

A retrospective review of the management and outcome of patients with retained intrathoracic foreign bodies

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Background: Minimally invasive surgery has transformed surgery. Video-assisted thoracoscopic surgery (VATS) has been used for a few specific acute indications, however there is a paucity of data describing the management of intrathoracic foreign body removal compared to open thoracotomy.

Method: A retrospective observational chart review of patients requiring surgical management of retained intrathoracic FB during the period of January 2005 to December 2021 at Inkosi Albert Luthuli Central Hospital was undertaken. This was approved as a sub-study of BCA207-09 by the UZKN BREC.

Results: Forty-two patients were identified. Sixteen (38%) were paediatric patients and 26 (62%) adults, with average age of 24 years (6 months–69 years) and a male predominance (78.6%). VATS was used initially in 33 patients, successfully in 11 (26%) and 12 (28%) required conversion to thoracotomy, while in 15 (36%) a thoracotomy was the initial procedure. Four (10%) required other surgical options. Median hospital stay was 7 days. Fourteen patients required postoperative ICU admission, 50% being those post-aspiration injury. Mechanistically, 13 were FB aspiration (31%), 25 trauma (60%) and 4 iatrogenic (9%) causes. Aspiration occurred only in paediatric patients. Among the trauma patients, 23 were adult and 2 paediatric. These included 12 retained knife blades, eight with bullets or bullet fragments in situ, 1 nail and 2 sewing needles. Of these, 8 were managed successfully with VATS (1 bullet and 7 knife blade extractions) and 12 required conversion to thoracotomy or sternotomy. Both paediatric patients with sewing needle FB required thoracotomy. Regarding the iatrogenic FB, two Malecot® drains were removed with VATS and one patient required bilateral thoracotomies for removal of intercostal drain caps.

Conclusion: Approximately 25% of all intrathoracic retained FB can be successfully removed by VATS, while many still require thoracotomy. Most patients will recover without sequelae.

Keywords: VATS, thoracotomy, foreign body intrathoracic, trauma, iatrogenic

Introduction

Open thoracotomy for penetrating trauma was pioneered in the late 1800s to allow for direct cardiac massage following a traumatic cardiac arrest.¹ A century later it remains an important skill for cardiac and trauma surgeons. Advancement in minimally invasive surgery has transformed thoracic surgery. Previously video-assisted thoracoscopic surgery (VATS) in the acute setting had few indications, namely managing retained or clotted haemothoraces, persistent pneumothoraces, and evaluation of diaphragmatic injuries in penetrating thoracoabdominal trauma.^{2,3} A newer indication is the management of retained intrathoracic foreign bodies (FB) that pose unique challenges depending on location in the chest, but may include delayed diagnosis (due to infective signs), migration with associated lung collapse or erosion of thoracic vessels, infection, and as a result of the potential difficulty in surgical access (e.g. mediastinal FB). The aim of this study is to describe the approaches to management of retained intrathoracic FB using either VATS or open surgical removal.

Patients and methods

This retrospective observational chart review aimed to identify patients admitted for surgical management of a retained intrathoracic FB during the period of January 2005 to December 2021 at the cardiothoracic surgical division at Inkosi Albert Luthuli Central Hospital. The study was approved as a sub-study of the IALCH Ethics Class Approval BCA207/09 by the University of KwaZulu-Natal biomedical research ethics committee.

Records were reviewed for patient age, sex, cause and type of retained FB, anatomical location, preoperative investigations, surgical method of removal, length of hospital stay, ICU admission, postoperative and long-term complications. All consecutive patients referred for management of a retained intrathoracic (airway, pleural space or lung parenchymal FB) or mediastinal FB were included from the records of the hospital trauma registry. Retained FB were defined as those where attempted removal by a primary discipline (e.g. paediatric or adult pulmonology

or using basic flexible bronchoscopy) was unsuccessful or not physically possible.

Radiological investigations (CXR or CT with contrast) as appropriate to injury mechanism were assessed. All patients underwent bronchoscopy evaluation to exclude airway injury.

