

Tolerance of brightness and contrast adjustments on chronic apical abscess and apical granuloma interpretation

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Abstract. In digitized radiography techniques, adjusting the image enhancement can improve the subjective image quality by optimizing the brightness and contrast for diagnostic needs. To determine the value range of image enhancement (brightness and contrast) on chronic apical abscess and apical granuloma interpretation. 30 periapical radiographs that diagnosed chronic apical abscess and 30 that diagnosed apical granuloma were adjusted by changing brightness and contrast values. The value range of brightness and contrast adjustment that can be tolerated in radiographic interpretations of chronic apical abscess and apical granuloma spans from -10 to +10. Brightness and contrast adjustments on digital radiographs do not affect the radiographic interpretation of chronic apical abscess and apical granuloma if conducted within the value range.

1. Introduction

Pulpoperiapical lesions are one of the pathological conditions frequently encountered in dentistry. Necrosis of the pulp, which can be caused by caries or mechanical trauma to the teeth, is mostly responsible for pulpoperiapical lesions [1]. When not treated, the bacterial invasion of the necrotic pulp product is pushed out of the root canal and propagates the infection to the periapical tissue [2]. The prevalence of pulpoperiapical lesions constantly increases; however, an increase in the prevalence of pathological conditions is unclear [3]. Nearly 90% of pulpoperiapical cases found in the dentistry practice are classified into apical abscesses, granulomas, and cysts. Previous study showed that the abscess rate ranged between 28.7-70.7%, while the granuloma incidence rate ranged between 9.3-87.1%, and the cyst incidence rate was between 6-55% [4].

Examination of pulpoperiapical lesions cannot be done through clinical examination alone; radiographic examination is required as a follow-up examination to establish the diagnosis. In this case, a periapical intraoral radiograph is used to visualize the teeth and the surrounding structures so that lesions could be detected and diagnosed, care plans prepared, and care outcomes evaluated. Interpretation of radiographs regarding radiodensity, location, shape, size, lesion borders, internal structure, and changes in the surrounding structure would complement the information from a clinical diagnostic exam. To distinguish each lesion, the observer should possess the anatomical considerations and pathogenesis of the pulpoperiapical lesions to avoid misdiagnosis.

Radiographically, pulpoperiapical lesions appear as a radiolucent area in the apical of the teeth. The differences in apical abscesses and granuloma are mainly seen from the periphery border. In apical abscesses, the radiographic features show radiolucent areas with irregular and diffuse borders, whereas



in granuloma, the lesions show a clearly bounded radiolucent area, which was a cancellous bone reaction to localize the lesion [5]. However, internal structures and borders are difficult to distinguish on conventional radiographs, whose interpretations rely solely on the observer's eyes to distinguish the radiodensity gradient, as compared to computer capabilities. Therefore, a radiograph with a good contrast and detail is required to distinguish both lesions.

In conventional radiographic techniques, radiographs that have been chemically processed in a dark room can no longer be altered in brightness or contrast; thus, image processing can not be performed. Therefore, if the radiograph had inferior quality, the radiograph must be redone, and the patient is exposed to an increased radiation dose. In digitized radiography techniques, the image enhancement can be adjusted to improve subjective image quality by optimizing the brightness and contrast for diagnostic needs. Based on Raitz *et al.*'s research, the spatial resolution of the human eye depends on brightness and contrast, and the study also mentioned that increased diagnostic accuracy is obtained through the use of brightness and contrast tools [6]. The spatial resolution in this case is the capacity to determine the picture's small details and smoothness [3]. Kullendorff *et al.*, supported by Raitz *et al.*'s findings, stating that adjusting the brightness and contrast was highly effective and the most frequently used technique to detect periapical lesions on a good-quality digitized radiography [7]. The adjustment makes it easier for the practitioner to visualize the changes that occurred in the periapical area, to detect the lesions, and to determine the boundaries and internal structures of the pulpoperiapical lesions [7-8].

