International Journal of Surgery Case Reports 123 (2024) 110288

Contents lists available at ScienceDirect

International Journal of Surgery Case Reports

journal homepage: www.elsevier.com/locate/ijscr

Case report

A rare case of endoscopic removal of the metal fragment from the segmental bronchus after gunshot injury to the chest in combat patient injured in the war in Ukraine

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ARTICLE INFO

Keywords:
Gunshot injury to the chest
Endoscopic bullet retrieval
Non-operative gunshot management
Bullet migration
Endoscopy for gunshot wounds
Russo-Ukrainian war

ABSTRACT

Introduction and importance: Russo-Ukrainian war is associated with severe injuries to the chest. Isolated chest injuries are associated with high mortality or advanced invalidization due to the severity of the trauma.
The aim of the study was to demonstrate the experience and the challenges in diagnosis and management of the combat patient with gunshot injury to the lungs with subsequent migration of the shrapnel projectile to the segmental bronchus and its bronchoscopic removal by using forceps.
Case presentation: A male patient 44 years of age was injured at an artillery strike in East Ukraine. The patient was evacuated to the Forward Surgical Team (Role 1) facility within one hour after the injury.
The bronchoscopy was performed and to our surprise, the metal fragment in the lumen of the right segmental S2 bronchi was visualized at bronchoscopy, indicating its migration from the first place. The decision was made to attempt to remove the metal fragment endoscopically. At bronchoscopy, the metal fragment was caught by the endoscopic forceps and therefore removed endoscopically. The time of endoscopic removal of the metal fragment was 8 min.
Clinical discussion: Removal of a foreign body (metal fragment) of gunshot origin from the lumen of a segmental bronchus by using bronchoscopy with endoscopic forceps is a rare phenomenon.
Conclusions: The use of minimally invasive technologies in the treatment of gunshot blind penetrating wounds of the chest contributes to the reduction of operative trauma and shortens the time of operative treatment.

1. Introduction

Russo-Ukrainian war is associated with severe injuries to the abdomen, chest, and extremities as well as vascular wounds in both military personnel and the civil population [1–6]. Of these, isolated chest injuries, as well as thoracoabdominal injuries, are associated with high mortality or advanced invalidization due to the severity of the trauma [2,7–9]. It is also worth mentioning, that thoracic trauma was and remained a frequent injury during the war constituting 8–12 % of cases out of all injuries [2]. In terms of the Russo-Ukrainian war, gunshot injuries to the chest are common during the full-scale invasion period (2022-nowadays) as well as the hybrid period (2014–2022) constituting 10–11.7 % of combat patients. In contrast to the hybrid period, the full-scale invasion period of Russo-Ukrainian war showed frequent penetrating gunshot wounds to the chest with injury to the lungs in 80 % of patients, to the pericardium in 10–15 % of patients, to the major vessels in 5 % patients, and less common to the trachea, esophagus, and diaphragm. Such wounds are characterized by significant damage to the chest bones and internal organs, as well as by severe bacterial contamination which is associated with complications and high mortality (up to

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https://doi.org/10.1016/j.ijscr.2024.110288
Received 7 August 2024; Received in revised form 5 September 2024; Accepted 9 September 2024
Available online 14 September 2024