Management

Operative technique – posterolateral thoracotomy

The patient is placed in the lateral decubitus position. The incision begins anterior to the anterior axillary line to midway between the vertebral column and medial edge of the scapula. The pleura is entered through the 5th intercostal space and a Finochietto retractor used to spread the ribs. Apical and basal pleural chest tubes are routinely placed during closure. The bronchus, if opened, is closed with polyglactic acid sutures and a leak test performed prior to completion. The thoracotomy incision is closed in the standard fashion.

Operative technique – VATS

The patient is placed in the lateral decubitus position. A horizontal incision is made at the 4th or 5th intercostal space overlying the anterior axillary line. Uniportal VATS is favoured.

A second intrathoracic port can be placed caudally. A 30-degree rigid telescope is used for visualisation. A flexible wound protector is used for retraction of soft tissue.

Postoperatively one pleural drain is required. Only muscle, subcutaneous and skin closure is performed.

Empiric antibiotics were prescribed for all patients with retained intrathoracic FB. Intraoperative specimens were obtained if clinical signs of infection were present and directed antibiotics given as per the sensitivity of the organism cultured. Patients were followed up at 6 weeks, 3,6 and 12 months after discharge.

Results

Forty-two FB removal cases were identified, 16 (38%) paediatric and 26 (62%) adults. The average age was 24 years (range 6 months–69 years) with a male predominance of 33 patients (78.6%), with 23 adult and 10 paediatric cases compared to 9 females (21.4%), this being 4 adult and 5 paediatric cases.

Eleven (26%) patients were managed successfully with VATS, while 12 (28%) necessitated conversion to thoracotomy. For the remaining 15 (36%) thoracotomy was the initial procedure of choice. The median hospital stay was 7 days with an interquartile range of 4–11 days.

Fourteen patients required postoperative ICU admission, 50% being those post-aspiration injury. The patients could be divided into three general groups as noted in Table I. Locations of aspirated FB are noted in Table II and traumatic FB location in Table III.

Table I: Injury pattern – mechanism of injury

Aspirated		Trauma		Iatrogenic	
Bead	3	Knife blade	12	Malecot® tube	
Plastic whistle/piece	4	Bullet/pellet	8	ICD cap	
Pen cap/tip	4	Needle/pencil	4		

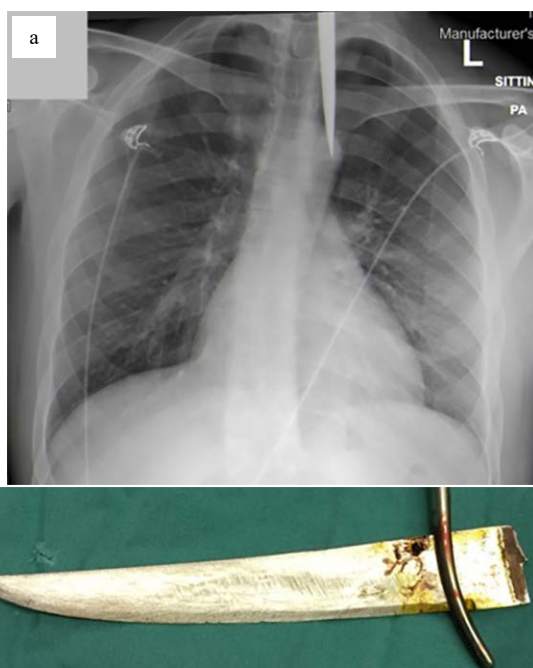


Figure 1: Knife in chest
Chest radiograph showing a retained left intrathoracic knife blade following posterior neck stab (Zone 3). The knife handle had broken off. After major vascular injury was excluded on preoperative CT aortic angiogram, the knife was removed under VATS guidance in the right lateral position.

In two of the patients with aspiration the FB was discovered incidentally during routine work-up for a chest infection and the others were witnessed events.

Table II: Location of aspirated foreign body

Right main bronchus	8
Left main bronchus	2
Trachea	2
Cricopharyngeus	1

Table III: Location of traumatic foreign body

Right thoracic cavity	8
Left thoracic cavity	11
Pericardium	3
Descending periaortic space	1
Mediastinum	1
Soft tissue of pericardial box	1

An 8-year-old male underwent a right posterolateral thoracotomy for an aspirated cigarette lighter bulb given the potential catastrophic consequence of shattering the bulb during removal at bronchoscopy. It was removed via bronchotomy from the bronchus intermedius.

