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Tips and tricks in the diagnostic workup and the removal of foreign bodies in extremities

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Objective: The aim of this study was to analyze the diagnostic and therapeutic challenges during the removal of foreign bodies in extremities, and to provide relevant tips and tricks.

Methods: The medical records of 295 patients (150 men, 145 women; mean 26.82±16.84 years; range: 3 to 79 years) who underwent foreign body removal from their limbs between February 2005 and July 2011, were retrospectively reviewed. Side of the extremity, foreign body type, location, complaints, imaging technique, the season of injury, the effects of foreign body in the body, the time between injury and extraction, indication forextraction, type of anesthesia, the use of fluoroscopy during the surgical procedure, and complications of surgical intervention were analyzed.

Results: The injury was in the right limb in 157 patients and in the left limb in 138 patients. Foreign bodies were in the elbow in 4 cases, in the forearm in 6, in the wrist in 6, in the hand in 75, in the hip in 1, in the thigh in 7, around the knee joint in 11, in the knee joint in 6, in the lower leg in 10, in the ankle in 8, and in the foot sole in 161. The season of injury was summer in 148 cases, winter in 107, spring in 35, and autumn in 5. The removed foreign bodies were needles in 216 cases, metallic objects in 33, pieces of glasses in 28, pieces of wood in 10, pieces of plastic in 4, and pieces of stone in 4. The time between the injury and foreign body removal was 1 day in 135 cases, 2 to 10 days in 114, 11 to 30 days in 22, and 30 to 365 days in 13. The removal time was longer than 1 year such in 11 cases.

Conclusion: Foreign body injuries may result in serious complications such as infection, migration and joint stiffness. A throughout history and physical and radiological examinations are of tremendous importance to achieve the best outcome in these patients.

Key words: Extraction; foreign bodies; limbs; extraction; removal.

The penetration of foreign bodies into the extremities is generally accepted as a simple injury with the misconception that treatment will be easy.

The aim of this study was to analyze the diagnostic and therapeutic challenges during the removal of foreign bodies in extremities, and to provide relevant tips and tricks.

Patients and methods

A retrospective evaluation was made of 295 cases (150 men, 145 women; mean age 26.82±16.84 (range: 3 to 79) years operated on because of penetrating foreign bodies (FBs) between February 2005 and July 2011. Cases were excluded where there was a high risk of damaging anatomic structures during removal or where the FB was

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too small to be removed. In addition, patients with high energy injuries from firearms were not included.

Side of the extremity, FB type, location, complaints, imaging technique; the season of injury, the effects of foreign body in the body, the time between injury and extraction, indication for extraction, type of anesthesia, the use of fluoroscopy during the surgical procedure and complications of surgical intervention were analyzed.

Preoperative plain radiographs were taken in all patients. In 2 cases with resistant infection following wooden and plastic FB removal, magnetic resonance imaging (MRI) was also taken to check for any residual FB.

Ultrasonography (USG) and computed tomography (CT) were not used in our series. Tetanus vaccination was performed in the acute cases without immunization. All patients received pre and post-operative prophylactic antibiotic therapy. Surgery was performed under local anesthesia in 187 cases and under general anesthesia in 108.

In 74 patients, FB removal was performed under fluoroscopic control. The radiolucent FBs like wood, glass and plastic was localized based on the patient history and findings of the physical examination. A total of 16 cases with active infection or with intraarticular FBs were hospitalized for 3 days for monitorization and antibiotic therapy (Table 1).

Results

The data of the cases included in the study are presented in Table 1. The cases were 150 males and 145 females with a mean age of 26.82±16.84 (range: 3 to 79) years. Injuries were in the right extremity in 157 cases and in the left in 138 cases. Foreign body was around the elbow in 6 patients, the wrist in 6, the hand in 75, the hip in 1, the thigh in 7, the knee in 11, the lower leg in 10, the ankle in 8, the sole of the foot in 161 and in the knee joint in 6. The season of injury was summer in 148 cases, winter in 107, spring in 35 and autumn in 5. Foreign bodies removed from extremities were 216 needles, 33 metal pieces, 28 glass pieces, 10 wooden pieces, 4 plastic pieces and 4 stones. The time between the injury and the operation were 1 day in 135 cases, 2 to 10 days in 114, 11 to 30 days in 22, 30 to 365 days in 13 and more than a year in 11.