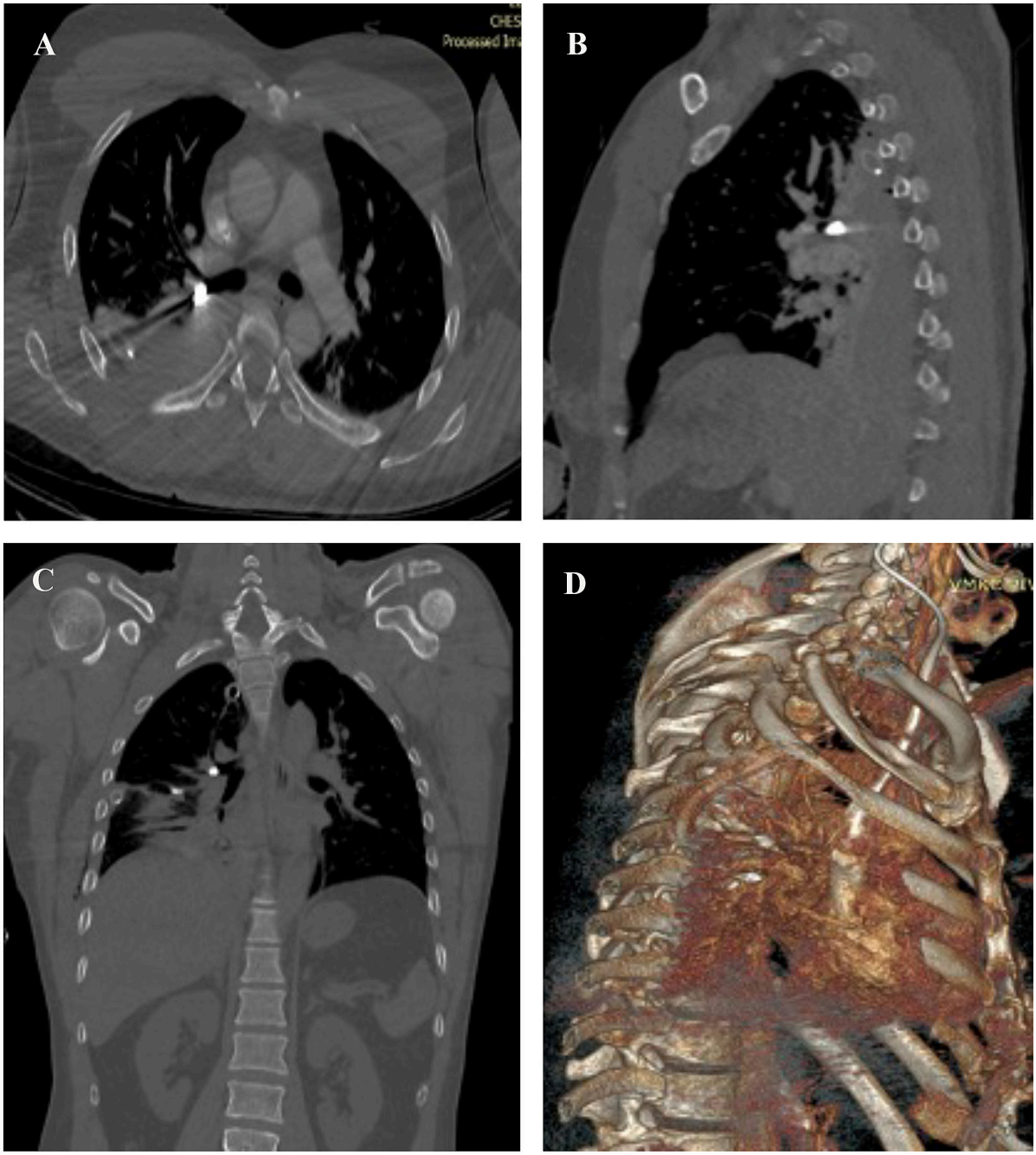

Fig. 1. CT scan of the injured upon admission: a metal fragment is located in the lumen of the segmental S2 bronchus of the upper lobe of the right lung, a metal fragment in the parenchyma of the middle lobe of the right lung, fluid in the pleural cavity on the right, pulmonitis along the course of the wound channels, there is drainage in the pleural cavity. A – axial projection; B – sagittal projection; C – coronal projection; D – 3D arterial phase volume-rendered CT image.

37 %) due to massive blood loss, traumatic shock, and acute respiratory failure [2].

A computed tomography (CT) scan is useful for the evaluation of patients with gunshot injuries to the chest and abdomen, and bronchoscopy is applied for the evaluation of the brachial tree in civil conditions [10,11]. It is worth mentioning, that application of the endoscopic technique is limited and uncommon for the management of patients with gunshot wounds to the chest, but the open surgery approach is performed more frequently [11–16]. It is also important to stress the fact, that despite Ukrainian surgeons being highly experienced in the management of all kinds of gunshot injuries, including injuries to the chest, it is frequently a clinical challenge to choose what method to apply in a particular case. In civil medicine, foreign bodies of the bronchi are removed by using bronchoscopic instruments, but it is usually associated with a minor risk (or even without risk) to damage major vessels. In case of a gunshot injury, there is a high risk for fatal complications, which is always considered. The work has been reported in line with the SCARE criteria [17].

The aim of the study was to demonstrate the experience and the challenges in of diagnosis and management of the combat patient with gunshot injury to the lungs with subsequent migration of the shrapnel projectile to the segmental bronchus and its bronchoscopic removal by using forceps.