A 6-year-old child was referred to base hospital for respiratory failure requiring ventilation due to suspected

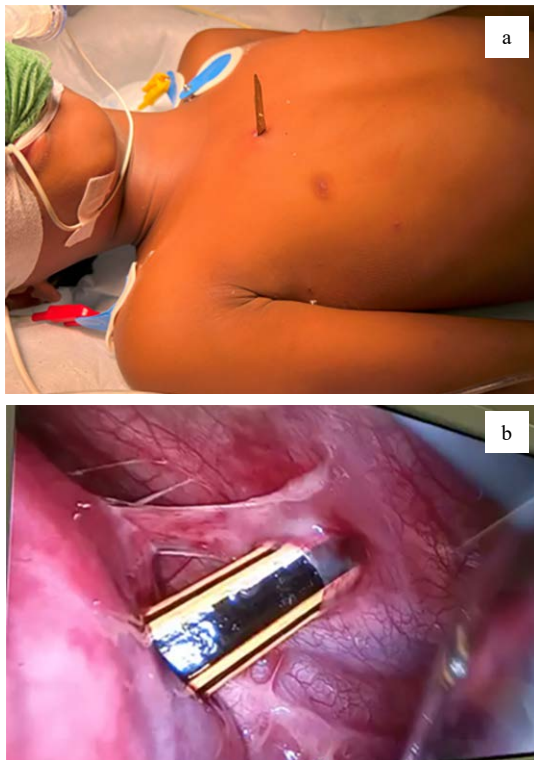


Figure 2: Child with pencil penetrating right chest – removed under VATS guidance

severe pneumonia. An opaque left lung was noted on chest X-ray (CXR) and the child was extubated 9 days later after empirical antibiotics. A post-extubation CXR demonstrated a shrunken opaque left lower lobe. Computed tomography (CT) demonstrated a saccular bronchiectasis of the left lower lobe and a FB obstructing the left lower lobe bronchus. The child underwent a left thoracotomy and left lower lobectomy, and a plastic pen cap was found.

Another 1-year-old presented with respiratory failure. CXR revealed an opaque left lung, and a foreign body was suspected. A bead was found at thoracotomy in the left main bronchus after failed bronchoscopy.

Paediatric trauma

A 1-year-old patient was found to have a FB in the mediastinum after a CXR to investigate recurrent fever and failure to thrive. A needle was found at thoracotomy with the tip in the pericardial cavity surrounded by fibrous tissue and was removed atraumatically.

A 10-year-old female unknowingly slept on a needle that migrated into the posterior aspect of her right lung and required intraoperative fluoroscopy location and right posterolateral thoracotomy for removal via bronchotomy.

Adult trauma

In the adult trauma cohort, 12 patients presented with a retained knife blade, 8 with bullets or bullet fragments in situ, 1 with a nail and 2 with sewing needles – one from a suicide attempt and the other following assault. In 20 of these patients, VATS was attempted at the outset. Of these 8 were managed successfully with VATS (1 bullet and 7 knife blade extractions) and 12 necessitated conversion to thoracotomy. The rest were removed via thoracotomy as the procedure of choice depending on the location, injury pattern and type of FB.

In one patient with a mediastinal bullet, the VATS procedure was initially attempted; however, no foreign body was located and a thoracotomy was performed where the bullet was palpated in close proximity to the right main bronchus (RMB) and extracted.

Another was taken for a sternotomy; however, no pericardial injury was noted intraoperatively. Intraoperative fluoroscopy was performed to locate the foreign body (bullet fragment) which was deduced to be lodged within the sternum and was left in situ.

A young woman with a bullet in close proximity to the aorta as well as a left subclavian artery (SCA) injury underwent a posterolateral thoracotomy due to the aforementioned risk criteria. The preoperative CT angiogram showed reconstitution of the SCA and clinically the limb was not threatened. The vascular team decided to manage the injury conservatively. The intraoperative findings were of localised adventitial hematoma around the thoracic descending aorta, which did not warrant exploration, and the bullet was extracted without sequelae.

