Journal of Oral Biology and Craniofacial Research xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Journal of Oral Biology and Craniofacial Research

journal homepage: www.elsevier.com/locate/jobcr

Original Article

Ultrasound evaluation of intra-osseous cavity: A preliminary study in pig mandibles

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ARTICLE INFO

Article history:
Received 30 June 2016
Accepted 5 October 2016
Available online xxx

Keywords:
Intra-osseous cavities
Ultrasonography
Diagnostic imaging
Ultrasound

ABSTRACT

Aims: To assess the role of ultrasonography as a possible tool for diagnosis of intra-osseous lesions.
Methods: Our sample comprised five macerated pig jaws. The regions of bony crypts of third molars were examined on both sides, totaling 10 examinations. The degrees of difficulty for both ultrasound image visualization and bone translucency were rated by two groups of evaluators (i.e. dental radiologists and physician ultrasonographers).
Results: Our results showed that it is possible to detect images of the intra-osseous cavity at a low-degree difficulty by using both radiographic and ultrasonic techniques (46.6% and 43.3%, respectively). However, the crypts were not fully detected by both groups (16.6% and 13.3%, respectively).
Conclusions: We concluded that ultrasonography is a useful method for evaluation of intra-osseous lesions in jaws, provided that the cortical bone is thin enough to allow ultrasound waves to pass through.

1. Introduction

The ultrasound imaging technique is widely used by physicians for evaluation of soft tissues. This method of evaluation is non-invasive, painless and performed at lower cost than other imaging methods, allowing for several differential resources such as real-time assessment of blood supply and internal nature of the disease (i.e. solid or cystic), thus making ultrasound a remarkably versatile diagnostic imaging tool for diagnosis.[1]

Ultrasound has been successfully used in dentistry and by several researchers who investigate its use for evaluation of temporomandibular joint, periodontal and periapical lesions, and mandibular fracture,[2–7] as well as its benefits compared to other imaging modalities.[7,8]

Ultrasound has been shown to be an interesting alternative new tool over the last few years for diagnosis of intra-osseous lesions in jaws, overcoming the limitations of conventional radiography and computerized tomography (CT) due to its availability of real-time multiplanar images, absence of ionizing radiation and accurate analysis.[1,2,4,5,7,9]

The purpose of this study was to perform an experimental model and assess whether ultrasound is effective for evaluation of intra-osseous lesions in the mandible.

2. Materials and methods

2.1. Bone specimens

The data acquisition and analysis in this study was approved by the University Institutional Review Board. The study was conducted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

Five macerated mandibles from young adult domestic pigs (previously slaughtered for human consumption) were used. The mandibular third molar of pigs has an enlarged bony crypt mimicking an intra-osseous lesion (confirmed by periapical and occlusal radiographs in a pilot study).

2.2. Experimental design

The mandibles were prepared in several steps. Sagittal osteotomy was made along the junction between mandibular body and ramus to expose the germ of the third molar bilaterally. Next, the entire germ was removed to expose a hypoechoic area

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http://dx.doi.org/10.1016/j.jobcr.2016.10.001
2212-4268/

and to confirm the penetration of ultrasound waves by means of a metallic sphere (4 mm in diameter) inserted inside the bony crypt. After the procedure, the bone was re-attached with a rubber tape.

2.3. Ultrasound assessment

Ultrasonographic imaging was performed by using a portable ultrasound machine (Terason t3000, Division of Teratech Corporation, Burlington, MA, USA) operating with a convex probe (model 5C2A, designed for a frequency range of 2–4 MHz and adjusted at 2 MHz). The specimens were immersed into a water tank and aligned on the bottom of it (11). The tank allows a fine and reliable acoustic coupling between transducer and mandibles, warranting that all reflections and reverberations from geometrically and acoustically complex clinical features are received by the transducer probe.[10,11] The ultrasound probe was positioned on the thinnest area of the crypt, resulting in 10 images from the five mandibles.

2.4. Imaging analysis

The 10 ultrasounds data were coded and independently reviewed by two groups of evaluators: three oral radiologists (Group 1) and three trained ultrasound-trained physicians (Group 2). All the evaluators were contacted in advance and appointments were arranged. Group 1 had evaluators with no experience in ultrasound examinations. They received training about ultrasound image formation. Next, the evaluators in both groups used the ultrasound machine to examine the hemi-mandibles by handling the probe individually and at will in a real-time examination. The ultrasound images were examined on the monitor by the evaluators, who then answered the Question 1 on the degree of difficulty in visualizing them before rating the images as being of low, moderate, or high or if they could not be detected (ND).

After each evaluator examined the ultrasound images, they were asked to visually examine the macerated jaws at the region of the bony crypts and to answer Question 2, thus evaluating the bones qualitatively in terms of (high, medium, and low) translucency according to their perception. The examinations were performed in a dark room and all hemi-mandibles were positioned side by side (to make comparisons and evaluations easier) on a negatoscope with uniform luminescence.

