ORIGINAL RESEARCH

Utility Of Digital Image Manipulation In Diagnosis Of Radiolucent Lesions Of The Jaws

Rita Singh[1], Mohit Sharma[2]

ABSTRACT

Introduction: The interest in digital image processing methods has arisen from the recent possibility of improving the quality of visual information for human interpretation and the ease of communication. The need for the digital manipulation tools, has been inculcated, because it is thought that these tools have better efficacy for improving the visualization of the radiographic image and thus promote improved radiographic diagnosis. This study aims to assess the use of digital manipulation tools for image enhancement of radiolucent lesions of the jaws and its outcome on the radiographic diagnosis.

Materials and Methods: Twenty four panoramic radiographs exhibiting radiolucent lesions were selected, digitized and evaluated by experts as well as non-experts in oral radiographic diagnosis. All investigators made their evaluations without (T1) and with (T2) the use of digital image manipulation tools (contrast, brightness, sharpness, and zoom tools). The percentages of correct and incorrect diagnosis, according to the use of tools were compared.

Results: The most preferred tools were contrast and sharpness. In both the expert and non expert groups, the percentage of correct diagnoses after the use of manipulation tools, was not statistically significant (p=0.234 and 0.33 respectively). Expert group showed statistically significant agreement in correct diagnosis after using manipulation tools (k = 0.007) and non expert group showed no such agreement after using manipulation tools (k =0.155). The number of correct diagnoses made by non expert 2 actually decreased following the use of digital manipulation tools.

Conclusions: Use of digital manipulation tools may not play an important role in obtaining correct radiographic diagnosis. Further studies are warranted in this regard.

Keywords: Digital manipulation tools, sharpness, brightness.

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INTRODUCTION

The interest in digital image processing methods has arisen from the recent possibility of improving the quality of visual information for human interpretation and the ease of communication. Sometimes these digital images need a particular type of processing in order to correct some non-optimal exposures that may negatively interfere with the image of the lesion.[1]

The tools most often used in digital manipulation are brightness, contrast, density and zoom, and their use can improve image quality. The great challenge is to know which tools are useful and applicable to each diagnostic task in order to discard superfluous signs and stress useful signs in the images. There have been very few studies published for the role of digital manipulation in the radiographic diagnosis of jaw cysts and tumors.[1,2]

The need for these digital manipulation tools, has been inculcated, because it is thought that these tools have better efficacy for improving the visualization of the radiographic image and thus promote improved radiographic diagnosis.

MATERIAL AND METHODS

Selection of the radiographs: Three radiologists selected 24{selection of OPGS were also based on the outpatient number in the daily opd having multilocular radiolucencies/ similar number of radiographs were also used in the study by Raitz etal.[3]} conventional panoramic radiographs presenting radiolucent lesions with histological diagnosis (Ameloblastoma, KCOT, Dentigerous Cyst, Central Giant Cell Granuloma, Odontogenic Myxoma, Ossifying fibroma) during a period of 6 months (June 2014 – Jan 2015). These radiologists were not included in the group of examiners. These radiologists chose radiographs with representative radiographic aspects of each lesion group. Panoramic radiographs with good contrast, correct alignment in the film and image of the lesion without any interference were selected.

Digitization process

The 24 radiographs were placed on a light viewing box and photographed using an Olympus Camedia 2500-L digital camera (Olympus Optical Co. Ltd., Tokyo, Japan).The camera images were taken at the same camera–radiograph distance using a specially designed jig.

Identical illumination was used throughout with the radiographs placed at the same location on the light box. The digital camera images were saved as JPEG files.Digital images were loaded directly onto a HP 430 laptop.The images were opened using Olympus Camedia Master software and, for the digital cameras, converted to 256 grey scale.[3]

Analysis of digital images by examiners:

A group of non-experts comprising of two graduates and a group of experts comprising of specialists in oral medicine and radiology observed all the digital images using the same display under default settings.

Previously, all examiners received training about the use of image processing tools (brightness, contrast, inversion, sharpness, highlight and zoom). They were able to work with the interface when homogeneous repetition in the sequence of clicking on the tool icons was detected. After this training, the examiners randomly observed all the digital images using the same display under default settings (HP, LCD15 inch, 0.297 pixel pitch, 10246768 dpi resolution and constant luminance of 250 cdm21; Tokyo, Japan). At the end of the observation/ manipulation, the examiners selected one of the six diagnostic possibilities (Ameloblastoma, KCOT, Dentigerous Cyst, Central Giant Cell Granuloma, Odontogenic Myxoma, Ossifying fibroma). The proportion of each lesion in the sample was not revealed.