One patient presented after injury on duty with a nail-gun nail in the anterior mediastinum during VATS abutting the right upper lobe. Removal, however, required a conversion to a lateral thoracotomy. Another patient presented with part of a knife blade sticking out of the jugular notch, a contrast swallow did not reveal oesophageal perforation, and a vascular injury was excluded prior to VATS which demonstrated a distal tracheal laceration. Conversion to a posterolateral thoracotomy was undertaken to extract the blade and repair the injury. In one female, VATS failed to locate a retained bullet fragment requiring conversion to a thoracotomy and it was subsequently found in close proximity to the right main bronchus and removed. She required postoperative extended hospital stay and ICU admission (Clavien-Dindo Grade IV-a).

Two patients had an extended stay post VATS, (Clavien-Dindo III-a and IV-a). The first was a delayed presentation of 3 days with a knife blade in the chest, removed via thoracoscopy complicated by persistent haemothorax postoperatively, but was managed conservatively. The other patient presented with a retained haemothorax following a gunshot chest. VATS evacuation of the clotted haemothorax, removal of the bullet fragment from the left lobar parenchyma and pleura decortication was undertaken. Postoperatively, ICU care was required for 3 days. The chest drain was kept in situ, and he was discharged on day 14.

A haemodynamically stable young female referred from a distant regional hospital case not requiring either VATS or open thoracotomy was impaled with a spear in the central thorax during intimate partner violence. The foreign body was visible both anteriorly and posteriorly and the patient required transfer in a sitting position. An awake intubation was performed, and the patient was placed in a lateral position ensuring no movement of the foreign body took place. Intraoperative fluoroscopy and on-table catheter angiography confirmed the spear trajectory avoided the great vessels and major organs and excluded vascular injuries. The FB was extracted, and post-extraction angiography confirmed the absence of vascular injuries.

Iatrogenic foreign bodies

With regard to the iatrogenic FB, there were 2 patients managed with ambulatory pleural drainage for chronic

Table IV: Long-term complications – age vs foreign body vs procedure

Complication and management	Foreign body	Age	Procedure
Bronchiectasis (at 3 months) - conservative	Pen cap	9	Thoracotomy
Chronic cough (at 6 months) - conservative	Pen cap	6	Thoracotomy
Pneumonia (at 6 weeks) - antibiotics	Bead	1	Thoracotomy
Lobar collapse (at 6 months) - physiotherapy and repeat bronchoscopy	Bead	6	Thoracotomy
Pleural effusion (at 6 weeks) - conservative with resolution at 6 months	Bullet	35	Converted from VATS
Sternal pain (at 3 months) - remove sternal wires	Bullet	53	Sternotomy

empyema thoracis. This involved the use of Malecot® drains which were cut short externally to allow drainage of pus into a colostomy bag. A napkin pin was inserted through the cut drain to prevent it dislodging into the pleural space. The retained drains were removed one with VATS and the other via thoracotomy.

A 6-month-old baby presented with severe pneumonia and bilateral tension pneumothoraces and further complicated with bilateral iatrogenic intrapleural plastic chest drain cap insertion. Staged bilateral thoracotomies were undertaken to remove the iatrogenic FB as the child was unsuitable for one lung ventilation. He had an extended ICU stay and was discharged well on day 70 (Clavien-Dindo IV-a).

Clinical outcomes

Three patients complicated postoperatively with hospital-acquired pneumonia; all were paediatric patients with FB aspiration (Clavien-Dindo II). Two paediatric patients complicated with empyema thoracis, one with bilateral empyema, the other with an incidental pre-existing finding of left lower lobe bronchiectasis from a chronic retained FB (Clavien-Dindo III-a). Fourteen patients required ICU admission postoperatively (8 paediatric, 6 adults). Table IV details the late complications identified at 3 or 6-month follow-up with 100% of these patients followed at least 6 months.

Discussion

Documentation of the removal of FB using VATS is rare, with case reports or case series dominating the literature. Retained chest drains and chest drain caps with management via VATS have rarely been reported in the literature.⁴

In cases of incidental thoracic FB and VATS removal, cases have been reported in the literature without any specific age predominance.⁵ In the current series, 5 patients presented with chest complaints and were found to have an incidental thoracic FB.

Of the 6 patients who showed long-term complications, four had aspirated FB. One patient post sternotomy for bullet pellet fragment removal complained of unresolving postoperative pain due to his sternal wires. The sternal wires were removed (Clavien-Dindo III-b).