The statistic analysis of all information collected in the present study was initially performed on a descriptive basis. The qualitative (categorized) variables were analyzed by analyzing absolute and relative (percent) frequency data.

Inference analyses were used to accept or reject the evidence found in the descriptive analysis. Chi-square test and Fisher's exact test were also used to study the association between the answers given by dental radiologists and physician ultrasonographers to Questions 1 and 2. The significance level (α) was set at 5% in all inference analysis.

3. Results

In Group 1 (three dental radiologists and 10 images *per* evaluation), the metallic spheres were not detected in five images. However, they could be observed with low (14; Fig. 1), moderate (4), and high (7; Fig. 2) degrees of difficulty in other images.

In Group 2 (three physician ultrasonographers; 10 images *per* evaluation), the metallic spheres were not detected in four images. However, they could be observed with low (14), moderate (6), and high (6) degrees of difficulty in other images.

Table 1 shows the distribution of answers given by dental radiologists and physician ultrasonographers to Question 1.

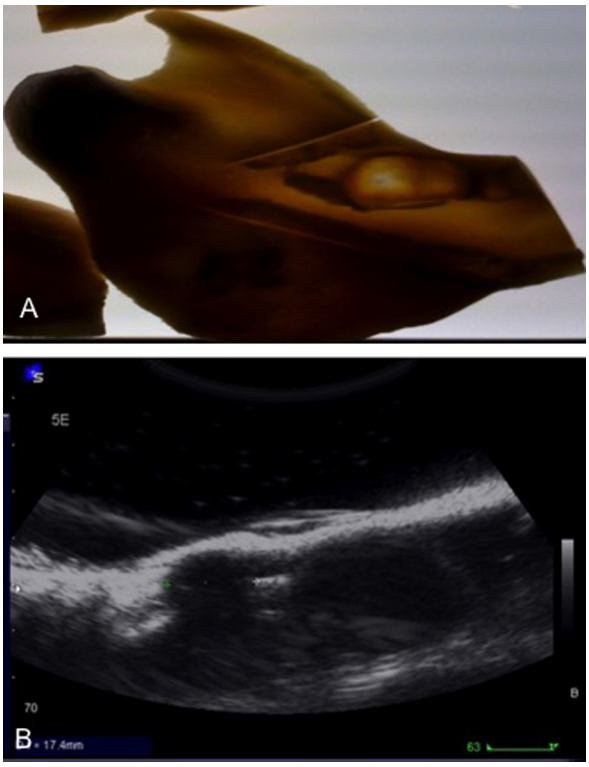

Fig. 1. (A) Part of a macerated lower jaw (rated as highly translucent); (B) ultrasound image (considered ease to visualize) showing the hyperechoic image of the metallic sphere.

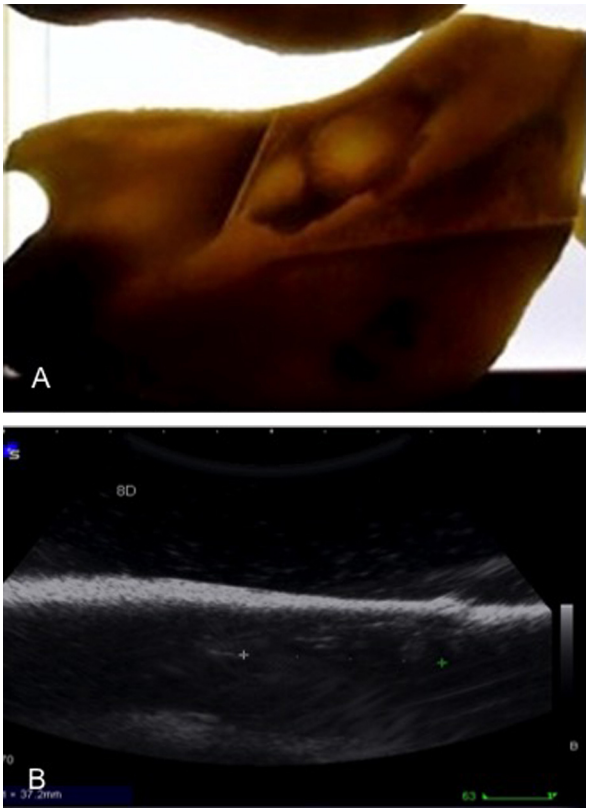

Fig. 2. (A) Part of a macerated lower jaw (rated as poorly translucent); (B) ultrasound image (considered hard to visualize) showing the slightly hyperechoic image of the metal sphere.

Please cite this article in press as: Ferreira TLD, et al. Ultrasound evaluation of intra-osseous cavity: A preliminary study in pig mandibles, *J Oral Biol Craniofac Res.* (2016), http://dx.doi.org/10.1016/j.jobcr.2016.10.001