









A Pictorial Review of Radiologic Findings of Foreign Bodies in the Thorax

흉부 이물의 영상의학적 소견

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Thoracic foreign bodies (FBs) are serious and relatively frequent in emergency departments. Thoracic FBs may occur in association with aspiration, ingestion, trauma, or iatrogenic causes. Imaging plays an important role in the identification of FBs and their dimensions, structures, and locations, before the initiation of interventional treatment. To guide proper clinical management, radiologists should be aware of the radiologic presentations and the consequences of thoracic FBs. In this pictorial essay, we reviewed the optimal imaging settings to identify FBs in the thorax, classified thoracic FBs into four types according to their etiology, and reviewed the characteristic imaging features and the possible complications.

Index terms Foreign Bodies; Thorax; Radiography; Computed Tomography, X-Ray

INTRODUCTION

Foreign bodies (FBs) are frequent and serious problems that occur in the thorax especially in emergency departments. FBs are more commonly found in children and are an important cause of morbidity and mortality in the pediatric population (1). In adults, iatrogenic or traumatic causes of FBs are much more common and associated with psychiatric disorders, developmental delay, alcohol intoxication, or dental procedures compared to children (2, 3). We have classified thoracic FBs into four types according to their causes: Type I; Aspiration, Type II; Ingestion, Type III; Trauma or accident, and

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Type IV; Iatrogenic.

Imaging plays an important role in the diagnosis of FBs and can be crucial for guiding clinical management in patients. Prompt identification, localization of FBs, and detection of any signs of obstruction or perforation are essential to determine the appropriate treatment, as several types of FBs require urgent removal and others can be managed conservatively; management depends on the characteristics of FBs such as shape, position, and composition (4).

The purpose of this pictorial essay is to demonstrate optimal imaging settings to identify FBs in the thorax. We have classified thoracic FBs into four types according to their etiology and reviewed characteristic imaging features and their consequences by presenting each case example.

IMAGING APPROACH FOR FBS

IMAGING MODALITIES

CONVENTIONAL RADIOGRAPHS

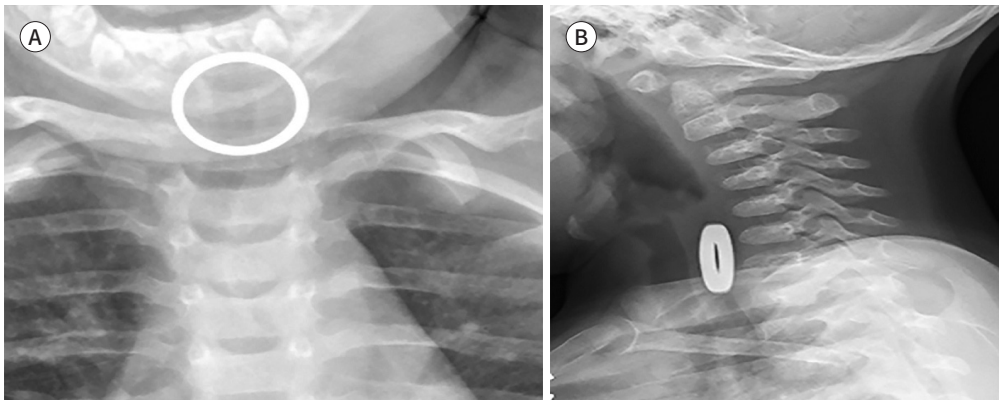
A radiograph is useful for the initial evaluation of suspected FB. Radiographs demonstrate most radiopaque FBs along with the location, size, shape, and number. Also, they help to distinguish aspiration from ingestion by a combination of frontal and lateral views and helps identify the location of FBs (Fig. 1) (4, 5). In children, additional expiration chest radiograph can help to identify presence of unilateral air trapping. And bilateral decubitus radiographs can be alternated when children cannot operate with expiration radiograph. However, nonradiopaque FBs limit the reliability of radiographs for initial evaluation like fish and chicken bones, wood, plastic, thin metal objects such as pull-tabs or pop-tabs of beverages (4). Generally, contrast study is not performed because it increases the risk of aspiration and can interrupt subsequent study by contrast coating of the FB and esophageal mucosa (5). Using the low-peak-kV technique (65–70 kVp), it can improve the visibility of low-opacity FBs on radiographs by increasing the contrast between the tissues and FBs (4).

Fig. 1. Ingestion of a gold ring in a 1-year-old boy.

A. The chest radiograph shows a ring-shaped metallic FB in the neck area.

B. The lateral radiograph of the neck shows the location of the FB posterior to the trachea, suggesting an esophageal FB.

FB = foreign body



CT

CT is a more sensitive tool for FB detection, although it may not detect radiolucent objects. The opacity of the object and the density of surrounding tissue influence on detectability of FB. Faintly opaque objects adjacent to osseous structures or muscles, detection might be difficult on both radiographs and CT. If faintly opaque objects are surrounded by air, the detection are more easy on CT than radiographs (4). CT unmask FB-associated complications undetectable on radiographs, such as abscess, empyema, or fistula formation and IV contrast agents may be helpful for diagnosis of inflammatory lesion (4). The sensitivity of CT may be improved with the use of multiplanar reformation (MPR) by enhancement of the visualization of FBs, re-

Fig. 2. A 40-year-old male with a history of aspiration of a pen lid 30 years ago.
A, B. The axial scan (**A**) and coronal multiplanar reformation (**B**) images demonstrate complete obstruction of the right bronchus intermedius by a radiopaque foreign body.

