Application of intraoperative navigation and positioning system in the removal of deep foreign bodies in the limbs

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To the Editor: Secondary trauma and patient discomfort resulting from residual foreign bodies in the human body is a common occurrence and most of the time, surgical interventions are required for their removal. Usually, foreign bodies lying just beneath the skin surface can be easily retrieved. The major issue is when such foreign bodies lie deep in the soft tissues and become more complicated when they are of small sizes. It may lead to consequences such as tissue damage, delayed wound healing, infection, allergic reactions, and late injury as a result of migration.[1] Surgical interventions for removal of such deep-lying and/or small foreign bodies are not only known to be highly time-consuming but also involve higher levels of trauma to the surrounding tissues. The incidence of the retained foreign body widely varies from one case in every 1000 to 10,000 procedures [Table 1].[2]

Our team has used the intraoperative and navigation and positioning system for removal of deep-seated foreign bodies. A 41-year-old man turned up at the department with a history of a metallic machine needle incarcerated in his left thigh for 3 days. Standard anteroposterior and lateral X-rays were done, confirming the presence of a deep-seated radio-opaque foreign body in the thigh [Figure 1A and 1B]. Surgical intervention was planned. Following anesthesia, radio-opaque threads and plastic film were used to make a grid construct which was stuck over the approximate site of the foreign body [Figure 1C], and then X-ray was taken to display the position of the foreign body in the grid [Figure 1D]. Precise localization with a needle and C-arm X-ray machine (Insight2, Shawnee, KS, USA; C-arm) was carried out in different planes and 0.3-mL methylene blue was injected [Figure 1E and 1F]. The skin was incised and carefully dissected to protect the neurovascular bundle; the foreign body was found in the blue-stained area and removed successfully [Figure 1G]. C-arm was used to confirm removal of the object and the wound was closed after tourniquet release, hemostasis, and washout [Figure 1H and 1I].

Till date, no standardized surgical procedures for removal of foreign bodies from limbs have been stated.[3] Wen *et al*[4] used enhanced computed tomography and three-dimensional angiography to show the accurate location and spatial relationship between foreign bodies and important blood vessels, which provide guidance for surgery. Ultrasound-guided extraction of soft-tissue foreign bodies was shown by Fu *et al*.[5] These procedures have had undisputed success but the technique largely depends on the use of special equipment; also, the amount of radioactivity is quite substantial. Therefore, the use of these technologies cannot be generalized.

Our system makes use of a double positioning system by combining the use of the sterile syringe needle, film, and C-arm with the use of methylene blue for more accurate localization. Removal of impacted foreign bodies with the use of the above-mentioned technique has several advantages. The technique is simple, fast, cost-effective, and highly accurate, thereby shortening the operation time and reducing radiation exposure to patient and operation theater staff. Furthermore, with the small incision and minimal exploration required and also the high success rate, it is a technique worth generalizing for the extraction of foreign bodies from extremities.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s)/patient's guardians has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients/patient's guardians understand that their names and initials will not be published and due

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Table 1: Demographic data of patients with INPS in the removal of deep foreign bodies in the limbs.

Case no.	Sex	Age (year)	Position of foreign body	C-arm using frequency (time)	Length of incision (cm)
1	Female	37	Right foot	5	4
2	Male	41	Left thigh	4	5
3	Male	44	Right forearm	5	5
4	Male	57	Right hand	6	4
5	Female	31	Left hand	5	4
6	Female	46	Left foot	5	5
7	Male	41	Left thigh	4	6
8	Male	47	Right foot	5	4

INPS: Intraoperative navigation and positioning system.