In one case, a needle FB was removed after 20 years with no complications. A secondary plastic FB was revealed during wound debridement in 1 case and in another case, a wooden FB led to resistant infection. In 5 cases with FB needle injury, the needle was comminuted so that all the pieces could not be removed. These patients had no complication during their follow-up.

Table 1. Demographic data of the patients in our series.

		Min-Max	Ort±SD
Age (years)		3-79	26.82±16.84
Hospitalization (days)		1-3	1.21±0.61
		n	**%**
Gender	Female	145	49.2
	Male	150	50.8
Time from injury to operation	1 day	135	45.8
	2-10 days	114	38.6
	11-30 days	22	7.5
	30-365 days	13	4.4
	≥366 days	11	3.7
Foreign body	Glass	28	9.4
	Needle	216	73.2
	Metal	33	11.2
	Plastic	4	1.4
	Wood	10	3.4
	Stone	4	1.4
Side	Right	157	53.2
	Left	138	46.8
Location	Ankle	8	2.7
	Sole of foot	161	54.7
	Elbow	4	1.4
	Knee joint	6	2.0
	Around knee	11	3.7
	Hand	75	25.4
	Wrist	6	2.0
	Hip	1	0.3
	Crus	10	3.4
	Forearm	6	2.0
	Thigh	7	2.4
Imaging	Radiograph	293	99.3
	MR	2	0.7
Fluoroscope	Not used	221	74.9
	Used	74	25.1
Anesthesia	Local	187	63.4
	General	108	36.6
Season	Spring	35	11.9
	Winter	107	36.3
	Autumn	5	1.7
	Summer	148	50.1

Discussion

Foreign bodies may be composed of different materials such as metal, glass, wood, plastic, etc.[1-4] The nature of the material affects radiological appearance of the FB. Metallic FBs appear radio-opaque on plain radiographs[5] (Fig. 1). In the current study, glass pieces were detected with plain radiograph in all cases injured with glass (Fig. 2). Courter reported that glass pieces larger than 2 mm can be detected on plain radiographs at a rate of 99% and those smaller than 2 mm at 61 -83%.[2] Plain radiographs give more useful information about deep-seated glass pieces than superficially located ones.

Fig. 1. Needle wound in the sole of the foot.

Fig. 2. Glass wound in the sole of the foot.

It has even been reported that once the wound is well explored, there is no need for radiographs in superficial glass pieces.[6] Ultrasonography should be the first choice in the imaging of radiolucent FBs such as wood and plastic.[7,8] USG will provide information on the nature of the FB and surrounding soft tissues. Metallic, plastic, glass and fresh wooden pieces will be hyperechoic on USG, while they will show a hypoechoic shadow beneath.[8] It would be hard to detect comminuted small wooden pieces. However, secondary changes such as edema, may be detected as hypoechoic areas.[8] The majority of the cases with wood and plastic FBs were addressed in the emergency room.

Due to the difficulties of finding an out-of-hours specialist radiologist and the need for special probes to visualize superficial objects,[7] none of our patients had a sonographic assessment. Radiolucent FBs was located with palpation or by exposing the wound with the guidance of the hematoma. In patients with a radiolucent FB and those who underwent first intervention in the emergency room but had findings of infection and those with persistent pain, MRI was preferred as a second imaging technique.

In literature, CT[9] and MRI[10] have been recommended if radiolucent FBs can not be localized by USG. In the wide bone window of CT, FBs may be detected.[11] The appearance of the FB on CT is not affected by the localization.[12] Metallic, as well as wooden FBs, may be detected on CT.[12] However, the soft tissue calcification in patients with atherosclerosis, neuropathy, venous stasis, trauma and renal insufficiency, may be mistaken as FBs.[13]

In a case with a piece of wood in the forearm, the FB was partially removed during the initial procedure. This case represented after one week with persistent pain, swelling and increased warmth in the forearm. MRI revealed a residual piece of wood of approximately 4 cm long and 0.5 cm wide surrounded by inflamed tissue (Fig. 3). Following abscess drainage and FB removal the symptoms of the patient resolved.

