

Ultrasonography - a New Paradigm Shift in Endodontics Literature Review

Rajeswari Kalaiselvam, Eswar Kandaswamy, Deivanayagam Kandaswamy

Abstract— Diagnostic imaging is an integral and essential component of Endodontics, especially for periapical lesions. Recent research has seen an increase in the development and testing of new and improved techniques. Ultrasonography (US) has the advantage of being a non-invasive, painless, rapid and radiation free method. It is also capable of revealing considerable amount of details on soft tissues and differentiates various periapical pathologies like cysts, granulomas, abscesses and surgical scars with their size and dimensions in the anteroposterior, superoinferior, and mesiodistal planes. Evaluation of imaging techniques is important to ensure optimal monitoring of the outcomes of surgical and conventional endodontic treatment and to diagnose periapical lesions accurately. The present literature review focuses on the principles and rationale behind the usage of US in the field of Endodontics.

Index Terms— Diagnosis, Ultrasonography, Cyst, Granuloma, Colour Doppler.

I. INTRODUCTION

Dental caries is the most prevalent non communicable disease affecting the permanent teeth of 92% of individuals between the age group of 20 and 60 years.¹ The progress of caries and incidence of cysts reported in literature amongst apical periodontitis lesions varies between 6 and 55%.²⁻⁵ The importance of distinguishing a true cyst and a non cystic lesion is of help in the treatment outcome prediction.⁶ Apical surgery might not be necessary for most of the endodontic lesions, but is often indicated for lesions which persist despite endodontic treatment. Currently, diagnosis of periapical lesions largely depends on biopsy. In general, conventional radiographs and direct digital radiographs are being used for diagnosis. Intra oral radiographic techniques possess low reliability in predicting the presence and sizes of lesions.⁷ Additionally, they do not allow the clinician to accurately differentiate between the cystic and non cystic lesions. The use of computerized tomography (CT) has proven to be an useful tool in the management of extensive periapical

lesions.⁸ Existing literature has reported CT to be a non invasive method that can aid in differentiating a cyst and granuloma.⁹ However, CT is associated with high cost and greater dosage of radiation than conventional radiographic techniques.¹⁰ To overcome the above limitations, Ultrasonography (USG) has been used in the field of Endodontics.

USG has applications in a wide variety of areas in healthcare, science and technology. The earliest reports of application of USG for medical imaging dates back to the 1950's.¹¹ Though the term *ultrasound* is synonymous with the terms *sonography* and *ultrasonography*, the terms are often used interchangeably. Since "*Ultrasound*" is the most widely used term in the published literature, the present literature review also uses the term *ultrasound (US)*.¹¹ In the field of medicine, US aids in investigating and diagnosing the suspected pathology and aids in treatment planning.

II. PRINCIPLE

Cotti et al published a report on the use of US for studying periradicular lesions. They included twelve patients who were diagnosed, using conventional radiographic and clinical examination, with periradicular lesions. They were subjected to an echogram (real time ultrasound imaging technique) at the site of the diagnosed lesion. The sonographic features were noted along with the information on size, content and vascular supply of the lesion. The authors provided a diagnosis of either a cyst or a granuloma based on the US findings.¹⁸

Researchers have compared the preoperative ultrasound & colour Doppler findings with the postoperative histopathological examination of the specimens following endodontic surgery to differentiate the periapical cysts and granulomas.^{19, 20} Parvathy et al studied a series of 20 cases preoperatively using color Doppler and ultrasound for various parameters.¹⁹ The diagnosis made using the US and color Doppler correlated with the histopathological diagnosis in all the 20 cases.¹⁹ A similar study performed by Khambete et al reported 10 cases of periapical radiolucencies that could not be diagnosed as either cyst or granuloma using conventional radiographic methods.²⁰ They concluded that in all the ten

Rajeswari Kalaiselvam, Senior Lecturer, Dept of Conservative Dentistry and Endodontics, Faculty of Dental Science, Sri Ramachandra University, Chennai, India.

