Received:
01 April 2020

Revised:
30 May 2020

Accepted:
03 June 2020

<https://doi.org/10.1259/bjr.20200316>

Cite this article as:

Contegiacomo A, Conti M, Trombatore P, Dezio M, Muciaccia M, Lozupone E, et al. Radiological features and management of retained needles. *Br J Radiol* 2020; **93**: 20200316.

PICTORIAL REVIEW

Radiological features and management of retained needles

¹ANDREA CONTEGIACOMO, ¹MARCO CONTI, ²PIETRO TROMBATORE, ³MICHELE DEZIO, ²MASSIMO MUCIACCIA, ¹EMILIO LOZUPONE, ^{1,2}LUIGI NATALE and ^{1,2}RICCARDO MANFREDI

¹Fondazione Policlinico Universitario A. Gemelli IRCCS, Rome, Italy

²Università Cattolica Sacro Cuore, Rome, Italy

³Ospedale Madonna delle Grazie, Matera, Italy

Address correspondence to: Dr Pietro Trombatore

E-mail: pietro.tr@outlook.it

ABSTRACT

The identification of retained needles is essential because of their sharp structure with possible life-threatening complications. However, radiological evaluation could be challenging, especially in case of needles' relatively poor conspicuity and small dimension. This pictorial essay focuses on clinical issues (needle features, retention mechanisms and associated complications) and technical aspects (choice of the best diagnostic modality and technique) that can lead the radiologist to an earlier and proper diagnosis of needle retention in order to provide the best treatment for the patient.

INTRODUCTION

The retention of foreign bodies represents a great challenge for the radiologist. The great variability in clinical history, clinical presentation and location, usually hinder a systematic approach to their diagnosis and management. In addition, material lying on the patient or in the patient's clothing may simulate a foreign body. Needles are a particular type of foreign body which is also used in the medical field, as well as in the general population. Research of retained needles is a common clinical request in the radiological emergency department. Prompt localization and removal are recommended due to needles' potential risk of injury related to their sharp shape.

The identification of needles could be a real challenge for the radiologist, because of their relatively poor conspicuity and small dimension. Patient history and the knowledge of radiological technical aspects and features, as well as the possible clinical implications of needles retention within the body, can lead the radiologist to an earlier and proper diagnosis, providing an adequate and personalized diagnostic workup and treatment for each patient.

This pictorial essay focuses on the technical and clinical aspects that the radiologist needs to know when facing up with the suspect of a retained needle.

MECHANISMS OF RETENTION

Patient history is the first step of the radiological workup of retained needles. The knowledge of the shape, dimension and the material of which the needle is made, as well as the temporal and spatial reconstruction of what happened, is important to set the most appropriate diagnostic process in order to rapidly reach the diagnosis and plan the proper treatment for each patient.

According to the mechanism of retention, three possible patterns are distinguishable: ingestion, iatrogenic retention and penetration.¹

Ingestion

Ingestion is more common in children than in adults, with a peak incidence occurring during the second year of life. A special attention is required for particular categories, such as patients with behavioural or mental disorders or healthy adults with predisposing factors (drugs abuse, criminal activities, extreme sporting activities, and spousal abuse).^{1,2}

Because of their shape and sharpness, needle ingestion is a rare event and sewing needles representing the 2.4% of all the ingested foreign bodies.³ Once ingested, needles may wedge in narrowing areas (from bowel adhesions or strictures) or anatomical acute angulation (duodenal loop, Treitz angle, appendix and ileocecal valve region)^{2,4} (Figure 1).

Figure 1. A 12-year-old child admitted to the emergency department after ingestion of a sewing needle, without clinical symptoms. Frontal and lateral radiographs showed the ingested needle located in the upper gastrointestinal tract, without radiological signs of perforation. After radiological identification, endoscopic examination quickly identified and removed the needle within the stomach lumen.

