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Influence of brightness and contrast adjustment on the detection of soft tissue calcifications in panoramic radiographs

Influência do ajuste do brilho e do contraste na detecção de calcificações em tecidos moles nas radiografias panorâmicas

Felipe Fernandes Peixoto Monteiro[1], Beatriz Caio Felipe[2*], Matheus Herreira Ferreira[3], Gustavo Nascimento de Souza Pinto[4], Mariliani Chicarelli da Silva[5], Lilian Cristina Vessoni Iwaki[5]

[1]Paraíso do Norte, PR, Brazil.

[2]Piracicaba Dental School, University of Campinas - FOP/UNICAMP, Piracicaba, SP, Brazil.

[3]Bauru School of Dentistry, University of São Paulo - FOB/USP, Bauru, SP, Brazil.

[4]Positivo University Londrina, Londrina, PR, Brazil.

[5]State University of Maringá - UEM, Maringá, PR, Brazil.

*biacaiofelipe10@gmail.com

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ABSTRACT

The aim of this study was to assess how changes in the adjustment of brightness and contrast settings affect the detection of calcifications in the soft tissues of the head and neck region on panoramic radiographs (PRs), taking into account the experience of Dental Radiology and Imaging professionals. A total of 2.661 RPs were evaluated, of which 53, whose images suggested the presence of different types of soft tissue calcifications, were selected and placed in different files (folders) with different changes in the brightness and contrast, including (V1) -30% brightness and +30% contrast; (V2) -15% brightness and -15% contrast; (V3) original image; (V4) +15% brightness and -15% contrast. Thus, a total of 212 images were obtained. Six volunteer dentists evaluated the radiographs, looking for suggestive images of soft tissue calcifications, divided into two groups: (1) evaluators with one to five years of experience and (2) evaluators with over five years of experience in the field. As a result, group 1 found it easier to detect calcifications in folder V3 compared to folder V4 (p=0.006), while group 2 detected more alterations in folder V1 compared to all others (p=0.000). It is important to consider different image modifications when assessing PRs to detect soft tissue calcifications, and the dentist's experience can influence the choice of the best brightness and contrast level settings for diagnostic purposes. The study highlights the importance of enhancing radiographic interpretation for a more accurate and effective diagnosis.

Keywords: Atheroma. Diagnostic imaging. Panoramic radiography.

RESUMO

Este trabalho objetivou avaliar como as alterações do ajuste da configuração de brilho e de contraste afetam a detecção de calcificações em tecidos moles da região de cabeça e pescoço em radiografias panorâmicas (RPs), levando em consideração a experiência dos profissionais em Radiologia Odontológica e Imaginologia. Foram avaliadas 2.661 RPs, em que 53, cujas imagens sugestivas da presença de diferentes tipos de calcificações em tecidos moles, foram selecionadas e inseridas em diferentes arquivos (pastas) com diferentes alterações de brilho e de contraste, sendo (V1) -30% de brilho e +30% de contraste; (V2) -15% de brilho e -15% de contraste; (V3) imagem original; (V4) +15% de brilho e -15% de contraste. Assim, resultou-se o total de 212 imagens. Seis dentistas voluntários avaliaram as radiografias, procurando por imagens sugestivas de calcificações de tecidos moles, divididos em dois grupos: (1) avaliadores com um a cinco anos de experiência e (2) avaliadores com mais de cinco anos de experiência na área. Como resultados, observou-se que o grupo 1 teve mais facilidade de detecção de calcificações na pasta V3 em comparação à pasta V4 (p=0,006), enquanto o grupo 2 detectou mais alterações na pasta V1 em comparação com todas as outras (p=0,000). É importante considerar diferentes modificações na imagem ao avaliar RPs para detectar calcificações em tecidos moles, ainda, a experiência do cirurgião-dentista pode influenciar na escolha das melhores configurações de níveis de brilho e de contraste para fins diagnósticos. O estudo ressalta a importância de aprimorar a interpretação radiográfica para um diagnóstico mais preciso e efetivo.

Palavras-chave: Ateroma. Diagnóstico por imagem. Radiografia panorâmica.

INTRODUCTION

The incidence of soft tissue calcifications, which are common in the maxillofacial region, is found in approximately 19% of panoramic radiographs (PRs) (Sutter et al., 2018). Among these calcifications, the most commonly detected are calcified atheromas of the carotid artery, calcified lymph nodes, tonsilloliths, anthroliths, rhinoliths, sialoliths, phleboliths and calcification of the stylohyoid ligament (Garay, Netto & Olate, 2014; Takahashi et al., 2017).