Eswar Kandaswamy, Dept of Conservative Dentistry and Endodontics, Faculty of Dental Sciences, Sri Ramachandra University., India

Deivanayagam Kandaswamy, Dean, Prof and Head, Department of Conservative Dentistry and Endodontics, Faculty of Dental Sciences, Sri Ramachandra University, Porur, Chennai

patients the ultrasound diagnosis correlated with the histopathological diagnoses.²⁰

III. HEALING PERIAPICAL LESIONS

Rajendran and Sundaresan¹⁷ studied the use of a monitoring tool in the form of high resolution ultrasound and color power doppler in the healing of periapical lesions. They included five patients who were previously diagnosed with periapical lesion in maxillary anterior teeth. Prior to any treatment, an US with a color doppler was done to analyze the periapical lesion. All patients underwent nonsurgical root canal treatment. Six months later, postoperatively, an US with color doppler was taken to observe the healing of the lesion. These images were then compared with preoperative images. They concluded that the application of US with color doppler can be used to monitor the healing of periapical lesions treated by conventional non surgical endodontic treatment.¹⁶ Tikku et al compared ultrasound with color Doppler and conventional x-rays as a tool to monitor the healing of periapical tissues after endodontic surgery.²¹ They included fifteen patients who had undergone endodontic surgery. They used the imaging tools to monitor the healing at 1 week and 6 months, post operatively. Color Doppler was used as a reference standard and the study results concluded that ultrasound and color Doppler performed significantly better than conventional radiography for monitoring the periapical healing after endodontic surgery.²¹ Maity et al²² studied ten cases for periapical healing after root canal treatment after six weeks, 3 months and 6 months. They compared the US imaging with Color Power Doppler against conventional radiography. Their results revealed that ultrasound with color power Doppler could identify signs of healing at six weeks postoperatively. On the other hand, detection of healing and associated changes was possible in an x-ray only after 3 months.²²

Advantages:

1. US don't produce superimposition of structures.
2. US provide a two dimensional picture, but can help to determine the volume of any lesion by scanning it in two different planes.¹⁴
3. No harmful effects of US waves have been documented when administered for diagnostic purposes.
4. US identify the underlying disease process with reasonable accuracy. The size of the lesion can be determined three dimensionally using the ultrasound software.¹⁸

Limitations:

1. US cannot image the periapical lesion unless there is a discontinuity or breach in the buccal plate of bone.¹⁴

2. When a larger area need to be studied, it is difficult to attribute the lesion to a specific area because roots may obscure the lesion.

CONCLUSION

US imaging can be considered as a potential imaging technique for the appropriate diagnosis of periapical lesions and to aid in accurate treatment planning. Being non invasive it can be used as a diagnostic aid from the preliminary step of differentiating the potential transition of a periapical infection into cyst or abscess and to test the treatment response following endodontic management. Though the application is limited to buccal spread of lesion and anterior teeth, it is worth to consider in practice because involvement of anterior teeth with buccal extension is most commonly seen in endodontic practice.