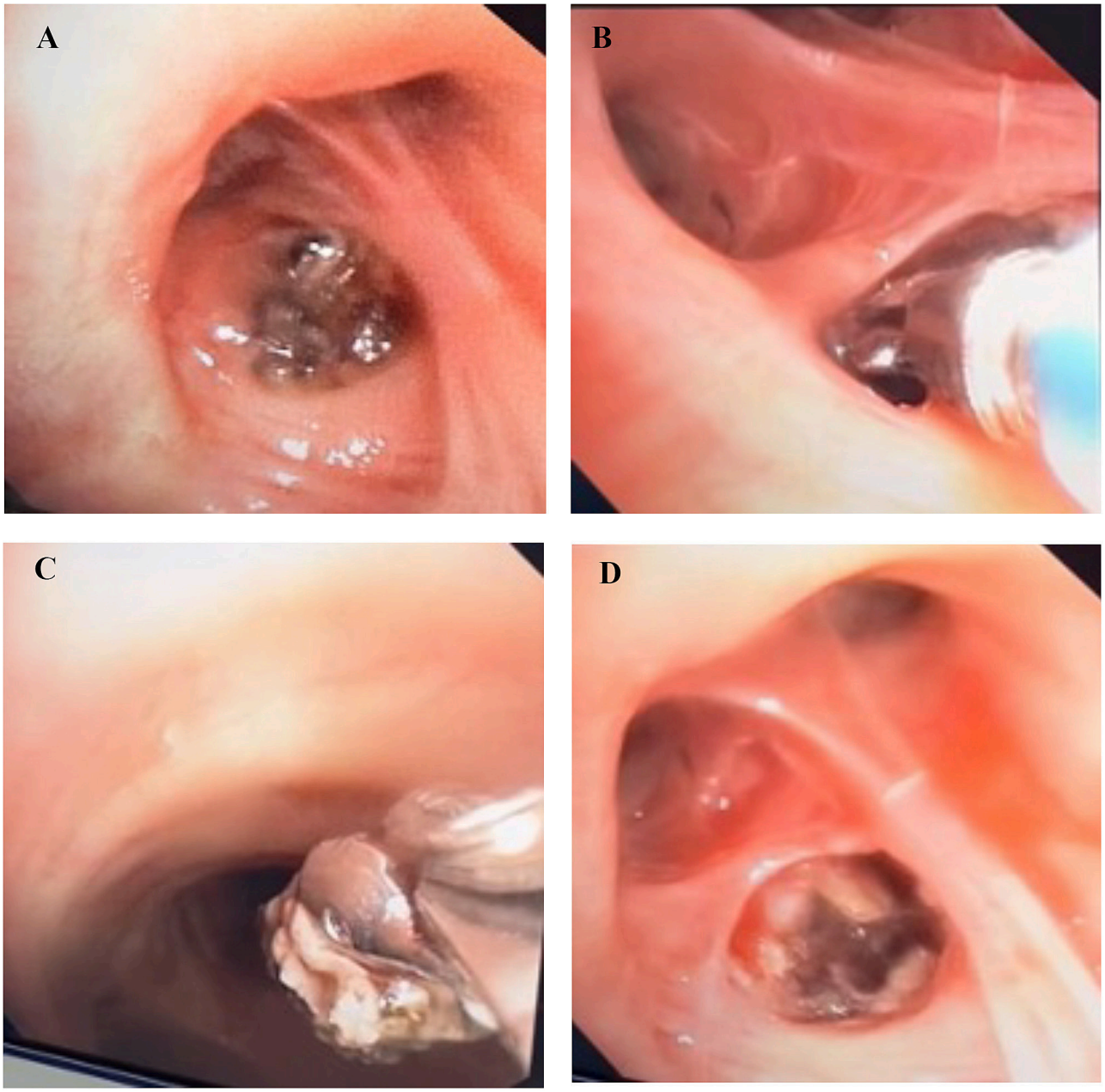

Fig. 2. A bronchoscopy visualization: A – a foreign body (a metal fragment) is present in the segmental bronchus S2 of the right lung; B – capture of a foreign body with bronchoscopic forceps; C – removal of a foreign body (metal fragment) with bronchoscopic forceps; D – appearance of the wall defect of the S2 segmental bronchus of the right lung.

2. Case presentation

A male patient 44 years of age was injured approximately at 07:00 am due to an artillery strike in East Ukraine. All combat patients are managed according to Military Medical Docrtrine, which is Role bases echelon system. Role 1 stands for Forward Surgical Team providing primary surgical care and stabilization measures. Role 2 is hospital level which is located 20–40 km from frontline providing specialized medical care and having beds whin the hospital. Role 3 and 4 are high specialized hospitals. Role 5 is rehabilitation center. The patient was evacuated to the Forward Surgical Team (Role 1) facility within one hour after the injury (i.e. "golden hour" principle). At Role 1 the patient was diagnosed with combined gunshot wounds to the right chest and VI rib's fracture, damage to the middle and low lobes of the right lung, right side hemopneumothorax, right-side posttraumatic pneumonitis, penetrating injury to the right shoulder with intraarticular comminuted fracture; perforating injury to the soft tissues of the right forearm and both calfs. At Role 1 the patient was managed by thoracocentesis draining of the right pleural cavity by Bulau, application of an external fixation device "arm-forearm" to the left as well as primary surgical debridement of gunshot wounds. Upon stabilization of the hemodynamics and considering the severe status of the patient, he was evacuated to Role 4 hospital in East Ukraine (*note: the reference to any hospital/study Locations is hidden for anonymous review*) 4 h after the injury.

