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CONGRESS PROCEEDING

Ultrasound examination of various dental materials and foreign bodies

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Abstract

Purpose: To provide information on the sonographic properties of different foreign bodies and dental materials to help with diagnosis.
Materials and Methods: : The investigation contained ten various dental materials and foreign bodies that were consisting of composite, glass ionomer cement, gutta percha, suture, a piece of wood, stone, canal file, acrylic, alginate, and silicone impression material. The objects were embedded to chicken meat and imaged using ultrasonography (USG). Their visibility and posterior acoustic behaviors were evaluated by both hockey and linear transducers. The actual sizes of these objects and measured dimensions by transducers were compared.
Results: Only gutta percha could not be distinguished in chicken meat. No difference was observed between the measurements made with the hockey and linear transducers and the actual size.
Conclusions: USG is a useful method for detecting and measuring foreign bodies and dental materials in soft tissues.

Key words: hockey transducer; linear transducer; ultrasound; dental material; foreign body

Introduction

A foreign body (FB) is an external object that becomes submerged inside tissues in the human body. It can enter the head and neck area as a consequence of trauma, medical procedures, dental treatments, accidents, or gunshot wounds. The composition and location of FBs may vary significantly depending on the kind of damage. [1] Needles, bullet fragments, metal, and glass fragments are the most typical FBs seen in the head and neck soft tissues. [2] To avoid consequences including discomfort, swelling, inflammation, and infection, FBs should be identified and removed as soon as possible. [3]

The diagnosis and localization of FBs are made possible by the patient's medical history, clinical examination, and radiological examination. [2] When the FB is in a key site (for example, near to a major vessel) and the operational removal has a significant risk for the patient, proper localization of the FB is crucial.

In diagnostic radiology, the challenge of finding foreign bodies is a common problem. Standard radiographs may identify even tiny foreign bodies made of glass or metal, but since many foreign bodies made of wood are radiolucent, they are typically overlooked on the first visit. [1–3] Radiological methods include cone beam computed tomography (CBCT), computed tomography (CT), magnetic resonance imaging (MRI), ultrasonography (US) and conventional radiography; which are among the techniques that may be utilized to accurately localize FBs in soft tissues. [3] The primary limitations of conventional radiography techniques are the superimposition of tissues in the X-ray beam's path and the occasionally undetected radiolucent FBs in the soft tissue.

The majority of emergency rooms and dentistry faculties in Turkey provide ultrasound scanning, similar to traditional X-ray imaging. When evaluating superficial tissues, US scanning is a good choice since it offers even better spatial resolutions than CT or MRI. [1,3] On the other hand, if the area of interest is covered by bone or air, it could be hard to evaluate deeper structures. The acoustic waves' depth of penetration also has an impact on the field of view. Ultrasound is thought to be less repeatable than other modalities and its diagnostic success typically depends on the examiner. However, not using ionizing radiation, easy accessibility, being able to be used as an intraoperative guide, and providing successful imaging in superficial tissues make it an advantageous imaging system for detecting foreign bodies in soft tissues. Ultrasound may offer the unique benefit of giving preliminary confirmation of foreign body removal whether it is used at the point-of-care during wound care or intraoperatively. Besides, the modern US technique has high-resolution and dynamic features. US enables imaging of the complex character of superficial soft tissues of the head and

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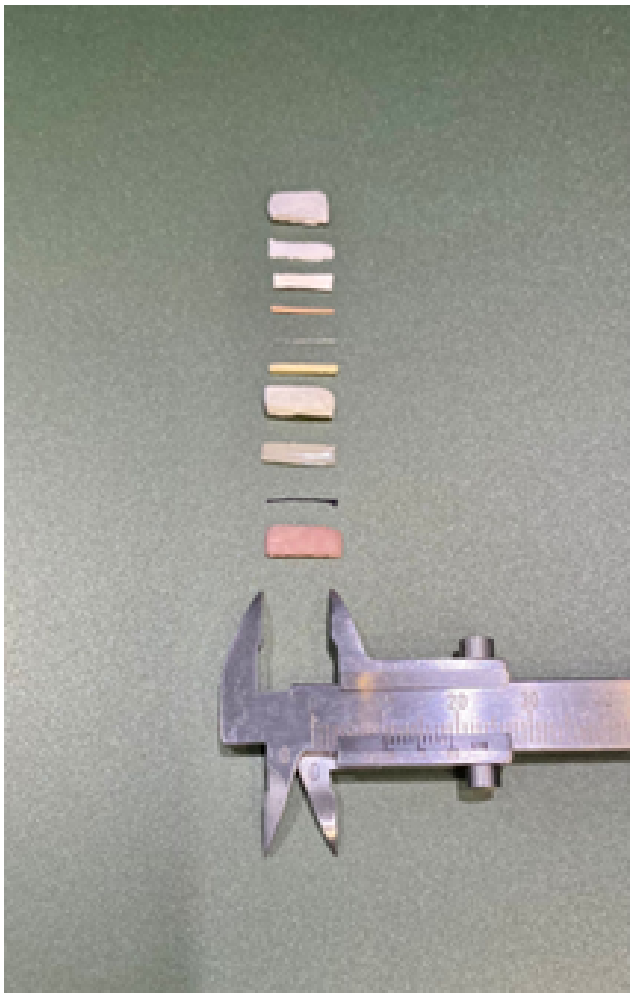

