




## CASE REPORT

# Ultrasound-guided interventional approach to intraperitoneal nail gun injury: A case report with literature review

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## Abstract

Literature review suggests that surgery is the only option for dealing with intraperitoneal foreign bodies (laparoscopy and laparotomy). We showed that an interventional method using ultrasound guidance could be considered alongside surgical options.

## KEYWORDS

case report, foreign body, intervention, nail gun injury, ultrasound

## 1 | INTRODUCTION

One of the most common causes of foreign bodies in soft tissue is nail gun injuries. Intraperitoneal foreign bodies caused by nail gun injuries were usually removed surgically. We present a 20-year-old carpenter with an intraperitoneal nail that was successfully removed using the ultrasound-guided interventional method for the first time.

Patients frequently visit emergency rooms due to complaints of pain caused by metal, wooden, or glass fragments lodged in their soft tissues as foreign bodies (FBs).<sup>1</sup> Retained FBs can lead to acute or delayed complications such as pain, organ dysfunction, allergies, inflammation, and infections.<sup>2</sup> Nail gun injuries are the most prevalent type of FB.<sup>3</sup> These injuries often include minor traumas to the extremities and are less common to the head, chest, or abdomen, which may be life-threatening.<sup>3-5</sup>

Superficial FBs may be detected by clinical examination and can be smoothly removed. However, imaging is necessary to determine the type of FB and its exact location before the removal attempt. Ultrasound is able to detect and localize FBs with high sensitivity and specificity, regardless of whether they are radiopaque or radiolucent, allowing for the detection of FBs that would otherwise go undetected by plain radiography.<sup>6,7</sup> The surgical method to remove a FB is invasive, technically challenging, and may be associated with some complications or even failure.<sup>1</sup> Percutaneous ultrasound-guided extraction of an FB was first launched in 1990 and is a minimally invasive, cost-effective, and low-risk method that offers an excellent three-dimensional vision of nearby tissues and structures. Increased success rates and improved patient safety of ultrasound-guided techniques have been demonstrated in multiple studies. White et al. reported 52

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ultrasound-guided FB removals with a 95% success rate over 3 years with no identified complications in a single institution.<sup>8</sup> Bradley has reported 252 successful percutaneous extractions of FBs under ultrasound guidance, with at least 88% success overall during 2008–2010 with no postprocedure complications.<sup>9</sup> Besides these remarkable satisfactory results, this method is restricted in some cases mostly due to the anatomical site, type of FB, instrumentation, bubbles (entrance of air bubbles during procedure and artifact formation), ultrasound beam width, and mobility of the FB.<sup>9</sup> The ultrasound-guided method is frequently used in clinical settings due to its advantages over conventional surgical methods.

Herein we present a case of penetrating nail gun injury with retained intraperitoneal metal nail successfully extracted under ultrasound guidance, the like of which has never been reported in the literature, thanks to the expertise of our interventional radiologist.

## 2 | CASE REPORT

A 20-year-old carpenter with no prior medical history was taken to our hospital after complaining of abdominal pain due a nail gun injury to the right lower abdomen during carpentry. He was using an ANCHOR 8016J Pneumatic Stapler™ when the nail accidentally came out and hit the opposite wall and ricocheted and sank into his abdomen. After seven days, he went to the emergency room of our hospital and was admitted. His delay in visiting was due to personal and family reasons.

On arrival, he was alert and oriented, hemodynamically stable, with a blood pressure of 110/70 mmHg, a heart rate of 82 bpm, a body temperature of 36.6, and a respiratory rate of 23. He was complaining of pain in the right lower quadrant. During the physical exam, there was no entrance site or an exit wound in the patient's right lower quadrant of the abdomen. Abdominal distention, rebound discomfort, or abdominal guarding were not seen. Blood tests and other biochemical parameters were within normal limits.

Antibiotic and anti-tetanus injections were administered. A focused assessment with sonography for trauma (FAST), chest x-ray, and abdominal and pelvic computed tomography scan (CT scan) with contrast was requested. FAST and chest x-ray was normal.