PR is an imaging modality frequently requested by dental surgeons, since it covers the teeth as a whole, maxilla, mandible, and adjacent structures. Despite this, this exam has limitations, such as overlap and difficulty in visualizing structures with low contrast differentiation. Even so, the breadth of structures encompassed by the examination makes it suitable for locating different calcifications in soft tissues (Gonçalves et al., 2016).

Therefore, PRs are able to identify a variety of calcifications, including calcified atheroma of the carotid artery, which consists of calcified atheromatous plaques that can lead to cerebrovascular accidents (Nasseh & Aoun, 2018; Maia, Tomaz, Maia, Lima & Oliveira, 2022). Although it can be asymptomatic, this condition can be detected early in PRs, as long as the dental surgeon and radiologist are attentive to images suggestive of this lesion. It is therefore important that the patient is referred to a cardiologist for appropriate treatment (Nasseh & Aoun, 2018).

With the advent of digital imaging and its more routine use in Dentistry, the quality of diagnoses of two-dimensional (2D) images has improved. The image software available today allows for greater accuracy in diagnosis and the possibility of adjusting the image after processing (Sabarudin & Tiau, 2013). Thus, brightness and contrast are the most commonly used adjustments among radiologists, both in scientific and clinical settings, being a subjective factor for each examiner (Kamburoğlu, Barenboim & Kaffe, 2008; Rovaris et al., 2016). Additionally, studies indicate that the level of professional experience can influence the use of diagnostic tools in images (Madarati, 2020).

Brightness and contrast adjustments have been used to assist in the diagnosis of dental caries (Nascimento et al., 2018), the detection of different anatomical structures (Oshagh et al., 2013), and even in the diagnosis of soft tissue calcifications (Moreira-Souza et al., 2019).

Therefore, the aim of the present study was to evaluate the frequency of soft tissue detection in PRs, using different brightness and contrast scales, by professionals with varying levels of experience in the field of Dental Radiology and Imaging.

MATERIALS AND METHODS

Ethics Committee

This study was submitted to and approved by the Permanent Committee of Ethics in Research Involving Human Subjects of the State University of Maringa (UEM) (CAAE: 45842820.9.0000.0104).

Sample

All the PRs were produced by the same team of specialists in Dental Radiology and Imaging, using the Orthopantomograph® OP300 equipment (Instrumentarium, Finland), with a standardized protocol (66 kVp, 8-10 mA, 16 seconds), and belonging to the Dental Radiology and Imaging Clinic of the State University of Maringa (UEM). A professional with more than five years' experience in dental radiology and imaging evaluated all the RPs performed between January 2017 and March 2020, totaling 2.661 RPs.

All radiographs of patients under 18 years of age were excluded from the study, as well as patients with craniofacial syndromes and/or anomalies and factors that could impair the diagnosis, such as artefacts and/or incorrect patient positioning.

Image acquisition

The patients were properly positioned with their heads fixed using the device's own apparatus, ensuring that the median sagittal plane was perpendicular to the horizontal plane and that the Frankfurt Plane remained parallel to this horizontal plane.

Brightness and contrast analysis

All images were exported in TIFF format and analysed using the public domain software JPEGView Portable 1.0.37.

The radiographs were evaluated by six volunteer dental surgeons with different levels of experience in the field of Dental Radiology and Imaging. The volunteers were then divided into two groups according to their level of experience: group 1 - three evaluators with one to five years of experience; group 2 - three evaluators with more than five years of experience in the field.