At admission to Role 4 hospital, the examination of the patient revealed the following gunshot defect 2*1 cm after the debridement at the right scapular area without signs of bleeding. Bulau drainage was functioning well in the area of the right VI intracoastal space, showing no signs of air leak. The inlet gunshot hole 7*3 in the area of low 1/3 of the left arm was clean without signs of bleeding. The left upper

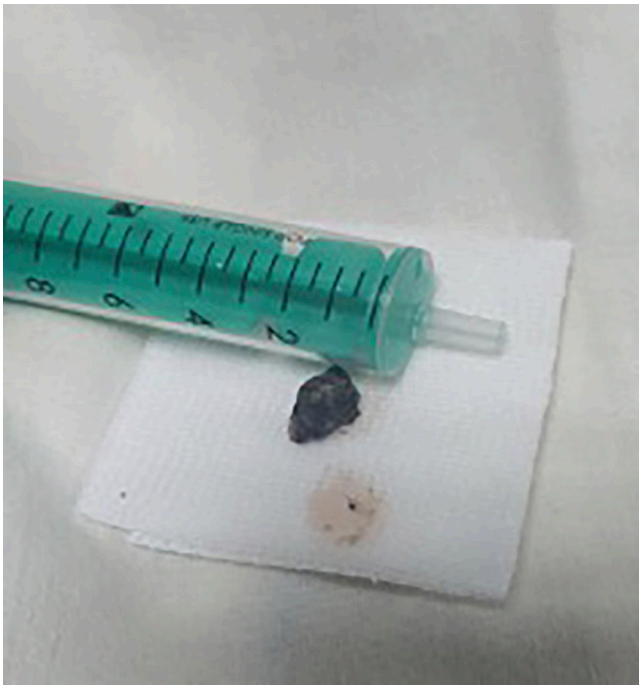

Fig. 3. A foreign body (metal fragment) with dimensions of 11 × 8 × 6 mm was removed by using bronchoscopy.

extremity was adequately fixed by the external fixator device with good immobilization, showing stable pulsation of the radial artery and warm left hand without neurological signs. After physical examination, the patients underwent routine clinical blood and urine tests. The blood tests showed hemoglobin 96 g/l, leukocytosis 14,0.2 × 10^9/L, and clinical chemistry showed no specific pathological changes.

A multispiral computed tomography scan (MS-CT) was performed for the head, chest, and abdomen with intravenous contrast and slice thicknesses of 0.5 mm by using the CT machine "Revolution EVO" (GE Healthcare, UK). Bronchoscopy was performed by using the video-endoscopic system Optera CV-170 (Olympus, Japan). Thoracoscopy was performed by using a video-endoscopic system Visera 4 K UHD OTV-S400 (Olympus, Japan).

Analyses of the CT scan showed a fragment of metal density within the lumen of segmental S2 bronchi of the upper right lung as well as a metal fragment in the parenchyma of the middle segment of the right lung, as well as exudate in the right pleural cavity and pulmonitis along the gunshot wound channel (Fig. 1). The decision was made to perform the bronchoscopy to perform an overall evaluation of the bronchial tree and to get into the area of the metal fragment projections by CT scan. To our surprise, the metal fragment in the lumen of the right segmental S2 bronchi was visualized at bronchoscopy, indicating its migration from the first place (Fig. 2). The decision was made to attempt to remove the metal fragment endoscopically. At bronchoscopy, the metal fragment was caught by the endoscopic forceps and therefore removed endoscopically. The time of endoscopic removal of the metal fragment was 8 min (Fig. 3).

After the bronchoscopy, the patient underwent VATS to the right chest (the management was performed by senior surgeons). The general anesthesia was performed under the intubation of the left lung. During the VATS, one thoracic trocar was installed in the VI intercostal space at the midaxillary line and the other one in the VIII intercostal space at the posterior axillary line. At revision, 300 ml of coagulated blood was evacuated from the pleural cavity. Aerostasis was normal and no bleeding was observed. The right parts of the pleural cavity were washed with antiseptical solutions followed by installation of the drains by using Bulau drain tubes. The VATS's time was 20 min. Drain tubes were removed from the pleural cavity on 3rd postoperative day. The MS-CT scan was performed on the 5th postoperative day, showing no pathological features (Fig. 4). The patient was discharged on the 14th day after the injury in good condition. The external fixation device "arm-forearm" was removed in 4 months.

3. Discussion

In this study we presented a rare case of endoscopic removal of the metal projectile, migrating from the lungs after a gunshot injury during the war. The removal of the foreign body of non-aspiration pathogenesis from the segmental bronchi is rare by using bronchoscopy equipment. It also should be considered a risk of severe hemorrhage from the segmental arteries of the lungs, which did not happen in this case [18].