Figure 1. Stone, glass ionomer cement, alginate, gutta percha, canal file, a piece of wood, silicone impression material, composite, suture, and acrylic in 10 mm length are shown respectively.

neck anatomy and provides the practitioner with a therapeutically focused environment. It can be used in tissue elasticity and microvascular imaging among other new diagnostic methods.

In this study, it was aimed to obtain information about the sonographic properties of different dental materials by US in order to examine trauma patients for foreign bodies or to assist in the diagnosis of dental materials escaping into the soft tissue due to dental treatment complications.

Methods

Ten different dental materials and foreign bodies consisting of stone, glass ionomer cement, alginate, gutta percha, canal file, a piece of wood, silicone impression material, composite, suture, and acrylic material were included in the study. Samples of 1 cm length were prepared from all objects. Dental materials included in the study are shown in Figure 1. Prepared samples were embedded in chicken meat. It was visualized using US by Hitachi Arietta 65 (Hitachi Aloka Medical Systems,Tokyo, Japan). Linear measurements were made by the dental and maxillofacial radiologist. Each material was measured 3 times. Their visibility and posterior acoustic behavior were evaluated using both hockey and linear transducers. The actual dimensions of these objects and the dimensions measured by the transducers were compared by independent sample t test (SPSS Statistics 21.0 (IBM Corp., New York, NY)).

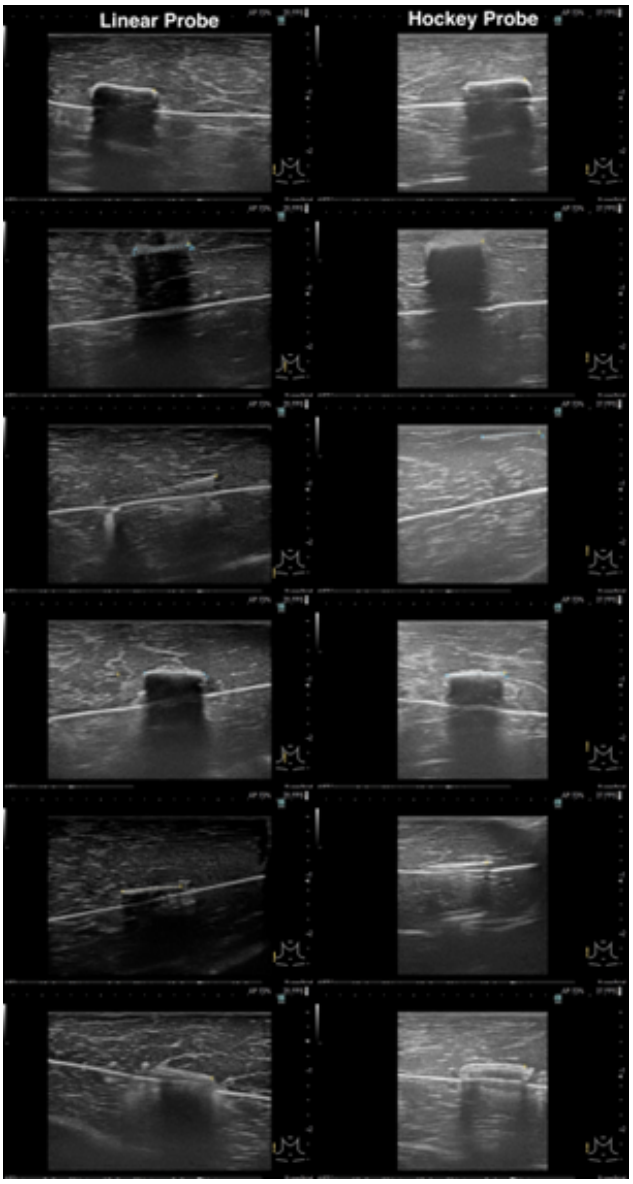

Figure 2. The images in the first column are the images obtained with the linear probe and the second column are the images obtained with the hockey probe. In each line, images and measurement values of linear and hockey probes of the stone, alginate, canal file, silicone impression material, composite, and acrylic are seen respectively.

