Minimally Invasive CT-Guided Retrieval of Marine Foreign Bodies: A Case of Sea Urchin Granuloma

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Abstract

Penetrating marine injuries, particularly from sea urchins, present unique diagnostic and therapeutic challenges due to the brittle nature of their calcareous spines and the propensity for fragmentation. We report a case of a 26-year-old male who sustained multiple sea urchin spine injuries to his bilateral lower limbs following an accidental fall into the sea. Initial surgical debridement at a peripheral hospital failed to remove deeply embedded spines. Plain radiographs revealed multiple radio-opaque spike-like foreign bodies distributed across the feet and posterior thigh. Despite precise surface marking based on imaging, repeat surgical exploration was unsuccessful due to the small size and unfavourable orientation of the spines. The patient was subsequently referred for CT-guided intervention, which enabled precise localization and successful minimally invasive removal of a retained spine from the posterior thigh. Histopathological examination confirmed an abscess with a calcified foreign body, consistent with a sea urchin spine granuloma. This case highlights the pivotal role of radiology—from initial detection and characterization to guiding definitive minimally invasive treatment—in managing complex retained marine foreign bodies when conventional surgical exploration fails.

Keywords: Sea urchin spine; foreign body granuloma; CT-guided removal; interventional radiology; marine injury.

How to cite this article: Abhijith R, Manikandan R, Murugan G, Jeyasoorian. Minimally invasive CT-guided retrieval of marine foreign bodies: a case of sea urchin granuloma. Int J Drug Deliv Technol. 2026;16(9s): 251-256; DOI: 10.25258/ijddt.16.9s.26

Introduction

Penetrating injuries from marine animals are frequently encountered in coastal regions and among individuals engaged in water-related activities. Sea urchins, belonging to the class Echinoidea, are benthic marine invertebrates characterized by rigid, globulous bodies covered in sharp, brittle spines [1]. These spines are composed of a single crystal of calcite, the most stable and least soluble polymorph of calcium carbonate ($CaCO_3$), with the crystallographic c-axis oriented along the spine's length. They also contain magnesium and trace amounts of other elements [2]. Due to this chemical composition, sea urchin spines are inherently radiopaque and readily visualized on plain radiographs, making radiography the preferred initial imaging modality for detection [3].

The initial injury may appear trivial; however, retained spines frequently lead to complications including pain, swelling, secondary infection, and the development of delayed granulomatous reactions, often termed "sea urchin granuloma" [4]. Histopathologically, these lesions are characterized by a chronic inflammatory infiltrate with epithelioid granulomas and multinucleated giant cells surrounding the spine fragments [5]. Complete removal of all spine fragments is essential to prevent chronic morbidity, yet this can be technically challenging due to spine fragmentation, small size, and deep location.

While conventional plain film radiography effectively demonstrates radio-opaque foreign bodies, it provides limited information regarding depth and relationship to adjacent critical structures. Ultrasound can offer real-time guidance but may be limited by acoustic shadowing from calcific fragments. Cross-sectional imaging with computed tomography (CT) provides precise three-dimensional localization and is invaluable for pre-operative planning and image-guided interventions [6]. This case report, presented from a radiology department perspective, emphasizes the critical role of imaging—from initial detection through guiding successful minimally invasive retrieval—in managing complex retained sea urchin spines when surgical exploration fails.

Case Presentation

A 26-year-old male presented with a history of an accidental fall into the sea at a private island. He sustained multiple penetrating injuries from sea urchin spines, resulting in numerous spike-like foreign bodies embedded throughout his back, thighs, and feet (Figure 1). He was initially rushed to a nearby hospital, where superficial debridement was performed. However, due to deeply embedded retained spines, he was referred to our tertiary care centre for further management.

Upon arrival, the patient complained of persistent pain over the bilateral feet and posterior thighs for ten days, accompanied by fever. Physical examination revealed multiple punctate entry wounds with surrounding erythema and tenderness. The patient was referred from the surgery outpatient department for radiological evaluation.

Radiological Investigation and Initial Surgical Attempt

Plain radiographs of the bilateral feet and thighs were obtained. Multiple linear and spike-like radio-opaque foreign bodies were visualized, distributed throughout the soft tissues of the feet and posterior thighs (Figures 1 and 2). These exhibited high radiographic attenuation, consistent with their calcite composition [2]. Based on these findings, the patient was referred back to the surgery outpatient department with precise surface marking to facilitate surgical removal.

