Dear Donors,

**Innovative dental ultrasound research** that can change the way we practice dentistry today will need your support!!

Ultrasound, being *non-radiation, real-time and 3-dimensional*, is a promising next generation dental imaging modality to supplement the use of dental radiology. It can be extremely useful in diagnosing **gum disease** in an earlier stage, evaluating **oral soft tissue lesions**, including oral cancers, and assisting **minimally invasive oral surgery**, to name some. Hundreds of thousands of patients may potentially benefit from this new imaging modality by improving quality of life, early disease detection and intervention, reduced radiation and decreased post-surgical complications.

Dr. Oliver Kripfgans, Research Associate Professor at University of Michigan Medical School and I have spent 3 years researching in this field and obtained initial success. We have published 4 papers in world-renowned journals (please see supplemental documents) and 2 are pending for publication at the time of writing. We are currently conducting human cadaver studies, preclinical animal studies, and human clinical trials and preparing for the 1st dental ultrasound-imaging book. Our research funding has been generously supported by the following institutes/organizations: *The School of Dentistry Collaborative Sciences Award, The Periodontics and Oral Medicine Clinical Research Supplementary Grant, The Osteology Foundation, Delta Dental Foundation Grant, and American Academy of Periodontology Innovation Research Grant*, etc. While these grants have provided enormous support to our research endeavor, we are still in need of generating more preliminary data in order to apply for larger-scale grants, e.g. National Institute Health Grants (NIH) and others.

Therefore, I kindly ask your monetary support so we can continue to improve oral health care through advancing dental ultrasound research. We aim to raise $20,000 USD each year. Your donation of any amount will benefit our research tremendously! Please use the attached form to make your donation. You will receive a tax deduction for your gift. I thank you for considering make a donation to “Next Breakthrough Dental Research Fund”.

Best regards,

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Short Communication

Non-ionizing real-time ultrasonography in implant and oral surgery: A feasibility study

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Key words: alveolar ridge, anatomy, bone regeneration, cone-beam computed tomography, dental implants, ultrasonography

Abstract

Purpose: Ultrasound imaging has potential to complement radiographic imaging modalities in implant and oral surgery given that it is non-ionizing and provides instantaneous images of anatomical structures. For application in oral and dental imaging, its qualities are dependent on its ability to accurately capture these complex structures. Therefore, the aim of this feasibility study was to investigate ultrasound to image soft tissue, hard tissue surface topography and specific vital structures.

Material and methods: A clinical ultrasound scanner, paired with two 14-MHz transducers of different sizes (one for extraoral and the other for intraoral scans), was used to scan the following structures on a fresh cadaver: (i) the facial bone surface and soft tissue of maxillary anterior teeth, (ii) the greater palatine foramen; (iii) the mental foramen and (iv) the lingual nerve. Multiple measurements relevant to these structures were made on the ultrasound images and compared to those on cone-beam computed tomography (CBCT) scans and/or direct measurements.

Results: Ultrasound imaging could delineate hard tissue surfaces, including enamel, root dentin and bone as well as soft tissue with high resolution (110 μm wavelength). The greater palatine foramen, mental foramen and lingual nerve were clearly shown in ultrasound images. Merging ultrasound and CBCT images demonstrated overall spatial accuracy of ultrasound images, which was corroborated by data gathered from direct measurements.

Conclusion: For the first time, this study provides proof-of-concept evidence that ultrasound can be a real-time and non-invasive alternative for the evaluation of oral and dental anatomical structures relevant for implant and oral surgery.

Understanding the location, size, shape and spatial relationships of dental and oral structures is essential for clinicians to plan and execute surgeries. During the past decade, cone-beam computed tomography (CBCT), owing to its ability to replicate anatomy accurately in three dimensions, has greatly supplemented the use of two-dimensional (2D) conventional dental radiographs (Loubelle et al. 2007; Ludlow et al. 2007; Chan et al. 2010b). Although a single CBCT scan delivers low-dose radiation, repeated scans on the same patient are not advisable (e.g., during a surgery to avoid injuring vital structures) [Horner et al. 2009]. Furthermore, CBCT is not applicable for evaluating peri-implant structures due to beam hardening and scattering artifacts (Gonzalez-Martín et al. 2015; Kuhl et al. 2015).

Non-ionizing, real-time and less expensive ultrasound imaging is extensively used in quantitative medical diagnostics for evaluating fetal tissue dimensions for several decades (Hadlock et al. 1991). The ultrasound scanner transmits high-frequency ultrasonic pulses, between 1 and 20 MHz in general, into the region of interest with a transducer that both transmits and receives such pulses. Based on time of travel of ultrasound pulses and their received pressure amplitudes, the scanner displays a grayscale image depicting the tissue distance from the ultrasound transducer and the tissue echogenicity (reflectivity) with respect to the original pulses. Although not able to reasonably penetrate bone with the current diagnostic imaging frequencies, ultrasound can delineate bone surface explicitly, providing an adequate
Non-invasive evaluation of facial crestal bone with ultrasonography

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Abstract

Purpose

Facial crestal bone level and dimension determine function and esthetics of dentition and dental implants. We have previously demonstrated that ultrasound can identify bony and soft tissue structures in the oral cavity. The aim of this study is to evaluate the accuracy of using ultrasound to measure facial crestal bone level and thickness.

