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OVERVIEW OF EFFICIENCY OF ULTRASOUND AND DIGITAL RADIOGRAPHY IN DISTINGUISHING PERIAPICAL LESIONS

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Abstract:
To visualize periapical lesions, periapical and panoramic radiographs are routinely employed. Furthermore, in the diagnosis of anterior teeth with periapical diseases, ultrasonography is an alternative way to digital radiography techniques. To December 2021, an electronic literature search was conducted using the databases PubMed, Embase, and CENTRAL. When compared to traditional radiography, ultrasonography can be considered a better imaging modality with greater efficacy due to its potential usefulness in differentiating periapical lesions.

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INTRODUCTION:

Periapical lesions accompanying endodontic infection are usually diagnosed and treated based on the initial radiological findings. Periapical surgery is sometimes required to remove and diagnose cystic and non-cystic lesions. In endodontics, radiographic examination is an essential adjunct to clinical examinations. Visualizing periapical bone lesions is frequently critical. Depending on the size and location of the disease process, various techniques may produce more or less accurate observations [1]. Diagnostic ultrasonography (USG), a noninvasive, safe, and easily reproducible dynamic modality that provides "live" images, could be used to distinguish between solid, cystic, mixed, and dense cystic lesions [2]. Real-time imaging is used to study moving parts of the body and obtain three-dimensional information by rapidly changing anatomy sections [3]. Color power Doppler ultrasound can be used to evaluate and determine the presence and direction of blood flow within an ultrasonographic image of tissue, as well as information about flow, velocity, and perfusion [1,3].

Recent advances in digital radiography (DR) have enabled dentists to perform radiographic examinations with up to 80% less radiation dose than conventional plain film radiography (PF) [4]. DR also provides software-controlled image enhancement. DR has a higher diagnostic yield when periapical lesions involve both cancellous and cortical bone, according to various authors who conducted research on extracted teeth and human cadaver jaws [5,6].

METHODOLOGY:

Electronic literature search included the databases PubMed, Embase and CENTRAL to December 2021. All languages were accepted provided there was an abstract in English. The MeSH terms were, ‘Radiography, panoramic’, ‘Periapical diseases’, ‘Sensitivity and specificity’ and ‘Radiography dental’.

DISCUSSION:

USG is a non-invasive, radiation-free alternative diagnostic imaging technique [7,8,9]. USG has conducted several studies to aid in the diagnosis of periapical lesions. Cotti et al [10] were the first to conduct a study evaluating the utility of USG in 12 patients with periapical endodontic lesion on periapical and panoramic radiographic views. Their research discovered that ultrasound is a reproducible method for diagnosing and monitoring periapical lesions. According to Gundappa et al [11], there is a strong correlation between ultrasonographic findings and histopathological results of periapical lesions. The same study also revealed that USG can be used to diagnose periapical lesions in the anterior region when the cortical bone is thinned or punctured. In their preliminary work on the pig mandible, Ferreira et al [12] stressed the need of cortical bone being thin enough to allow ultrasonic waves to pass through and allow for ultrasonographic examination. Sandhu et al [13] examined 30 patients diagnosed with periapical lesion by intraoral radiography in the anterior region with color Doppler ultrasonography. They reported that USG is useful in diagnosing periapical lesions in the anterior region that induce perforation or weakening of the buccal bones. It is simple to do ultrasonographic evaluation in the anterior region, but positioning the probes in the posterior teeth and obtaining a clear image is more challenging due to region structure [7].

Cotti et al [14] used ultrasonography and color power Doppler to assess several aspects of lesion content and vascularization in a study. They demonstrated that ultrasonography aids in the differential diagnosis of periapical lesions. Gad et colleagues [15] used CBCT and histopathologic results as a reference and used USG to analyze cystic jaw lesions in 32 individuals. They examined the vascularization and internal structure of different lesions with Doppler. It has been emphasized that USG and Doppler can be used routinely as a diagnostic tool.