Despite meticulous surgical exploration guided by these surface markings, the deeply embedded spines could not be successfully retrieved. The small size of the fragments, unfavourable orientation, and tendency to fragment further during dissection precluded complete removal. The patient was subsequently referred back to radiology, this time requesting image-guided intervention.

CT-Guided Minimally Invasive Retrieval

A non-contrast computed tomography (CT) scan of the affected regions was performed using a multi-detector CT scanner. Thin-section axial images with multi-planar reformations were obtained to precisely localize the retained foreign bodies. CT provided superior delineation of the spines' dimensions, depth, and spatial orientation relative to adjacent neurovascular structures and bone (Figure 3).

Under strict aseptic precautions, CT-guided localization and removal was planned. With the patient in a comfortable position, a radiopaque grid was placed over the skin surface, and a limited CT scan was repeated to identify the exact entry point. The optimal trajectory was planned to avoid critical structures. Under intermittent CT fluoroscopic guidance, a spinal needle was advanced to the tip of the targeted foreign body. A small skin incision was made, and a fine forceps was introduced along the needle tract under CT guidance (Figure 4). The foreign body was grasped and gently extracted. A post-procedure CT scan confirmed complete removal with no residual fragments.

Three-dimensional reformatted coronal CT image demonstrates the precise spatial orientation and anatomical relationship of a retained linear hyperdense foreign body (sea urchin spine) within the soft tissues of the foot. The multiplanar reformation clearly depicts the foreign body oriented obliquely, with its proximal end located superficially and the distal end extending deeper toward the plantar fascia. (Figure 5)

The retrieved specimen was a single, linear, grey-black foreign body measuring approximately 0.5 cm in length, with a hard, spine-like consistency (Figure 6). It was sent for histopathological examination.

Histopathological Findings

Microscopic examination of the specimen revealed fragments of fibrocollagenous tissue containing a well-defined abscess cavity surrounded by acute and chronic inflammatory infiltrate. At the centre of this reaction, a tiny, calcified foreign body was identified (Figure 7). The morphology was consistent with a degraded sea urchin spine. The final histopathological diagnosis was an abscess with foreign body, confirming a sea urchin spine granuloma.

Discussion

This case illustrates the diagnostic and therapeutic challenges posed by retained marine foreign bodies and underscores the indispensable role of radiology in their management. Sea urchin spine injuries are a well-recognized clinical entity, yet management can be fraught with difficulty due to the unique physical properties of the spines [1,3].

Radiological Perspective: Why Imaging Matters

The calcite composition of sea urchin spines renders them inherently radiopaque, allowing excellent visualization on plain radiographs [2]. In our case, initial radiographs clearly demonstrated multiple radio-opaque foreign bodies. However, plain films have inherent limitations: they provide a two-dimensional representation and cannot accurately depict the depth of a foreign body or its relationship to adjacent tendons, vessels, or nerves [6]. This limitation likely contributed to the failure of the initial surgical exploration, despite surface marking. The surgeon, relying on external landmarks, could not adequately localize the deeply embedded, small fragments intra-operatively.

Ultrasonography is another valuable tool, particularly for radiolucent foreign bodies such as wood or plastic. Most foreign bodies are hyperechoic, and ultrasound can help identify dimensions and depth. However, calcific spines may cast acoustic shadows, and the technique is operator-dependent [7]. In this case, CT was the pivotal imaging modality.

CT offers distinct advantages: high spatial resolution, multi-planar reformation capabilities, and precise three-dimensional localization [6]. It overcomes the superimposition of structures inherent to plain radiography. In our patient, CT precisely delineated the spines' size, orientation, and depth, enabling safe trajectory planning for intervention. Furthermore, CT-guided intervention allowed real-time confirmation of needle and forceps positioning, ensuring accurate targeting and complete removal. This minimally invasive approach obviated the need for a more extensive, potentially morbid, open surgical procedure.

The Challenge of Surgical Exploration

The failure of conventional surgical exploration in this case is instructive. Sea urchin spines are notoriously brittle and tend to fragment further during manipulation [1,4]. Their small size (the retrieved fragment was only 0.5 cm) makes them difficult to palpate intra-operatively, especially within inflamed, indurated tissue. Without precise real-time image guidance, even a well-intentioned surgical exploration can be futile and may cause additional tissue trauma. This experience aligns with the observation by Skedros et al., who noted that attempted surgical removal can be challenging and that spines may remain embedded for years, sometimes being followed radiographically without intervention [3].

