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ORIGINAL ARTICLE

Application of Ultrasound in the Identification of Foreign Bodies in Scalp Wound: A Cross-sectional Study

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Abstract

Introduction: Retained foreign bodies in wounds are among the most challenging problems in the emergency department (ED). They lead to wound infection and abscess, delayed healing, and wound scars. Therefore, the present study aimed to determine the diagnostic value of ultrasound as an accessible and non-invasive modality in determining foreign bodies in scalp wounds.

Methods: This cross-sectional analytical study was performed on 58 ED patients with scalp wounds who needed brain computed tomography (CT) scans and met the inclusion criteria. Firstly, wound exploration and irrigation of visible foreign bodies were performed. Thereafter, an ultrasound was carried out by an emergency medicine resident to detect the hidden foreign bodies (if exist) in the wound. Finally, a CT scan was administered (as the gold standard) to detect any remained foreign bodies. The foreign bodies were removed and the wound was sutured in the end. Sensitivity, specificity, positive likelihood ratio, negative likelihood ratio, disease prevalence, positive predictive value, negative predictive value, and accuracy were assessed.

Results: In total, the sensitivity, specificity, and accuracy of ultrasound were estimated as 91.43%, 100%, and 91.55%, respectively. Moreover, the positive predictive value and negative predictive value of ultrasound were reported as 100% and14.29%, respectively.

Conclusion: As evidenced by the results of this study, ultrasound is a highly sensitive diagnostic method to detect foreign bodies in scalp wounds. In some cases, such as frontal lobe wounds, this modality may not detect all foreign bodies.

Key words: Diagnostic imaging, Foreign bodies, Scalp, Ultrasonography, Wound infections

Introduction

Open wounds are among the most common complaints in emergency departments (ED). The prevalence of foreign bodies left in the wound, in the initial evaluationsby the physician,varies from 7%-38% (1). The most ideal time for the removal of foreign bodies is within the first 24 hours of wound occurrencesince the borders and depth of the wounds are clear, inflammation is low-grade, and t he incidence of scarring is minimized. On the other hand, any delay in treatment may caultrasounde serioultrasound complications, ,such as infection delayed wound healing, inflammation, and loss of function (2). Attempting removal can lead to complications, including further tissue damage, foreign body migration or retention, infection, and nerve damage. Moreover, f oreign bodies remaining in soft tissues can result in medical malpractice claims and high compensation payments (2).

Imaging methods to identify foreign bodies include plain radiography computed tomography (CT),

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ultrasound, and magnetic resonance imaging (MRI). methods depends on the The choice of each of these size, characteristics, and location of foreign bodies (3). In fact, foreign objects that may not be easily detected by one method might be detected by another method (4). Each of these methods has its own advantages and disadvantages; therefore, they are effective in specific situations which are described below:

Plain radiography is the usual method for foreign body detection, allowing radiologists to determine the location of the object and whether the location is clinically significant; nonetheless, in some cases, such as thin glasses or wood, it may not be ultrasoundeable (3). The CT scan shows the exact shape and size of the foreign body in the wound, and if there is an indication for surgery, it is helpful. It is up to 15 times more sensitive than simple radiography in detecting foreign bodies. MRI is inappropriate as a primary diagnostic tool for foreign bodies; in fact, all patients should be checked for foreign bodies before an MRI is performed since existing magnetism may move and rotate the object, posing a great risk to the patient (5).

Another diagnostic method is point-of-care ultrasound. One of the advantages of the ultrasound is the absence of radiation and the ability to perform it at the patient's bedside. In previousstudies , the sensitivity and specificity of the ultrasound in the detection of foreign bodies have been reported as 89.5%, %-100%, and 95%-100%, respectively (5, 6). The ULTRASOUND is able to accurately localize the three-dimensional parameters of foreign objects with an accuracy of one millimeter. If a foreign body is located superficially, ultrasound is a more efficient tool than CT or plain radiography (7). The effectiveness of this imaging method depends on the skill of the operator, as well as the size and material of the object. Foreign bodies that are deep in the tissues cannot be detected by ultrasound (8). Ultrasound can be used for foreign body detection, especially in emergency wards, since it is portable, achievable, and with no radiation exposure. In light of the aforementioned issues, the present study aimed to assess the diagnostic values of ultrasound in the detection of foreign bodies in emergency wards.

Methods

This descriptive-analytical study was performed on 58 ED patients with scalp wounds who underwent brain CT scans in two academic hospitals in Yazd, Iran. The Ethical Code of this manuscript was IR.SSU.MEDICINE.REC.1400.141. The inclusion criteria entailed scalp wounds which need to be explored for the detection and removal of foreign bodies and perform spiral brain CT Scan. This study was carried out in three stages respectively, in each, the number and material of foreign bodies was detected, recorded, and finally analyzed.

After ensuring the patient was lying at the appropriate height and good ambient light, the wound was anesthetized and fully rinsed in order to remove clots and other debris. In stage one, the wound was explored by a physician, and any foreign body was removed by forceps. In stage two, ultrasound was performed by an emergency medicine final-year resident (as is described below), and the detected foreign bodies were recorded. In stage three, CT scan was performed (as the gold standard) for detecting foreign bodies. The foreign bodies were removed and the wound was finally sutured. The number of foreign bodies and their material at each stage were recorded.