In line with others, it is good to perform a CT scan and VATS to evaluate the injury patterns of the lungs and to make the decision about the removal of gunshot projectiles. Such an approach allowed us to identify all metal fragments and make the decision of its removal. Considering the size and the risk of operation, one small metal fragment was not removed, which was also suggested by others [19].

In this case report we showed another example of a differential approach to the management of severe combat chest trauma in the Russo-Ukrainian War. This case report is an additional example of the possibility for the application of minimally invasive technologies during a full-scale war, which is supported by studies of larger series [2,7,20,21].

The migration of ballistic projectiles from the lungs to the bronchi, or between the bronchi is rare [22]. Gunshot injury to the chest or thoracoabdominal gunshot trauma in war conditions is usually severe and associated with high mortality due to the application of high-energy weapons. It is also worth mentioning, that the russian army attacked medical facilities at all levels of medical care and sanitary transport, creating significant problems for the fast evacuation of the patients under high risk of artillery, drones, and MLRS strikes by russians. Also, there is a problem with medical supplies and planning of the medical provision [1,2,4,7,8,23,24].

According to a published series, the presence of the foreign body in the bronchi is associated with specific symptoms such as wheezing, coughing, and changes in the breezing act due to obstruction [25]. Although such symptoms were expected, our patient did not report it probably due to the severity of his status as well as due to the absence of the projectile migration at the Role 2 care, but further migration within the longer time from the point of injury.

The removal of the foreign body from the respiratory tract might be performed by using a minimally invasive (i.e. bronchoscopy) approach by thoracotomy [26]. These approaches are associated with advantages and disadvantages, but the decision on what to apply should be within the patient-centered approach concerning the injury patterns and risks for the patient. In line with Choh and Adler, but in contrast to Widjada et al., we decided to remove the foreign body by using bronchoscopy considering the quick identification of the projectile in the bronchi [22,27]. Similar to Prakash et al., we decided to remove the projectile by using forceps, considering the size of the foreign body and operative risks [28]. Still, the risk of bleeding was considered because of the close localization of the projectile to the lung vessels, but fortunately, it did not happen. In contrast to our study, Lax et al. used a Dormia basket to remove the projectile, however, we consider it also a good alternative approach, which is under the surgical team decision [28,29].

It is also worth mentioning that migration of the bullet or other projectiles might be seen in low-velocity gunshot injury [27]. As shown by other reports, endoscopy removal of the bullet was not associated with complications, indicating the endoscopic approach as a safe method [27–29].

As shown in other reports and our studies, the thoracic and thoracoabdominal injury might be associated with the migration of projectiles. Although the frequency of such a migration is relatively low, it

