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Microstructure analysis of periapical area in abscess patients before and after endodontic treatment

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ABSTRACT

Objectives: The study aims to analyze the microstructure of the alveolar bone in the periapical area by knowing the area of the lesion, the number of particles, and the area of the particles in patients before and after endodontic treatment in the diagnosis of inflammatory periapical abscess lesions through digitizing periapical radiographs using ImageJ software. By using this approach, it is hoped that more objective and accurate data can be obtained in evaluating changes that occur in periapical lesions, thereby improving the overall quality of endodontic treatment.

Materials and Methods: This research uses an observational analysis design using the paired t-test and the Wilcoxon. Samples were taken using a purposive sampling technique, namely 28 pairs of periapical radiographs before and after endodontic treatment, with a diagnosis of periapical abscess carried out at Hasanuddin University Dental Hospital in the period February-April 2024, who met the radiographic inclusion criteria were included in this study.

Results: The results showed that from 28 pairs of, there was a decrease in the average lesion area from 20.00 ± 16.71 to 18.19 ± 6.92mm^2, an increase in the average number of particles from 4.89 ± 2.15 to 4.93 ± 1.82, and an increase in the average area of particles from 130.14 ± 2.15mm^2 to 131.82 ± 24.28 mm^2.

Conclusion: The conclusion of this research is that there was a difference in decreasing the area of the lesion, the number of, but the results were not significant within three months during endodontic treatment. Minimal changes are obtained from the minimal and particles produced.

Keywords: *Periapical abscess, digitization of periapical radiographs, ImageJ software*
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INTRODUCTION

Periapical radiography is used in diagnosis, determining treatment and its course, including in root canal treatment. Periapical radiography is an imaging technique with low ionizing radiation compared to other types of radiography.[1] Evaluation methods using periapical radiography still rely on subjective visual interpretation, so they often have the potential to cause errors in assessment.[2] Therefore, it is necessary to develop more sophisticated technology to ensure a more accurate and objective assessment of periapical lesion healing.[3] Changes in lesion size and an increase in bone density are parameters in assessing the healing of periapical lesions after endodontic treatment.[4] Radiologically, an increase in periapical bone density indicates the healing process that occurs after endodontic treatment, illustrating a positive response to the results of the treatment carried out.[5] These changes can be proven using a computerized system to detect changes that occur during the endodontic treatment process to provide a more objective interpretation, as well as reduce variability in inter- and intra-observer assessments.[6]

Periapical inflammatory lesions of endodontic origin represent an inflammatory response to bacterial infection of the root canal. Bacterial infections generally result in pulp necrosis accompanied by the development of an immune response in the periapical lesion that causes periapical bone destruction. Periapical radiolucency is the most prominent clinical feature of this lesion. Most, but not all, periapical lesions will heal in response to properly performed endodontic treatment.[7] Endodontic treatment relies on three principles: cavity cleaning, retention, and obturation.[8] The use of irrigation and sterilization, area filler materials that act as bactericides, results in a reduction in bacterial activity and deactivation of inflammatory mediators. The loss of debris and

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bacteria in the cavity of this process will restore the activation of regeneration and stimulate the formation of new bone in the periapical.[9] The process of forming new bone starts from the outer edge of the lesion and moves towards the centre of the lesion. In the early stages, there is proliferation and differentiation of osteoblast cells or mesenchymal cells that line the endosteum. These cells then produce bone matrix that forms new bone structures.[10]

A number of studies have been carried out to see the image of trabecular through radiographs based on trabecular patterns, which correlate well with dual-energy x-ray absorptiometry (DXA) as the standard in determining bone quality. Trabecular are considered to play an important role in radiographic imaging, so trabecular can cause a decrease in radiographic density. Analysis of trabecular patterns has been developed using ImageJ software with a filter method to remove noise so that the results are expected to be close to the actual density of trabecular.[11] ImageJ software is a computerized system that is widely used in research using image processing processes today. Display for image, process, and analyze, as well as various features for analyzing particles, thresholding, and statistical histograms. The ability of this software can measure the area of the lesion as well as the number of particles and the area of trabecular bone particles. This research, conducted by Sogur et. al (2013), stated that in periapical lesions, there is increased demineralization, which causes the fractal dimension to decrease.[12]

Based on this, the author is interested in seeing whether there are differences and relationships between the values of lesion area, number, and area of trabecular particles before and after endodontic treatment of periapical abscesses by digitizing periapical radiographs using ImageJ software.

