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DIGITAL RADIOGRAPHIC ANALYSIS OF ENDODONTIC TREATMENT OUTCOME MORPHOLOGY ON GRANULOMA AND ABSCESS USING IMAGE

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ABSTRACT

Introduction: Endodontic treatment on dental granuloma and periapical abscess are the most cases found in dental treatment. To assess the success of treatment commonly used visual roentgenography. This situation makes difference possibility quite large in both inter-observer and intra-observer. The purpose of this study was to assess the results of treatment by using ImageJ® software.

Methods: Cross-sectional analysis towards 122 data samples of granuloma and abscess radiograph, consisted of 60 granuloma cases (30 data before treatment and 30 data after treatment), 62 abscess cases (31 data before treatment and 31 data after treatment). Treatment time was 5-6 months. Radiograph analysis using ImageJ® software.

Results: The average number of particles on granuloma endodontic treatment before and after treatment was consecutively 56.22 and 76.61, there was 29.3% difference. In abscess case, before and after was consecutively 70.16 and 99.73, there was 29.6% difference. The average of particle extensive before granuloma endodontic treatment was 8.93 ± 2 $mm^{2,}$, whilst after treatment was 11.42 ± 2 mm^2, there was 27% difference. Whilst In abscess case of particle extensive increased from 14.03 became 19.01, so there was 26% difference.

Conclusion: Abscess and granuloma treatment could be detected early by using ImageJ® software.

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INTRODUCTION

Periapical radiograph is the most used radiographs by dentists, especially in endodontic treatment. Determination of periapical lesions healing process only done visually all this time, by using viewer tools to make assessment results subjective.[1] Large differences still occur between inter-observer and intra-observer, reaching the amount more than 20.4% (Taguchi *et al*., 1997), especially on the assessment of lesions with no explicit boundaries (Suyambukesan, 2013). The computerized system expected to help detecting changes in endodontic treatment quantitatively. Computerized system able to perform as objective interpreter to minimize the interpretation difference between intra-observer and inter-observer (Suyambukesan *et al*. (2013)).

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Several studies have been developed to see the radiographic trabecular picture based on trabecular pattern by using various parameters. The morphometry fraction method according to Vander Stelt, can be used to assess bone quality. Morphometric analysis correlates well with Dual-energy X-ray Absorptiometry (DXA) as bone quality standards (Ingle, 2003). Granuloma and abscess lesions are the results of infection process as the outcome of Polymorphonuclear Leukocytes (PMNL) cell reaction. This situation will change trabecular structure that affected the X-rays attenuation. Digital radiograph software able to displayed variety of parameters such as particle numbers and trabecular area. Response of abscess and granuloma contains relatively fewer inflammatory cells and having explicit boundaries expected to affect the healing time. Endodontic treatments intend to remove irritants in the form of debris and bacteria inside root canal through the cleaning and shaping phase, sterilization and obturation.

The use of irrigation materials, sterilization and filler that acts as bactericidal agents resulted in decrease of bacterial activity and deactivation of inflammatory mediators. The formation of new bone will running from the periphery to the center of the lesion, and there are differences between the pattern of abscess and granuloma (Neville *et al*., 2003). The purpose of this study was to determine the healing process differences between endodontic treatments of abscess and granuloma by using ImageJ® software.

METHODS

After getting permission from the Ethics Committee, a cross-sectional study was conducted towards 122 periapical radiograph by using parallel technique. Radiographs were consisted of 60 abscess cases (30 data before treatment and 30 data after treatment) and 62 periapical granuloma cases (31 data before treatment and 31 data after treatment). Treatment time was 5-6 months and collected from January-December 2014 at Universitas Padjadjaran Dental Hospital Bandung. Data collected was digitalized by using Epson Scan® program for image acquisition, then processed by using ImageJ® software. Then the image was cropped and stored as image1. After that, the image was filtered using Gaussian blur filtering by entering the number 3, then saved as image2.bmp as file extension. The image was subtracted and multiplied by the menu available in the program, then added with the value of 128 so that the image could be converted into binary. The image noise was removed with erode option and dilate option for 3 times, the feature was extracted.