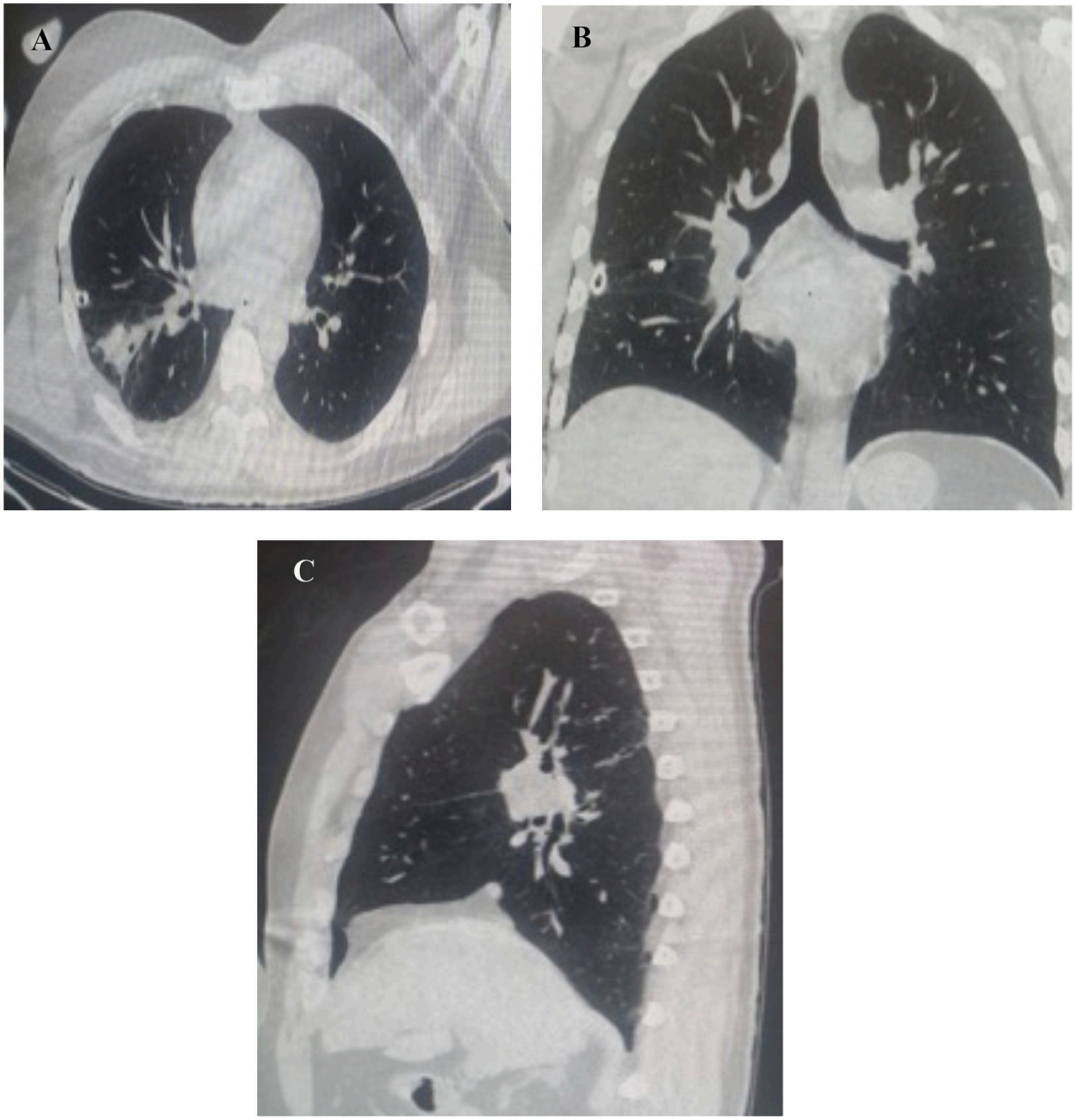

Fig. 4. Control CT scan of the patient's chest on the 5th day after the injury showing pulmonitis along the course of the wound channels, a foreign body (metal fragment) of the middle lobe of the left lung: A - axial projection; B – coronal projection; C – sagittal projection.

should be considered in all patients with a gunshot injury to the chest in warfare [2,7,20,22,29,30]. In such circumstances, we consider to apply all diagnostics, including CT scan and endoscopic methods, with consideration of its availability.

In this case report we have showed follow up of the patient for 4 month, indicating excellent clinical approach for this particular case. However, it is worth to mention, that follow-up for the combat patients can not be performed in all cases, due to absence of universal follow up network between the hospitals, which is a limitation.

The possible future perspectives might be obtain from this case reports in management of patients with isolated or combined thoracoabdominal gunshot injury in war settings. All cases of the war related injury might be associated with unusual clinical course, representing a clinical challenge to the surgeons, which is in line with our previous publications showing surgical challenges in patients injured in war in Ukraine [1,3,4,7,8,20,31–33]. We suggest to consider all possible approaches for the management of the patient, including minimally invasive surgery such as bronchoscopy, thoracoscopy and laparoscopy if applicable and with regards to the possible strikes on the medical facilities by the aggressor.

4. Conclusions

Removal of a foreign body (metal fragment) of gunshot origin from the lumen of a segmental bronchus by using bronchoscopy with endoscopic forceps is a rare phenomenon. The use of minimally invasive technologies in the treatment of gunshot blind penetrating wounds of the chest contributes to the reduction of operative trauma and shortens

the time of operative treatment. The application of minimally invasive surgical tools might be considered as a future perspective for military medical units on routine basis.

CRediт authorship contribution statement

Igor Lurin - Conceptualization; Data curation; Formal analysis; Writing - original draft; Writing - review & editing), final approval

Eduard Khoroshun - Writing - review & editing; resourses

Vitalii Makarov - Formal analysis; Visualization; Writing original draft; Writing – review & editing

Volodymyr Nehoduiko - Formal analysis; Visualization; Writing original draft; Writing – review & editing

Yevhenii Cherniavskyi - Writing - review & editing; editing figures

Maksym Gorobeiko - Writing - review & editing; editing figures

Olga Marchenko - Writing - review & editing; Formal analysis

Andrii Dinets - Supervision; Writing - review & editing, critical revision of the manuscript, final approval.

Consent for publication

Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Registration of research studies

N/A

Ethics approval and consent to participate

This study was approved by the Ethical Committee at the Kharkiv National Medical University (Kharkiv, Ukraine). The study was performed by the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Written informed consent was obtained from the participant.

Funding

The study received no funding.

Guarantor

Prof. Volodymyr Nehoduiko, MD, PhD

Declaration of competing interest

The authors declare that they have no competing interests.