It is critical to understand the nature of periapical lesions because it influences treatment methods, outcomes, and success. Furthermore, partial or excessive treatment is avoided. Radiographs alone cannot differentiate between cystic, non-cystic, and granuloma periapical lesions. Histopathological results, CBCT, and USG procedures are necessary for more specific information. Ultrasound has some advantages over other imaging technologies, such as being less expensive, having no known biologic side effects, using non-ionized radiation, being more practical, and providing improved patient comfort [16].

With the advancement of computed tomography (CT), it has been reported that CT can distinguish between a cyst and a granuloma as well as diagnosis widespread abnormalities. However, using CT to diagnose periapical lesions would expose patients to unnecessary high doses of radiation, which is difficult to justify [17]. The development of low-dose cone beam computed tomography should address this shortcoming (CBCT). Ultrasound real-time imaging (also known as sonography or echography) has several diagnostic applications in medicine. It is based on the phenomenon of ultrasound wave reflection (echoes) at the interface of two tissues with different acoustic properties. An interface or area of tissue that creates significant ultrasonic reflection is referred to as hyperechoic, whereas an area that shows lower echo intensity than surrounding tissues is referred to as hypoechoic or transonic. An anechoic zone is one in which there is no echoes reflected, often inside homogeneous liquids. Non-homogeneous areas with different types of tissues exhibit a heterogeneous echo texture, which includes hyperechoic and hypoechoic signals. Because bone surfaces completely reflect ultrasonic waves (hyperechoic/echogenic), objects within and beyond unbroken bone are generally undetectable by ultrasonography. However, ultrasonic imaging can still be performed through bone "windows" when the bone cortex has thinned or punctured. Furthermore, the use of color Doppler ultrasound can provide additional information about the existence, direction, and velocity of blood flow within the studied tissue. Ultrasound is widely regarded as one of the safest means of diagnosing any ailment in the human body. It is regularly used to identify salivary gland illness in the head and neck region, but only one group of researchers, Cotti et al, have described the use of ultrasonography in the assessment of bone lesions of endodontic origin [10,18]. The goal of this investigation was to see if the findings of Cotti et al could be validated by conducting a comparable study using a specialized endodontist with a special interest in ultrasound and utilizing histological evidence as the gold standard. As a result, patients were needed to undergo endodontic surgery, which is no longer deemed necessary for the majority of endodontic diseases. However, providing specialized endodontic treatment in some parts of India can be quite challenging. Some patients must travel long distances with great difficulty, making several appointments and follow-up visits onerous. These patients are regularly offered a one-visit endodontic treatment option along with apical surgery. As a result, these patients gave a sample for histological examination of apical illness [19].

Recent research, however, has demonstrated that direct DR, even with image processing and augmentation, is no better than CR in terms of periapical lesion diagnosis accuracy [20]. To address these deficiencies, new and promising technologies in the identification of periapical lesions, such as ultrasound (US), computed tomographic (CT) scan, digital radiometric analysis, and biochemical procedures, must be evaluated. Ultrasound imaging is a simple and reproducible approach that could be used to supplement CR or DR in the diagnosis of periapical lesions. Ultrasound and Color Doppler describe the lesion's content and vascularization, which is important in diagnosing periapical lesions and distinguishing a periapical cyst from a granuloma [21,22]. As a result, US imaging can be utilized as an addition to CR and DR because it is less expensive and less risky in terms of radiation exposure than CT scan [17,18]. Correct diagnosis of periapical lesions aids in predicting treatment outcome and reduces the occurrence of root canal treatment failures caused by a lack of correct diagnosis due to the limits of commonly employed CR or DR [23].