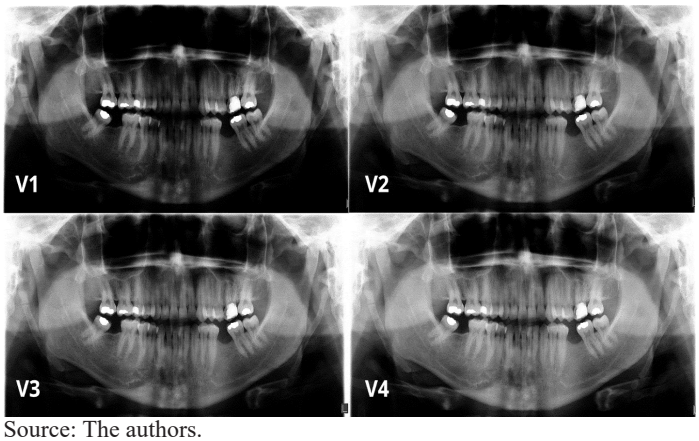
Among the 2.661 PRs present in the database of the UEM Dental Clinic, there were 150 PRs that showed images suggestive of the presence of different types of calcifications in soft tissues, based on the diagnostic criteria and in accordance with the studies of Carter (2000), Mori et al. (2011), Ribeiro et al. (2018) and Moreira-Souza et al. (2019). The images suggestive of calcifications observed were: sialoliths; tonsiloliths; calcified carotid artery atheromas; phleboliths; rhinoliths; antroliths; calcifications of the stylohyoid ligament; calcified lymph nodes; calcifications of the triticeous cartilage; calcifications of the thyroid cartilage; and synovial chondromatosis.

Of these 150 radiographs, 53 PRs were selected to form part of the final sample of this study and were evaluated in four different scales of brightness and contrast by all the evaluators. This quantity of 53 PRs was determined by sample calculation (GPower 3.1, Germany; significance level at 5%, power = 80%, and medium effect size = 0.5). The images were presented to the evaluators according to the paper by Nascimento et al. (2018), in which they underwent predefined brightness and contrast alterations, resulting in three different variations and the original image.

These images were made available to the evaluators in different folders of a digital file. These folders contained the altered images as described below: (V1) -30% brightness and +30% contrast; (V2) -15% brightness and -15% contrast; (V3) original image; and (V4) +15% brightness and -15% contrast, totaling 212 resulting images (Figure 1). After 30 days, 20% of the sample was randomized and screened for reassessment and assessment reproducibility.

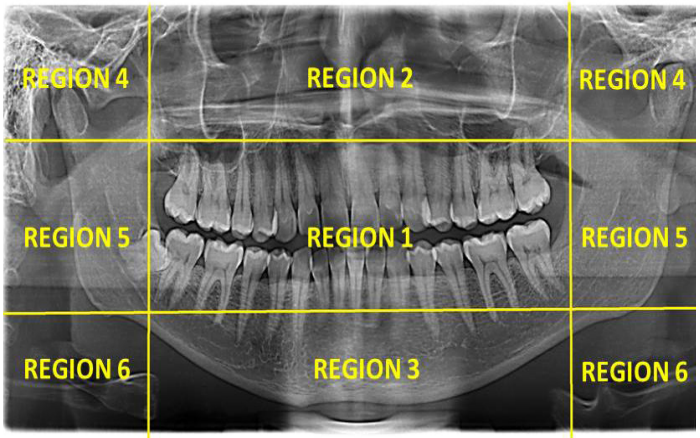
The evaluators categorized and signaled the presence of calcifications in the PRs. All evaluations were conducted in a low-light environment and on a computer with Microsoft Windows XP Professional SP-2 operating system (Microsoft Corp., Redmond, WA, USA), featuring an Intel® Core™ 2 Duo 1.86 GHz-6300 processor (Intel Corporation, USA), NVIDIA GeForce 6200 turbo cache graphics card (NVIDIA Corporation, USA), and EIZO - S2000 FlexScan monitor, with a resolution of 1600 × 1200 pixels (EIZO Nanao Corporation, Hakusan, Japan).

Figure 1
Brightness and contrast adjustments in panoramic radiography.



Source: The authors.
Note. (V1) -30% of brightness and +30% of contrast; (V2) -15% of brightness and -15% of contrast; (V3) original image and (V4) +15% of brightness and -15% of contrast.

Figure 2
Panoramic radiography divided in the regions of interest to visualize soft tissue calcifications.



Source: The authors.

The PRs were divided into six different regions that were statistically analysed individually (Figure 2) (Sabarudin & Tiau, 2013). The regions were determined as: region 1, which shows the dentition; region 2, which shows the nasal cavity and maxillary sinuses; region 3, which shows the body of the mandible; region 4, which shows temporomandibular articulations; region 5, which shows the mandibular ramus and often the vertebrae; region 6, which shows the hyoid bone (Sabarudin & Tiau, 2013).