MATERIALS & METHODS

This observational analytic pre and post-study analyzed 28 pairs of intraoral periapical radiographs from patients with suspected inflammatory periapical abscesses treated at RSGMP Hasanuddin University (February–April 2024). Digitized images were processed in ImageJ with standardized calibration, ROI selection, threshold-based segmentation, and particle analysis to obtain lesion area, particle count, and particle area (total/mean). Two blinded examiners assessed measurements; reliability was evaluated using ICC. Normality was assessed with Shapiro–Wilk; paired t-tests or Wilcoxon signed-rank tests were applied accordingly, with effect sizes and 95% CIs ($\alpha = 0.05$).

Periapical radiographs for all twenty-eight patients were taken using the bisecting angle technique, Belmont Phot-x II digital dental x-ray unit with Ezden-I system for processing periapical radiography results via computer. The collected data were then saved using ImageJ software developed version 1.34s (National Institutes of Health, Bethesda, http://rsb.info.nih.gov/nih-image). NIH images are public domain programs that can be downloaded from the World Wide Web (http://rsb.info.nih.gov/ij/java1.3.1_13). This program is used to process the image and then determine the pixel intensity for all lesions.

With the file menu opened, the periapical radiography data is then measured in a rectangular area of interest (ROI) of 30x30 pixels. 8-bit is selected as the rectangular area of the focus of the abscess at the apical of the tooth; the same rectangle is taken in each ROI on the periapical radiography before and after endodontic treatment. The rectangular area does not involve the tooth root, periodontal ligament space, and lamina dura (Figure 1).

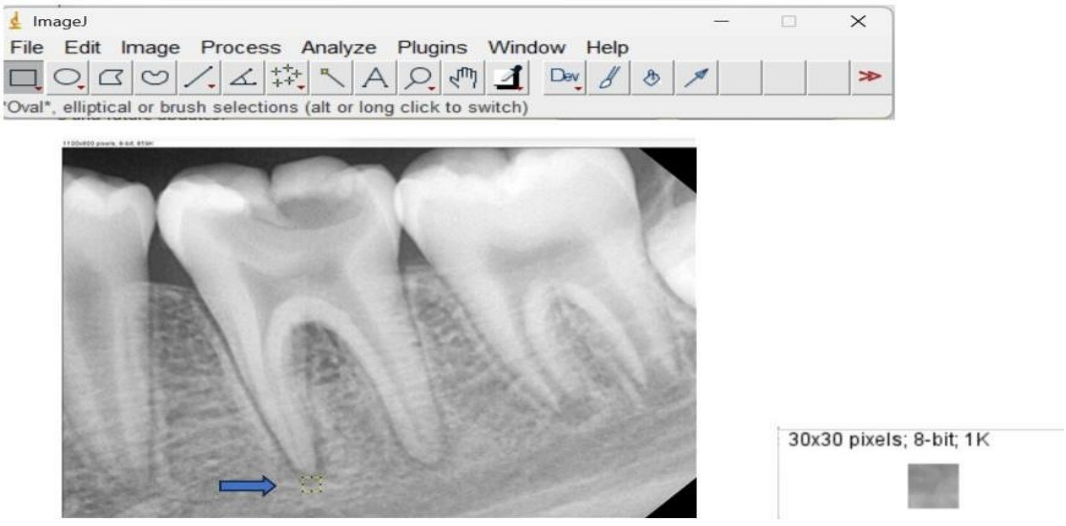

Figure 1. Periapical radiograph, ImageJ Cropping the blue arrow ROI area

The image collected, cropping and duplicates are saved as data with the code image1. Open image one by eroding and dilating and selecting the threshold so that the results are obtained in the mean value (mm^2). All results are saved as a result of measuring the area of the lesion according to the steps in Figure 2.