Several radiographic findings, including lesion size and shape, as well as the presence of a sclerotic line demarcating the lesion, support the diagnosis of periapical lesions. Although the statistical likelihood of cyst occurrence is higher in larger lesions, a definitive association between lesion size and cystic type has yet to be established. Radiographic characteristics alone cannot distinguish cystic and noncystic periapical lesions. A recent histopathologic investigation of periapical lesions shown conclusively that there was no relationship between the presence of radiopaque borders and the histopathologic diagnosis of the cysts [24,25]. Operator and diagnostic errors are two of the most common causes of root canal therapy failure. It is critical to distinguish between periapical granuloma and cyst since it aids not only in treatment planning but also in predicting treatment outcomes. Traditional root canal therapy is the primary therapeutic option for periapical granuloma but has no benefit for periapical cysts since genuine cysts are less likely to heal with conventional root canal therapy and require surgical intervention. Periapical pocket cysts, especially smaller ones, heal entirely after root canal therapy, whereas real cysts, especially large ones, are less likely to cure by nonsurgical endodontics and hence may have an impact on treatment result. Similarly, periapical surgery based on cyst radiography may have been cured by root canal therapy alone [25].

Real-time ultrasound imaging is more convenient than other imaging modalities, has less biologic side effects, and is less expensive. Color-powered ultrasound in cases where CR or DR are inconclusive, Doppler can provide an accurate diagnosis, assisting in treatment planning and follow-up of periapical lesions [22]. Yokota et al. [6] and Tirell et al. [24] found that DR outperforms CR in the diagnosis of first periapical lesions. In the current investigation, the percentage accuracy for DR was 55.6% compared to 47.6% for CR, and picture enhancement did not increase observer performance, which was consistent with the findings of Barbat et al., [25]. According to

Bart et al. [26] and other research, 66%-70.2% of radiographic diagnoses correspond to histological diagnoses of periapical lesions. At the end of their study, Estrela et al [9] demonstrated that the accuracy of periapical radiographs in the diagnosis of periapical lesions was significantly higher than that of panoramic radiography. According to certain studies that support this finding, panoramic radiographs provide diagnostic information but may not be sufficient in detecting periapical lesions alone and should be supplemented with intraoral radiography [9].

According to Nardi et al [27], the visualization of the apical lesion was connected to the anatomical location, the extent of the lesion, and its effects on cortical bone. The establishment of thinning or fenestration in the cortical bone enables USG to visualize the periapical lesion. Furthermore, periapical lesions cannot be seen on a periapical or panoramic radiograph till the bone has lost 30-50% of its mineral content. Factors such as morphologic changes in the apical region, bone density, X-ray angulations, and radiographic contrast can all lead to radiographic misinterpretation [9,23]. False-positive lesions found on panoramic radiography due to artifact or other factors can be appropriately removed using ultrasonography [15]. Furthermore, apical or cystic lesions in the maxillary posterior region may be difficult to recognize using panoramic radiographs due to factors such as anatomical diversity of the maxillary sinus, pathology, and superposition of tooth roots [28]. In some circumstances, USG can diagnose lesions overlooked on panoramic imaging, and several periapical lesions that could not be detected or well visible on panoramic radiography were assessed by USG (Figure 1).

