Modern combat casualty care statistics report rates of conflict-related neck injury among military personnel ranging from 5% to 11%, depending on the combat theater [1]. Improvements in personal protective equipment and rapid aeromedical evacuation have improved outcomes for casualties with combat-related neck injuries, although the neck remains challenging to protect, with wide variability in strategies across militaries [2].

According to experience from World War II, ear, nose, throat, and neck injuries occurred in about 1.6% of the wounded, with 0.8% sustaining isolated injuries and 0.8% combined injuries. The distribution of ear, nose, and throat injuries by mechanism during World War II was 32.2% gunshot wounds and 66.1% shrapnel [3]. In more recent theaters of war like Iraq and Afghanistan, among United States and United Kingdom military personnel, 4.9% of casualties arriving at a treatment facility sustained neck injuries; when those who died on the battlefield were included, this rate was 10% [4]. Of these injuries, 58% were due to explosive mechanisms and 36% to gunshot wounds [4]. In certain combat theaters, including Ukraine, a restrained approach to early surgical intervention led to mortality rates for neck injuries exceeding 54% during the initial stages of medical evacuation, and almost 80% of the wounded developed severe complications. With advances in combat casualty care over the course of the war in Ukraine, the mortality rate among casualties with neck injuries has decreased to approximately 2% to 6% [5–7].

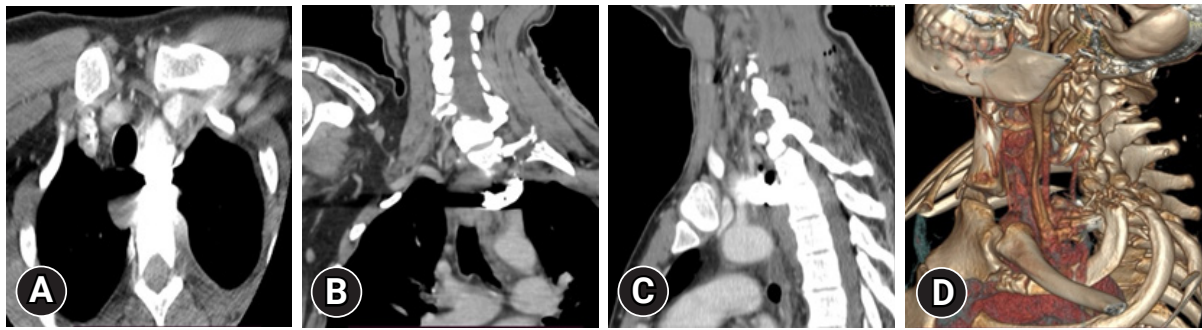
Mediastinal foreign bodies are rare [8]. Little has been reported regarding mediastinal foreign bodies in the context of combat-related neck trauma. Given the rarity of neck gunshot wounds with a large foreign body in the mediastinum, the authors present a case from the war in Ukraine that highlights their experience with this pathology [6,9]. The objective of this case report is to describe key features of the diagnosis and surgical management of a shrapnel wound to the neck with a foreign body (metal fragment) in the anterior mediastinum. The use of minimally invasive techniques to manage this injury may reduce morbidity associated with combat-related neck and mediastinal injuries in an appropriate patient population.

## CASE REPORT

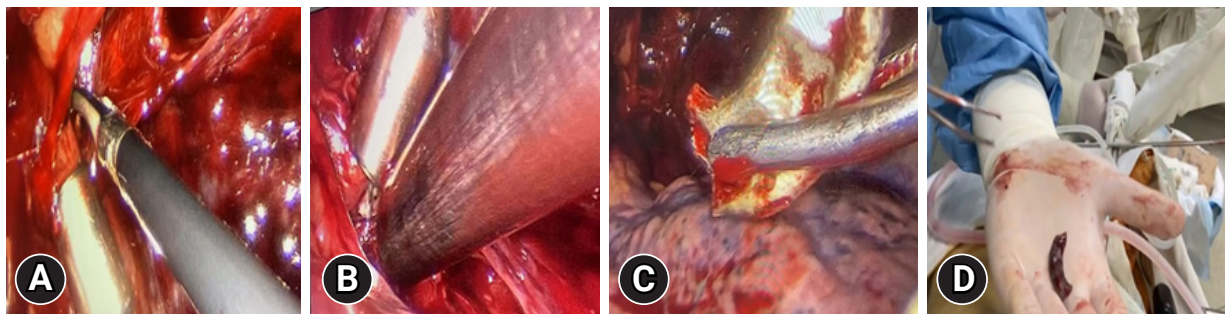
This case report describes the injuries and management of a 44-year-old patient with no known medical or surgical history who sustained a neck wound during an air raid. Phases of care included the following: (1) immediate bystander basic first aid at the point of injury; (2) resuscitation with wound irrigation and debridement at a forward surgical post 30 minutes after injury; and (3) definitive workup and surgical management 12 to 24 hours after injury at a tertiary military treatment facility. Thirty minutes after injury, the patient arrived at a forward surgical post with a blood pressure of 100/60 mmHg and a heart rate of 60 beats per minute, both of which responded to resuscitation. At the forward surgical post, x-rays of the neck, chest, abdomen, and extremities were obtained, and primary surgical treatment of the wounds was performed (hemostasis, irrigation and debridement, and drainage).