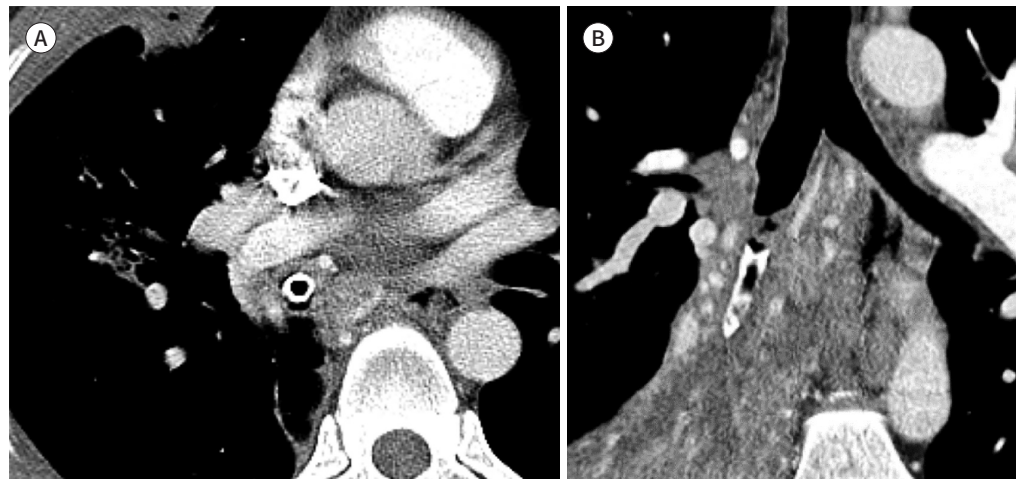
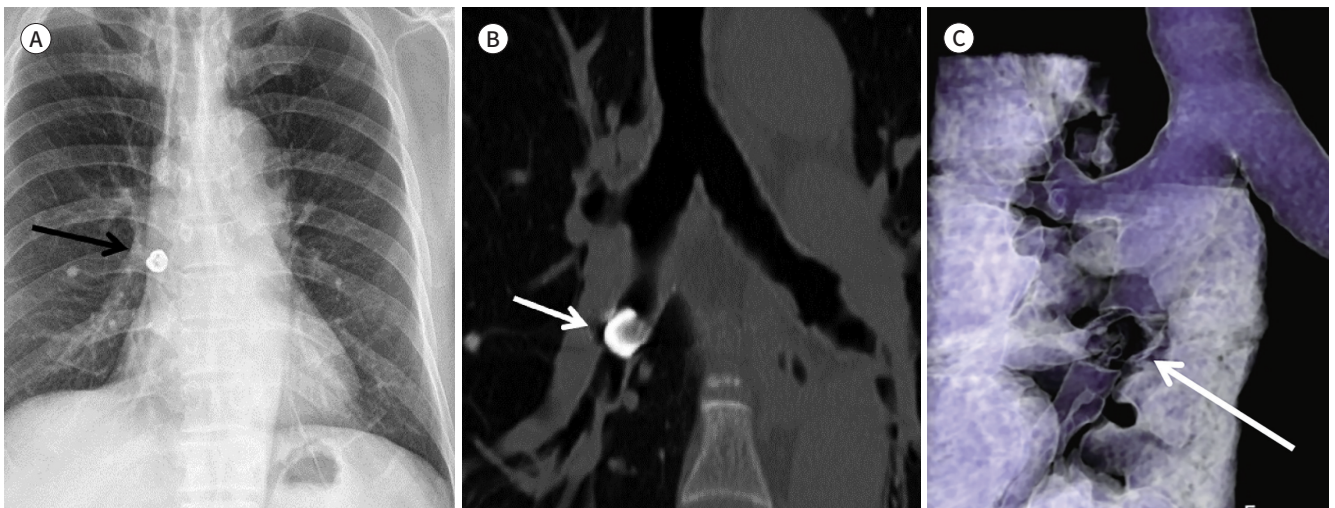


Fig. 3. A 74-year-old male who accidentally aspirated a metal tooth crown following tooth extraction.
A. The chest radiograph shows a radiopaque material (arrow) in the RBI.
B. The coronal multiplanar reformation images demonstrate the presence of a metallic FB (arrow) in the distal RBI.
C. A three-dimensional volume-rendering technique image also demonstrates that the FB (arrow) is impacting the RBI.
 FB = foreign body, RBI = right bronchus intermedius



assessing the extent of complication, and directing preprocedural planning (Figs. 2-4) (6).