Statistical analysis

For the statistical analysis, the SPSS® software version 26.0 (IBM Corp) was used, with a significance level of 5%. The Cochran's Q test was applied to compare the frequency of detection of soft tissue calcifications in relation to the different brightness and contrast values and, when significant, the Tukey *post hoc* test was applied to determine where the difference occurred. The Kappa test was used to determine the degree of inter-examiner agreement per group, based on Landis and Koch's criteria (1997): <0 indicating no agreement; 0-0.20 indicating poor agreement; 0.21-0.40 indicating fair agreement; 0.41-0.60 indicating moderate agreement; 0.61-0.80 indicating substantial agreement; and 0.81-1.00 indicating an excellent agreement.

RESULTS AND DISCUSSION

The inter-examiner agreement was assessed using the Kappa test (Landis & Koch, 1977) and showed results indicating substantial to excellent agreement between the examiners in both groups, 1 and 2 (Table 1).

Table 1
Kappa test to evaluate the inter-examiner agreement.

	Interaction	Kappa value	P value
Group 1	Evaluator 4 x Evaluator 5	0.648	p=0.001
	Evaluator 4 x Evaluator 6	1.000	p=0.001
	Evaluator 5 x Evaluator 6	0.648	p=0.001
Group 2	Evaluator 7 x Evaluator 8	0.648	p=0.001
	Evaluator 7 x Evaluator 9	1.000	p=0.000
	Evaluator 8 x Evaluator 9	0.648	p=0.001

Source: The authors.

In group 1, statistically significant differences were found in the identification of the following alterations: sialoliths, atheroma, antrolith, calcification of the stylohyoid ligament, calcification of the triticeous cartilage, and calcification of the thyroid cartilage (Table 2). In the identification of the presence of all alterations, significant differences were also found, in which, in the V3 folder (original image), more alterations were found than in V4 folder (+15% brightness and -15% contrast).

Also in group 1, for sialoliths, more alterations were noticed in the V1 (-30% brightness and +30% contrast) and V2 (-15% brightness and -15% contrast) folders, when compared to the V4 folder. On the other hand, for the identification of the atheroma, in the V1 folder, the volunteers found more calcifications in relation to the V3 folder (Table 2).

The volunteers found it easier to identify antroliths in the V4 folder when compared to the others. As for calcification of the stylohyoid ligament, they reported that it was easier to identify alterations in folder V3 compared to the other folders (Table 2). The volunteers had no difficulty to identify changes related to calcifications of the triticeal cartilage in the V3 folder compared to the V1 folder. Regarding the calcification of the thyroid cartilage, more alterations were found in the V2 folder compared to the V3 folder (Table 2).

Furthermore, in group 1, it is possible to observe in Table 3 that all dental surgeons identified calcifications more easily in region 5 when analysing the original images (V3 folder) compared to the other folders.

For group 2, composed of evaluators with more than five years of experience in the field of dental radiology, statistically significant differences were found for the following alterations: sialoliths, atheromas, antroliths, calcifications of the stylohyoid ligament, calcifications of the triticeal cartilage, and synovial chondromatosis (Table 4).

Table 2
Overall frequency and change in the detection of soft tissue calcifications by group 1 in the different changes in brightness and contrast.

	V1	V2	V3	V4	P value
Presence	134 (84.3%)	131 (82.4%)	143 (89.9%)[a]	126 (79.2%)[a]	p=0.006*
Sialoliths	19 (11.9%)[a]	15 (9.4%)[b]	8 (5.0%)	2 (1.3%)[a,b]	p=0.000*
Tonsiloliths	14 (8.8%)	13 (8.2%)	16 (10.1%)	20 (12.6%)	p=0.099
Atheroma	21 (13.2%)[a]	11 (6.9%)	4 (2.5%)[a]	11 (6.9%)	p=0.000*
Phlebolith	1 (0.6%)	0 (0.0%)	0 (0.0%)	1 (0.6%)	N/A
Rhinolith	0 (0.0%)	1 (0.6%)	1 (0.6%)	0 (0.0%)	p=0.572
Antrolith	1 (0.6%)[a]	2 (1.3%)[b]	1 (0.6%)[c]	15 (9.4%)[a,b,c]	p=0.000*
Calcification of the stylohyoid ligament	60 (37.7%)[a]	62 (39.0%)[b]	84 (52.8%)[a,b,c]	62 (39.0%)[c]	p=0.000*
Calcified lymph node	3 (1.9%)	4 (2.5%)	3 (1.9%)	4 (2.5%)	p=0.861
Calcification of the triticeous cartilage	31 (19.5%)[a]	41 (25.8%)	52 (32.7%)[a]	43 (27.0%)	p=0.001*
Calcification of the thyroid cartilage	27 (17.0%)	35 (22.0%)[a]	19 (11.9%)[a]	24 (15.1%)	p=0.007*
Synovial chondromatosis	3 (1.9%)	3 (1.9%)	4 (2.5%)	3 (1.9%)	p=0.896