A number of qualitative studies have been conducted on adjusting the brightness and contrast in digitized radiography techniques, and the results have shown image enhancement plays a positive role during the diagnosis. Choi *et al.* mentioned that image enhancement adjustments could improve the radiograph's subjective quality [8]. Furthermore, Güneri *et al.* conducted a quantitative study to determine the cut-off point for brightness and contrast adjustments; however, the study did not mention the range of brightness and contrast that can be tolerated in radiographic interpretation [9].

In some developing countries, particularly Indonesia, digitized radiography has not completely replaced conventional radiography. This is due to the relatively high cost and the difficulty of integrating the necessary software system [9]. However, in semi-direct digital radiography, the digitalized radiograph is made from a photostimulable phosphor plate (PSP) scanner and transferred to a computer via a Universal Serial Bus (USB) Network [10]. Once the photo is transferred to the computer, the image enhancement adjustment can be made in the same manner as with direct digital radiography. The other type of digitized radiography digitizes the radiograph by using a special scanner, and then the radiograph is adjusted with general software, such as Adobe Photoshop. Therefore, this study aimed to determine the value range of the brightness and contrast adjustment that can be tolerated on chronic apical abscess and apical granuloma interpretation. This study will discuss two types of pulpoperiapical lesions: chronic apical abscesses and apical granulomas.

2. Materials and Methods

This research has a cross-sectional and descriptive-analytic design. The samples used in this study were 60 periapical radiographs from the dental medical records of Teaching Hospital Faculty of Dentistry, Universitas Indonesia patients, consisting of 30 periapical radiographs diagnosed as chronic apical abscesses and 30 periapical radiographs diagnosed as apical granulomas. This study's independent variables were digitized periapical radiograph data, and the dependent variable was the range of values that can be tolerated for brightness and contrast adjustment.

This study's inclusion criteria were periapical intraoral radiographs with pulpoperiapical lesions diagnosed as chronic apical abscesses and apical granulomas with dubious radiographic diagnoses, good-quality radiographs, and radiographs taken from the medical records of Teaching Hospital Faculty of Dentistry, Universitas Indonesia patients. This study's exclusion criteria were poor-quality radiographs that cannot be interpreted, unclear radiographic diagnoses, a lack of abnormal pulpoperiapical lesions, and no definitive clinical diagnosis. The tools and materials used are a radiograph viewer, stationery, research data form, 15-inch MacBook Pro laptop, UMAX Power Look

1120 scanner, and patient dental periapical medical records from Teaching Hospital Faculty of Dentistry, Universitas Indonesia.

This research begins with the selection of research samples corresponding to the inclusion criteria, and then the radiograph sample was scanned using a UMAX Power Look 1120 scanner. The digitized sample was transferred to the laptop and divided by the anterior maxilla and the posterior maxilla regions, as well as the anterior mandible and the posterior mandible regions. Next, image enhancement was performed by adjusting the brightness and contrast values in intervals of 5 (-5 or +5). The lower limit value of brightness was obtained when the lesion border became unclear (irregular), leading to different diagnoses. The upper limit of brightness was obtained when the lesion border became clearer (radiopaque), thus leading to a different diagnosis. The lower-limit value of the contrast was obtained when the lesion's border became more obvious (radiopaque), thus leading to different diagnoses. The upper-limit value of the contrast was obtained when the lesion's border became more unclear (irregular), thus leading to different diagnoses. The radiograph was interpreted by looking at the conspicuousness of the lesion using the seven-clues guidelines, i.e., the lesions' radiodensity, location, extension, border, shape and size, internal structure, and effects on the surrounding tissue. Furthermore, the results of the radiographic image evaluation was confirmed with a radiological preceptor. Observations were recorded in the research form. The resulting research data was processed using a statistical analysis program. Intraobserver and interobserver reliability tests were analyzed using Cohen's Kappa coefficients. The significant difference between the radiograph before and after the adjustment of brightness and contrast was tested using a Wilcoxon test, and the difference of the mean value of brightness and contrast in each region was tested using a Kruskal-Wallis test.