Ultrasonography

In this study, the entire area of the wound was examined by 6-13 MHz linear probe ultrasound (Fujifilm SonoSite TM). The physician put a gel-coated probe on the wound edge and moved it horizontally and vertically to detect all foreign bodies all around the wound (as described in similar studies) (9, 10). Foreign bodies will appear as echogenic or hypoechoic objects with posterior shadow or reverberation. In the end, the distribution of detected foreign bodies and the percentage of them in each stage by each diagnostic modality were listed. Sensitivity, specificity, positive likelihood ratio, negative likelihood ratio, disease prevalence, positive predictive value, negative predictive value, and accuracy were assessed.

Results

Finally, 58 patients met the inclusion criteria, with a mean age of 42.6 years. Regarding gender, 35 (60.3%) and 23 (39.6%) of cases were male and female, respectively. Moreover, 39.5% of patients had occipital wounds, and some others had two or more wounds. (Table 1)

Most foreign bodies in the wound included sand (38.3%), and in 28.4% of wounds, no foreign body was detected. Other wounds had wood, plastic, or glass particles. There was one piece of wood (1mm) in the frontal lobe wound of a female which was not detected by sonography and CT scan but was explored during suturing. There were five sands with diameters of about 1-1.5 mm that could not be explored by ultrasound. Table 2 displays the diagnostic value of ultrasound for the detection of foreign bodies in scalp wounds.

Table 1. Distribution of the frequency of wounds in the scalp area based on gender

scalp area	Female	Male	Total N(%)
Occipital	11(17.1)	14(21.8)	25(39.5)
Frontal	5 (7.8)	12(18.7)	17(25.9)
Parietal	5 (7.8)	10(15.6)	15(23.5)
Temporal	2 (3.1)	5 (7.8)	7(11.1)
total	23(35.9)	41 (64.0)	64(100)

Table 2. Diagnostic value of ultrasound in the detection of foreign bodies in a scalp wound

	Value	95% CI
Sensitivity	91.43%	82.27% to 96.79%
Specificity	100.00%	25.0% to 100.00%
Disease prevalence (*)	98.59%	92.40% to 99.96%
Positive predictive value (*)	100.00%	94.40% to 100.00%
Negative predictive value (*)	14.29%	7.20% to 26.37%
Accuracy (*)	91.55%	82.51% to 96.84%

(*) These values are dependent on disease prevalence.

Discussion

In total, the sensitivity, specificity, and accuracy of ultrasound were estimated at 91.43%, 100%, and 91.55%, respectively. In addition, the positive predictive value and negative predictive value of ultrasound were 100% and 14.29%, respectivel. In a study by Hiremath, R. et al. (11), foreign bodies were detected by ultrasound in 43 patients (41 positive and 2 false positive). The sensitivity and specificity of ultrasound in this study were 100% and 95.1%, respectively. In these studies, wood was the most common foreign object, while in our research, most foreign bodies were sand. Moreover, the previous studies were performed by a radiologistwhile this research was performed by an emergency medicine assistant. In the same vein, a similar study detected foreign bodies with a sensitivity of 94%-100% and specificity of 95%-99.5% (12).

Our study demonstrated that six of all foreign bodies were sandy, had under 2 mm diameter, and were detected by CT scan, while ultrasound and the physician could not discern them. This finding can be attributed to more prevalence of sand as a foreign body in our patients' soft tissue. Given that sands were less than 5mm, they had fewer shadows or reverberation on ultrasound. In the scalp, we have more bone artifacts and sands can be missed by them as it was reported that most foreign bodies are echogenic (especially wood and metal) and regularly reveal posterior shadow or reverberation artifacts on the screen picture. The degree of echogenicity of an object differs on the origin of the material and thickness of the object, as well as the angle of the probe; therefore, it may lead to some missed objects.

As indicated in previous studies, when foreign bodies are deep, they can be missed by the operator .(13) Ultrasound has an additional worth due to it can help physicians plan the removal of a foreign body and also guide the removal procedure thoroughly. (10) Limitationsin in this study were as follows: in cases where there is severe bleeding in the woundit might be necessary to repair the wound before ultrasound tostop bleeding. Moving the ultrasound probe over the wound may be painful for the patient despite anesthesia. In addition, the presence of bone under the tissue limits the vision. The number of patients in this study was limited and further studies are needed to be performed on a larger sample size. It is recommended to determine the diagnostic value of ultrasound in determining foreign bodies in patients with limb injuries. It is suggested to calculate the diagnostic value of ultrasound in different radiolucent and radiopaque objects separately. It is recommended to compare the diagnostic value of radiography and ultrasound in determining foreign bodies remaining in soft tissue. It is also recommended to conduct a similar study with a larger sample size.

Conclusions

The findings of our study pointed ultrasound is a diagnostic and also practical method with high sensitivity to detec the presence of a foreign body in scalp wounds. Point-of-care ultrasound has reduced the probability of remaining foreignbodies by explorer; nonetheless, thereis also a small percentage of foreign bodiesremaining by ultrasound (mostly in small objects). Regarding the bony structure of the frontal area, it is recommended to perform a CT scan if there is any doubt about the presence of a foreign body in this area.

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Conflict of Interest

The authors declare no conflict of interest.

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