Source: The authors.
Note. *Considered significant if p<0.05; a, b, c Tukey post hoc test; V1: alteration of -30% brightness and +30% contrast; V2: alteration of -15% brightness and -15% contrast; V3: original images; V4: alteration of +15% brightness and -15% contrast.

Table 3
Overall frequency of detection of soft tissue calcifications by group 1 in the different changes in brightness and contrast in the regions evaluated.

	V1	V2	V3	V4	P value
Region 1	0 (0.0%)	1 (0.6%)	0 (0.0%)	0 (0.0%)	p=0.392
Region 2	4 (2.5%)	2 (1.3%)	2 (1.3%)	0 (0.0%)	p=0.261
Region 3	1 (0.6%)	0 (0.0%)	2 (1.3%)	2 (1.3%)	p=0.194
Region 4	2 (1.3%)	3 (1.9%)	4 (2.5%)	3 (1.9%)	p=0.682
Region 5	75 (47.2%)[a]	78 (49.1%)[b]	97 (61.0%)[a,b,c]	80 (50.3%)[c]	p=0.000*
Region 6	81 (50.9%)	81 (50.9%)	71 (44.7%)	77 (48.8%)	p=0.264

Source: The authors.
Note. *Considered significant if p<0.05; a,b,c Tukey post hoc test; V1: -30% brightness and +30% contrast alteration; V2: -15% brightness and -15% contrast alteration; V3: original images; V4: +15% brightness and -15% contrast alteration.

Moreover, it was possible to observe a significant difference in the ability to identify the presence of any alteration, since the dental surgeons found more calcifications in the V1 folder compared to the others, meaning that the evaluators had

an easier time finding the alterations when the brightness and contrast adjustment were at -30% brightness and +30% contrast.

As for the alterations assessed separately, it was possible to noticed that more sialoliths were found in the V1 folder, while more alterations were found in the V4 folder than in the V3 folder when identifying atheromas. Regarding calcifications in the stylohyoid ligament, the volunteers found it easier to find this alteration in the V1 folder compared to the V4 folder (Table 4).

For the calcification of the triticeal cartilage, the volunteers noticed more alteration in the V1 folder when compared to the V3 folder. For synovial chondromatosis, more calcifications were found in V1 when compared to V4 folder (Table 4). This demonstrates greater ease to identify changes when the image was presented with -30% brightness and +30% contrast.

Table 4
Overall frequency and change in the detection of soft tissue calcifications by group 2 in the different brightness and contrast alterations.

	V1	V2	V3	V4	P value
Presence	131 (82.4%)[a,b,c]	75 (47.2%)[a]	70 (44.0%)[b]	75 (47.2%)[c]	p=0.000*
Sialolith	7 (4.4%)	3 (1.9%)	3 (1.9%)	5 (3.1%)	p=0.024*
Tonsilolith	23 (14.5%)	23 (14.5%)	19 (11.9%)	21 (13.2%)	p=0.412
Atheroma	18 (11.3%)	16 (10.1%)	12 (7.5%)[a]	22 (13.8%)[a]	p=0.015*
Phebolith	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	N/A
Rhinolith	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	N/A
Antrolith	4 (2.5%)	6 (3.8%)[a,b]	0 (0.0%)[a]	0 (0.0%)[b]	p=0.013*
Stylohyoid Ligament Calcification	50 (31.4%)[a]	48 (30.2%)	46 (28.9%)	40 (25.2%)[a]	p=0.020*
Calcified Lymph Node	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	N/A
Calcification of the Triteous Cartilage	31 (19.5%)[a]	24 (15.1%)	17 (10.7%)[a]	24 (15.1%)	p=0.009*
Calcification of the Thyroid Cartilage	30 (18.9%)	22 (13.8%)	20 (12.6%)	26 (16.4%)	p=0.097
Synovial Chondromatosis	4 (2.5%)[a]	2 (1.3%)	2 (1.3%)	0 (0.0%)[a]	p=0.046*

Source: The authors.
Note. *Considered significant if p<0.05; a,b,c Tukey post hoc test; V1: -30% brightness and +30% contrast alteration; V2: -15% brightness and -15% contrast alteration; V3: original images; V4: +15% brightness and -15% contrast alteration.