These findings are in keeping with those reported in the literature. They showed patients in the VATS arm were more satisfied with their health status and surgical scar and return to lifestyle was quicker.⁶ Paediatric FB aspiration is one of the main causes of accidental morbidity and mortality.^{7,8}

In this study, we focused on the paediatric cohort that had aspirated FB which could only be removed through a bronchotomy via posterolateral thoracotomy. In these cases, VATS is not an option due to the difficulty and potential risks in attempting lung isolation. A male-to-female ratio

of 2:1 respectively was demonstrated in keeping with psychological and social developmental differences.⁹

Presenting symptoms vary from acute respiratory distress and stridor to cyanosis and asphyxiation. Often the incident is not witnessed, and the caregiver reports the child has a new onset cough, or failure to thrive. These patients have frequent admissions for chest infections and are treated with empirical antibiotics for pneumonia. Bronchoscopy is imperative where patients receive multiple courses of treatment with non-resolving chest infections to exclude intrabronchial FB.^{7,8,10} Non-metallic FB are not radio-opaque and do not show up on CXR, evading diagnosis. A FB must be excluded in those presenting with respiratory symptoms as irreversible bronchiectasis may result and removing the FB bronchoscopically may be fatal if any pus contamination of the unaffected bronchi occurs.^{9,11} In keeping with previous reports, similar location findings were noted, most commonly the right main bronchus, this being attributed to its anatomical structure.¹² Inorganic objects such as glass bulbs which are difficult to grasp may be removed via bronchotomy.¹¹

VATS has been uncommonly reported in the literature for removal of an aspirated FB following failed bronchoscopy. It has been previously reported to identify bronchial injury in case reports.¹³ In the current series of patients with aspiration, none had undergone VATS for retrieval of the FB. ICU admission is frequently necessary to mitigate the risk of bronchospasm post-extubation where multiple attempts at bronchoscopy result in subglottic and laryngeal oedema prior to progressing to definitive thoracotomy.⁷ In the current cohort 6 of the 14 patients requiring ICU had failed bronchoscopy.

Pericardial or intracardiac FB are infrequent, and usually due to penetrating cardiac injury. In most cases patients do not survive the initial trauma. In some rare instances it has been noted in case reports due to other causes, for example procedural intervention in patients undergoing cardiac or orthopaedic procedures.¹⁴

In the East infanticide is a common occurrence especially in female infants. Sewing needles have been used for this purpose, as they are easy to conceal.¹⁵ In the current study neither cases was attempted infanticide; however, one was an attempted suicide.

Traumatic pericardial FB are more common than non-traumatic in our setting.

It is advocated that all pericardial FB be removed even if they do not pose any immediate complications and are away from major blood vessels and valves, since these may cause pericarditis, arrhythmias, pericardial bleeding and may migrate to distal structures causing major complications. However, if the patient is asymptomatic and without risk,

these patients may be managed conservatively, especially if they are embedded in the cardiac muscle.^{14,16}

All four of our patients with a suspected pericardial FB underwent removal via thoracotomy or sternotomy. One patient who sustained a pellet gun injury presented with occasional chest pain 2 years later. Management of these cases needs to be tailored to the patient considering the risks of intervention.

VATS for pericardial window for penetrating cardiac injury in the haemodynamically stable patient has been successfully reported in the literature as a safe way to evaluate cardiac injuries.^{17,18} VATS may be effective in diagnosing and possibly retrieving pericardial FB safely without the complications of a thoracotomy, however more studies are needed before this can be recommended.

The earliest use of VATS in trauma comprised its use in diagnosis for diaphragmatic injuries.^{2,19,20} A contraindication to VATS is, however, the unstable patient who should be taken directly for a thoracotomy or sternotomy.²¹ Additionally, it is contraindicated where the facility or expertise for conversion to an open procedure is lacking.

VATS using the uniportal and biportal approach has been popularised²⁰. VATS has a well-recognised role in trauma surgery.^{19,22,23} It has various advantages over open thoracotomy, including shorter hospital stay, earlier recovery of respiratory function and less postoperative pain.¹⁶ This was reinforced in our trauma cohort where average hospital stay in those without concurrent injuries was 24–48 hours and no long-term complications were noted. It may be undertaken in all stable trauma patients who present with a retained FB, where imaging suggests safe uncomplicated removal. Paediatric and adult patients with aspirated FB are equally good candidates for safe removal with VATS. Complications should be anticipated and avoided.