Pathological Correlation: The Foreign Body Reaction

The histopathological findings in this case—an abscess surrounding a calcified nidus—are characteristic of a foreign body reaction. The initial insult triggers neutrophil recruitment. If the material persists, the immune response evolves into chronic granulomatous inflammation. Macrophages fuse to form multinucleated giant cells in an attempt to isolate the foreign material [5,8]. This reaction, centered on the retained spine, explains the patient's persistent pain and fever. The differential diagnosis for such lesions includes other foreign body granulomas (Table 1), but the clinical history of sea urchin exposure is pathognomonic [9].

Clinical Implications and Learning Points

This case reinforces several key principles for managing marine foreign bodies. Plain radiography is the essential first-line investigation for suspected radio-opaque foreign bodies. However, when spines are deep, multiple, or when surgical exploration based on surface landmarks fails, cross-sectional imaging with CT is mandatory. CT not only provides precise diagnostic localization but also enables definitive, minimally invasive treatment through image-guided intervention. Interventional radiology techniques should be considered early in the management algorithm for complex retained foreign bodies, potentially sparing patients from unsuccessful surgical explorations and their associated morbidity.

Conclusion

We report a case of retained sea urchin spines where initial surgical exploration failed, but subsequent CT-guided minimally invasive retrieval was successful. This case highlights the pivotal, multi-faceted role of radiology: from initial detection with plain radiography, through precise characterization with CT, to definitive image-guided intervention. It underscores that for complex, deeply embedded radiodense foreign bodies, a radiology-centric approach can be the key to successful management, and interventional radiology techniques should be integrated early into the treatment pathway.

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Figures and Legends

Figure 1: Multiple radiodense spike-like foreign bodies visualized in the soft tissues of the foot on plain radiography, consistent with retained sea urchin spines.

Figure 2: Plain radiograph demonstrating linear hyperdense foreign bodies in the posterior thigh soft tissues.

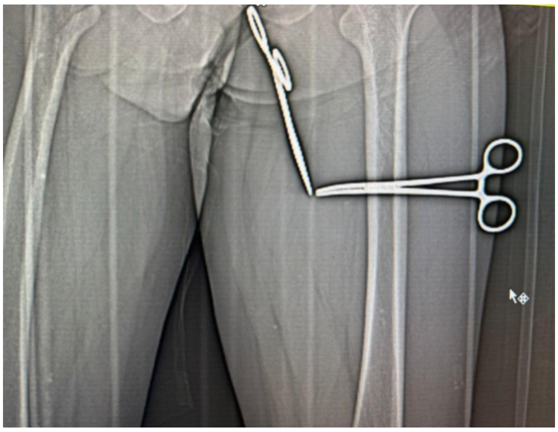

Figure 3: CT scannogram planning shows precise localization of a hyperdense foreign body.

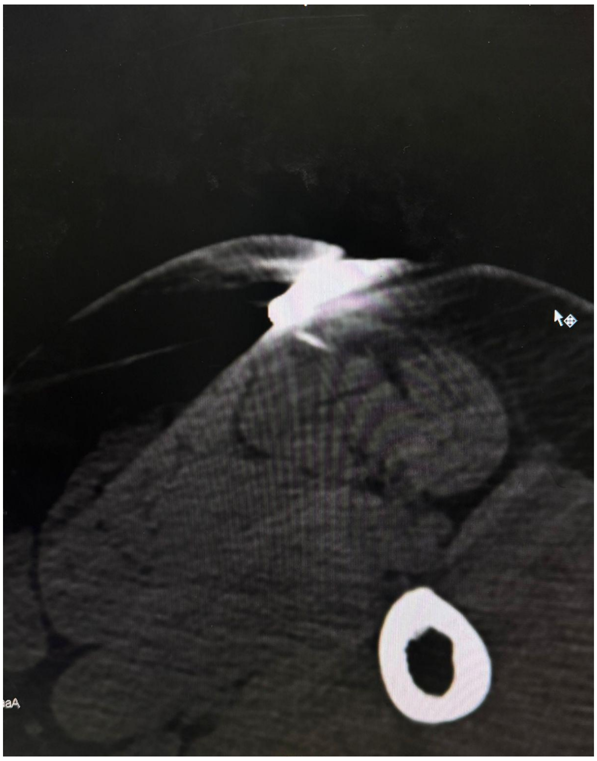

Figure 4: CT-guided intervention: Intra-procedural image demonstrating the needle and forceps positioned adjacent to the targeted foreign body for minimally invasive retrieval.