When analysing the PR regions, group 2 found more calcifications in region 6. It was found that in the V3 folder, which contained the original images, there were fewer changes observed compared to the other folders that contained images with different modifications in brightness and contrast (Table 5).

Based on the results of this study, it was possible to infer that the modification of brightness and contrast in radiographic images can significantly influence the detection of soft tissue calcifications in PRs. Additionally, dental surgeons with more experience in dental radiology tended to use these tools more adeptly.

It was found that dental surgeons with less experience in dental radiology and imaging tended to identify alterations more easily in the original images compared to the V4 folder, particularly in calcifications of the stylohyoid ligament and triticeal cartilage.

Table 5
Overall frequency of detection of soft tissue calcifications by group 2 in the different brightness and contrast changes in the evaluated regions.

	V1	V2	V3	V4	P value
Region 1	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	N/A
Region 2	4 (2.5%)	4 (2.5%)	0 (0.0%)	0 (0.0%)	p=0.046
Region 3	1 (0.6%)	1 (0.6%)	1 (0.6%)	1 (0.6%)	p=1.000
Region 4	4 (2.5%)	2 (1.3%)	2 (1.3%)	2 (1.3%)	p=0.112
Region 5	62 (39.0%)	58 (36.5%)	59 (37.1%)	55 (34.6%)	p=0.290
Region 6	86 (54.1%)[a]	71 (44.7%)[b]	63 (39.7%)[a,b,c]	80 (50.3%)[c]	p=0.000*

Source: The authors.
Note. *Considered significant if p<0.05; a,b,c Tukey post hoc test; V1: -30% brightness and +30% contrast alteration; V2: -15% brightness and -15% contrast alteration; V3: original images; V4: +15% brightness and -15% contrast alteration.

In addition, the evaluators identified more alterations in region 5 in the original images. Group 2, made up of dental surgeons with more than five years' experience in dental radiology and imaging, found that it was easier to identify different soft tissue calcifications in the V1 folder.

PR is an imaging exam widely used in dentistry, as it provides an overview of the teeth, maxilla, mandible and some adjacent structures. In these radiographs, radiographic findings such as soft tissue calcifications are often identified (Maia et al., 2022). Although it is not considered the gold standard for diagnosing these calcifications, its early identification can prevent more serious problems in many patients.

Upon identifying these changes, the dental surgeon can refer the patient for the gold standard test or to a physician if necessary (Maia et al., 2022). One of the calcifications that can be found first on panoramic radiographs is calcified atheroma of the carotid artery (Nasseh & Aoun, 2018; Maia et al., 2022).

This lesion may be related to atherosclerosis, which consists of the calcification of atheromatous plaques located in the carotid artery, which can detach and cause strokes. This condition may not be symptomatic and can be identified first in PR (Nasseh & Aoun, 2018). Thus, it is important to conduct studies investigating how the use of image enhancement tools can help in the diagnosis of such calcifications, often helping in their early diagnosis.

With the advent of digital dental radiology, various image acquisition software programs offer different features to help diagnose 2D images, such as RP. Among all the options, both in the scientific field and in clinical routine, brightness and contrast are the most common adjustments among radiologists. However, the perception of these factors is subjective and varies according to each examiner, which can impact the diagnosis of different alterations that present risks to the patients' health, such as calcified atheroma of the carotid artery (Kamburoğlu et al., 2008; Rovaris et al., 2016).

It is possible to find studies in the literature that evaluate how different levels of brightness and contrast in digital radiographs can affect the detection of various types of alterations in images, such as dental caries and soft tissue calcifications

(Nascimento et al., 2018; Moreira-Souza et al., 2019). Considering the identification of soft tissue calcifications in PRs, the use of tools that can help in the diagnosis can be extremely important for the dental surgeon and the dental radiologist.