The time of onset of the symptomatology is extremely variable, but 64% of the cases present with symptoms after 48 h of ingestion, with epigastric pain being the most common one.⁴ Complications such as ulcers, lacerations, erosions and perforation are not a rare event, as reported by Sung *et al*⁵ and their risk of occurrence increases when the persistence of the needle in the gastrointestinal tract is protracted. Finally, needle migration through the intestinal wall is infrequent (1% of all ingestions)^{2,3} but when occurs, multiple anatomical structures can be involved³ (Figure 2).

Iatrogenic retention

The necessity for intraoperative counting of needles is an unavoidable occurrence in the operating room⁶ (Figure 3).

Figure 3. 65-year-old male underwent hip replacement surgery. At the end of the operation, the needle count was incorrect. Because of the mismatch, a frontal radiograph of the left hip was obtained in operating room (A) and showed a curvilinear surgical needle (arrow) near the prosthesis. The surgical cavity was then re-explored and the needle removed. The subsequent radiograph demonstrated no remnants (B).

Several risk factors for iatrogenic retention have been reported: emergency procedures, increased body mass index, procedural unexpected variation, number of instruments used, involvement of more than two surgical teams, equipment malfunction and suboptimal communication between team operators.^{7,8} As the consequence of poor literature evidence, it is reasonable to consider underestimated real incidence of iatrogenic retention that probably ranges from 1/1.000 to 1/1.500 procedures.⁶ In addition, the missing needle sometimes remains asymptomatic in the post-operative period and could be an incidental finding many years later (Figure 4).

Figure 2. A 63-year-old female admitted to the emergency department after ingestion of a sewing needle, without clinical symptoms. Frontal and lateral radiographs (A, B) showed the ingested needle (arrows) located in the upper gastrointestinal tract without radiological signs of perforation or other complication. Before entering the endoscopy room, the patient suddenly complained of upper abdominal pain; an ultrasound examination was performed and demonstrated (C, parasagittal oblique scan) that the needle (arrows) had penetrated through the stomach wall (point of arrow) and got stuck into the segment III of the liver (*). It was then removed in the operating room.

Figure 4. A 20-year-old male admitted to the emergency department for atrial fibrillation. Frontal and lateral chest radiographs showed a surgical needle in the subcutaneous tissue along the right lateral wall of the thorax that external physical examination failed to identify. It was concluded that probably the needle was lost during the surgery for pectus excavatum that the patient underwent several years before.

More frequently, the needle become painful and may be confused with normal post-operative pain, with subsequent delayed diagnosis (Figure 5).

Figure 5. A 41-year-old female was admitted to the emergency department for upper abdominal pain 15 days after bariatric surgery. An abdominal radiograph (A, B) showed a surgical needle (arrows) in the subdiaphragmatic region. The CT scan (C, D, E) showed the surgical curvilinear needle between the segment II of the liver and the diaphragm.

Figure 6. A 19-year-old female with type 1 diabetes was admitted to the emergency department with right leg pain after insulin injection. Frontal and lateral radiographs showed in the lateral projection (A), the fragment of a broken insulin needle (arrow) in the anterior portion of right thigh; in the frontal view (B), the broken needle was undetectable because of his orientation (parallel to X-ray beam), thinness and the femoral overlap.

Intravenous migration of the fragmented needle is a rare but described occurrence⁹; once in the systemic circulation, the needle could potentially migrate through the veins to the heart and the pulmonary circulation, with the high risk of injuring the right cardiac chambers or the lung. Drug intravenous abuse or subcutaneous injection of drugs with very tiny needles (*i.e.*, insulin or heparin) (Figures 6 and 7) are usually the underlying causes but uncommon events such as iatrogenic surgical needle embolism may occur (Figure 8).

Penetration

Penetration is an uncommon but well-known mechanism that can lead to a retained needle.¹ The majority of cases are accidental, often described in a working setting, such as tailoring workers (Figure 9). Less frequently needle penetration could be

Figure 7. A 37-year-old drug addict was admitted to the emergency department after the breaking of an injection needle inside the right elbow during an attempt of heroine injection. Frontal and lateral radiographs (A, B) showed a fragment of a broken needle (arrows) in the anterior soft tissues of the elbow.