The CT scan revealed a tubular foreign body (nail) with metallic density was entirely intraperitoneal. Beyond the inferior epigastric vessels and the right rectus abdominis muscle, it was located near to the ileum loop and was 20 millimeters in length. There was no sign of pneumoperitoneum or intraperitoneal fluid effusion requiring emergent surgery. (Figures 1,2).



FIGURE 1 CT topogram image shows the nail at the right lower quadrant of the abdomen.

Due to the thinness of the nail, which made it difficult to find it in the abdomen through open surgery, and because of the consult of the surgical team to remove the nail by radiologic intervention and lack of emergent need for surgery, it was decided to remove the nail under ultrasound guidance. The patient was transferred to the intervention clinic and lay down in a comfortable supine position. A diagnostic ultrasound examination using a Siemens Acuson Juniper™ ultrasound device and a low frequency 2–5 MHz transducers were done to establish the exact location of the nail, its morphology, and its relations with nearby structures such as vessels, bowel loops, and other organs. Without inducing sedation, overlying skin was sterilized using povidone-iodine, a surgical drape was placed on the sterilized area, and the transducer was covered with sterile gloves. Local anesthesia with lidocaine chlorhydrate 2% was obtained around the presumed site of the skin incision. The dense granulation tissues surrounding the nail were hydrodissected away from the nail after a second bolus of anesthesia was administered at the nail's tip and along its body. A 5 mm-sized incision was made with *no. 11* blade scalpel at the nearest point from the nail where no passing vessels were present. Under real-time ultrasound guidance, a mosquito forceps was inserted through the incision site. During blunt dissection, the forceps tips remained closed until contact with the nail, avoiding undesired grab and soft tissue injury. There was a tap sensation when the forceps stroked the

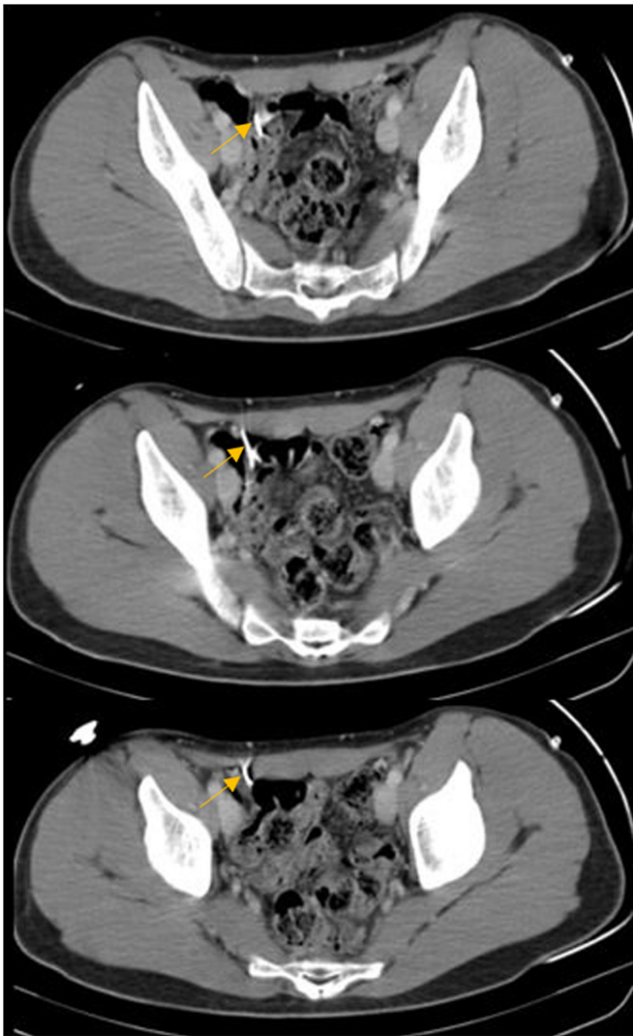


FIGURE 2 Abdominal CT scan. Nail in the pelvis near bowel loops without pneumoperitoneum or intraperitoneal fluid effusion.