The surgical decision of a thoracotomy versus VATS largely depends on the surgical competence with VATS and patient condition. If the potential for hemodynamic decompensation during the procedure and following removal of the retained foreign body exists, then open surgery is generally advocated (thoracotomy or sternotomy). Where removing the FB would be difficult to visualise and access efficiently with VATS, the conventional posterolateral thoracotomy remains unchallenged; however, initially starting the procedure with VATS in all cases of intrapleural FB is ideal for reducing the VATS learning curve.

Limitations

This study was conducted at a single quaternary-level academic institution, which may limit the generalisability of the findings to other clinical settings, particularly those with differing levels of surgical expertise, resources, or patient demographics. The surgeon's expertise in VATS will determine the applicability thereof to the average practising trauma or thoracic surgeon. Furthermore, the limited sample-size and retrospective nature, despite an electronic patient record and prospective registry, limits the contextualisation to the average trauma patient.

Conclusion

This study analysed the incidence of retained intrathoracic FB requiring surgical intervention at a quaternary centre, the Inkosi Albert Luthuli Central Hospital located in Durban, South Africa. The majority of patients required extraction

via either VATS or posterolateral thoracotomy. Clear roles were defined for each procedure and indications discussed. Performing VATS for removal of an intrathoracic foreign body is safe and effective in the haemodynamically stable patient, provided no contraindications exist. Prompt identification and individualised surgical intervention for retained intrathoracic FB is essential to minimise morbidity and optimise recovery.


Conflict of interest


Authors declare no conflict of interest. TC Hardcastle is an Associate Editor of various journals.

Ethical approval

Approved as a sub-study of the University of KwaZulu-Natal Biomedical Research Ethics Committee, BCA207-09 Class Approval toward the MMed study for Dr Manicum.

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REFERENCES

1. Alzaga-Fernandez AG, Varon J. Open-chest cardiopulmonary resuscitation: past, present and future. *Resuscitation*. 2005;64(2):149-56. <https://doi.org/10.1016/j.resuscitation.2004.06.022>.
2. Peter SY, Chan HH, Lau RW, et al. Penetrating thoracic injury with retained foreign body: can video-assisted thoracic surgery take up the leading role in acute management? *J Thorac Dis*. 2016;8(8):2247-51. <https://doi.org/10.21037/jtd.2016.07.05>.
3. Manlulu AV, Lee TW, Thung KH, Wong R, Yim APC. Current indications and results of VATS in the evaluation and management of hemodynamically stable thoracic injuries. *Eur J Cardio-thorac Surg*. 2004;25(6):1048-53. <https://doi.org/10.1016/j.ejcts.2004.02.017>.
4. Paddle A, Elahi M, Newcomb A. Retained foreign body following pleural drainage with a small-bore catheter. *Gen Thorac Cardiovasc Surg*. 2010;58:42-4. <https://doi.org/10.1007/s11748-009-0469-2>.
5. Shoko T. Accidental chest penetration of glass foreign bodies in a 53-year-old lady – The challenges with video assisted thoracoscopic extraction. *Int J Surg Case Rep*. 2016;23:124-7. <https://doi.org/10.1016/j.ijscr.2016.03.045>.
6. Ben-Nun A, Orlovsky M, Best LA. Video-assisted thoracoscopic surgery in the treatment of chest trauma: Long-term benefit. *Ann Thorac Surg*. 2007;83(2):383-7. <https://doi.org/10.1016/j.athoracsur.2006.09.082>.
7. Oğuzkaya F, Akçalı Y, Kahraman C, Bilgin M, Şahin A. Tracheobronchial foreign body aspirations in childhood: a 10-year experience. *Eur J Cardio-thorac Surg*. 1998;14(4):388-92. [https://doi.org/10.1016/S1010-7940\(98\)00205-X](https://doi.org/10.1016/S1010-7940(98)00205-X).
8. Agrawal SR, Gopi Shankar S, Joshi AA, Patekar S, Bradoo RA. Role of bronchoscopy and imaging in long-standing foreign body bronchus presenting as recurrent or non-resolving lower respiratory tract infection. *Eur Arch Otorhinolaryngol*. 2021;278:1477-81. <https://doi.org/10.1007/s00405-020-06497-4>.
9. Grover S, Bansal A, Singhi SC. Airway foreign body aspiration. *Ind J Paediatr*. 2011;78:1401-3. <https://doi.org/10.1007/s12098-011-0488-8>.
10. Tenjović Đ, Petrović S, Vilotijević DG, Lovrenski J, Bjelica RB. Clinical and radiological characteristics of unrecognised

