

Available online at www.sciencedirect.com

ScienceDirect

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

Case Report

Pure ballistic sonic pressure wave lung injury on computed tomography (CT) and plain radiograph [☆]

Fadhila Mohd Hanapiah, MD^{a,b}, Ahmad Aizuddin Mohamad Jamali, MBBS, MMed^{a,b,*}, Mohd Ezane Aziz, MD, MMed^{a,b}, Mohd Syazwan Mohktar, MBBS, MMed^c, Zul Khairul Azwadi Ismail, MD, MMed^{a,b}, Mohd Hafizuddin Husin, MD, MMed^{a,b}, Bazli Md Yusoff, MbBCH BaO, MMed^{a,b}

^aRadiology Department, Hospital Universiti Sains Malaysia, Jalan Raja Perempuan Zainab 2, 16150, Kota Bharu, Kelantan, Malaysia

^bRadiology Department, Universiti Sains Malaysia Health Campus, Kota Bharu, Kelantan, Malaysia

^cRadiology Department, Hospital Tawau, Tawau, Sabah, Malaysia

ARTICLE INFO

Article history:

Received 12 April 2023

Revised 28 April 2023

Accepted 30 April 2023

Keywords:

Ballistic lung injury

Sonic pressure wave

Ballistic computed tomography

ABSTRACT

Sonic pressure wave should be taken into consideration in all ballistic injury. We review a young gentleman with ballistic injury of his lateral chest wall. The bullet trajectory passed through the lateral chest wall. Chest radiograph shows a wedge-shaped consolidation adjacent to the wound with blunted right costophrenic angle. Subsequent CT scan confirms the consolidation adjacent to the bullet trajectory. This case report emphasizes on value of CT in ballistic chest trauma and indirect injury caused by the sonic pressure wave of the bullet.

© 2023 The Authors. Published by Elsevier Inc. on behalf of University of Washington.

This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

Introduction

Malaysia is among the strictest country in the world regulating firearm ownership. According to the Arms Act 1960, no person is allowed to possess, carry or use any firearms or ammunition without a valid arms license or permit. Therefore, possessing one is considered almost impossible in the country. Hence, firearm injury is not commonly encountered in our emergency setting, as compared to countries with liberal access to firearms. The ballistic injury involves a series

of complex mechanism of damage pathway that may include direct injury to tissues, cavitation or pressure shock wave.

We report a case in which a gunshot injury manifests a shock wave pattern on lung parenchyma.

Case report

A 30-year-old gentleman, a law enforcement officer, previously well with no record of medical illness, was brought to

[☆] Competing Interests: The authors have declared that no competing interests exist.

* Corresponding author.

E-mail address: aizuddinjamali@gmail.com (A.A.M. Jamali).

<https://doi.org/10.1016/j.radcr.2023.04.058>

1930-0433/© 2023 The Authors. Published by Elsevier Inc. on behalf of University of Washington. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

the emergency department after sustaining gunshot wound over the right chest wall with the suspicion of transthoracic trajectory. The injury was self-inflicted when his Walther P99 semi-automatic pistol loaded with .40 S&W 9 mm bullet was incidentally fired within range less than 5 meter, unintentionally. On arrival to trauma center, he was hemodynamically stable with no neurological deficit and notably, not in respiratory distress. He was alert, with full Glasgow Coma Scale (GCS) and normal vital signs. The main complaint was pain and bleeding over the injury site, with blood-stained cough.

Focused assessment with sonography in trauma (FAST) examination was unremarkable without evidence of pleural or pericardial effusion. We proceeded with CT thorax to ascertain the degree of lung injury and to look for possible retained fragmented bullet substances.

Discussion and conclusion

Pulmonary trauma is common in high-velocity injuries. Unlike most other organs, the lung is elastic and distensible, with a physiologic capacity to withstand significant changes in contour and volume [1]. The most common types of lung parenchymal injury are contusion, atelectasis, laceration and hematoma [2] - each having characteristic imaging appearances.

In our case, we have observed a peculiar pattern of lung injury with wedge-shaped consolidation with surrounding ground-glass opacity on CT thorax findings. What makes it even more astonishing and interesting was the fact that the bullet trajectory was in an oblique pattern with a composite