Figure 8. A 34-year-old female underwent abdominal surgery for ovarian cancer. During the attempt to suture the inferior vena cava, accidentally injured, the surgical needle was lost. Chest radiograph (A, magnified in B) in the operating room showed the surgical needle (arrow) projectively displayed on the left border of heart and the subsequent CT scan (C, D) identified the needle inside the artery for the posterior segment of the left lower lobe, with no signs of bleeding, pneumothorax, heart injury or infarct. The needle embolized to pulmonary circulation through the tear in the inferior vena cava. In a following CT scan (E, F), the needle migrated and was located in a distal segment of the same vessel. According to both the absence of complications in the CT scan and the clinical stability, no endovascular or surgical attempt to remove the needle was made.

a voluntary gesture; this occurrence is more frequent in children or adults with mental disorders² (Figure 10).

Needles, and their fragments, usually lie in the soft tissues and are easily identified because partially surfacing or due to the formation of foreign body granulomas.

Deep penetration in the abdomen or thorax is not described in the literature but is a potentially possible event. (Figure 10).

RADIOLOGICAL TECHNIQUE

Radiography

Radiography is usually the first radiological test performed if needles count is incomplete and usually allows the identification of the needle and visible complications such as pneumothorax or free gas in the abdomen.¹⁰ The advantages of radiography consist of its diffuse availability (also intraoperative if necessary), a relatively low radiation dose and a panoramic visualization of the anatomical district of interest. Double-projection should always be performed because anatomical structures, such as bones and soft tissues (Figure 6), and/or other radiopaque devices (Figure 3) could prevent needle visualization if a single-projection is performed. Double-projection also allows the correct anatomical location of the lost needle (Figures 6 and 7). When feasible, the radiograph should be performed with a static machine in a radiological room because of the higher quality of the images provided in comparison with a mobile machine. If the scan is performed in the operative room, some authors suggest that a C-arm is more useful than a mobile machine for detecting lost needles.¹¹ In all cases, all removable devices should be shifted or removed from the field of view.

Needles could have different shapes and dimensions; on this basis, radiograph performed with standard “diagnostic” voltage and milliamperage parameters could fail the identification of the needle, in particular the smaller ones, due to their poor conspicuity. For this reason, a more penetrating scan could be performed. Surgical needles smaller than 5–0 are faintly visualized on radiographs¹² and it was demonstrated that the detection sensitivity rate of imaging studies inside the operative room is strongly correlated with the size of the needle with 29% of sensitivity with needles from 4 to 10 mm in size.¹³

Limitations associated with intraoperative radiographs include poor technique such as underexposure, repositioning of the patient, higher likelihood of incomplete radiographical field visualization, and an increased risk of overlapping images (osseous structures, bowel gas or faecal matter) that could impair adequate imaging evaluation.⁷

Computed tomography (CT)

CT is considered a second-level examination and is usually performed when radiography is not conclusive. CT plays an important role due to its higher sensitivity and specificity for both identification (Figure 5) and proper localization (Figure 11), when compared to radiography.¹⁴ Non-contrast CT scan is usually performed to confirm the suspect of retained needle at the radiography, if diagnosis is not clearly assured, and to provide more elements about possible complications, such as visceral perforation, haematomas or fluid collections; CT is also a useful tool for clinicians to choose among a conservative, interventional or surgical approach.^{3,14} The use of contrast medium is usually not necessary for the identification of the needle but post-contrast examination may be useful to define the needle relationships with surrounding structures (parenchymal organs, vessels, etc.) and to better characterize possible complications (Figure 10) in order to improve a patient-specific management.^{3,14}

Figure 9. A 52-year-old seamstress reported metallic foreign bodies in the informed consent for MRI. Radiograph (A) and CT scan (B, C) were performed and identified two straight needles (arrows) in the medial region of the thigh, accidentally penetrated by sewing several years before. They were subsequently removed to perform the MRI.

Ultrasonography (US) and magnetic resonance imaging (MRI)

Both US and MRI have a marginal role in the evaluation of patients with retained needles.