Twelve hours later, the patient was transported by ground to a military treatment facility of the Armed Forces of Ukraine and admitted to the surgical department. He was hemodynamically stable on arrival. Physical examination revealed penetrating wounds to the left lateral neck, left chest, left shoulder, and left forearm measuring approximately 5 × 5 to 10 × 10 mm, with well-demarcated edges and no signs of active bleeding. Based on clinical findings and radiographs obtained at the forward surgical post, the working diagnosis was combined gunshot and shrapnel wounds of the neck, chest, and extremities; fractures of left ribs 1 to 2; and a foreign body (metal fragment) in the upper anterior mediastinum. Given the minimal diagnostic capabilities at the forward surgical post, a broader workup was performed upon arrival. Laboratory tests included a complete blood count, coagulation studies, a chemistry panel, and urinalysis. Further imaging included computed tomography (CT) of the head, chest, abdomen, and pelvis with and without contrast, which demonstrated fracture of left ribs 1 and 2, a 40 × 15-mm metal fragment in the anterior superior mediastinum with pneumomediastinum and hemomediastinum, and metal fragments in the soft tissues of the neck without contrast extravasation (Fig. 1). Video esophagogastroduodenoscopy (EGD) showed no evidence of esophageal injury. Based on CT and physical examination findings, the neck injury did not appear to involve critical structures.

To manage the patient's hemopneumothorax and extract the mediastinal foreign body, operative treatment with video-assisted thoracoscopic surgery (VATS) was recommended, for which the patient provided informed consent. This procedure was performed under general anesthesia with single-lung ventilation us-



**Fig. 1.** Computed tomography of the chest in angiographic mode at admission. (A) Axial plane. (B) Coronal plane. (C) Sagittal plane. (D) Three-dimensional modeling. Gunshot fracture of left ribs 1 and 2, a 40×15-mm metal fragment in the anterior superior mediastinum, pneumomediastinum and hemomediastinum, and metal fragments in the soft tissues of the neck measuring 20×8 and 12×8 mm are shown. No contrast extravasation is seen.



**Fig. 2.** Stages of surgical intervention. (A) Fixation of the foreign body (metal fragment) with an endoscopic magnetic instrument designed to remove ferromagnetic foreign bodies from the pleural or abdominal cavity; the device allows adjustment of the working end's angle of inclination. Mobilization of the foreign body from the anterior mediastinum via thoracoscopic access. (B) Additional fixation of the foreign body with a magnetic instrument for endovideoscopic diagnosis and removal of metallic ferromagnetic foreign bodies from the abdominal and pleural cavities. (C) Grasping of the foreign body using a Mikulicz clamp. (D) Removed foreign body (metal fragment).

ing a double-lumen endotracheal tube (Fig. 2). VATS ports were placed in the fifth intercostal space along the anterior axillary and midscapular lines, as well as in the seventh intercostal space along the midaxillary line. Upon video-assisted entry to the left chest, a hematoma was visualized in the pleural cavity and anterior mediastinum. The pleura of the anterior mediastinum was opened, and the retained shrapnel fragment, measuring 35×10×5 mm, was removed using a minimally invasive magnetic technique. Foreign bodies (metal fragments) were removed thoracoscopically using a magnetic instrument designed for endovideoscopic diagnosis and removal of metallic ferromagnetic foreign bodies from the abdominal and pleural cavities; this device enables adjustment of the working end's angle of inclination to facilitate access to body cavities [10,11]. The pleural cavity was then evacuated and drained with a chest tube. The neck wounds underwent repeat exploration, including irrigation and debridement, with removal of remaining foreign bodies (two additional

metal fragments measuring 20×5×3 and 10×7×3 mm), also assisted by magnetic instruments. Additional necrosectomy of the neck wound was required to debride nonviable tissue associated with the contaminated ballistic wounds, and hematoma evacuation was also necessary. The total intraoperative time was 40 minutes, and no complications occurred during the procedure.