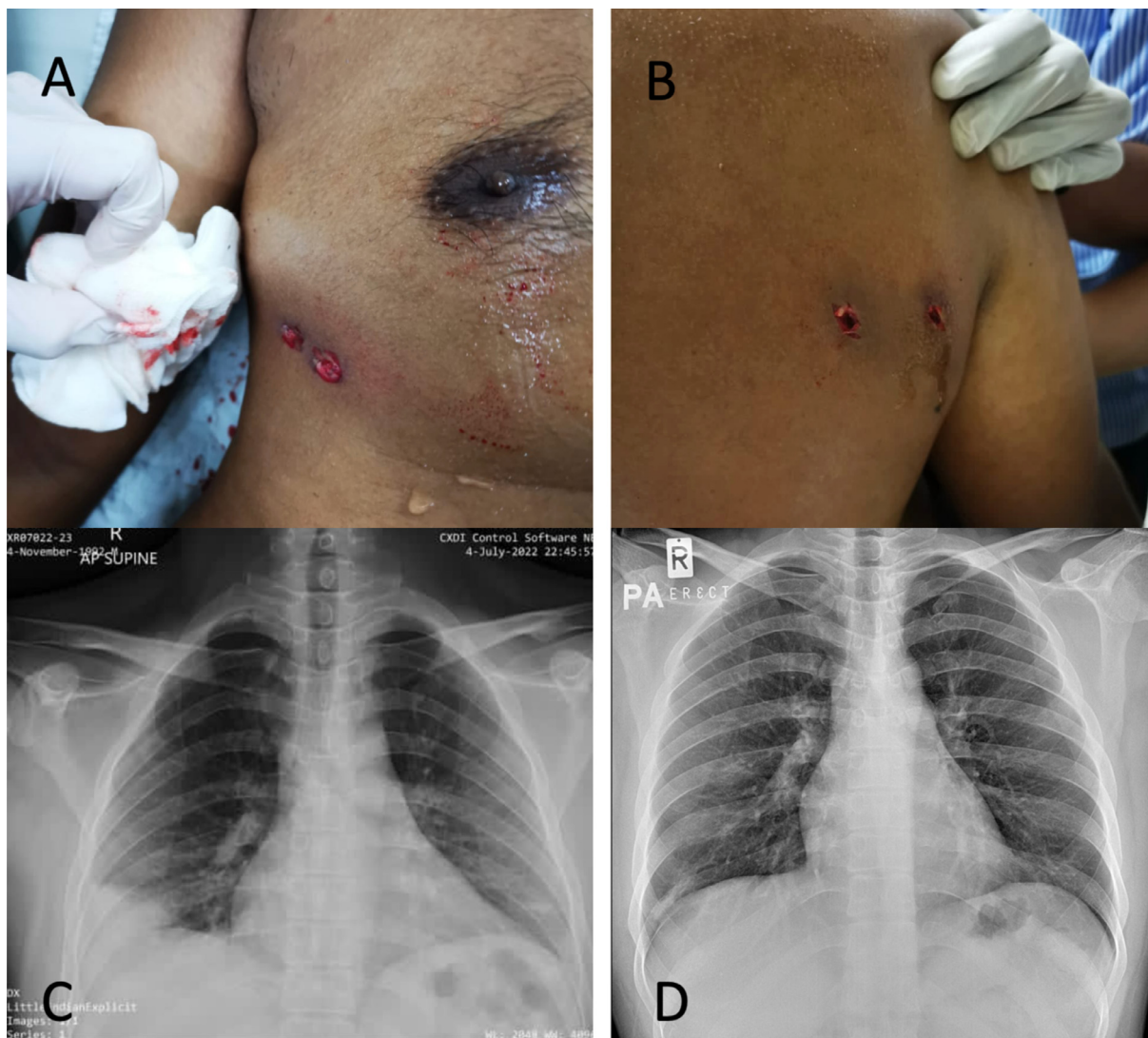


Fig. 1 – (A) Two oval-shaped entry wounds measuring approximately 1 cm x 2 cm at right anterior axillary line, at the level of seventh intercostal space. Abrasion collar seen, surrounding the wound defect. The wounds were 0.5 cm from each other. (B) Exit wound at the back with stellate-shaped adjacent to the posterolateral margin of the right scapula at mid-scapular line, at the level of third intercostal space, measuring 1 cm x 1 cm each, approximately 2 cm apart from one another. (C) Chest radiograph taken during admission demonstrates a loculated triangular opacity at right lower lateral margin with preservation of right costophrenic angle. (D) Resolution from the ballistic lung injury 1 week after.