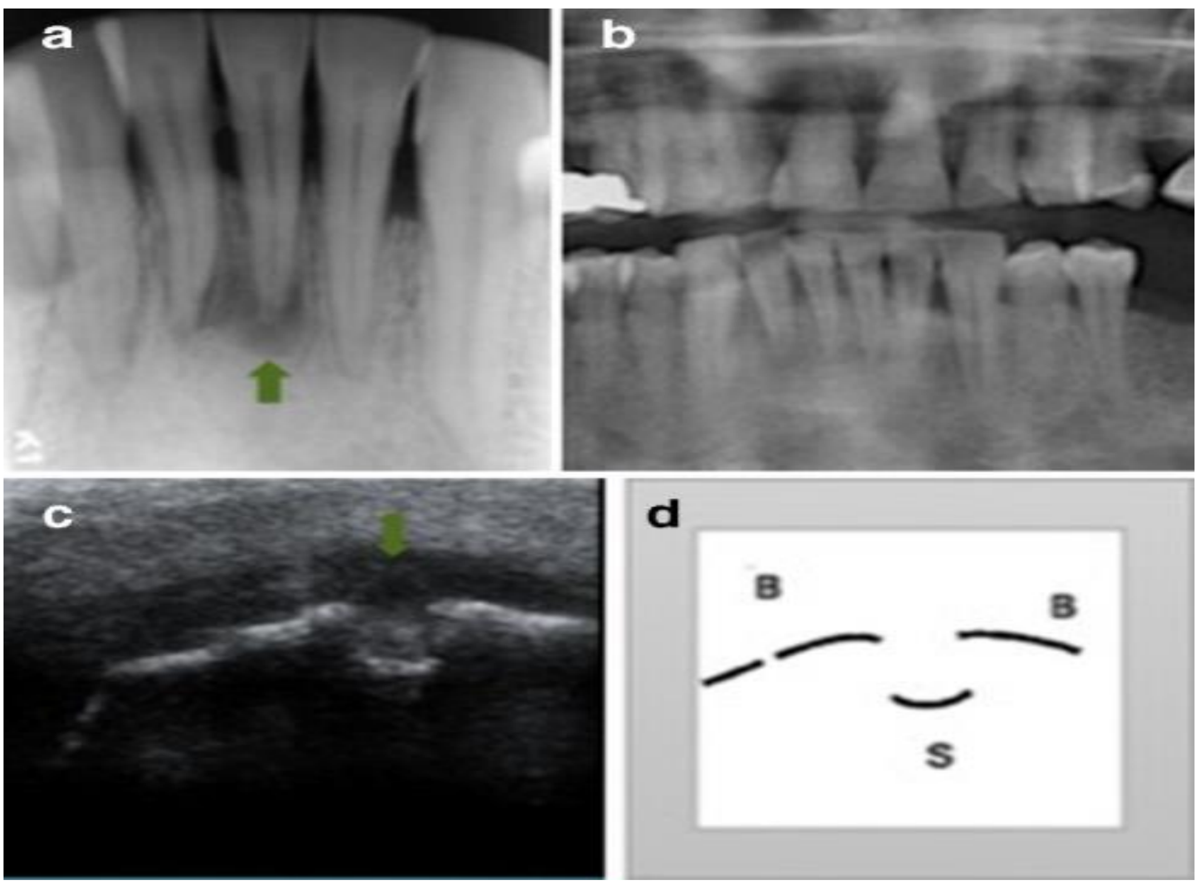

Figure 1: (a) Periapical radiography shows periapical lesion of the mandibular incisor tooth. (b) Panoramic view (lesion is not seen clearly identifiable) (c) Ultrasonography showing a periapical lesion and buccal perforation (yellow arrow: interrupted the hyperechoic image of the buccal cortical bone of the lesion) caused by lesion. (d) Schematic equivalent of c; B: surface of buccal cortical plate of bone, S: the deep surface of the periapical lesion. Region of between B and S showing lesion area.

CONCULSION:

Radiographic examination is absolutely necessary during the diagnostic process, treatment, and post-treatment follow-up of periapical lesions, exposing patients to repeated radiation doses. Periapical radiographs have long been the most widely used and accepted primary diagnostic method for periapical lesions due to their ease of use, accessibility, and low cost. Ultrasound has been widely used as a diagnostic tool in many medical fields, but its applications in dentistry have yet to be fully explored. The evidence confirmed that, unlike CR and DR, US imaging provides sufficient information about the nature of periapical lesions and is a reliable diagnostic technique for differentiating periapical lesions, such as periapical cysts and granulomas, based on the echotexture of their contents and the presence of vascularity using color power Doppler. US imaging can be used as an adjunct to routine CR and DR in the diagnosis of periapical lesions, contributing significantly to the trend toward radiation-free oral diagnostics.

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