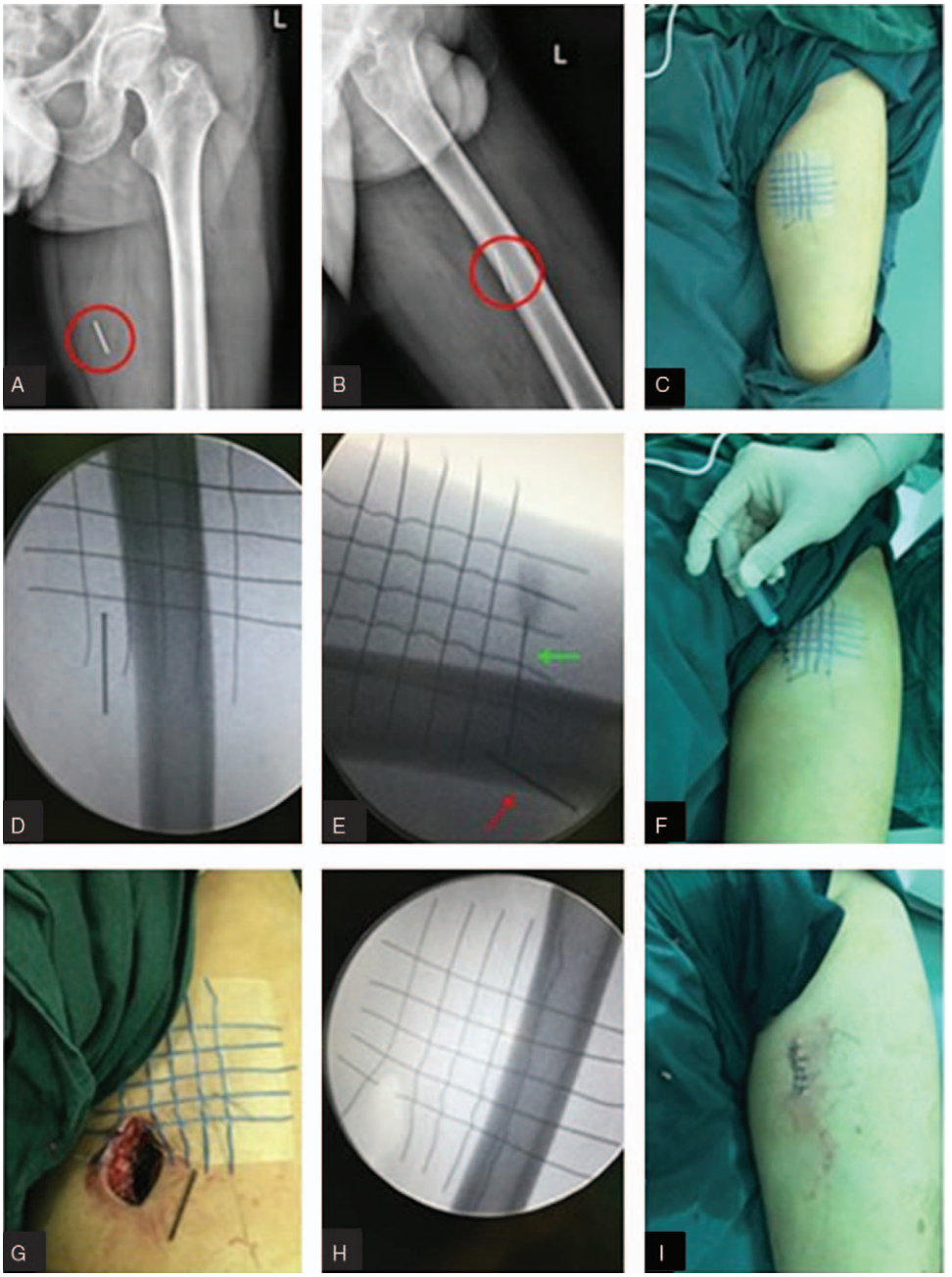

Figure 1: Left femoral anteroposterior radiograph shows the presence of metallic foreign bodies in the thigh (A and B). The mesh development mask is installed (C). The C-arm is positioned to display the position of the foreign body in the grid (D). Under the C-arm perspective, a 1-mL syringe needle (green arrow; E) is introduced vertically followed by methylene blue injection (F) around the metallic foreign body (red arrow; E). Incision and wound exploration in layers is to localize the bluish-stained tissues and the metal foreign body (G). Then X-ray is taken again, which confirms that the foreign body is removed completely and the wound is sutured (H and I).

efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflicts of interest

None.

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