Materials and methods

A commercially available medical ultrasound scanner, paired with a 14 MHz imaging probe was used to scan dental and periodontal tissues at the mid-crestal site of each tooth on 6 fresh cadavers. The alveolar crest level in relation to the cemento-enamel junction and its thickness on ultrasound images were measured and compared to those on cone-beam computed tomography (CBCT) scans and/or direct measurements on a total of 144 teeth.

Results

The mean crestal bone level measured by means of ultrasound, CBCT and direct measures was 2.66 ± 0.86 mm, 2.51 ± 0.82 mm, and 2.71 ± 1.04 mm, respectively. The mean crestal bone thickness was 0.71 ± 0.44 mm and 0.74 ± 0.34 mm, measured by means of ultrasound and CBCT, respectively. The correlations of the ultrasound readings to the other two methods were between 0.78 and 0.88. The mean absolute differences in crestal bone height and thickness between ultrasound and CBCT were 0.09 mm (-1.20 to 1.00 mm, p = 0.06) and 0.03 mm (-0.48 to 0.54 mm, p = 0.03), respectively.

Conclusion

Ultrasound was as accurate in determining alveolar bone level and its thickness as CBCT and direct measurements. Clinical trials will be required to further validate this non-ionizing and non-invasive method for determining facial crestal bone position and dimension.
INTRODUCTION

Dental implants are nowadays a mainstream approach for replacing missing teeth. High implant survival rate and patient satisfaction are the driving force for the popularity of this treatment option. While achieving osseointegration and providing function are predictable outcomes, recent emphases have focused on improving long-term implant functional and aesthetic results. These outcomes are highly dependent on the quality and quantity of peri-implant supporting tissues (Fu, Lee, & Wang, 2011; Kan, Rungcharassaeng, Umezu, & Kois, 2003; Lin, Chan, & Wang, 2013; Spray, Black, Morris, & Ochi, 2000). Peri-implant tissue volume determines tissue biotype (Fu et al., 2010), which is currently evaluated by a visual examination, probing and bone sounding (Kan, Morimoto, Rungcharassaeng, Roe, & Smith, 2010; Kan et al., 2003). Each method has its own advantages and limitations. There is little doubt that an aesthetic outcome can be more easily achieved with thick rather than thin soft tissues (Jung, Sailer, Hammerle, Attin, & Schmidlin, 2007; Steigmann, Monje, Chan, & Wang, 2014). It is now understood that the mucosal level could be maintained when a certain amount of peri-implant hard tissue is present (Miyamoto & Obama, 2011; Spray et al., 2000). In addition, tissue biotype may dictate extraction socket and implant healing...
SYSTEMATIC REVIEW

Updates on ultrasound research in implant dentistry: a systematic review of potential clinical indications

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Objectives: Ultrasonography has shown promising diagnostic value in dental implant imaging research; however, exactly how ultrasound was used and at what stage of implant therapy it can be applied has not been systematically evaluated. Therefore, the aim of this review is to investigate potential indications of ultrasound use in the three implant treatment phases, namely planning, intraoperative and post-operative phase.

Methods: Eligible manuscripts were searched in major databases with a combination of keywords related to the use of ultrasound imaging in implant therapy. An initial search yielded 414 articles, after further review, 28 articles were finally included for this systematic review.

Results: Ultrasound was found valuable, though at various development stages, for evaluating (1) soft tissues, (2) hard tissues (3) vital structures and (4) implant stability. B-mode, the main function to image anatomical structures of interest, has been evaluated in pre-clinical and clinical studies. Quantitative ultrasound parameters, e.g. sound speed and amplitude, are being developed to evaluate implant-bone stability, mainly in simulation and pre-clinical studies. Ultrasound could be potentially useful in all three treatment phases. In the planning phase, ultrasound could evaluate vital structures, tissue biotype, ridge width/density, and cortical bone thickness. During surgery, it can provide feedback by identifying vital structures and bone boundary. At follow-up visits, it could evaluate marginal bone level and implant stability.

Conclusions: Understanding the current status of ultrasound imaging research for implant therapy would be extremely beneficial for accelerating translational research and its use in dental clinics.


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Keywords: Ultrasonography; soft tissue; alveolar bone; peri-implantitis; dental implants; cone beam computed tomography

Introduction

The use of dental implants to replace missing dentition is rapidly increasing and has become the standard of care owing to the high survival rate. Successful implant treatment requires prudent clinical evaluation and high-quality images of the surgical site. An ideal imaging modality should provide sufficient anatomical information pertinent to the implant site and cause no harm, in addition to being easy to use and low cost. Currently, two-dimensional (2D) imaging modalities including panoramic films and intraoral radiographs are the most commonly used. However, image magnification/distortion and the lack of cross-sectional information, etc are among the major disadvantages. During the past decade, the use of cone beam CT (CBCT) is on a rise. The American Academy of Oral and Maxillofacial...
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