3. Results and Discussion

3.1 Results

Intraobserver and interobserver reliability test results using the Cohen's Kappa coefficients show an excellent observation level of agreements. From the samples collected there were 15 periapical radiographs in the maxillary anterior, 15 posterior maxillary radiographs, one periapical radiograph of the mandibular anterior, and 29 posterior periapical radiographs of the mandible. Table 1 shows the lower limit of the brightness value, with a -5 adjustment value, as zero samples (0%) encountered diagnostic changes. At the -10 adjustment value, 12 samples (20%) encountered diagnostic changes and were significantly different statistically. At the -15 adjustment value, 59 samples (98.3%) encountered diagnostic changes and were significantly different statistically. At the -20 adjustment value, all samples had diagnostic changes and were significantly different statistically.

Table 1. The frequency of adjustment and the lower limit and upper limit of brightness value that begins to change the diagnosis

Adjustment	Number	Percentage	p-value
Brightness lower limit	-5	0	1.000
	-10	12	0.001*
	-15	59	0.000*
	-20	60	0.000*
Brightness upper limit	5	0	1.000
	10	6	0.014*
	15	55	0.000*
	20	60	0.000*

Furthermore, at the upper limit of brightness with a +5 adjustment value, zero samples (0%) encountered diagnostic changes. At the +10 adjustment value, six samples (10%) encountered

diagnostic changes and were significantly different statistically. At the +15 adjustment value, 55 samples (91.7%) encountered diagnostic changes and were significantly different statistically. While at the +20 adjustment value, all samples had diagnostic changes and were significantly different statistically. Table 2 shows that at the lower limit of the contrast, with a -5 adjustment value, zero samples (0%) encountered diagnostic changes. At the -10 adjustment value, 10 samples (16.7%) encountered diagnostic changes and were significantly different statistically. At the -15 adjustment values, 58 samples (96.7%) encountered diagnostic changes and were significantly different statistically. While at the -20 adjustment value, all samples had diagnostic changes and were significantly different statistically. Furthermore, at the upper limit of the contrast, with a +5 adjustment value, zero samples (0%) encountered diagnostic changes. At the +10 adjustment value, six samples (10%) encountered diagnostic changes and were significantly different statistically. At the +15 adjustment value, 58 samples (96.7%) encountered diagnostic changes and were significantly different statistically. While at the +20 adjustment value, all samples had diagnostic changes and were significantly different statistically.

Table 2. The frequency of adjustment and the lower limit and upper limit of contrast value that begins to change the diagnosis

Adjustment	Number	Percentage	p-value
Contrast lower limit	-5	0	1.000
	-10	10	16.7
	-15	58	96.7
	-20	60	100
Contrast upper limit	5	0	1.000
	10	6	10
	15	58	96.7
	20	60	100

Table 3 shows that the lower limit of brightness had a 0.937 p-value ($p > 0.05$); thus, there is no statistically significant difference in the mean value of the brightness adjustment in each region. The upper limit of brightness had a 0.795 p-value ($p > 0.05$), meaning there is no statistically significant difference in the mean value of the brightness adjustment in each region. The lower limit value of the contrast had a 0.874 p-value ($p > 0.05$), meaning there is no statistically significant difference in the mean value of the contrast adjustment in each region. The upper limit of the contrast had a 0.839 p-value ($p > 0.05$), meaning there is no statistically significant difference in the mean value of the contrast adjustment in each region.