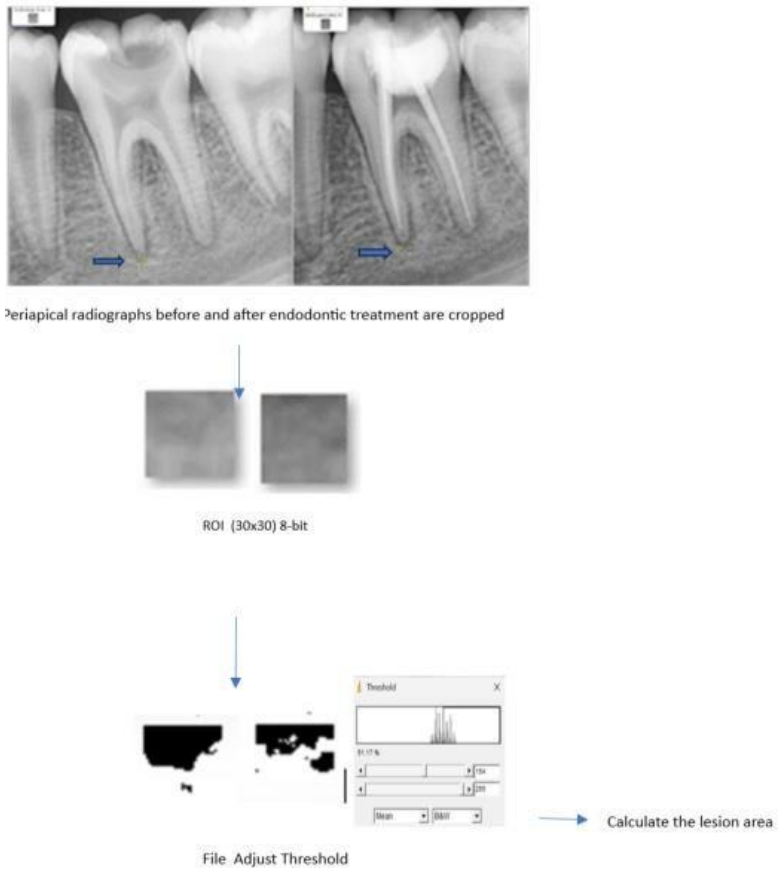

Figure 2. Periapical radiograph measuring the area of the lesion

Next, open the Image1 file again to get the results of calculating the number of particles and particle area using the Gaussian blur filtering process by entering the number 3. The results of this filtering are saved as image2 in BMP form. The image is subtracted and multiplied, then added with a value of 128. The image is converted into binary data, then image noise is removed by eroding and dilating, which is repeated 3 times and then converted into an outline, the flow of which can be seen in Figure 3. The results are stored as values for the number of particles and area. particles before and after endodontic treatment.[12,13]

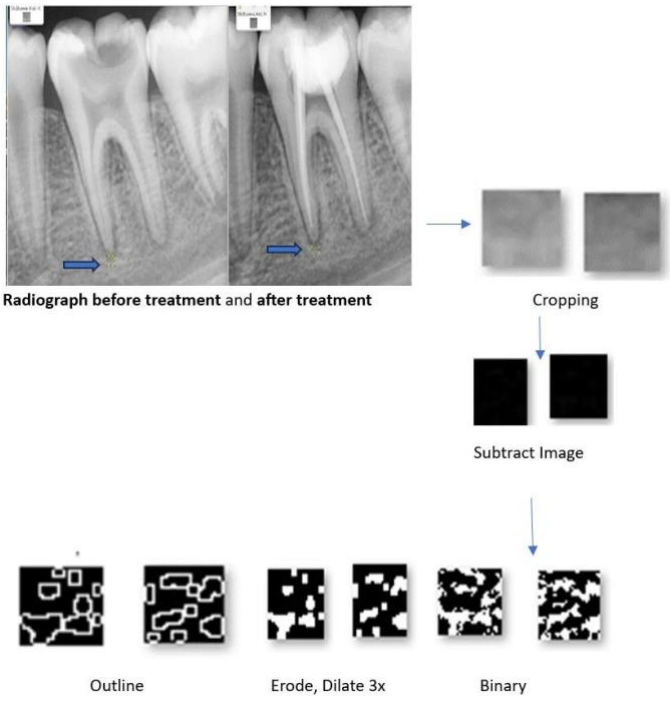

Figure 3. Periapical radiography counts the number of particles and particle area

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RESULTS

Research on 28 pairs of periapical radiograph data, the areas are presented in Table 1.