Inflamed tissue around a residual FB will appear on MRI as hypointensity on T1-weighted sequences and iso-hyperintensity on T2-weighted sequences.[10] Wooden or too small FBs without any inflammation may not be detected on MRI.[10,11] Foreign bodies of different properties give varying degrees of hypointense signal on all sequences.[12] FBs with inflammation in the surrounding tissue giving hypointense signal may be confused with tendons, scar tissue or calcification.[10-14] Computed tomography is cheaper, faster and more effective in the visualization of small wooden pieces than MRI.[12-16]

Foreign body injury was most frequently in the foot (161 cases; 54.7%) and the hand (75 cases; 25.4%). These results were paralel with the previous data from the literature.[17,18]

Foreign body migration varies according to the properties of the FB and the anatomic region. Long, thin FBs with a smooth surface located in the tendon sheath and those in the upper extremities may move more easily and over longer distances.[19-21] Wooden FBs are organic and they are the ideal environment for the proliferation of microorganisms[22] (Fig. 3).

According to the experience gained from the cases in this study, the patient's age and the location of the FB

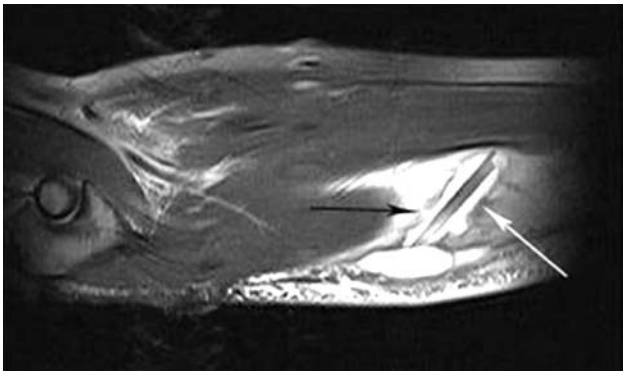

Fig. 3. Abscess formation around a wood wound in the forearm.

are factors influencing whether removal of the FB should be made under local or general anesthesia in the operating theater or in the emergency room. Superficial FBs in adults can be removed in the emergency room under local anesthesia whereas in pediatric cases, even the superficial FBs should be removed in the operating theater under general anesthesia. Deep-seated FBs in adults should also be removed in the operating theater under general or local anesthesia.

All lacerations or penetration wounds should be explored and palpated to detect any FBs in the emergency room.[18] It should be explained that the residual FBs without any sign of infection may be removed with an elective surgery.[18]

Foreign bodies due to firearms injuries were not included in our study. There is no indication to remove extraarticular FBs with no symptoms.[23,24]

For deep or superficially located radio-opaque objects, a curved hemostat was placed over the estimated point-of-entry, then the FB was localized with antero-posterior and lateral fluoroscopic images and then the incision was made. Foreign body's proximity to the main anatomic structures should be considered before grasping it with surgical instruments. We did not have any iatrogenic neurovascular injury in our series. If the FB has not been localized preoperatively, possibly a larger incision and exposure will be necessary.[25]

Sharma and Azzopardi used a 3×20-gauge needle to find radio-opaque FBs.[25] Mardel stated that the Trandelenburg position may reduce the blood flow to the lower extremity, providing a clearer view and thus, FBs in the foot could be more easily removed.[26] Some authors have recommended the removal of FBs in the operating theater under sonographic guidance.[7,27] In the current study, of 16 cases with FB located in the joint, 6 cases were in the knee joint and 3 of those underwent arthroscopy. In one of these cases, which had resulted from a broken needle, a 2 mm piece of the needle remained between the posterior tibial plateau and the joint capsule inferior to the posterior medial meniscus and could not be removed. In the 21-month follow-up of this patient, the needle fragment was not seen to lead to synovitis, infection or mechanical damage.

We recommend low-pressure irrigation during arthroscopic removal of intraarticular FBs. The FB, once grasped with a clamp, should be removed gently without any forcible maneuver. Mahirogullari et al. reported arthroscopic removal of an intraarticular bullet and emphasized the non-invasivity of the technique.[28]

We recommend removal of the FBs in the hand in only symptomatic patients. Lamb and Kuczynski recommended not removing FBs from the hand because of the risk of iatrogenic injuries.[29] On the contrary, Humzah and Moss suggested removal of the FBs in the hand for the risk of injury over time.[30]