Overall, the patient recovered well with no postoperative complications. The chest tube was removed on postoperative day 3. The patient underwent delayed primary closure of his wounds on postoperative day 5. Sutures were removed 2 weeks postoperatively. At that time, the patient was deemed to have returned to his baseline functional status and resumed active duty.

#### Ethics statement

Informed consent for treatment and authorization for publication of the research details and clinical images were obtained

from the patient and the Medical Forces of the Armed Forces of Ukraine.

## DISCUSSION

Cervicomediastinal injury with a large foreign body in the mediastinum is rare [3,5,7]. In this case report, we present the clinical characteristics and surgical management of combat-related shrapnel wounds to the neck and chest, using a minimally invasive approach to remove a mediastinal foreign body. Research on mediastinal foreign bodies as a clinical entity is limited [8]. Although extensive guidance has been published on the management of penetrating neck injury, less evidence is available regarding the optimal approach to conflict-related wounds with retained foreign bodies in the mediastinum [12]. Drawing on the experience of a forward surgical team during the war in Ukraine, this case report highlights key steps in the diagnostic approach to this injury pattern and the potential utility of a minimally invasive surgical approach in appropriately selected (i.e., hemodynamically stable) patients.

Multiphasic CT of the neck and chest with contrast provides the most thorough information for preoperative planning and should be used where available [13]. In this case, preoperative CT revealed detailed information about the location of the anterior mediastinal foreign body (retained shrapnel fragment) in relation to critical structures. Radiographically, the left subclavian and left vertebral arteries appeared intact. The fragment's proximity to the mediastinal pleura permitted a minimally invasive surgical approach and guided intraoperative planning. EGD was also used as an adjunct to rule out aerodigestive tract injury. In patients with similar injury patterns, EGD can be considered in addition to a contrast esophagram, although concern exists that air insufflation may worsen perforation.

Key features of the surgeons' intraoperative approach included the use of two types of magnetic surgical instruments specifically designed for minimally invasive diagnosis and removal of metallic ferromagnetic foreign bodies from the abdominal and pleural cavities. One of these instruments offers the capability to adjust the angle of inclination of the working end, which greatly facilitates removal of the mediastinal foreign body. The use of modern magnetic surgical instruments during thoroscopic surgery can significantly reduce operative time and surgical trauma [14,15]. These instruments are patented and widely used in Ukraine. The generalizability of the technique may be limited in settings without access to such instruments. Nevertheless, this case report also highlights the potential utility of magnetic surgical instruments

in other environments.

This case report has several limitations. First, as a case report, it describes only a single patient. This limits the generalizability of our findings, as the specific injury pattern, anatomic location of the retained foreign body, and patient physiology may dictate different diagnostic and operative approaches. Similarly, this report presents the experience of a single surgical team in a conflict setting in Ukraine. Diagnostic and surgical capabilities may vary substantially in other contexts, where resource constraints could limit the availability of the techniques described here. Nonetheless, by describing a rare combat-related injury, this report has value in informing clinical decision-making and operative planning for surgeons managing patients with similar injury patterns.

In summary, penetrating neck injury with a large foreign body in the anterior mediastinum is rare. After initial resuscitation, diagnostic evaluation in hemodynamically stable patients can include CT, contrast esophagram, and EGD. In selected patients, minimally invasive surgical approaches to anterior mediastinal foreign bodies can be appropriate and may reduce operative morbidity. Modern magnetic surgical instruments can facilitate the removal of ferromagnetic foreign bodies and reduce intraoperative time. The use of such instruments at tertiary medical facilities in other settings could be explored for the management of casualties with intrathoracic or intraabdominal metallic foreign bodies. Finally, given the potential lethality of conflict-related neck injuries, continued attention should be given to personal protective equipment and injury prevention strategies across combat theaters.

## ARTICLE INFORMATION

### Author contributions

Conceptualization: IL, EK, VM, VN, ST, YB; Investigation: all authors; Formal analysis: IL, EK, VM, VN, ST, YB; Methodology: EK, VM, VN, ST, YB; Project administration: all authors; Visualization: VM, ST, YB; Writing—original draft: ST; Writing—review & editing: all authors. All authors read and approved the final manuscript.

### Conflicts of interest

The authors have no conflicts of interest to declare.

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## Data availability

Data sharing is not applicable as no new data were created or analyzed in this study.

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