RESULTS

Study about 122 periapical radiographs obtained data based on particle numbers and extensively represented trabecular. This situation proved tissue regeneration as the following results:

According to data shown in Table 1, the average particle numbers on granuloma endodontic treatment before and after treatment were consecutively 56.22 and 76.61, there was a 29.3% difference. Whilst in the abscess case, before and after treatment were consecutively 70.16 and 99.73, there was a 29.6% difference. This data showed that in both cases, there were increasing particle numbers after endodontic treatment. The results of independent t-test showed significant difference between the particle numbers before and after endodontic treatment. Table 2. Showed the average particle size before granuloma endodontic treatment was 8.93 ± 2 $mm^{2,}$ while after treatment was 11.42 ± 2 mm^2, there was 27% difference. In the abscess case, the particle size was increased from 14.03 became 19.01, there was 26% difference. There were increased particle area in both cases after endodontic treatment. The results of independent t-test showed significant difference of the particle area before and after endodontic treatment.

DISCUSSION

Periapical abscess pathogenesis process preceded by vascular vasodilation that retarded the blood flow and pile up in periapical. The increase of fluid amount in periapical will reduces the absorption of X-ray photons. This circumstances makes the bounded radiolucent picture is not clearly imprinted. If the treatment is not immediately given, lesions will continue to last over time and localized limited by the calsification of fibrous tissue, thus providing a clear bounded radiopaque picture (Byström *et al*., 1987; White *et al*., 2014; Carneiro *et al*., 2009). Necrotic pulp will cause inflammatory reaction due to the inclusion of irritants (Neville *et al*., 2003). Irritants such as bacterial toxins, enzymes and metabolic outcomes intruding directly to the periapical tissues through root canal microorganisms (Hargreaves *et al*., 2011). These conditions triggers inflammatory reaction. The formation of inflammatory response prevents the spread of infection (Walton *et al*., 2002).

Table 1. Average particle numbers of abscess and granuloma before and after endodontic treatment

Sample numbers		Particle numbers				
		Before	n	After	n	Difference
Granuloma	(62)	56.22	(31)	79.61	(31)	29.3%
Abscess	(60)	70.16 ± 7	(30)	99.73 ± 7	(30)	29.6%

X: 122

Table 2. Average particle size of abscess and granuloma before and after endodontic treatment

Sample numbers		Lesion area				
		Before	n	After	n	Difference
Granuloma	(62)	8.93 ± 2	(31)	11.42 ± 2	(31)	27%
Abscess	(60)	14.03 ± 1	(30)	19:01 ± 1	(30)	26%