Volume-rendering technique is diagnostically useful because it enables better detection of the extension and morphology of FBs with a significant reduction in time needed to analyze

Fig. 4. A 49-year-old female who choked while eating Tteokbokki (Korean traditional rice cake).
A. Sagittal multiplanar reformation image shows the presence of a triangular-shaped FB (arrow) in the LLL bronchus.
B. Volume-rendering technique image demonstrates that the triangular-shaped FB (arrow) is impacting the LLL bronchus.
 FB = foreign body, LLL = left lower lobar

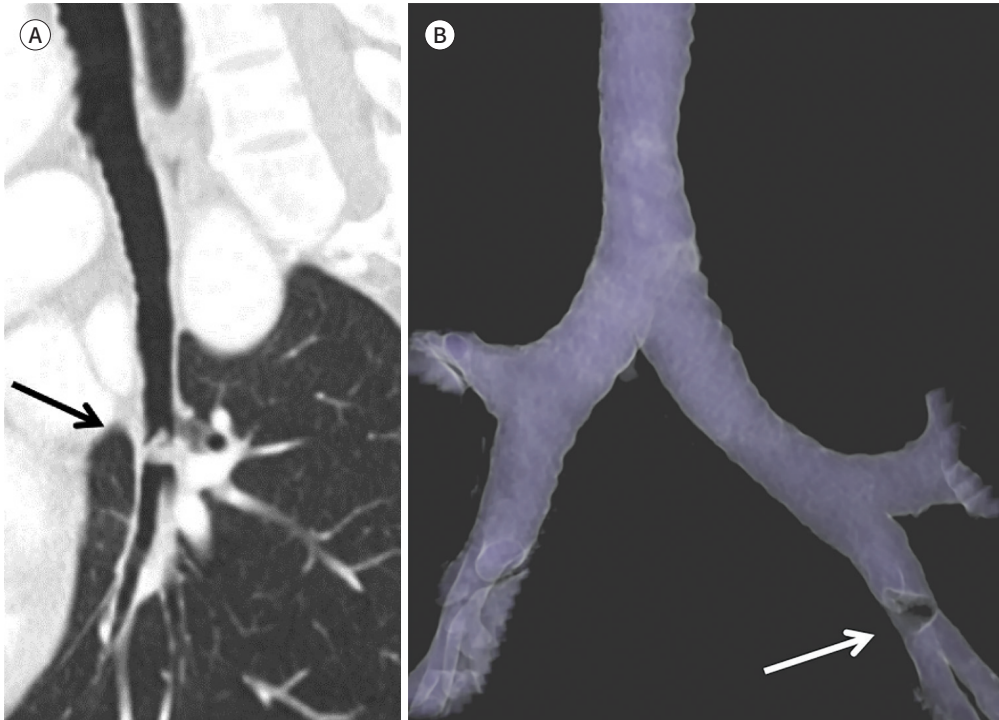
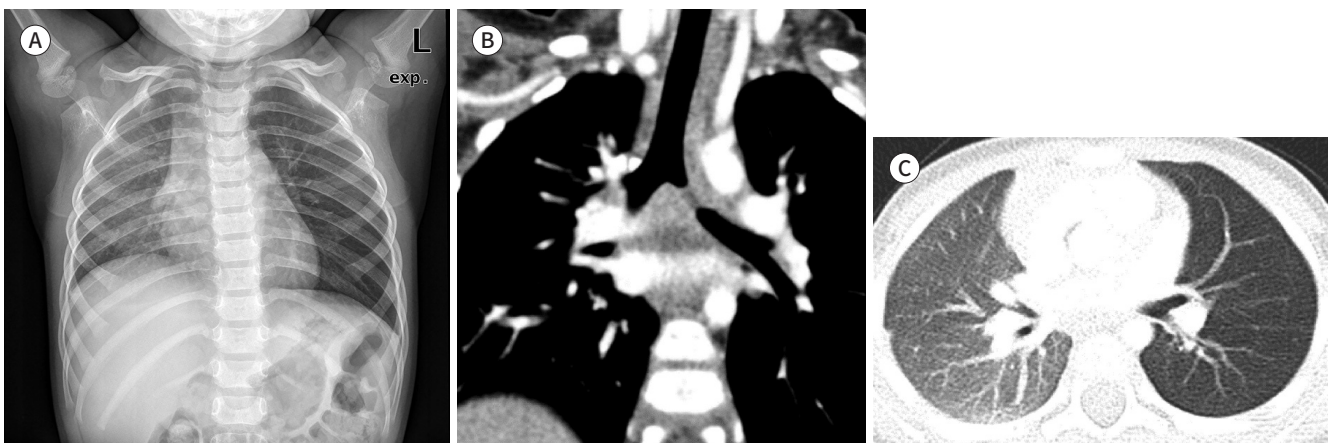


Fig. 5. A 20-month-old girl with a history of aspiration of almond slices.
A. The expiration radiograph shows low attenuation of the left lung.
B. The coronal multiplanar reformation image indicates the presence of a low-density material at the left main bronchus, suggesting the presence of foreign body.
C. Axial CT demonstrates low attenuation of the left lung due to hyperinflation.



complex structures in different planes and with the non-linear course (Figs. 3, 4). Thoracic FBs on chest CT, often appear negative on standard mediastinal window setting (level 45/width 440) (7). Therefore, manipulating images on wider window settings (lung: L -700/W 1500, bone: L 250/W 2056) may help better detection of FBs owing to the attenuation of the minor difference in density (7).