The examiners analysed the images at two distinct time intervals: first consulting a list of parameters containing objective radiographic criteria for the diagnosis of each lesion without the help of digital manipulation tools (T1) and then using both the parameters and the manipulation tools (T2) (Figure - 1,2).

The radiographic parameters were established. These parameters describe the characteristics of such lesions with regard to the patient's age, size and delimitation of the lesion, presence of a radio-opaque halo, dental and cortical involvement, presence of alterations in the jaw base, degree of radiolucency, growth pattern and margins of the lesion. The proportion of each lesion in the sample was not revealed. The examiners analyzed the images at two distinct time intervals of two weeks:

Diagnostic criteria were given at both the times.

During the analysis, a researcher recorded the frequency of use of digital tools. At the end of eachanalysis, the examiner selected the tool he considered the most important for the particular interpretation. Statistical analysis Frequencies of correct/non-correct diagnosis were crossed with use/non-use of each digital tool

STATISTICAL ANALYSIS

Frequencies of correct/non-correct diagnosis were crossed with use/non-use of each digital tool and the association between these variables was determined by Pearson's $\chi 2$ test.

The agreement of use/non-use at the two time intervals was measured using the kappa coefficient.

Calculations were performed using SPSS software (IBM Corporation, Armonk, NY). Statistical significance was determined when $p < 0.05$.

RESULTS

Out of 24 lesions studied by the non-expert group, 29.2% were correctly diagnosed by both of them without making use of digital manipulation tools. Out of 24 lesions studied by the expert group, expert 1 diagnosed 54.2% lesions correctly and expert 2 diagnosed 16.7 % lesions correctly without making use of digital manipulation tools.

Post digital manipulation, correct lesions diagnosed by non-expert 1 were 20.8%. Non- expert 2 diagnosed 33.3% of the lesions correctly.

Similarly, expert 1 diagnosed 58.3% lesions correctly and expert 2 gave correct diagnosis for 41.7% of the lesions (table-2).

The overall percentage of correct changes made in the diagnosis after using image manipulation tools in case of expert group are statistically insignificant ($p=0.248$ i.e., > 0.05).The non experts group too showed no significant improvement in results with the use of image manipulation tools ($p=0.330$ i.e., > 0.05).

Between two non experts, there is significant difference in the correct changes made after using manipulation tools ($p=0.020$ i.e.,< 0.005). The number of correct diagnoses made by non expert 2 actually decreased following the use of digital manipulation tools (table-2).

In the expert group most preferred digital enhancement tool was contrast and was used 62.5% of the times. Brightness was used 25% of the times for image manipulation by the expert group. In the non-expert group most preferred tool was sharpness and was used 58% of the times. Brightness and contrast were used 21% of the times for image manipulation.

	Location	Borders	Internal Structure	Effect On Surrounding Structures	Growth Pattern	Involvement Of Dental Elements
Ameloblastoma	Mandible-molar ramus region	Well defined with cortication. Ill defined in cases of maxilla	Coarse, curved septa. Larger-soap bubble Smaller – honey comb Larger loculation posterior mandible	Root resorption / teeth displacement common	vertical	May mimic dentigerous cyst Lesion does not originate from tooth, tooth encapsulate by the lesion
Kcot	Posterior body of mandible	Smooth round/ oval shaped / scalloped outline	Curved internal septa and hazy internals(keratin)	Tooth resorption lower than in amelo.	Along the internal aspect of the jaws (antero-posterior/ medullar)	May be related
Dentigerous Cyst	Mandibular/ maxillary 3rd molars, maxillary canine	Well defined cortex with curved or circular outline	Completely radiolucent except for the crown of tooth involved	Root resorption/ tooth displacem-ent apical	Bucco-lingual, may be expansive but less than amelo.	Circumferential, lateral, or in central position origin at CEJ.
Central Giant Cell Granuloma	Mand. Anterior to 1st molar Maxilla – anterior to cuspids	Well defined borders with no cortications	Ill defined wispy septa, (granular septa characteristics)	Resorption/ deviation of teeth noted.		
Ossifying Fibroma	Mand.-premolar/molar Maxilla-canine fossa and zygomatic arch	Well defined borders with thin radiolucent line separating from adjacent areas	Stretched tufts of cotton(wispy), heavy snowflakes(flocculant)			
Odontogenicmyxoma	Mandibular premolar/molar region m/c	Poorly defined	One or two straight thin septa(characteristic)	Deviation / no resorption	Grows along the involved bone	Scallops b/w the roots of adjacent teeth

Table-1 Diagnostic parameters[7,8,9]

DISCUSSION

The present study focused on the usability of digital tools by expert and non expert examiners in the analysis of radiolucent lesions of the jaws. The motive was to ascertain the effect of digital manipulation on the percentage improvement in the radiographic diagnosis by experts.