Table 1. Research data on the extent of periapical abscess lesions before and after endodontic treatment

Assessment criteria	Before	After
1. Lesion area (mm^2)	20.00 ± 16.71	18.19 ± 6.92
2. Number of Particles	4.89 ± 2,15	4,93 ± 1,82
3. Particle Area	130.14 ± 2.15	131.82 ± 24.28

Based on Table point 1, the average area of the lesion can be seen. Before endodontic treatment, the average was 20.00, but for the endodontic treatment, it was 18.19. From the results of the Wilcoxon test, the p-value (0.848) > 0.05 was obtained, which means there is no significant difference between before and after endodontic treatment. The results obtained from this average were a reduction in the area of the lesion.

Based on Table point 2. The number of particles can be seen. Before endodontic treatment, the average was 4.89; after intervention, endodontic treatment was 4.93. From the results of the paired t-test, a p-value (0.944) > 0.05, which means there is no difference between before and after endodontic treatment, but the results obtained from the average have increased.

Based on Table point 3. The particle area can be seen. Before endodontic treatment, the average was 130.14, and after intervention, it was 131.82. From the results of the Wilcoxon test, the p-value (0.740) > 0.05 was obtained, which means there was no difference between before and after the intervention, but the results obtained from the average increased.

DISCUSSION

Digital imaging with pixel intensity analysis, qualitative and quantitative analysis of alveolar bone microstructural density. Pixel intensity analysis is considered a simple method that provides an objective measure of the radiographic density of alveolar bone microstructures. This means measuring the black or whiteness of an 8-bit digital image on a scale from zero (total black) to 255 (total white). The number and size of pixels, along with the amount of grey available in a radiograph, determine the amount of particle information in an image.[13]

The pathogenesis process of periapical abscess begins with vasodilation of blood vessels, which causes slowing of blood flow and accumulation of fluid in the periapical area. This fluid buildup reduces the absorption of X-ray photons, resulting in a radiolucency image with indistinct and blurry boundaries. In the healing phase of a periapical abscess, there is increased vascularization, fibroblast activity, and cellular cementum formation, as well as osteoblast activation, which leads to the formation of trabecular bone from the endosteum, where osteoblasts and mesenchymal cells proliferate into osteoblasts and form new bone matrix. On the other hand, in the healing condition of a periapical abscess, tissue compaction occurs, which increases the absorption of X-ray photons because the newly formed bone has a higher absorption capacity, resulting in a clear radiopaque image. Quantification of these changes is carried out through a digitization process, which converts conventional radiographs into digital form, allowing the detection of small periapical bone resorption through analysis of changes in pixel values in the digital image.[14,15]

Based on the table, point 1 shows a decrease in the show periapical abscess lesions on radiographs after endodontic treatment of 1.1%. According to Torabinejad (2008), this situation shows that there is improvement in the periapical abscess lesion; conversely, if there is an increase in the area of the lesion after endodontic treatment, it is said that healing has not occurred.[12] The results of measuring the number of particles (Point 2) and particle area (Point 3) showed that there was no significant increase in the number of particles after endodontic treatment, only 0.4% and 1.7%. This change in situation does not indicate progress in improving the mineralization process in the microstructure of the alveolar bone. In digital analysis, there are changes in pixel values in areas that initially did not absorb X-ray photons. The pixels are separated by converting the time into a binary image so that the low ones are removed while the high pixels are displayed. Saeed et al (2014) also confirmed that variations in grayscale values in periapical lesions, when associated with histological changes, have a direct correlation between the values and the type of material filling the lesion.

The variable that differentiates the results of this study from previous research is the time sampling. This is because the radiographs in this study were taken during the endodontic treatment period, which was on average less than 3 months. Density changes due to increased mineralization can be detected 90 days after root canal filling, and bone formation is said to occur after 180 days. Angerame et al (2013) stated that the digital subtraction radiograph analysis method was effective in the healing process after 6 months. According to Yasar and Akgunlu et al (2005), in periapical abscess, there is an increase in demineralization, which causes the fractal dimension to also decrease. Differences in results are caused by differences in sampling time,

anatomical variations, differences in techniques used to acquire two-dimensional bone images, and differences in the position of the ROI area before and after endodontic treatment.[16]

CONCLUSION

Based on research using the software above, it was concluded that there were differences in the form of a decrease in the area of the lesion, and an increase in the number and particles during 3 months of endodontic treatment, but no significant changes were seen in the microstructure of the inflamed alveolar bone in the periapical abscess.