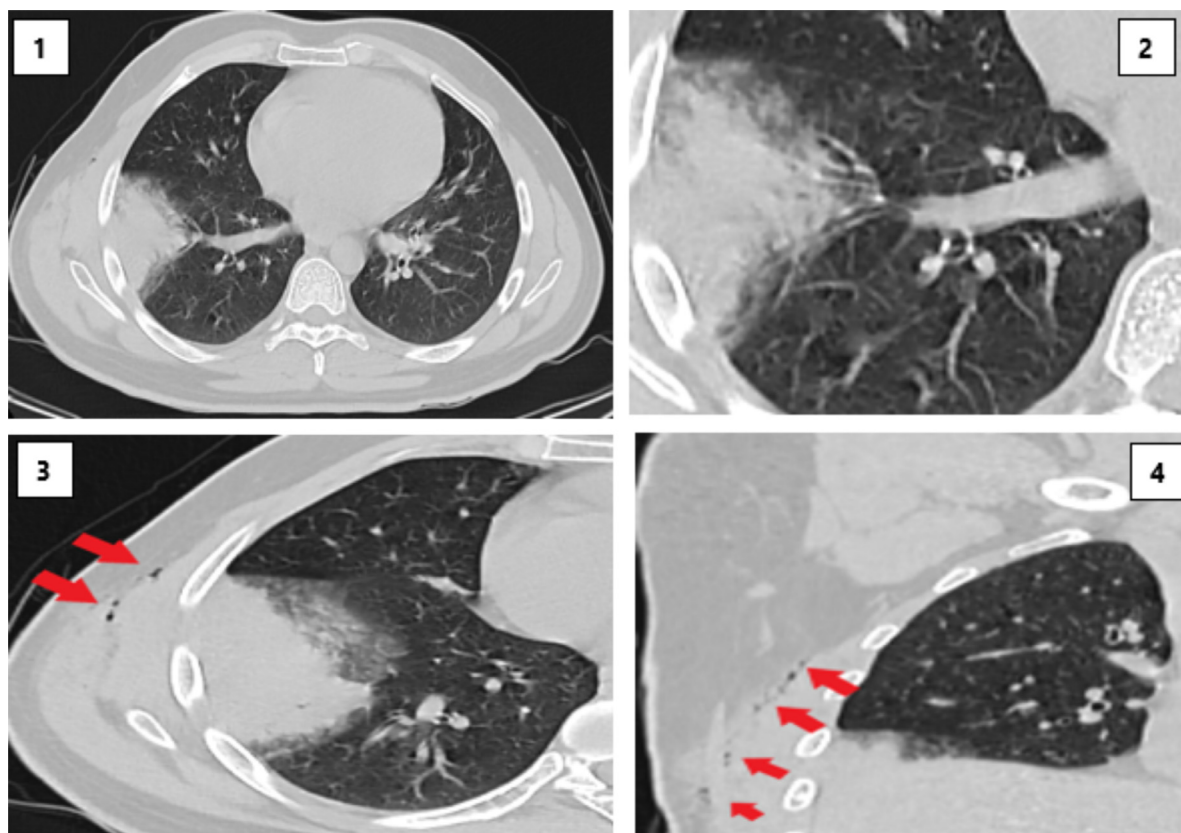


Fig. 2 – A large wedge-shaped homogeneous opacity and air bronchogram at lateral basal segment of left lung (A). In close up view (B), irregularity within the subsegmental bronchus may represent fluid. Subcutaneous emphysema adjacent to bullet trajectory (C,D).

of complex bullet pathway (antero-posterior, latero-medially and infero-superior) direction – going through the anterior chest wall at the level of seventh intercostal space, traversing lateromedially from lower border of lateral skin margin of right chest wall, going upward towards the axilla and crossing the shoulder region at the back (by sparing the thoracic cavity), and exiting posteriorly at the level of third intercostal space. By CT imaging, we found no evidence of transthoracic projectile, no linear or tubular track lung contusion. No retained bullets seen, supported by physical and visual evidence identified on patient himself and was further confirmed by definitive CT findings (Figs. 1 and 2).

We concluded in our case that the lung parenchymal injury pattern inflicted by the ballistic wound was mostly contributed by sonic pressure wave mechanism. As described in literature, this pattern of injury is produced by an indirect effect of a bullet passing through the tissues without physical contact between both the tissue and projectile. It is a highly dynamic pressure phenomenon which involves a radial stretching of the tissue around the bullet tunnel, and at the point of impact, a stress wave is generated and rapidly spreads ahead from the maximum pressure point at the leading edge of the bullet [3].

This patient deemed extremely fortunate to survive such a traumatic circumstance. He was able to be discharged home with no solid vital organ injury after a-week stay in hospital.

Though in Malaysia, we have rare occurrences of gunshot injury in emergency setting, but the consequences of ballistic injury can be quite damaging and unpredictable since it may be influenced by various physical and dynamic properties of a projectile, including its mass, caliber, trajectory, velocity, distance travelled and as well as spin motion [3]. A complex mechanism behind it can be manifested with perplexed medical and radiological findings – as uncommon as this one-of-a-kind case.

Patient consent

Verbal and written informed consent was obtained from the patient for inclusion in this case report. Research and ethics committee approval for this case report is not a requirement according to Medical Research and Ethics Committee and Institute of Clinical Research Malaysia.

REFERENCES

- [1] Brittany TL, Keith DH, Scott AH, Travis H, Brent PL, David MN, et al. Imaging manifestation of Chest trauma. *RadioGraphics (RSNA)* 2021;41:1321–34. doi:10.1148/rg.2021210042.

[2] de Melo ASA, Moreira LBM, Pessoa FMC, Saint-Martin N, Ancilotti Filho R, Souza AS Jr, et al. Tomographic aspects of penetrating thoracic trauma: injuries from firearms and other weapons. *Radiol Bras* 2017;50(6):372–7.

[3] Yuuki M, Sena I, Emiri S, Sato Y, Shindo K, Ishida M, et al. Atypical gunshot injury traversing the neck with an unexpected non-linear bullet trajectory: a case report and review of the literature. *SN Compr Clin Med* 2021;3:765–71. doi:10.1007/s42399-021-00760-3.