In addition, the non experts were also included to determine whether their radiographic diagnostic perception improved following digital manipulation. It was found that the use of digital tools associated with the consultation of radiographic parameters made no significant difference in the correct diagnosis for experts

This result is consistent with the results of other studies that demonstrated no effects of image manipulation on the efficiency of diagnosis by experienced readers.[2]

It was found that the use of digital tools associated with the consultation of radiographic parameters made no significant difference in the correct diagnosis for non-experts. However, this was in stark contrast to other studies that reported improvement in correct diagnosis of lesions by non-experts during image manipulation.[3] The choice of digital tool may be associated with the level of experience, as well as with the natural preferences of the eye. The human

	T1	T2	Total Changes	Correct Changes
Expert 1	13/24	14/24	04	01
Expert 2	04/24	10/24	15	09
Non Expert 1	07/24	08/24	09	03
Non Expert2	07/24	04/24	08	0

Table-2 – Number of correct diagnoses and changes made by each group(t1 without the use of manipulation tools, t2 with use of manipulation tools)

eye contains specialized neural cells devoted to the perception of edges. The sharpness filter accentuates the margin of the lesion, i.e. enhances the edges and removes noise so that the image becomes better suited to visual needs.[2-5]

Other aspects of the image, such as spatial resolution, may be more essential for the diagnosis of radiolucent lesions.To the human eye, spatial resolution depends on brightness and contrast.In the present study, a significantly high frequency of correct diagnoses was obtained using brightness/ contrast, in both the groups.[4]

One study demonstrated that decreased brightness and increased contrast causes some improvement in the diagnostic accuracy of periapical lesions.In the present study, the non-experts achieved successful diagnosis using this tool only after consulting the radiographic parameters, which indicates that this list influenced the adequate use of this tool.[3]

Digital zoom was used with relatively high frequency in comparison with the other tools, mainly by nonexperts. The property of this tool in the magnification of structures could contribute to its high preference in some studies.[3-6]

Furthermore, the application of this tool is more intuitive, which induces its use by inexperienced readers. However, it did not determine improvement in the frequency of correct diagnoses. Several lesions of this sample had a very large radiolucent image and perhaps the application of zoom negatively influenced the diagnosis, owing to the extreme magnification of the lesion.

CONCLUSION

The association of assessing radiographic parameters with use of some digital tools was important for improving the number of correct diagnoses. Contrast and brightness were the most preferred tools in expert group. In cases of Non experts the use of digital image manipulation tools can have a negative effect on the diagnostic outcome. As seen with non expert 2, the number of correct diagnoses made were decreased post digital manipulation. So further studies focusing on the perceptibility of digital images must be conducted in order to elucidate various aspects in the interpretation of diagnostic imaging.

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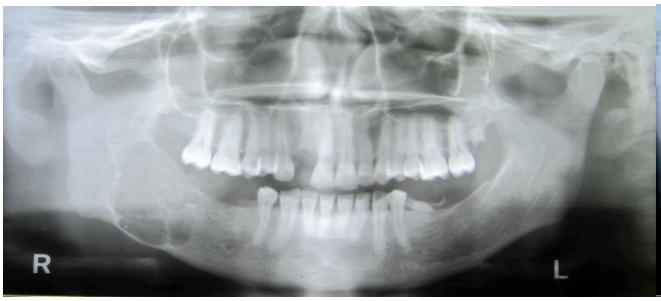

Figure-1: Digital image without manipulation

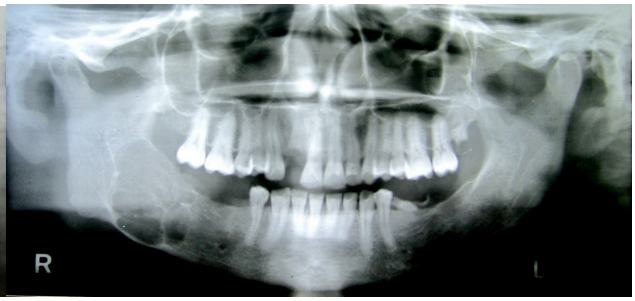

Figure-2: Digital image post –manipulation (decreased brightness and increased contrast)