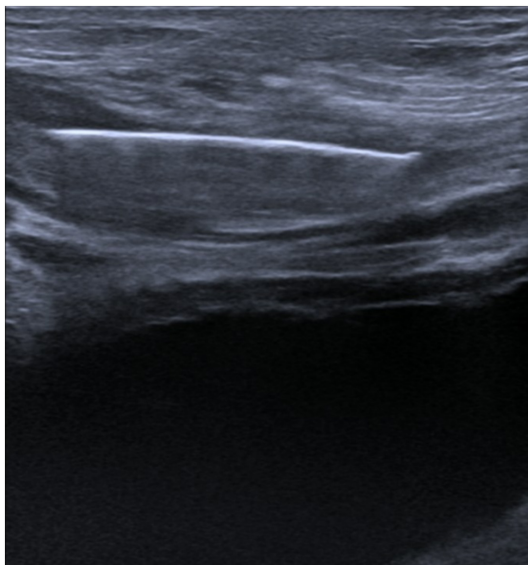


FIGURE 3 The stuck nail in the abdominal wall.



FIGURE 4 Extracted foreign body.

nail. Forceps jaws were opened, the nail was grasped, and then was removed carefully under ultrasound sight in two steps. First, the nail was transferred from the peritoneum to the abdominal wall (Videos SS1 and SS2), and then it was removed from the abdominal wall (Figure 3, Videos S3 and S4). The removed nail, which was about the size of a needle, had granulation tissue fragments that can be seen in Figure 4.

After removal, a second sonographic investigation was performed to evaluate for retention of small fragments, which was negative. On the incision region, only one simple suture was used.

The postoperative period was uneventful; clinical and laboratory monitorings were of no abnormalities, and the patient was discharged after one day. We carefully followed up the patient, and it was explained to him to return to the hospital in case of any problems. He had no complications during admission and three months after discharge, as long as we communicated.

### 3 | DISCUSSION

We searched the literature in the databases Medline, Scopus, Embase, Google Scholar, and Web of Science using keywords such as intraperitoneal, nail gun injury, and foreign body. Few studies of intraperitoneal nail gun injury have been published.<sup>3,10-12</sup> Herein we have reported these studies' demographic features, diagnostic method, imaging findings, treatment, outcome, and treatment complications in the following Table 1. The gender of all the cases was male, and all of them underwent abdominal CT scan. Nails have been removed surgically in all of these studies (by laparotomy or laparoscopy). To my knowledge,

TABLE 1 Summary of reviewed cases.

Author	Age	Sex	Occupation	Diagnostic method	Imaging findings	Treatment	Outcome	Complications of treatment
Aissaoui et al. <sup>9</sup>	32	Male	Tradesperson	Chest x-ray and abdominal CT scan	Chest x-ray: thoracoabdominal foreign body penetrating the left thoracic base without pneumoperitoneum or intraperitoneal effusion. CT scan: foreign body (nail) in the left thoracoabdominal region, 3 millimeters from the stomach without pneumoperitoneum or intraperitoneal fluid effusion	Laparotomy	Discharged after 3 days.	-
Stephens et al. <sup>11</sup>	30	Male	Tradesperson	Abdominal X-ray and abdominal CT scan	Abdominal radiograph: presence of a single nail in the abdomen. CT scan: nail positioned within the transverse colon with free air and fluid surrounding the liver, spleen, and paracolic gutters and perforation of the horizontal duodenum with retroperitoneal free air and fluid.	Emergent laparotomy	Intensive care unit for 15 days, discharged home 27 days after admission.	Unexplained anemia, a bleeding branch of the gastroduodenal artery identified during surgery and clipped.
Saricik et al. <sup>3</sup>	30	Male	Carpenter	Abdominal X-ray and abdominal CT scan	Abdominal X-ray: nail in the abdomen. CT scan: some free fluid between the bowel loops	Laparotomy	Discharged after 3 days.	-
Bonatti et al. <sup>10</sup>	55	Male	-	Abdominal CT scan	CT scan: two foreign bodies penetrating from the right upper quadrant with one reaching the transverse colon.	Emergent laparoscopy (Loop colostomy created)	Discharged after 3 days in good condition.	Severe posttraumatic inflammatory reaction of the fat tissue in the right upper quadrant on day 5, controlled with pain killer and antibiotics, recovered within a few days and discharged.

Abbreviations: CT scan, computed tomography scan.

the ultrasound-guided intervention has not been used in any of the mentioned studies to remove the metal nail as a FB from the intraperitoneal cavity.