Regarding US, a possible application could be the needle search in the superficial soft tissue as described by Blake Primi.¹⁵ In our experience (Figure 2), sonographic identification of a needle into the gastric wall was made possible by the lack of depth from the skin plane. It is our opinion to use ultrasound in paediatric subjects in order to reduce exposure to ionizing radiation.

Figure 10. A 81-year-old female suffering from depression was taken to the hospital by her family because of lower abdominal pain. Radiographs on frontal (A) and left lateral decubitus views (B) showed a long needle (18cm) placed in the lower abdomen without radiological signs of perforation. The female confessed that she had tried to commit suicide by sticking an upholstery needle inside her rectum. After removing the needle, a CT scan (C, D) was performed because of increasing of abdominal pain and showed a fluid collection in Douglas pouch (star) with free air inside (arrows).

As known, MRI examination is absolutely contraindicated in case of metallic foreign bodies, especially for needles, due to the potential migration into vital structures. An adequate informed consent prior to MRI examinations must contain questions regarding the possible presence of retained metallic foreign bodies and the use of radiography or CT scan is justified to resolve possible doubtful cases (Figure 9).

Management

Radiologists play a key role in the diagnostic management of the retained needles.

Some protocols based on multistep approach have been proposed for needles lost during surgical procedures,^{7,10} but there is no evidence in the literature about radiological management for ingested and penetrated needles. Radiography is usually the first imaging modality used while CT is still a second instance method useful for detection of needles not visible in the radiographs.

Figure 11. A 72-year-old female was admitted to the emergency department with lower abdominal pain after a fall while she was walking with a box of sewing needles in her hands. Radiographs (A) showed a sewing needle projectively on the left iliac crest. The subsequent CT scan (B) demonstrated the needle in the subcutaneous tissue of the anterior abdominal wall.

Figure 12. Management of needle ingestion and penetration.

A possible workup is proposed according to the time of onset of the suspicion and the possible localization of the needle for each mechanism of retention (Figures 12 and 13). Interventional radiology (IR) should always be considered for the recovery of retained needles. The mini-invasiveness, the low risk of complications and the good probability of technical success are the

Figure 13. Management of iatrogenic retained needles.

strengths of these approach. However, the role of the IR in the operational management of the retained needles is still basic; future prospects could be the endovascular recovery of needles retained within the vessel lumen¹⁶ or the cardiac chambers¹⁷ or of needles in the context of soft tissue.¹⁸

CONCLUSIONS

The knowledge of the shape, size and material of the retained needle, as well as the choice of the best diagnostic modality, is essential to reach the diagnosis in each patient. In addition, the production of high-quality radiological images, with adequate technical parameters, is fundamental to confirm/exclude the diagnosis, to recognize possible complications and to eventually offer a personalized treatment.

REFERENCES

- Kim TJ, Goo JM, Moon MH, Im JG, Kim MY. Foreign bodies in the chest: how come they are seen in adults? *Korean J Radiol* 2001; **2**: 87–96. doi: <https://doi.org/10.3348/kjr.2001.2.2.87>
- Hunter TB, Taljanovic MS, Bodies F. Foreign bodies.. *Radiographics* 2003; **23**: 731–57. doi: <https://doi.org/10.1148/rg.233025137>
- Dal F, Hatipoğlu E, Teksöz S, Ertem M, .Department of General Surgery, Istanbul University Cerrahpasa School of Medicine, Istanbul, Turkey Foreign body: a sewing needle migrating from the gastrointestinal tract to pancreas. *Turk J Surg* 2018; **34**: 256–8. doi: <https://doi.org/10.5152/turkjsurg.2017.3391>
- Khan U, Shahrukh S, Bint-E-Khalid T, Memon AS, Ahmad J. Odyssey of an accidentally ingested sewing needle from mouth to mesentery of small bowel in a young female - Case Report. *J Pak Med Assoc* 2018; **68**: 1418–20.
- Sung SH, Jeon SW, Son HS, Kim SK, Jung MK, Cho CM, et al. Factors predictive of risk for complications in patients with oesophageal foreign bodies. *Dig Liver Dis* 2011; **43**: 632–5. doi: <https://doi.org/10.1016/j.dld.2011.02.018>
- O'Brien L, Eyster KM, Hansen KA. Retained Foreign Body: "Needle in a Haystack". *J Patient Saf* 2015; **11**: 228–9. doi: <https://doi.org/10.1097/PTS.0000000000000078>
- Medina LG, Martin O, Cacciamani GE, Ahmadi N, Castro JC, Sotelo R. Needle lost in minimally invasive surgery: management proposal and literature review. *J Robot Surg*