Table 3. Analysis of the relation between brightness and contrast to the region using a Kruskal-Wallis test

Adjustment	p-value
Brightness lower limit	0.937
Brightness upper limit	0.795
Contrast lower limit	0.874
Contrast upper limit	0.839

3.2 Discussion

The results of the Wilcoxon test analysis shown in Table 2 demonstrate there is a statistically significant difference in the adjustment of the lower limit of brightness at -10 and the upper limit of brightness at +10; thus, it can be concluded that the range of values that can be tolerated in the brightness setting ranges from -10 to +10. Therefore, if the brightness is adjusted outside the tolerance range, there will be changes in the radiographic image. The results are contrary to the research conducted by Güneri *et al.*, which stated that the brightness adjustment value did not cause significant radiographic image changes because the bright areas and dark areas will change in the same direction with the same number of changes. In addition, the adjustment of brightness value did not affect the original mean gray value (MGV). The sample used in the Güneri *et al.* study was a digital radiograph obtained from a digital device (direct digital); therefore, the results obtained were different from this study [10].

The results of the Wilcoxon test analysis shown in Table 3 denote a significant difference of the lower limit of contrast at the adjustment value of -10 and the upper limit of contrast at +10; thus, it can be concluded that the tolerance range in contrast adjustment is from -10 to +10. Therefore, if the contrast is adjusted outside the range of tolerance values, there will be changes in the radiographic image [15]. Based on the results of the quantitative research conducted by Güneri *et al.*, increasing the contrast value will cause changes in the different values on each pixel, and the dark areas would be darker and the bright areas would be brighter; unlike with the brightness, the same change occurs in all elements of the image. The study also found that an increase in contrast over the cut-off levels (+50 units) would cause a significant loss of diagnostic information, due to the changes in pixel intensity or MGV. However, the sample used in the Güneri *et al.* study was a digital radiograph obtained from a digital device (direct digital); therefore, the results obtained differ from this study [10].

In this study, the dental elements were divided by their location, i.e., anterior maxillary, posterior maxillary, anterior mandibular, and posterior mandibular. The division is done because each region has a different thickness and bone density, and these differences are expected to affect the values that can be tolerated in brightness and contrast adjustment. The maxillary anterior region has thin cortical bones with small and large trabeculae that form a dense pattern. The maxillary posterior region also has thin cortical bones; however, the marrow bone is larger than in the maxillary anterior region.[3] In the study conducted by Borges *et al.* and Park *et al.*, it was mentioned that the highest bone density of the maxilla was present in the canine, premolar, d molar areas, while the lowest bone density was found in the maxillary tuberosity [11-12]. Chugh *et al.*'s study also mentioned that the area around the midline of the maxilla has a low bone density [13].

The mandibular anterior region has a slightly thicker cortical bone than the maxilla, a rougher-looking trabeculae, and a larger hollow space for the bone marrow. The mandibular posterior region has the thickest cortical bone, with periradicular trabeculae and a larger marrow hollow space than the anterior mandibular region [3]. Lim *et al.*'s study mentioned that the thickness of the cortical bone in the posterior maxillary and mandibular regions showed significant differences, whereas the thickness of the cortical bone in the anterior region of the maxillary and the mandible was not significantly different [14]. Borges *et al.* and Park *et al.* stated that the mandible had a higher bone density than the maxilla, and the posterior area had a higher density than the anterior area. In the mandible, the bone density increases from the incisive area to the retromolar area [11-12].

Based on the described theories and research results regarding bone thickness and density, a Kruskal-Wallis significance test was performed on more than two independent groups to determine whether there is a difference in the mean values of brightness and contrast in each region. However, Table 4 shows there is no significant difference in the mean values in the lower and upper limits of brightness or contrast in each region. This may be due to the distribution of samples in each disproportionate region. To be generalized, this study has weaknesses in that the number of research samples was limited, the numbers of samples in each region were not proportional, and the results of digitized radiographs are not the same as digital radiographs that use digital devices.

Further advanced research is required that uses larger sample quantities; primary data with the same radiograph manufacturing conditions; a proportional number of samples in each region; comparisons between apical granulomas and cysts; other image enhancement tools in addition to brightness and contrast, such as sharpness, highlight, inversion, level, exposure, curve, and saturation; and samples of digital radiographs obtained from other digital devices.