In a study carried out by Moreira-Souza et al. (2019), it was evaluated how changes in brightness and contrast levels in RPs aided in the detection of calcifications. The results of this study showed that changing the brightness and/or contrast in the images can facilitate the detection of these changes (Moreira-Souza et al., 2019). This is in line with the results of this study, in which it was observed that more experienced evaluators find it easier to use digital image enhancement tools, such as altering different levels of brightness and contrast.

Another study carried out to evaluate the use of different digital image modification technologies by general dental surgeons and endodontists in endodontic treatment was carried out by Madarati (2020). The study found that dental surgeons specializing in the field prefer to use these diagnostic tools when interpreting images (Madarati, 2020). Although the research was carried out on endodontic cases, the results are consistent with the present work, indicating that specialized dental surgeons have a greater preference and ease in using digital image enhancement tools for diagnosis.

The detection of soft tissue calcifications in PRs is a crucial aspect in dental practice and can be affected by different levels of experience in Dental Radiology. Several studies emphasize the importance of the dental surgeon being able to identify these alterations in images, especially in cases of calcified carotid artery atheroma, in order to prevent serious problems for the patient (Nasseh & Aoun, 2018; Schroder et al., 2019; Maia et al., 2022). Additionally, there are research studies investigating how different learning methodologies can affect the diagnostic capability of dental surgeons (Felipe et al., 2020). This study contributes to the literature by demonstrating how different levels of experience in Dental Radiology can influence the detection of these alterations.

Other calcifications, such as calcification of the stylohyoid ligament, are associated with Eagle's syndrome, which is characterized by the association of the calcification image on imaging tests with symptoms, such as pain in the neck region, pain when yawning and turning the head sideways, as well as dysphagia and foreign body sensation (Badhey et al., 2017).

Similarly, sialolithiasis caused by obstruction of the salivary gland ducts by calcifications can cause symptoms such as pain, purulent saliva and swelling (Avishai, Ben-Zvi, Ghanaiem, Chaushu & Gilat, 2020). These conditions require the aid of imaging exams to finalize the diagnosis, so it is necessary to know about these changes in imaging exams, such as panoramic radiographs and different ways of manipulating these exams to better visualize them.

For some calcifications, such as sialolith, atheroma and thyroid cartilage calcification for group 1, and sialolith, thyroid cartilage calcification and tritix for group 2, it was found that the evaluators found them easier to detect in folders V1 and V2, which may be due to different experience and training. It is important to remember that each evaluator has their own perception and experience in analyzing radiographic images, which can lead to differences in preferences for brightness and contrast adjustments. It should be noted that although brightness and contrast adjustments can be useful in interpreting radiographic images, it is essential to consider the specific characteristics of each case and adjust the settings according to clinical needs.

One limitation of this study is that the volunteers were not divided into different groups from different dental specialties. Future studies that present this division could provide greater depth to the discussion proposed in this paper.

Furthermore, another limitation is that the evaluators' reports based on PRs were not compared with other imaging exams, considered gold standard for detecting soft tissue calcifications, such as cone beam computed tomography and ultrasonography. For this reason, the current study design does not assess the frequency or accuracy of the diagnosis of soft tissue calcifications, but is solely aimed at investigating how manipulation of brightness and contrast can influence the detection of calcifications in PRs, as well as observing the behaviour of dental surgeons with different levels of experience in Dental Radiology. This difference in experience can lead to different performances in the use of digital image enhancement tools for diagnosis.

CONCLUSION

These results highlight the importance of using different brightness and contrast modifications when evaluating RPs for the detection of soft tissue calcifications in the head and neck region. Furthermore, this study suggests that the experience of the dental surgeon can influence the choice of which modifications are most effective. It is therefore recommended that consideration be given to altering different brightness and contrast levels when interpreting PRs and that, depending on the experience of the evaluator, specific image modifications may be more effective in detecting soft tissue calcifications.

COMPETING INTERESTS

The authors declare that there are no conflicts of interest.

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The authors declare that they have no financial interests.

AUTHOR CONTRIBUTIONS

Conceptualization: L. C. V. I. *Data curation*: F. F. P. M. *Formal analysis*: F. F. P. M. *Investigation*: F. F. P. M. *Methodology*: G. N. S. P. *Project administration*: L. C. V. I. *Resources*: M. C. S. *Software*: M. H. F. *Supervision*: B. C. F. *Validation*: M. H. F. *Visualization*: M. H. F. *Writing the initial draft*: F. F. P. M. *Revision and editing of writing*: B. C. F.

PEER REVIEW

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