TYPES OF FBS

TYPE I; ASPIRATION (AIRWAY FBS)

FB aspiration is more frequent in children than in adults with peak incidence occurring in the second year of life among children (2).

In adults, it occurs under certain clinical conditions like swallowing disorders, neuromuscular or neurologic disease, alcohol intoxication, traumatic intubation, mental retardation, and dental procedures. The peak incidence is during the sixth decade in adults (2).

Aspirated FBs in children are generally food particles, the most common being peanuts, while in adults FBs range from bone fragments to metallic pins.

The most common location of FBs by aspiration is the right bronchial tree, especially the bronchus intermedius in adults (Figs. 2, 3). If the FBs obstruct bronchus, secondary findings such as unilateral lung hyperinflation, atelectasis, bronchiectasis, mediastinal shift, and consolidation can be seen (8). Atelectasis in adults is a more common finding, whereas air trapping is more common in children (Fig. 5) (1).

TYPE II; INGESTION (ESOPHAGEAL FBS)

Most of the ingested FBs pass spontaneously through the gastrointestinal tract without difficulty (Fig. 6). However, about 76% of intentional ingestion needs interventional removal (Fig. 7), and 28% results in the surgical intervention (Fig. 8) (4). Without treatment, complications such as perforation, obstruction, esophageal-aortic fistula or tracheoesophageal fistula formation, or sepsis could occur. Ingestion of multiple FBs and repeated episodes of ingestion are common, especially in prisoners, psychiatric patients, and patients with peptic strictures (Fig. 9). The possibility of additional FBs should always be considered.

TYPE III; TRAUMA OR ACCIDENT

FBs associated with accidents or trauma can present anywhere in the chest. Penetrating thoracic trauma caused by a knife, fragment of glass, or hand grenade fragment may cause pneumomediastinum, pneumothorax, or hemothorax (Fig. 10) (2).

Penetrating wounds of the lung may cause damage to other intrathoracic structures with or without obvious external thoracic injuries, therefore attention should be paid to the patient's clinical history and mechanism of injury.

Intracardiac FBs are associated with intravenous drug abuse, mental retardation, suicide attempt, or iatrogenic insertion. Catheter fragments or broken guide wires are most commonly reported as intravascular or intracardiac FBs. Intracardiac metallic needle is rare and is usually related with drug abuse or suicide (Fig. 11) (2).

Fig. 6. A 5-year-old boy who ingested a coin.

A. The initial chest radiograph shows an ovoid metallic FB in the upper thoracic area.

B. The follow-up chest radiograph shows the FB (arrow) in the upper abdomen. As the patient was asymptomatic, he was monitored with serial radiographs until the passage of the coin was confirmed.

FB = foreign body

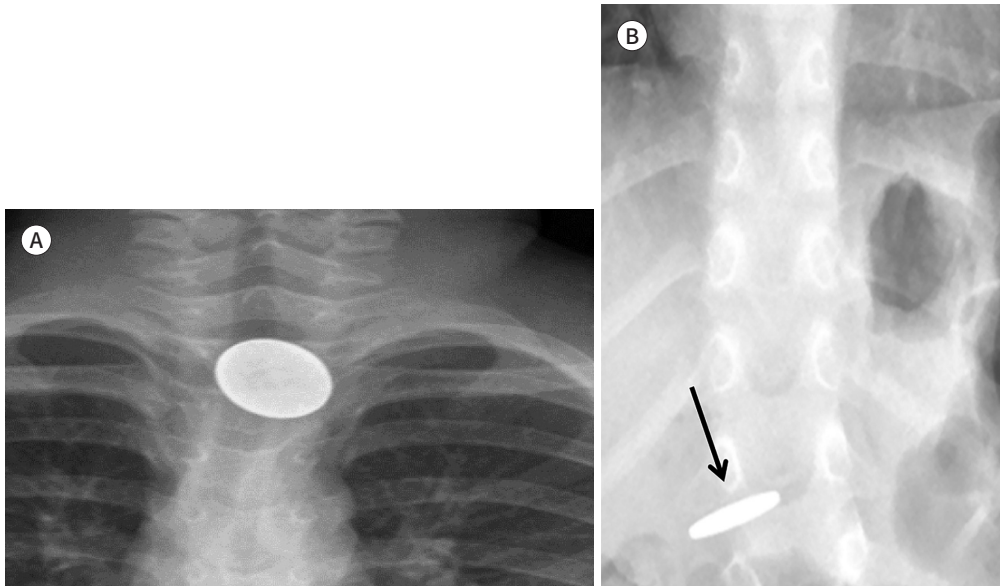


Fig. 7. An 86-year-old male who ingested a germanium stone which he placed in his mouth to relieve his gum pain.