- foreign body aspiration into respiratory tract in children. *Medicinski Pregled*. 2013;66(5-6):214-9. <https://doi.org/10.2298/MPNS1306214T>.
11. Ayed AK, Jafar AM, Owayed A. Foreign body aspiration in children: diagnosis and treatment. *Paediatr Surg Int*. 2003;19:485-8. <https://doi.org/10.1007/s00383-003-0965-x>.
 12. Zerella JT, Dimler M, McGill LC, Pippus KJ. Foreign body aspiration in children: Value of radiography and complications of bronchoscopy. *J Paediatr Surg*. 1998;33(11):1651-4. [https://doi.org/10.1016/S0022-3468\(98\)90601-7](https://doi.org/10.1016/S0022-3468(98)90601-7).
 13. Asaf BB, Vijay CL, Bishnoi S, Dua N, Kumar A. Thoracoscopic foreign body removal and repair of bronchus intermedius following injury during failed bronchoscopic retrieval. *Lung India*. 2017;34(2):182-4. <https://doi.org/10.4103/0970-2113.201296>.
 14. Wong MK, Rocha BA, Au TW. Intracardiac foreign body: A rare cause of recurrent fungemia. *J Cardiac Surg*. 2020;35(10):2844-6. <https://doi.org/10.1111/jocs.14875>.
 15. Huang LC, Dai XF. Video-assisted thoracoscopic removal of sewing needle in the ventricular septum. *Ann Thorac Surg*. 2020;110(6):e487-e488. <https://doi.org/10.1016/j.athoracsur.2020.04.057>.
 16. Oosthuizen GV, Clarke DL, Laing GL, et al. Introducing video-assisted thoracoscopy for trauma into a South African township hospital. *World J Surg*. 2013;37:1652-5. <https://doi.org/10.1007/s00268-013-2026-5>.
 17. Navsaria PH, Nicol AJ. Video-assisted thoracoscopic pericardial window for penetrating cardiac trauma. *S Afr J Surg*. 2006;44(1):18-20.
 18. Dato GMA, Arslanian A, Di Marzio P, Filosso PL, Ruffini E. Post-traumatic and iatrogenic foreign bodies in the heart: report of fourteen cases and review of the literature. *J Thorac Cardiovasc Surg*. 2003;126(2):408-14. [https://doi.org/10.1016/S0022-5223\(03\)00399-4](https://doi.org/10.1016/S0022-5223(03)00399-4).
 19. Radjou AN, Uthrapathy M. Video-assisted thoracoscopy in trauma: Case report and review of literature. *Lung India*. 2011;28(2):142. <https://doi.org/10.4103/0970-2113.80335>.
 20. Billetter AT, Druen D, Franklin GA, et al. Video-assisted thoracoscopy as an important tool for trauma surgeons: a systematic review. *Langenbecks Arch Surg*. 2013;398:515-23. <https://doi.org/10.1007/s00423-012-1016-7>.
 21. Cetindag IB, Neideen T, Hazelrigg SR. Video-assisted thoracic surgical applications in thoracic trauma. *Thorac Surg Clin*. 2007;17(1):73-9. <https://doi.org/10.1016/j.thorsurg.2007.02.007>.
 22. Khalil MW, Khan T, Gower S, Loubani M. Removal of a bullet in the pericardial cavity by video-assisted thoracoscopic surgery. *Interactive Cardiovasc Thorac Surg*. 2012;15(2):297-8. <https://doi.org/10.1093/icvts/ivs079>.
 23. Le Roux BT, Mohlala ML, Odell JA, Whitton ID. Suppurative diseases of the lung and pleural space part I: Empyema thoracis and lung abscess. *Curr Prob Surg*. 1986;23(1):5-89. [https://doi.org/10.1016/0011-3840\(86\)90031-6](https://doi.org/10.1016/0011-3840(86)90031-6).