Data availability

All data regarding this case report has been reported in the manuscript. Please contact the corresponding author in case of require any further information.

References

[1] I. Lurin, O. Burianov, Y. Yarmolyuk, Y. Klapchuk, S. Derkach, M. Gorobeiko, et al., Management of severe defects of humerus in combat patients injured in Russo-Ukrainian war, Injury 55 (2) (2024) 111280.

[2] I. Lurin, E. Khoroshun, V. Negoduiko, V. Makarov, S. Shypilov, V. Boroday, et al., Retrieval of ferromagnetic fragments from the lung using video-assisted thoracoscopic surgery and magnetic tool: a case report of combat patient injured in the war in Ukraine, Int. J. Emerg. Med. 16 (1) (2023) 51.

[3] S.V. Tertyshnyi, I. Lurin, I.P. Khomenko, K.V. Gumeniuk, V.Y. Shapovalov, V. V. Nehoduiko, et al., A new approach for reconstruction of the gunshot defect of the flexor surface of the ungual (distal) phalanx by the proper transverse branch of the digital artery: a case report of combat patient injured in the Russo-Ukrainian war, Scand. J. Trauma Resusc. Emerg. Med. 31 (1) (2023) 64.

[4] V.M. Rogovskyi, B. Koval, I.A. Lurin, K. Gumeniuk, M. Gorobeiko, A. Dinets, Temporary arterial shunts in combat patient with vascular injuries to extremities wounded in Russian-Ukrainian war: a case report, Int. J. Surg. Case Rep. (2023) 102.

[5] K. Gumeniuk, I.A. Lurin, I. Tsema, L. Malynovska, M. Gorobeiko, A. Dinets, Gunshot injury to the colon by expanding bullets in combat patients wounded in hybrid period of the Russian-Ukrainian war during 2014–2020, BMC Surg. 23 (1) (2023).

[6] I.V. Tsema, A.A. Bespalenko, A.V. Dinets, B.M. Koval, V.G. Mishalov, Study of damaging factors of contemporary war, leading to the limb loss, Novosti Khirurgii. 26 (3) (2018) 321–331.

[7] I. Lurin, O. Vorovskiy, V. Makarov, E. Khoroshun, V. Nehoduiko, A. Ryzhenko, et al., Management of thoracoabdominal gunshot injuries by using minimally invasive surgery at role 2 deployed field hospitals in Ukraine, BMC Surg. 24 (1) (2024) 183.

[8] K. Gumeniuk, I.A. Lurin, I. Tsema, L. Malynovska, M. Gorobeiko, A. Dinets, Gunshot injury to the colon by expanding bullets in combat patients wounded in hybrid period of the Russian-Ukrainian war during 2014-2020, BMC Surg. 23 (1) (2023) 23.

[9] V. Tsymbaliuk, I. Lurin, K. Gumeniuk, O. Herasymenko, S. Furkalo, D. Oklei, et al., Modeling of wound ballistics in biological tissues simulators, Medicni Perspektivi. 28 (1) (2023) 37–48.

[10] M.E. Boleken, A. Dusak, T. Günendi, O.H. Kocaman, V. Kaya, M.E. Dörterler, Bullet trajectory detection in the lung: multiplanar reformatted imaging of multidetector computed tomography in children, Ulus. Travma Acil Cerrahi Derg. 29 (2) (2023) 176–182.

[11] A. Swiech, G. Boddaert, J.L. Daban, E. Falzone, S. Ausset, M. Boutonnet, Penetrating thoracic injuries: a retrospective analysis from a French military trauma Centre, BMJ Mil Health. 167 (1) (2021) 33–39.

[12] F.H. Kakamad, R.K. Ali, S.H. Mohammed, H.A. Sofi Mohammed, M.Q. Mustafa, A. M. Salih, et al., Single port video-assisted thoracoscopic surgery for removal of a retained bullet in the lung parenchyma; a case report with literature review, Ann Med Surg (Lond). 71 (2021) 102977.

[13] A.N. Radjou, M. Uthrapathy, Video-assisted thoracoscopy in trauma: case report and review of literature, Lung India 28 (2) (2011) 142–144.

[14] G.A. Marsico, A.L. Almeida, D.E. Azevedo, G.C. Venturini, A.E. Azevedo, Marsico PoS, Video-assisted thoracoscopic removal of foreign bodies from the pleural cavity, J. Bras. Pneumol. 34 (4) (2008) 241–244.

[15] L.L. Stafman, L.G. Gutwein, D.N. Ang, Use of video-assisted thoracoscopic surgery in penetrating chest trauma, J. Thorac. Cardiovasc. Surg. 146 (4) (2013) 979.

[16] M.W. Khalil, T. Khan, S. Gower, M. Loubani, Removal of a bullet in the pericardial cavity by video-assisted thoracoscopic surgery, Interact. Cardiovasc. Thorac. Surg. 15 (2) (2012) 297–298.

