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Novel methods of removing metallic foreign body from human soft tissue: a report of 7390 cases

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ABSTRACT

Background: We studied methods of locating metallic foreign bodies in soft tissue of the human body.

Methods: Using a three-dimensional (3D) locator, we removed metallic foreign bodies precisely from soft tissue of 7390 patients through magnetic forceps between June 1999 and June 2009.

Results: In 7390 patients, we successfully removed 99.5% of all metallic foreign bodies by 3D locator and forceps. Average operation time was 5 min.

Conclusions: Metallic foreign bodies can be located precisely and removed simply with few complications using our 3D location method. The method may lead to minor trauma, less suffering, and a high success rate.

Taking out metallic foreign bodies (MFBs) from soft tissue has been a surgical challenge, and it is sometimes difficult to achieve the goal. We developed a technique to solve this issue. From June 1999 to June 2009, we took out MFBs from soft tissue successfully in 7390 cases in our hospital by using a three-dimensional (3D) locator to navigate special magnetic forceps. The results were satisfying; we report them below.

1. Patients and methods

From June 1999 to June 2009, we treated 7390 patients with MFBs in soft tissue in our hospital and took them out as intended. Among the patients were 5505 males, which accounted for 74.5% of cases, and 1885 female, which accounted for 25.5%. Patients were 2–95 y of age (average, 29.7 ± 15.3 y).

The causes of MFBs in human soft tissue vary widely; most are from improper security measures. Among 7390 patients, 4611 were builders and construction workers, which was about 62.4% of portion. They had MFBs such as fragments of steel, iron, wire, nails, or aluminum products. Women working in textile factories could have acquired MFBs through accidents with metallic needles. Iatrogenic causes of MFBs accounted for 21.2% of all cases; they were needle fractures from surgeries or other medical procedures. Common incidences of MFBs occur from fracture of acupuncture needles, surgical stitches, and birth control rings. Finally, injuries from gunshots or other accidents involving metal can also cause MFBs. These cases account for 15.9%, the smallest proportion in our report (Tables 1–3).

Some patients with MFBs (93.1%; 6880 of 7390 patients) showed symptoms occurring as local pain, numbness, local mass, or prolonged healing from wound infection. Non-symptomatic cases were about 2.1% (155 of 7390), whereas patients who had excessive anxiety caused by MFBs but no local symptoms were about 4.8% (355 of 7390).

We discovered that we could use the triangular geometry mechanism and puncture technique of minimally invasive

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Table 1 – Position distribution of MFBs found in human soft tissue (cases).

	Hand or foot	Upper extremity	Lower limb	Hip	Chest or abdomen	Head or neck	Total
Metal fragments	996	795	819	360	429	783	4182
Metal needle	486	192	171	798	108	141	1896
Metal bullets	182	152	263	104	342	269	1312
Total	1664	1139	1253	1262	879	1193	7390

surgery to remove MFBs in soft tissue of patients. The first step of this specific method is to fix the 3D locator (TDL) (Fig. 1) (Chinese Patent No. 9020721317) on the body surface near the MFB (Fig. 2). Next, we determine the MFB's exact location and depth to the skin simply through the grids on both sides of TDL, with x-ray irradiation (Fig. 3). Then, we mark the skin point closest to the MFB.

After disinfection and local infiltrating anesthesia at the marked skin point, we usually cut the skin incision within 5–8 mm at the marked point while selecting appropriate forceps special for MFBs (Figs. 4 and 5), based on the different shapes of MFBs. Then, we insert forceps from the incision to the MFB's location under x-ray (Fig. 6). Because there is a depth scale on the surface of each special forceps, they can be used easily to hit upon the MFB accurately. We can feel the MFB when the forceps touch it. We then open the forceps' tips with a magnetic clamp, hold the MFB (Fig. 7), and take it out by pulling out the forceps (Figs. 8 and 9). A great advantage of this surgical method is that the incision wound can heal without stitches.

2. Results

In 37 of 7390 cases (0.5%), the MFB was in the abdominal or thoracic cavity. We removed the MFB successfully under laparoscopy or with an open operation. In the other cases (7353; 99.5%), we removed the MFB successfully with our new technique. The average surgical time from incising the skin to taking out the MFB was about 5 min using our method. There was almost no bleeding from the wound. In a few cases, active bleeding could be stopped with a pressure bandage. In one case, we removed 261 small lead bullets completely from one patient with several operations.

We found migratory MFBs in 1529 cases (20.6%). From x-ray imaging, the location of this kind of MFB was different from the original location in which the injury happened initially. The MFB shifted owing to body movement and muscle contraction. In all cases, the MFB were successfully removed, related symptoms were alleviated, and there were no iatrogenic injuries or complications.

3. Discussion

Metallic foreign bodies in the human body are usually caused by industrial accidents, war, and other misfortunes, including iatrogenic incidents. Not all patients with MFBs need operations, especially those who do not have symptoms or complications. On the other hand, MFBs could result in pain, bleeding, infection, sinus, dysfunction, and anxiety. Furthermore, the MFB itself sometimes has potential danger and toxicity. Hence, in most cases the MFB must be removed. As reported in previous literature, in 33.8% of cases the MFB was removed within 72 h, whereas for 49.6%, it was removed between 72 h and 6 wk afterward. We observed that within 72 h after the injury, the MFB was always accompanied by wound passing from skin but without adhesion to surroundings, which was the best time to be located and easily operated upon. Adhesion and scar around the MFB would occur after 6 wk or longer, which would make an operation more difficult and complications more likely. However, some studies suggested that the right time to remove an MFB is 3 mo afterward [1]. It was stated that the MFB could be wrapped and fixed by fibrous scar after 3 mo, and therefore removal would be more achievable.

Locating an MFB precisely is the key point in the operation. Several important steps are helpful and should not be omitted. A careful historical and physical examination may indicate the site, nature, and size of the MFB. A visual inspection will show the puncture wound of entrance, if it happened recently. Other direct locating methods such as x-ray, computed tomography, and ultrasonic examination [2–4] can pinpoint the MFB and further show the relation between the MFB and its surrounding organs or tissues. These imaging diagnostic systems are reliable and beneficial when the MFB is close to major blood vessels in an anatomical complex area such as the head and

Table 2 – Time distribution of MFBs in human soft tissue.

Time	Cases	Proportion (%)
~24 h	916	12.4
~72 h	1582	21.4
~6 wk	3666	49.6
~1 y	576	7.8
~5 y	311	4.2
~10 y	299	3.1
>10 y	110	1.5

Table 3 – Length distribution of different MFBs in human soft tissue (cases).

	Largest diameters of MFB (mm)				
	1–5	10	20	20	Total
Metal fragments	1698	1116	825	543	4182
Metal needle	726	516	459	195	1896
Metal bullets	802	441	69	0	1312
Total	3226	2073	1353	738	7390