A. The initial chest radiograph shows a hexagonal-shaped FB (arrow) in the cervical esophagus.

B. Coronal CT shows that the FB (arrow) is in the cervical esophagus, without esophageal perforation. The hexagonal-shaped FB in the upper cervical esophagus was successfully removed by balloon-guided extraction (not shown).

FB = foreign body

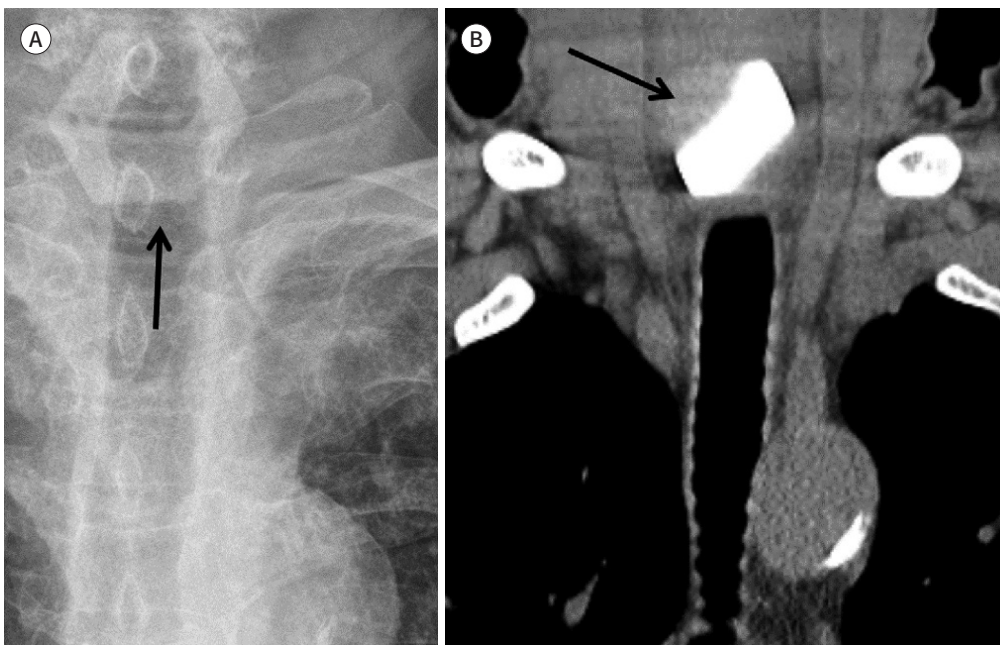


Fig. 8. A 25-year-old female with FB sensation after drinking fish soup.

A, B. The axial (**A**) and sagittal (**B**) CT images showing a high density linear FB (arrows) with focal perforation (arrowhead) in the distal thoracic esophagus.

C. A week after primary closure of the perforated esophagus, the patient presented with fever and right flank pain. A follow-up CT shows a slit-like opening at the distal thoracic esophagus (arrowhead) and an adjacent air bubble (arrows) with moderate amount of right pleural effusion. Retreatment by primary closure with an intercostal muscle flap was performed.