[17] C. Sohrabi, G. Mathew, N. Maria, A. Kerwan, T. Franchi, R.A. Agha, et al., The SCARE 2023 guideline: updating consensus surgical CAse REport (SCARE) guidelines, Int. J. Surg. 109 (5) (2023) 1136–1140.

[18] J. Ng, S. Kim, B. Chang, K. Lee, S.W. Um, H. Kim, et al., Clinical features and treatment outcomes of airway foreign body aspiration in adults, J. Thorac. Dis. 11 (3) (2019) 1056–1064.

[19] H. Kim, G. Byun, S.J. Lee, S.H. Woo, Removal of a bronchial foreign body by Bronchoscopic cryotherapy: a case study, Medical Lasers; Engineering, Basic Research, and Clinical Application. 10 (1) (2021) 55–59.

[20] R.V. Gybalo, I.A. Lurin, V. Safonov, D.I. Dudla, D.V. Oklei, A. Dinets, Retained bullet in the neck after gunshot wounds to the chest and arm in combat patient injured in the war in Ukraine: a case report, Int. J. Surg. Case Rep. 99 (2022) 107658.

[21] I. Khomenko, I. Tsema, P. Shklyarevych, K. Kravchenko, V. Holinko, S. Nikolaienko, et al., Pulmonary artery embolism by a metal fragment after a booby trap explosion in a combat patient injured in the armed conflict in East Ukraine: a case report and review of the literature, J Med Case Reports 12 (1) (2018) 330.

[22] E.Y. Widjaja, D. Jiwangga, C.N. Rachmi, A rare case of migration of ballistic projectile from left to right main bronchus, Medical Journal of Indonesia. 31 (3) (2022) 207–210.

[23] I. Lurin, E. Khoroshun, V. Negoduiko, V. Makarov, S. Shypilov, V. Boroday, et al., Retrieval of ferromagnetic fragments from the lung using video-assisted thoracoscopic surgery and magnetic tool: a case report of combat patient injured in the war in Ukraine. International, J. Emerg. Med. 16 (1) (2023).

[24] A. Dinets, O. Nykytiuk, M. Gorobeiko, O. Barabanchyk, N. Khrol, Milestones and pitfalls in strategic planning of healthcare in capital city in transition, Georgian Med. News 315 (2021) 189–195.

[25] K.L. Swanson, E.S. Edell, Tracheobronchial foreign bodies, Chest Surg. Clin. N. Am. 11 (4) (2001) 861–872.

[26] J. Fulginiti, H.V. Dedhia, J. Kizer, G. Timberlake, Retrieval of an aspirated bullet fragment by flexible bronchoscopy in a mechanically ventilated patient, Chest 103 (2) (1993) 626–627.

[27] J.H. Choh, R.H. Adler, Penetrating bullet wound of chest with bronchoscopic removal of bullet, J. Thorac. Cardiovasc. Surg. 82 (1) (1981) 150–153.

[28] A.K. Prakash, A. Jaiswal, A. Aggarwal, B. Datta, S. Khanna, K.K. Handa, et al., Bullet in tracheobronchial tree without lung contusion removed by fibreoptic bronchoscopy in two parts, Respir. Med. Case. Rep. 26 (2019) 255–259.

[29] E.A. Lax, S.H. Kiran, M.W. Lee, Bronchoscopic retrieval of a bullet using a Dormia basket: a case report, J Med Case Reports 8 (2014) 358.

[30] G.G. Fernandez-Ranvier, P. Mehta, U. Zaid, K. Singh, M. Barry, A. Mahmoud, Pulmonary artery bullet embolism-case report and review, Int. J. Surg. Case Rep. 4 (5) (2013) 521–523.
[31] S. Golovko, R. Gybalo, I. Lurin, I. Taraban, A. Kobirnichenko, V. Ganiuk, et al., Penetrating gunshot wounds to the penis: a case report of combat patient injured in the war in Ukraine, Int. J. Emerg. Med. 16 (1) (2023) 5.
[32] A. Kazmirchuk, Y. Yarmoliuk, I. Lurin, R. Gybalo, O. Burianov, S. Derkach, et al., Ukraine's experience with Management of Combat Casualties Using NATO's four-tier "changing as needed" healthcare system, World J. Surg. 46 (12) (2022) 2858–2862.
[33] I. Khomenko, I. Tsema, P. Shklyarevych, K. Kravchenko, V. Holinko, S. Nikolaienko, et al., Pulmonary artery embolism by a metal fragment after a booby trap explosion in a combat patient injured in the armed conflict in East Ukraine: a case report and review of the literature, J Med Case Reports 12 (1) (2018).