X: 122

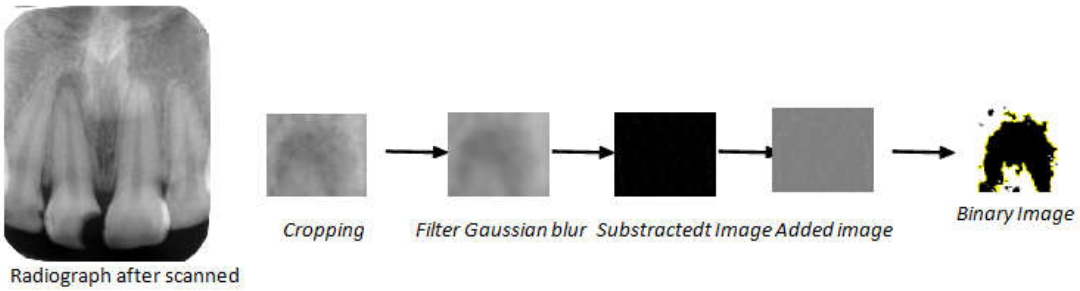

Figure 1. Processing

Radiographically, periradicular bone resorption decreases the absorption of X-rays, thus providing a radiolusent picture (Byström *et al*., 1987). The loss of debris, bacteria, and root canal filling materials (gutta-percha) activates the regeneration process in the form new bone reformation. Addition of fibrous and bone matrix will changes density by increasing the X-rays absorption (White, 2014). The addition of density material (fibrous and bone matrix) will increases gray gradation in radiographs and morphometry, Statde in the amount of particles and the lesion extent which can becoming an important healing process marker (Hargreaves *et al*., 2011; Estrela *et al*., 2009; Southard *et al*., 1996). On the healing process of periapical abscess, occurred the vascularity increase, fibroblasts, cellular cementum and the activity of osteoblasts which leads to the formation process of endosseous trabecular bone formation, where osteoblasts and mesenchymal stem cells will proliferate into osteoblasts and will form bone matrix (Dove, 2001; Hargreaves *et al*., 2011; Carneiro *et al*., 2011). The addition of matrix formation causes density increase in the periapical lesions area thus will improve the absorption of X-ray photons. That new matrix will absorb more X-rays so that only a few X-rays captured by the sensor resulting in a more radiopaque picture (Byström *et al*., 1987; White, 2014; Carneiro *et al*., 2009). Teixeira *et al*. (2010) stated that small changes on the periapical bone was enough to cause the pixel value change of lesion area in digital method (Saeed *et al*., 2014). Developed method for estimating trabecular bone density in dental radiographs is fractal analysis by using ImageJ®. This method has been widely developed because its non-invasive and low cost characteristic (Walton, 2002; Byström *et al*., 1987; Dove, 2001; Teixeira *et al*., 2011). The density increase that expressed in particle extents and amounts can be used as bone structure complexity indicator that occurs in the recovery process of endodontic treatment (Sogur *et al*., 2013).

In this study also conducted erotion and dilution three times in order to eliminated noise and controlling radiographs confounding factors. Some researchers also developed ImageJ® software for trabecular disorder analysis and bone tumor-like lesion. Jolley *et al*. (2006) was able to use this method to determine the alveolar diseases (Amer *et al*., 2012). Demirbas *et al*. stated that fractal analysis can be used to determine the sickle-cell anemia with indicators were mandibular trabecular pattern changes. Shrout *et al*. (2011) was using fractal analysis and found that there was correlation between the area particle extents and the amount of particles (Amer *et al*., 2012). The results of the measurement of particle amounts (Table 1) and particle extents (Table 2) showed an increasing after endodontic treatment. The accelerated regeneration process occured relatively the same in both granuloma and abscess cases. This situation indicated that the parameter used was same between particle amounts and particle extents. Density changes ran from the edge to the center of the lesion, thus the extents of the lesion became slightly reduced and the amount of particles was increase. This situation showed that changes in the absorption level that lead to the start of the formation of improvement materials. The earliest sign of the formation of bone matrix material that caused by density difference in the internal structure of periapical abscess lesion. Carnerio *et al*. (2009) and Ostravik *et al*. (2001) research showed a decrease in periapical index by using CBCT (Saeed *et al*., 2014; Ferreira *et al*., 2012). Increased on the amounts and extents of particle in this study showed the occurrence of regeneration process.

Saeed *et al*. (2014) also confirmed that variation in grayscale values on periapical lesion was associated with histological changes, and there was a direct correlation between the density value and density of lesion filler materials as stated by Camps *et al*. (2004) (Sogur *et al*., 2013). From the fractal analysis of dimension parameters found correlation between the particle amounts and particle extents Amer *et al*. (2011). The use of digital analysis able to minimize subjectivity due to observer experience differences (Southard *et al*., 1996). Angerame *et al*. (2013) stated that radiograph digital analysis (digital substraction radiograph) was effective in the healing process after six months (Teixeira *et al*., 2011). Research done by Estrela and Figueiredo (1999) stated that the optimal healing time of periapical abscess lesion after endodontic treatment was approximately 2 years (Pornprasertsuk *et al*., 2014). This research generally has the results according to the research done by Yasar and Akgunlu (2005), Sogur *et al*. (2013), and also Chen and Chen (1998) which stated that there was mineralization increase in the endodontic treatment of periapical abscess which led into the increase of particle extents (Dove, 2001; Waltimo *et al*., 2001; Amer, 2012).

Conclusion

Digital analysis by using ImageJ® software able to determine the early detection of changes caused by granuloma and abscess endodontic treatment, with particle amounts and extents as the main parameter.

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