4. Conclusion

From this study's results, it can be concluded that the tolerable values in brightness adjustment for the interpretation of chronic apical abscesses and apical granulomas range from -10 to +10, and the tolerable range of values in the contrast setting ranges from -10 to +10. Therefore, the brightness and contrast adjustments of the radiograph did not affect the radiographic interpretation of chronic apical abscesses and apical granulomas when the adjustments were made within the tolerance range.

References

- [1] Chazel J-C and Mafart B 2004 Apical Lesions. *Br. Dent. J.* **196** 2-3.
- [2] Vier F V and Figueiredo J 2002 Prevalence of different periapical lesions associated with human teeth and their correlation with the presence and extension of apical external root resorption. *Int. Endod.* **35** 710-9.
- [3] Pharoah M J and White S C 2009 *Oral Radiology: Principles and Interpretation*. 6th ed. (California: Mosby Elsevier).
- [4] Fernandes M and Ataide I D 2010 Non-surgical Management Of a Large Periapical Lesion Using A Simple Aspiration Technique: A Case Report. *Int. Endod. J.* **43** 536-42.
- [5] Suyambukesan S, Perumal G C L, Pandian E S N J and Manigandan T 2013 Analyzing periapical lesions on intraoral periapical radiographs: incongruity in diagnosis. *J. Indian. Acad. Oral Med. Radiol.* **25** 5-9.
- [6] Raitz R, Assunção Junior J N R, Fenyo-Pereira M, Correa L and de Lima L P 2012 Assessment of using digital manipulation tools for diagnosing mandibular radiolucent lesions. *Dentomaxillofac. Radiol.* **41** 203-10.
- [7] Kullendorff B and Nilsson M 1996 Diagnostic accuracy of direct digital dental radiography for the detection of periapical bone lesions. II. Effects on diagnostic accuracy after application of image processing. *Oral. Surg. Oral. Med. Oral. Pathol. Oral Radiol. Endod.* **82** 585-9.
- [8] Choi J-W, Han W-J and Kim E-K 2014 Image enhancement of digital periapical radiographs according to diagnostic tasks. *Imaging Sci. Dent.* **44** 31-5.
- [9] Ting N A, Broadbent J M and Duncan W J 2013 Dental Radiography in New Zealand: Digital versus Film. *N. Z. Dent. J.* **109** 107-14.
- [10] Güneri P and Lomçali G 2005 The effects of incremental brightness and contrast adjustments on radiographic data: a quantitative study. *Dentomaxillofac. Radiol.* **34** 20-7.
- [11] Borges M S and Mucha J N 2010 Bone density assessment for mini-implants positioning. *Dental Press J. Orthod.* **15** e1-9.
- [12] Park H-S, Lee Y-J, Jeong S-H and Kwon T-G 2008 Density of the alveolar and basal bones of the maxilla and the mandible. *Am. J. Orthod. Dentofac. Orthop.* **133** 30-7.
- [13] Chugh T, Ganeshkar S V, Revankar A V and Jain A K 2013 Quantitative assessment of interradicular bone density in the maxilla and mandible: implications in clinical orthodontics. *Prog. Orthod.* **14** 38.
- [14] Lim J E, Lee S J, Kim Y J, Lim W H and Chun Y S 2009 Comparison of cortical bone thickness and root proximity at maxillary and mandibular interradicular sites for orthodontic mini-implant placement. *Orthod. Craniofacial Res.* **12** 299-304.
- [15] Rere L M R, Fanany M I and Murni A 2015 Adaptive de based on chaotic sequences and random adjustment for image Contrast Enhancement. Proceedings - 2014 International Conference on Advanced Informatics: Concept, Theory and Application. *ICAICTA*. **2014** 220-5.