REFERENCES

- [1] National Institute of Dental and Craniofacial Research. Oral Health in America: A Report of the Surgeon General. Bethesda, MD: National Institute of Dental and Craniofacial Research; 2000.
- [2] Nair R. New perspective on radicular cysts: do they heal? *Int Endod J.* 1998 ;31:155-60
- [3] Scarfe WC, Czerniejewski VJ, Farman AG, Avant SL, Molteni R. In vivo accuracy and reliability of colour- coded image enhancement for the assessment of periradicular lesion dimensions. *Oral Surg, Oral Med and Oral Path.* 1999; 88: 603-11.
- [4] Mortensen H, Winther JE, Birn H. Periapical granulomas and cyst. *Scand J Dent Res.* 1970;78:241-50
- [5] Seltzer S, Bender IB, Smith J, Freedman I, Nazimov H. Endodontic failures — an analysis based on clinical, roentgenographic and histologic findings. Part I. *Oral Surg Oral Med Oral Pathol.* 1967; 23(4):500–16.
- [6] Simon JH. Incidence of periapical cysts in relation to root canal. *J Endod* 1980; (6):845-8
- [7] Spataforce CM, Griffin JA, Keyes CG, Wearden S, Skidmore AE. Periapical biopsy report; an analysis over over a 10 year period. *J Endod.* 1990;16:239-41
- [8] Zinskin MC. Applications of ultrasound in medicine: Comparison with other modalities. In: Rapacholi MH, Grandolfo M, Rindi A, eds. *Ultrasound: medical applications, biological effects and hazard potential.* New York: Plenum Press, 1987:49-59
- [9] Maylia E, Nokes LD. The use of ultrasonics in orthopaedics: a review. *Technol Health Care.* 1999; 7: 1-28.
- [10] Cotti E, Vargiu P, Dettori C, Mallarini G. Computerized tomography in the management and follow-up of extensive periapical lesion. *Endod Dent Traumatology.* 1999;15: 186-9
- [11] S. Michelle Bierig and Anne Jones. Accuracy and Cost Comparison of Ultrasound versus Alternative Imaging Modalities, Including CT, MR, PET, and Angiography. *J Diagnostic Med Sonography.* 2009; 25:138–144.
- [12] Dula K, Mini R, van der Stelt PF, et al. Hypothetical mortality risk associated with spiral computed tomography of the maxilla and mandible. *Europ J Oral Sci* 1996; 104: 503-10.
- [13] Trope M, Pettigrew J, Petras J, Barnett F, Tronstad L. Differentiation of radicular cysts and granulomas using computerized tomography. *Endod Dent Traumatology* 1989; 5: 69-72.
- [14] Dr. Joseph Woo. History of ultrasonics, a summary. 2nd August 2004. Available at <http://www.ob-ultrasound.net/ultrasonics/history.htm>.
- [15] Merritt CRB. Physics of ultrasound. In: Carol MR, Stephanie RW, William CJ, editors. *Diagnostic ultrasound.* 3rd ed. Philadelphia, Pennsylvania: Elsevier Mosby Pub; 2005. P 3 –34.
- [16] Cotti E, Campisi G, Garau V, Puddu G. A new technique for the study of Periapical bone lesions: ultrasound real time imaging. *Int Endod J.* 2002; 35:148-152.

- [17] Cotti E, Campisi G, Ambu R, Dettori C. Ultrasound real time imaging in the differential diagnosis of Periapical lesions. *Int Endod J.* 2003; 36:556-563.
- [18] Rajendran N and Sundaresan B. Efficacy of ultrasound and color power Doppler monitoring tool in the healing of endodontic Periapical lesions. *J Endod.* 2007; 33: 181 -186.
- [19] Prince CN, Annapurna CS, Sivaraj S, Ali IM. Ultrasound imaging in the diagnosis of periapical lesions. *J Pharm Bioallied Sci.* 2012; 4(Suppl 2): 369-72.
- [20] Tikku A, Kumar S, Loomba K, et al. Use of ultrasound, color Doppler imaging and radiography to monitor periapical healing after endodontic surgery. *J Oral Sci.* 2010; 52(3):411-416.
- [21] Khambete N, Kumar R. Ultrasound in differential diagnosis of periapical radiolucencies: A radiohistopathological study. *J Conserv Dent.* 2015; 18(1):39-43.
- [22] Parvathy V, Kumar R, James E, George S. Ultrasound imaging versus conventional histopathology in diagnosis of periapical lesions of endodontic origin: A comparative evaluation. *Indian J Dent Res.* 2014; 25(1):54-57.
- [23] Maity I, Kumari A, Shukla A, Usha H, Naveen D. Monitoring of healing by ultrasound with colour power Doppler after root canal treatment of maxillary anterior teeth with periapical lesions. *J Conserv Dent.* 2011; 14(3):252-257.