As much as 38% of the time, a diagnosis of FB cannot be made on physical examination alone due to post-trauma pain, edema, and hemorrhage.<sup>13</sup> Consequently, imaging methods are crucial for locating FBs precisely and detecting them. Plain radiography is the most extensively used imaging method, although it can only identify radiopaque FBs. Computed tomography has restrictions due to cost, radiation, and sensitivity, yet it can identify radiolucent FBs. Radiolucent FBs can also be identified using magnetic resonance imaging; however, this method is often costly and difficult to use. Contrarily, ultrasonography not only does not provide a radiation risk, but also provides real-time imaging and may be performed at the patient's bedside.<sup>14</sup> Based on the angle of insonation, FBs are seen via ultrasound as hyperechoic foci with acoustic shadowing.<sup>15</sup> It is also possible to create comet tail artifacts, especially metal items. Hypoechoic halos can be caused by edema, abscesses, or granulation tissue. Almost all FBs should be detectable on an ultrasound, albeit this does depend on the insonation angle. In order to detect the strongest signal, the probe should be aimed as perpendicular to the FB as feasible.<sup>16</sup>

In recent years, the care of patients who have suffered penetrating abdominal injuries has changed greatly.<sup>10</sup> As a kind of damage control, laparotomies should be performed immediately on patients with hemodynamic instability. Hemodynamically stable individuals should have diagnostic laparoscopy and then early total care surgery depending on the clinical and diagnostic imaging findings. Patients without clinical symptoms or abnormal imaging findings should be managed closely, clinically, and by SNOM (selective nonoperative management).<sup>17</sup> In light of recent advancements in imaging and interventional radiology, as well as our increased understanding of injury mechanisms and surgery outcomes, physicians are opting for less invasive treatment methods.<sup>18</sup> Although ultrasound-guided removal of FBs is not a novel concept,<sup>19</sup> this study provides further information about the procedure's success and limitations. Since surgical removal of FBs can result in severe bleeding and surgical infection, it is recommended that small FBs be removed with a narrow entry hole under ultrasound guidance.<sup>1,20</sup> In the event that the ultrasound-guided removal of the FB is unsuccessful, surgical removal might also be performed subsequently. Unlike with traditional surgical excision, the incision for ultrasound-guided FB excision is less than a centimeter in length, resulting in little scarring.<sup>1</sup>

Our findings imply that ultrasound-guided removal should be the primary method for eliminating FBs in the absence of concurrent lesions necessitating surgical intervention. Even for intraperitoneal FBs, interventional

techniques are applicable and may yield encouraging results. Patients who do not have unstable hemodynamics, organ damage, or a life-threatening disease may be good candidates for this approach. Considering that this method has been proposed for the first time in the case of intraperitoneal FBs, more studies are needed to investigate this method. Finally, based on each case, a decision should be considered between a surgical or a nonsurgical method (like an ultrasound-guided method).

## 4 | CONCLUSION

The intraperitoneal kind of nail gun injury is one of the less prevalent types of this injury, yet it can still result in morbidity and fatality. The foreign body that was causing these symptoms has previously been surgically removed, according to the review of the related literature and clinical experiences. The ultrasound-guided interventional method, which was utilized for the first time in the presented case without any subsequent complications, may also be beneficial for treating the intraperitoneal nail gun-related foreign body.

## AUTHOR CONTRIBUTIONS

**Javad Jalili:** Investigation; supervision; writing – review and editing. **Milad Babazadeh Ghane:** Investigation. **Morteza Azari:** Writing – original draft. **Ali Jafarizadeh:** Visualization; writing – original draft; writing – review and editing. **Mojtaba Azari:** Writing – original draft. **Masih Falahatian:** Investigation; writing – review and editing. **Samin Alihosseini:** Conceptualization; investigation; visualization.

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No author states to have any conflicts of interest.

## DATA AVAILABILITY STATEMENT

The datasets supporting the conclusions of this article is(are) included within the article and its additional files.




## PATIENT CONSENT STATEMENT

Written informed consent was obtained from the patient for publication of this case report and accompanying images.

## PERMISSION TO REPRODUCE MATERIAL FROM OTHER SOURCES

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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