Results

While all foreign bodies and dental materials included in the study could be observed by ultrasound, only gutta-percha and suture could not be distinguished. It was observed that the measurements made with hockey and linear transducers were similar to their actual dimensions. The images of foreign bodies and dental materials obtained by ultrasonography are shown in Figure 2. Stone, alginate, canal file, silicone impression material, composite, and acrylic showed a typical echogenicity that is hyperechoic. Acoustic shadowing was observed in foreign bodies except the canal file. It has been determined that there is no difference between the measurements visualized by both probes and their actual dimensions ($p>0.05$). (Table 1)

Table 1. The average sizes of foreign bodies measured with both probes are shown. Each measurement was repeated three times.

Foreign Body	Linear Probe (mm)	Hockey Probe (mm)
Stone	10	10
Alginate	9.2	10
Canal File	10	9.7
Acrylic	10	10
Silicone Impression Material	10.2	9.7
Glass Ionomer Cement	9.6	9.6
Suture	Not visualised	Not visualised
Gutta percha	Not visualised	Not visualised
Wood	10	10
Composite	10.3	10

Discussion

FB identification and precise localization are crucial to be safely removed. Treatment of the dislocated and remaining foreign bodies in head and neck tissues related to dental treatment/oral surgery can be hard because of difficult access, unfavorable location or a combination of both. Because there are so many essential structures in the head and neck region, some of these foreign bodies and residual dental materials are potentially life-threatening. When the missing object is not evident during the clinical examination, the identification of oral foreign bodies might be very difficult. A thorough clinical examination should come after a medical anamnesis. To detect superficial foreign bodies, it has been recommended to use xeroradiography, US, CT, CBCT and MRI. The most effective imaging technique must be chosen by the physicians.[1–4] Depending on FB's composition, various imaging techniques' visualization quality varies. Using conventional radiography as an initial imaging technique is an option if it is known that the missing object is radioopaque. While CT and MRI are undoubtedly useful in some circumstances, they are both impractical and too expensive for routine use.[1–4] Abolvardi et al. demonstrated that CBCT may be utilized almost equally as accurately as CT for the detection of foreign bodies in the head and neck region.[4] In addition to that, Demiralp et al concluded that, CBCT provided superior visualization of FBs with high radiopacity compared to US. However, the first line of defense for detecting low-radiodensity foreign entities confined in soft tissue should be US using a linear probe.[5]

Ultrasonography is a great alternative if the missing oral foreign body is in the easily accessible superficial soft tissue of the head and neck region. But, it might not be appropriate for FBs located in deep areas or air-filled cavities. In particular, high-resolution US offers a dynamic, affordable, and portable imaging technique with real-time imaging and no radiation exposure. However, features and structure of the probe have a significant impact on the effectiveness and image quality of US. The linear probes with rectangular and flat surfaces are best for inspection and are helpful for imaging the shallow structures and tiny portions in the head and neck area.[6] The convex probes' ability to create a trapezoidal view field is made possible by the US beams' divergence as depth increases. The range of vision is wider, but there is less line density at depth and less lateral resolution.[7]

The identification of FBs using US was the topic of a comprehensive review and meta-analysis published recently by Davis et al.[8] They concluded that US may be a helpful diagnostic tool for FBs found in the skin and soft tissues. According to Panigrahi et al., US was a helpful technique for detecting shallow and deep (up to 3 cm) low-radiopaque FBs including wood, sand, and fiber plastic.[9]

It was reported that CBCT has the highest sensitivity (79.19%), followed by US (33.33%) and MRI (20.83%) for the identification of FBs in a sheep's head.[3] It was shown that wood is the hardest to image, stone and barium glass were the FBs that were the easiest to see. But we were also able to observe wood in our study. The difference with these studies may be that the foreign body samples we used were 10 mm in length, Shokri et al. used 5 mm length wood pieces in their study.[3]

According to a recent comprehensive review, US may be an effective method for finding FBs in the skin and soft tissues.[8] Valizadeh et al. researched FBs with US utilizing linear probes in various setups for various FBs. In the tissues, it was claimed that US could locate and identify superficial FBs with low radiopacity, but not in the air cavities.[10] The sensitivity of US with the single linear probe for the imaging of FBs was assessed in some publications.[1,10] The extra-oral and intra-oral linear probes were employed by Aras et al. and Demiralp to find FBs.[1,5] In this study, we observed that the data of the linear and hockey probes are similar. Additionally, there was no difference between the measurements visualized by both probes and their actual dimensions ($p>0.05$).

The limitation of our study is that the samples were not prepared in various sizes. However, it should be noted that this study, which was conducted in chicken meat, did not simulate the clinical environment. The next study was planned to be done on a comprehensive method.

Conclusion

In conclusion, USG is a useful method for detecting and measuring FBs in soft tissues. Although it cannot be an alternative to CT and CBCT in air and bone containing tissues, it is especially suitable for the first examination of soft tissue injuries.

Author Contributions

Conceptualization YD, HE; Data curation YD, RSA; Investigation YD, RSA, HE; Methodology YD, RSA, HE; Visualization YD, RSA, HE; Writing - original draft YD; Writing - review & editing RSA, HE

Conflict of Interest

None

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