FB = foreign body

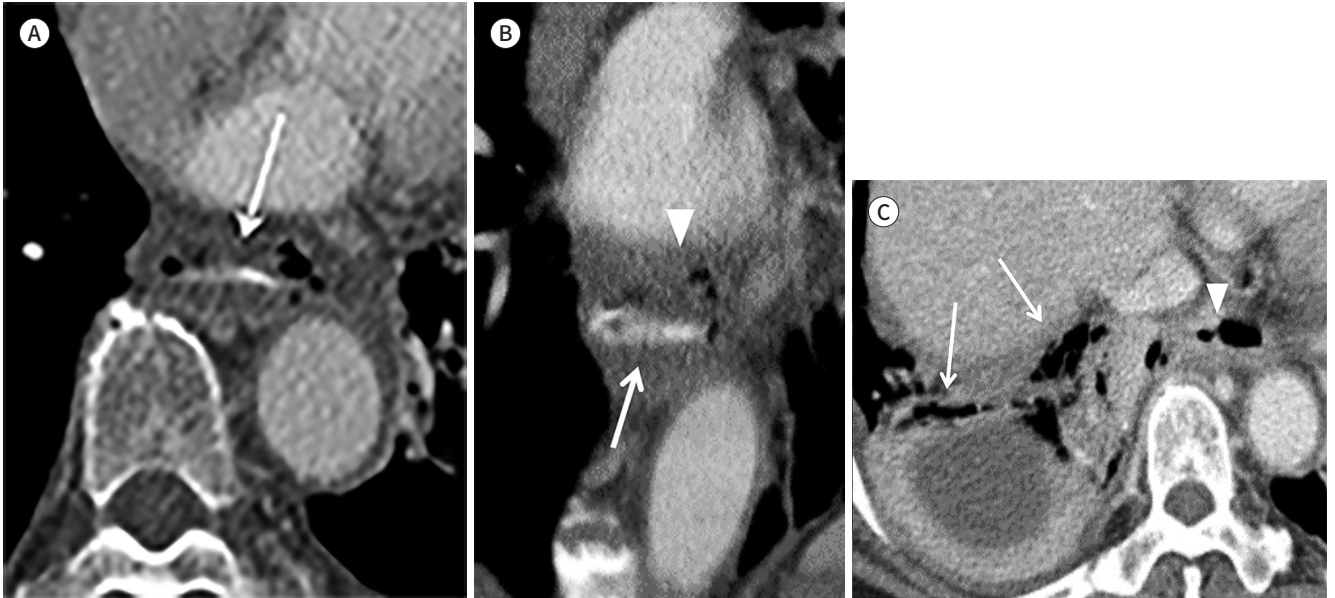


Fig. 9. A 48-year-old female who ingested multiple FBs during a suicide attempt

A. The chest radiograph shows metallic FBs (arrows) in the mid-esophagus and the upper abdomen.

B, C. Coronal multiplanar reformation images demonstrate V-shaped metallic FBs (arrows) in the mid esophagus (**B**) and the gastric fundus (**C**).

FB = foreign body

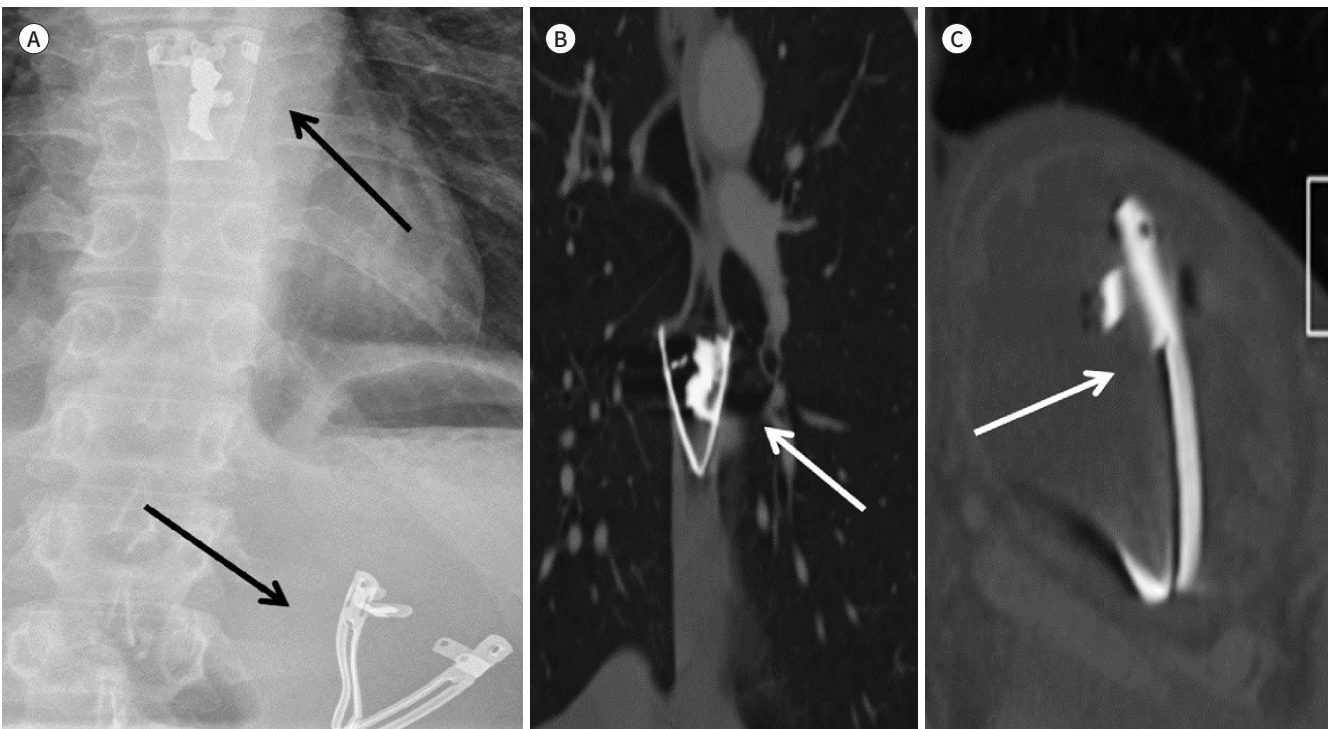


Fig. 10. A 44-year-old female with a scissor blade in her neck. The patient reported that it fell while cutting her hair.

A. The chest radiograph shows a metallic FB in the lower neck area.

B. The axial CT image with bone window setting shows a sharp metallic FB in the lower neck to thoracic inlet area, measuring approximately 12 cm in length. The metallic FB passes just beside the trachea.