- 2018; **12**: 391–5. doi: <https://doi.org/10.1007/s11701-018-0802-9>
8. Sakorafas GH, Sampanis D, Lappas C, Papantoni E, Christodoulou S, Mastoraki A, et al. Retained surgical sponges: what the practicing clinician should know. *Langenbecks Arch Surg* 2010; **395**: 1001–7. doi: <https://doi.org/10.1007/s00423-010-0684-4>
9. Danek BA, Kuchynka P, Palecek T, Cerny V, Hlavacek K, Lambert L, et al. Needle fragment embolism into the right ventricle: a rare cause of chest pain case report and literature review. *Wien Klin Wochenschr* 2016; **128**(5–6): 215–20. doi: <https://doi.org/10.1007/s00508-015-0811-x>
10. Jayadevan R, Stensland K, Small A, Hall S, Palese M. A protocol to recover needles lost during minimally invasive surgery. *JSLS* 2014; **18**: e2014.00165: 00165. doi: <https://doi.org/10.4293/JSLS.2014.00165>
11. Sharma AP, Mete UK, Bendapuddi D, Bora GS, Mavuduru RS. Needle in a haystack: lost in transition. *J Robot Surg* 2018; **12**: 177–9. doi: <https://doi.org/10.1007/s11701-017-0695-z>
12. Macilquham MD, Riley RG, Grossberg P. Identifying lost surgical needles using radiographic techniques. *Aorn J* 2003; **78**: 73–8. doi: [https://doi.org/10.1016/S0001-2092\(06\)61347-1](https://doi.org/10.1016/S0001-2092(06)61347-1)
13. Ponrartana S, Coakley FV, Yeh BM, Breiman RS, Qayyum A, Joe BN, et al. Accuracy of plain abdominal radiographs in the detection of retained surgical needles in the peritoneal cavity. *Ann Surg* 2008; **247**: 8–12. doi: <https://doi.org/10.1097/SLA.0b013e31812eeca5>
14. Ariz C, Horton KM, Fishman EK. 3D CT evaluation of retained foreign bodies. *Emerg Radiol* 2004; **11**: 95–9. doi: <https://doi.org/10.1007/s10140-004-0373-0>
15. Primi B, Thiessen MEW. Point-Of-Care ultrasound to locate retained intravenous drug needle in the femoral artery. *West J Emerg Med* 2016; **17**: 817–8. doi: <https://doi.org/10.5811/westjem.2016.8.31074>
16. Moore K, Khan NR, Michael LM, Arthur AS, Hoit D. Endovascular retrieval of dental needle retained in the internal carotid artery. *BMJ Case Rep* 2017; bcr2016012771. doi: <https://doi.org/10.1136/bcr-2016-012771>
17. Bompotis G, Karkanis G, Chatziavramidis A, Konstantinidis I, Dokopoulos P, Lazaridis I, et al. Percutaneous removal of a tiny needle fracture from the right ventricle of the heart in a drug abuser. *Vasc Endovascular Surg* 2016; **50**: 575–8. doi: <https://doi.org/10.1177/1538574416680979>
18. Cazzato RL, Garnon J, Ramamurthy N, Tsoumakidou G, Caudrelier J, Thénint M-A, et al. Percutaneous management of accidentally retained foreign bodies during image-guided non-vascular procedures: novel technique using a Large-Bore biopsy system. *Cardiovasc Intervent Radiol* 2016; **39**: 1050–6. doi: <https://doi.org/10.1007/s00270-016-1302-9>