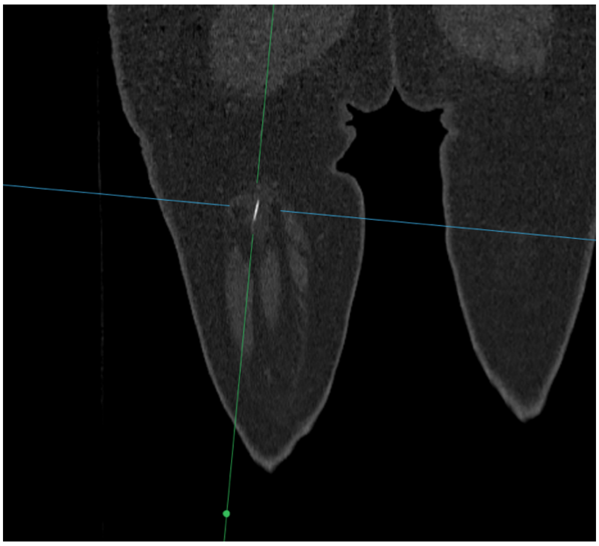

Figure 5: 3D reformatted Cornal imaging shows the orientation of the foreign body.

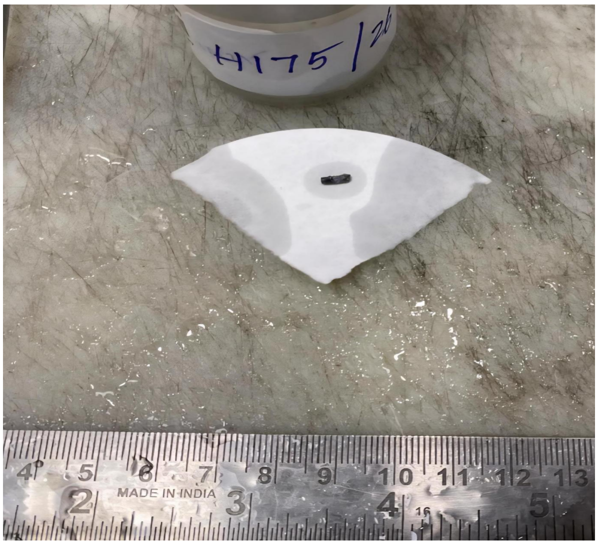

Figure 6: Gross specimen photograph showing the retrieved linear, grey-black foreign body measuring 0.5 cm in length with hard consistency, characteristic of a sea urchin spine.

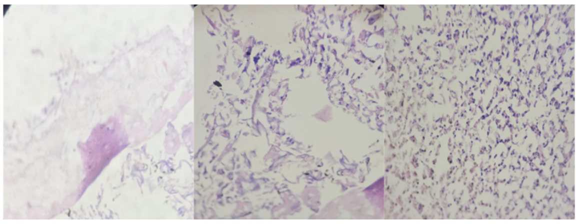

Figure 7: Photomicrograph (H&E stain, low power) showing fibrocollagenous tissue with a well-defined abscess cavity (black arrow) and a central tiny, calcified foreign body (white arrow), confirming sea urchin spine granuloma.

Table 1: Summary of Common Foreign Bodies and Their Histological Features

Foreign Body Type	**Microscopic Appearance**	**Special Staining/Features**
Suture material	Varied; may be refractile or have a distinct structure.	-
Talc	Birefringent particles under polarized light.	Polarized light
Starch	"Maltese cross" shape under polarized light.	PAS positive
Plant materials	Partially digested plant cells, often found in GI specimens.	-
Tattoo pigments	Pigment within macrophages and in the interstitium.	-

Paraffin	Cystic spaces of varying size ("swiss cheese" pattern).	Oil red O positive on fresh tissue
Silicone	Cystic spaces of varying size ("swiss cheese" pattern).	Oil red O negative
Silica	Crystalline particles, birefringent under polarized light.	Polarized light
Collagen (injected)	Pale grey-violet.	Masson's trichrome
Hyaluronic acid	-	Stains blue with Alcian blue