FB = foreign body

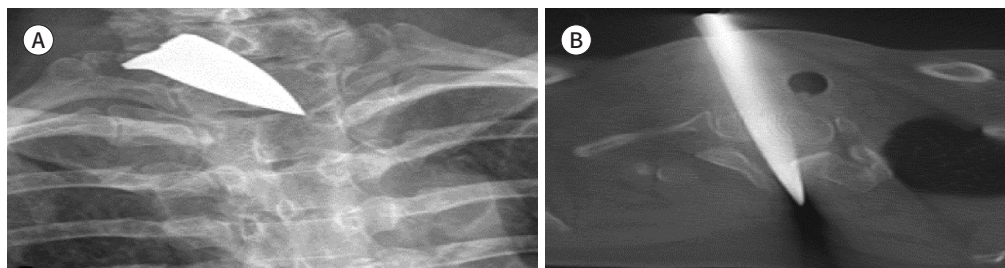
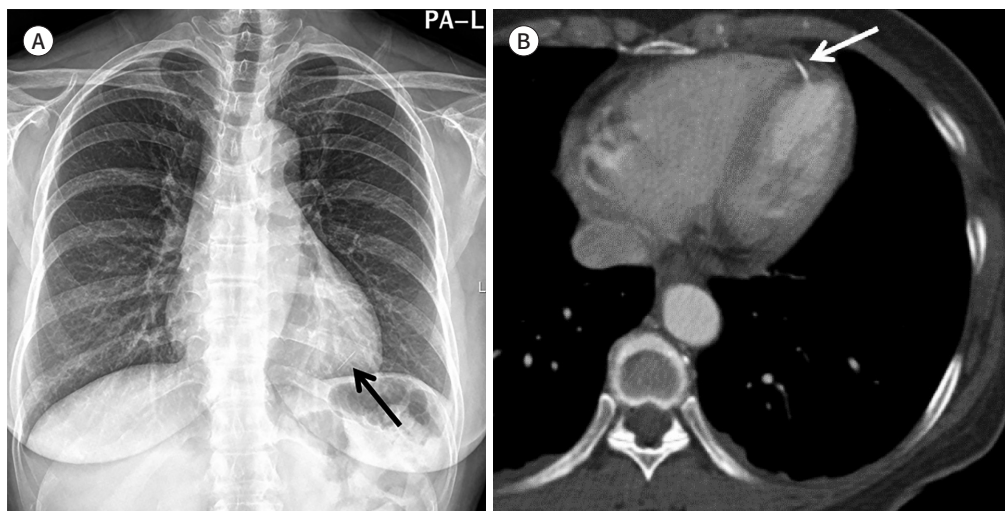


Fig. 11. A 59-year-old female working at an insulin needle factory with retrosternal chest pain.

A. The chest radiograph shows a linear radiopaque material (arrow) in the left side of the heart.

B. The axial CT shows a metallic linear foreign body (arrow) measuring 18 mm, in the anterior portion of the myocardium in the left ventricle of the heart.



TYPE IV; IATROGENIC

The practice of insertion of gold acupuncture was developed in China and widely performed in Korea. Multiple fine gold needles inserted through the skin into the subcutaneous tissue can be broken off at the skin and permanently be left in the subcutaneous tissue (2). If the needle penetrates the pleural cavity or abdomen, several complications can occur because of acupuncture (Fig. 12).

Malposition of the central venous catheter is a relatively common complication (5.01%) and misplaced catheters can be detected in various extra-cava structures such as the mediastinum, pleura, pericardium, etc. (Fig. 13) (9).

CONCLUSION

Thoracic FBs may occur in association with aspiration, ingestion, trauma, or iatrogenic

Fig. 12. An 81-year-old male with a history of acupuncture needle insertion who complained of dyspnea and upper respiratory symptoms.

A. The chest radiograph shows a linear radiopaque material (arrow), resembling an acupuncture needle, at the left lower lung. The radiograph also indicates opacity in the left lower lung zone and blunting of the left costophrenic angle, suggesting left-side pleural effusion.

B. Multiplanar reformation image at the bone setting shows a linear metallic foreign body, measuring 6 cm, (arrow) in the left pleural cavity, with a large amount of left pleural effusion.