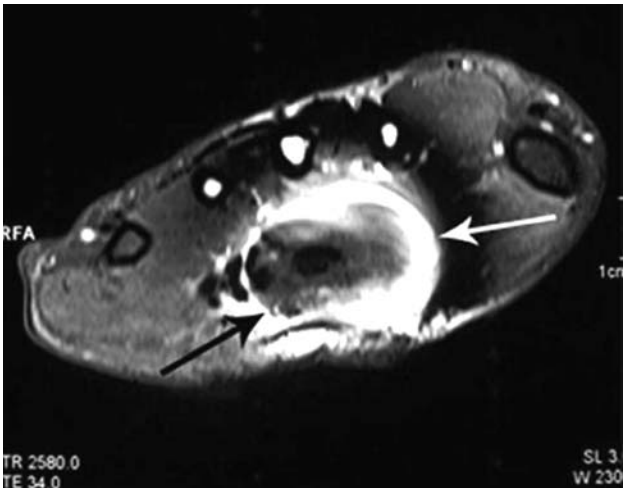

Fig. 4. Granulation tissue around a stone piece in the volar aspect of the hand.

We had a case with a stone FB in the volar aspect of the hand with findings mimicking soft tissue tumor and carpal tunnel syndrome (Fig. 4). The development of a pseudo capsula surrounding FBs remaining in the body for a long time mimics tumor-like lesions.[31,32]

We removed a plastic piece of a shoe during the debridement of a fistula which developed after a nail penetration. This plastic shoe piece had most probably entered the sole of the foot together with the nail, gone into the deep tissue and caused resistant infection. The symptoms of the patient resolved after removal of the plastic FB. This case shows that with any FB entering through the skin, a secondary FB may also enter the wound. Rubin et al., reported similar cases.[4]

However, the FB injuries where a part remained under the skin, either because it was not noticed on first presentation or only the part above the skin was

Table 2. Complications associated with foreign body wounds.

Foreign body	No of cases	Complication
Glass	28	None
Needle	216	In complete removal in 5 cases
Metal	33	None
Plastic	4	One resistant infection associated with a residual piece of FB
Wood	10	One resistant infection associated with a residual piece of FB
Stone	4	One pseudotumor and carpal tunnel syndrome

removed, were plastic, stone and wood FB injuries. Complications of persistent pain, pseudotumor and resistant infection were seen in these cases (Table 2).

We did not see any FB migration in our 160 cases with FB removal. Most of the reports on FB migration in the literature are case reports.[19-21]

If the FB can not be removed or is only partially removed, the piece left inside may lead to complications such as infection, delayed healing, persistent pain, migration, osteomyelitis, cellulitis, pseudotumor and damage to adjacent anatomic structures.[2-4,19-21,25,30-35]

Foreign bodies which penetrate or come close to the bone may lead to osteomyelitis.[35] In the current study, no cases of FB injury resulted in osteomyelitis.

With the increasing rate of medical litigations, missed FBs should also be considered within a medicolegal perspective.[36] One can easily miss the probability of a FB following a superficial history and an incomplete initial examination and close the wound. In the US, this is a frequent reason to sue a physician.[37-39] Vukmir reported that 32% of the 109 court cases against emergency room physicians in Massachusetts were due to undiagnosed FBs.[37]

In the current study, the increase in injuries in the summer is probably due to not wearing shoes and socks and the increase in the winter may be due to more home-based activities during this period. Of the removed FBs, 73.2% were needles, which may be related to the residential location of our hospital.

Foreign bodies can remain in the extremities without any clinical symptom, as in one of our cases where there were no need to remove the FB for 20 years. All the FBs remaining for long periods were metallic needles. The request of the patients for a delayed surgical FB removal was due to psychological discomfort. In lately presenting missed cases of non-organic FBs (i.e. metal or glass) who are not symptomatic, the possibility of not removing is also a reasonable alternative to be discussed with the patient.

We did not have any postoperative scar problem in our series.

In conclusion, foreign bodies in the extremities should not be taken as simple injuries. Imaging studies should be planned based on the nature of FB. Plain radiographs will show radio-opaque materials such as metal and glass and advanced techniques such as USG, CT or MRI will be necessary to show radiolucent materials such as wood, plastic and aluminium.

The possibility of an incomplete removal is always a probability which should be discussed with the patient before the surgery.

In cases of persistent pain or resistant infection after removal, the probability of incomplete removal and residual FB must be kept in mind. In lately presenting missed, but asymptomatic cases the possibility of not removing the FB is also a reasonable alternative.

Conflicts of Interest: No conflicts declared.

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