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FOOTNOTES

All authors have no potential conflict of interest to declare for this article. This research has received ethical approval from the Research Ethics Commission of the Faculty of Dentistry, Hasanuddin University, with number 05018/UN4.13/PT.01.04/2024 All procedures conducted were in accordance with the ethical standards.

REFERENCES

1. Tosun S, Karatasliogl E, Tulgar MM, Derindag G. Fractal analysis and periapical index evaluation of multivisit nonsurgical endodontic retreatment: A retrospective study. Oral Surg Oral Med Oral Pathol Oral Radiol. 2022;133(2):245–51.
2. Suyambukesan S, Perumal GCL, Somasundaram E, Pandian NJ, Manigandan T. Analyzing periapical lesions on intraoral periapical radiographs: incongruity in diagnosis. J Indian Acad Oral Med Radiol. 2013;25(1):5–9.
3. Janani M, Ghasemi N, Johari M, Nazari L. Comparison of Root Canal Filling Quality and Periapical Health Using Periapical, Panoramic, and Cone-beam Computed Tomography Radiographic Techniques. J Dent Mater Tech. 2022;11(1).
4. Karkle A, Slaidina A, Zolovs M, Vaskevica A, Meistere D, Bokvalde Z, et al. Comparative analysis of examination methods for periapical lesion diagnostics: assessing cone-beam computer tomography, ultrasound, and periapical radiography. Diagnostics. 2024;14(7):766
5. Nešković J, Jovanović-Medojević M, Živković S. Clinical and radiological analysis of the causes for endodontic treatment failure. Stomatol Glas Srb. 2017;64(2):63–73
6. Antony DP, Thomas T, Nivedhitha MS. Two-dimensional periapical, panoramic radiography versus three-dimensional cone-beam computed tomography in the detection of periapical lesion after endodontic treatment: A systematic review. Cureus. 2020;12(4)
7. Abdelgawad LM, Kenawi LM. Clinical and radiographic evaluation of healing effect of low level laser therapy on chronic apical lesions. Egypt Dent J. 2016;62(1-January (Part 5)):1039–49
8. Duncan HF, Kirkevang L, Peters OA, El-Karim I, Krastl G, Del Fabbro M, et al. Treatment of pulpal and apical disease: the European Society of Endodontology (ESE) S3-level clinical practice guideline. Int Endod J. 2023;56:238–95
9. Thomas A, Firman RN, Azhari A. Analisis radiograf periapikal menggunakan software ImageJ pada granuloma periapikal pada perawatan endodontik. Maj Kedokt Gigi Indones. 2017;3(2):105–10
10. Soltani P, Sami S, Yaghini J, Golkar E, Riccitiello F, Spagnuolo G. Application of fractal analysis in detecting trabecular bone changes in periapical radiograph of patients with periodontitis. Int J Dent. 2021;2021(1):1-5
11. Epsilawati L, Wulansari DP, Asykarie INA. Fractal Dimension Approach for Quantitative Analysis Radiograph in Periapical Inflammation: A Systematic Review. Acta Med Philipp. 2025;59(3):125
12. Sumantri DDS, Firman RN, Azhari A. Analisis radiograf periapikal menggunakan software imageJ pada abses periapikal setelah perawatan endodontik. Maj Kedokt Gigi Indones. 2017;3(1):29–34
13. Saeed SS, Ibraheem UM, Alnema MM. Quantitative analysis by pixel intensity and fractal dimensions for imaging diagnosis of periapical lesions. Int J Enhanc Res Sci Technol Eng. 2014;3(5):138–44.
14. Fayyaz A, Ehsan S, Waseem RF. Radiographic Evaluation of Endodontic Treatment Performed by Undergraduate Students and Interns. J Pakistan Dent Assoc. 2018;27(3)
15. Mahasneh SA, Al-Hadidi A, Kadim Wahab F, Sawair FA, AL-Rabab'ah MA, Al-Nazer S, et al. A cone beam CT study on the correlation between crestal bone loss and periapical disease. J Clin Med. 2023;12(6):2423
16. Al-Fouzan KS. A new classification of endodontic-periodontal lesions. Int J Dent.2014(1):919173