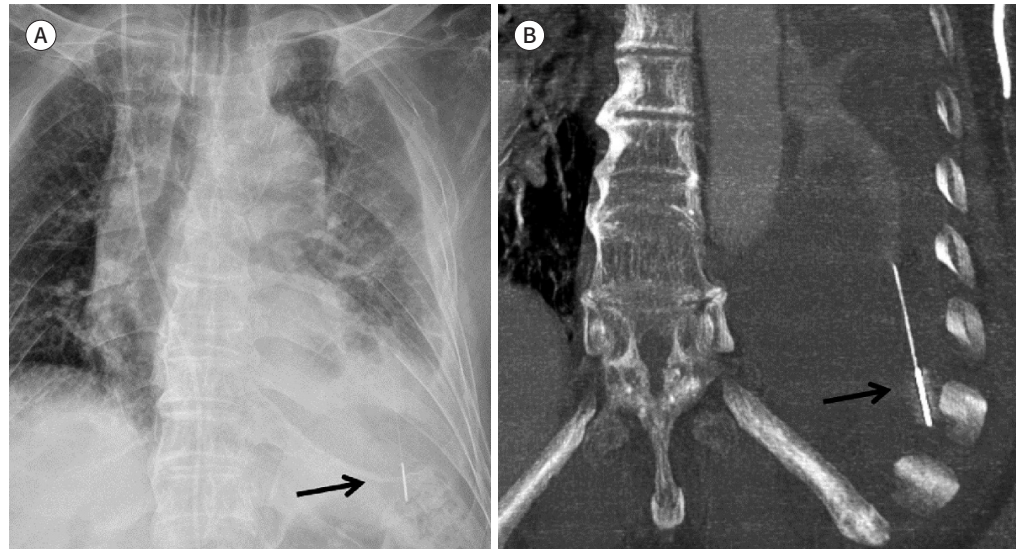
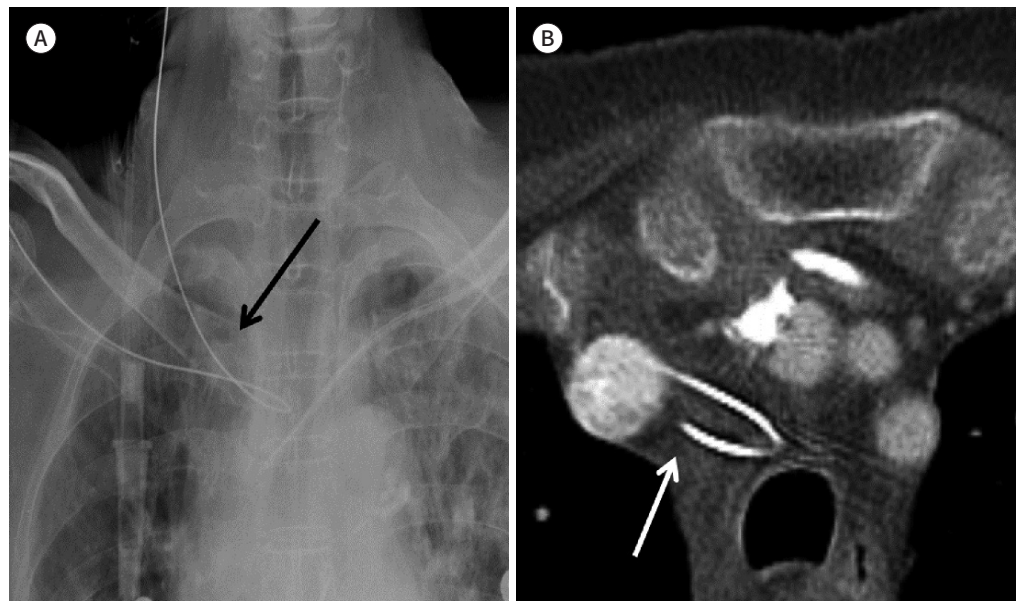


Fig. 13. A 93-year-old female who was transferred due to a stuck guidewire during central catheter insertion at a local clinic.

A. The chest radiograph shows kinking of the linear metallic FB (arrow) at the right upper thorax.

B. The enhanced axial CT image shows a linear metallic FB (arrow) inserted in the right subclavian vein and extending from the extraluminal portion through to the right brachiocephalic vein. The end of the twisted portion is in the anterior portion of the trachea.

FB = foreign body



causes. When clinical symptoms are non-specific, imaging plays an important role as an initial approach to manage FBs. Chest radiographs and CT are helpful tools to identify FBs' number, location, and evaluate the possible complications. The presence of aspirated FBs in the bronchus leads to atelectasis or air trapping. Ingested FBs are commonly associated with psychiatric problems, so the presence of multiple FBs should be considered. Also, penetrating FBs may induce pneumomediastinum, pneumothorax, and hemothorax.

Thus, familiarity with the radiologic features of FBs in the thorax is essential for the prompt diagnosis and appropriate management in such patients.

Author Contributions

Conceptualization, C.Y.K.; data curation, W.H.S, J.S.J, C.Y.K.; formal analysis, W.H.S, C.Y.K.; investigation, W.H.S, J.S.J, C.Y.K.; methodology, W.H.S, J.S.J, C.Y.K.; project administration, C.Y.K.; resources, W.H.S, J.S.J, C.Y.K.; supervision, C.Y.K, K.J.S.; validation, C.Y.K, K.J.S.; visualization, C.Y.K.; writing—original draft, all authors; and writing—review & editing, all authors.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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흉부 이물의 영상의학적 소견

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흉부 이물은 응급실에 내원한 환자들에게서 빈번하게 볼 수 있으며 심각한 문제를 일으킬 수 있다. 흉부 이물은 흡인, 섭취, 외상, 의인성 원인으로 발생할 수 있다. 영상 검사는 흉부 이물의 유무와 크기, 구조, 위치를 인지하는데 중요한 역할을 하기 때문에 영상의학과 의사는 중재적 시술 등 적절한 치료를 결정하기 위해 흉부 이물의 영상의학적 소견과 발생 가능한 합병증을 알아야 한다. 이 임상화보에서는 흉부 이물을 식별하기 위한 적절한 영상 검사 세팅, 원인에 따른 4가지 분류, 흉부 이물과 이로 인해 발생할 수 있는 합병증의 영상의학적 소견을 정리하였다.

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