

FRAUDULENT USE OF RADIOGRAPHIC IMAGES

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ABSTRACT

The aim of this study was to evaluate the ability of trained observers to identify altered radiographic images after modifications using an image-editing software. Based on implantology in 10 radiographs, eight panoramic and one linear tomograph were modified while one tomograph was untouched. Implants were placed or removed and bone levels were altered, and seventy dentists were invited to identify these alterations. The results showed that the percentage of the correct answers was 12.5% or 2 identifications per examiner. The rate of false positives in relation to correct answers was at a level of 6:1. We concluded that the professionals have difficulty in identifying altered radiographs after using an image-editing software and that the seriousness of this situation demands that dentists be warned of the dangers of the use and abuse of this technology. (*J Forensic Odontostomatol* 2002;20:25-30)

Key words: dental radiography; radiographic image enhancement; forensic dentistry

INTRODUCTION

Radiography is an important tool to dentists as it provides valuable information about internal dental and bony tissues, which would be inaccessible through clinical examination. It is therefore considered as the main, and sometimes the only means of exploring the details of a subject's jaws, including given treatment, and is useful when legal aspects regarding dentistry are considered.

Advances in radiographic technology have now led to digital imaging, first as the indirect method through digitized film and subsequently as the direct method, where digital sensors are substituted for film. The many advantages of digital radiography have led to a wide acceptance of this method by professionals, in agreement with some authors¹⁻³ who believe it has great potential for use in the clinical routine, doing away with the radiographic film within the next decades and on through the improvement and cost reduction of the digital systems.

The legal implications of digital radiography are however to be considered. Some authors have emphasized the seriousness of this issue,⁴⁻⁸ and agree that the original image can be altered when image-editing software is used. Diagnosis, prognosis and treatment plans can be completely modified in accordance with legal interests and in order to disguise iatrogenesis. Such alterations can be done specifically in an area of interest in the original image, by adding, subtracting or disguising dental materials, pathologies or even anatomical structures.

As a result of the rapid growth of implantology where some non-skilled professionals practise this speciality, and the resulting occasionally dissatisfied patients who have instituted lawsuits, we decided to undertake the present study in order to evaluate professionals' ability to identify altered images after using image-editing software. It was also intended to show dentists the potential dangers of computerized tools.

MATERIALS AND METHODS

Eight panoramic radiographs and two linear tomographs from the files of the Radiology Clinic at FOP-UNICAMP/BR were scanned into a computer in order to allow manipulation and analysis.

Those images were exported to an I-Omega zip drive* (100 MB storage device) in TIFF-8 BIT format and submitted to an image-editing software.** Nine out of 10 images in the study were modified, with the number of alterations ranging from 1 to 3 in each radiograph, totalling 15 manipulations, all concerned

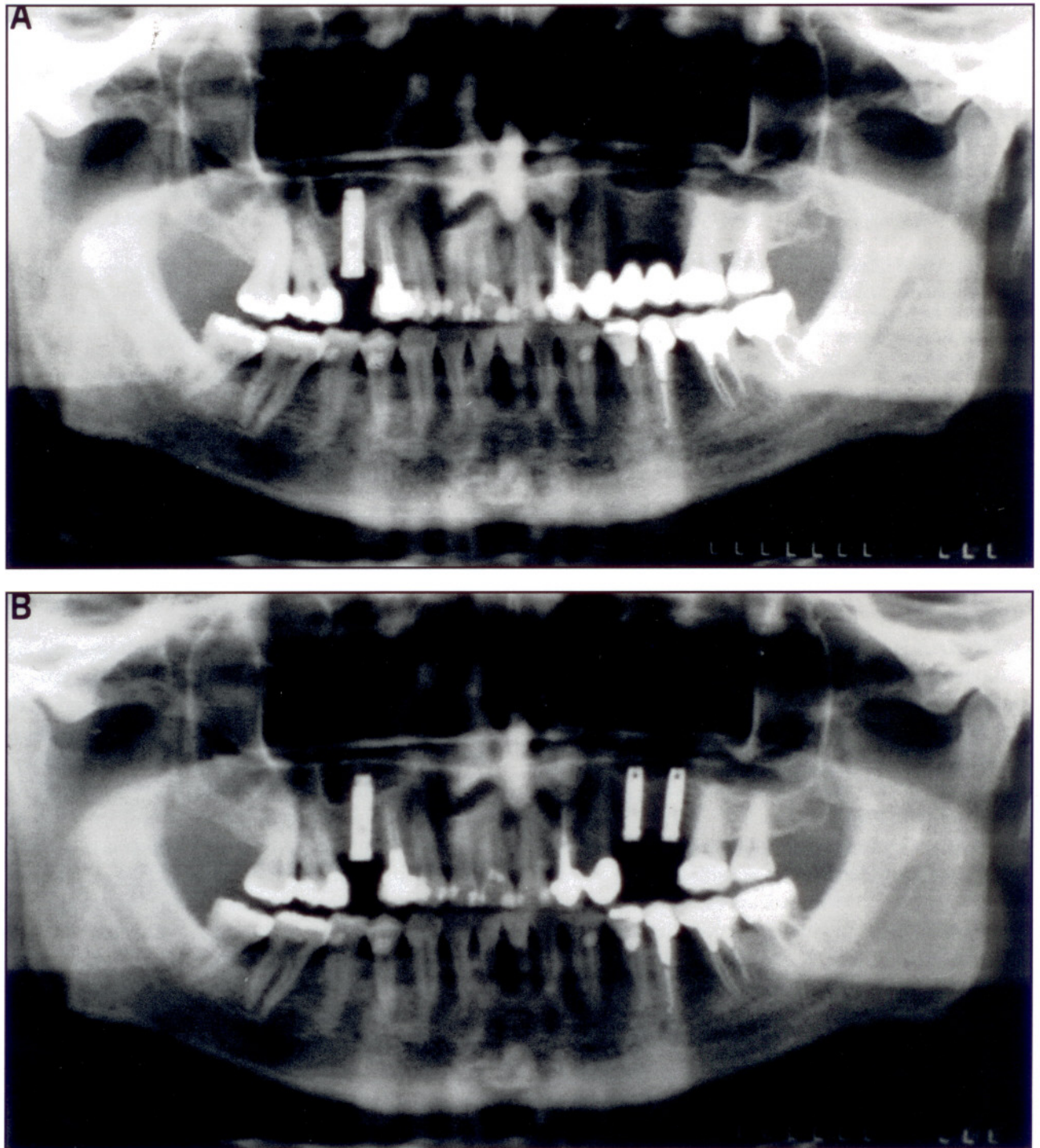


Fig.1: Original (A) and manipulated (B) images, showing the removal of a bridge in the left side of maxilla and replacement with two implants.

* Hewlett Packard Scanjet 4c/t, Vancouver, WA, USA.

** Corel Photo Paint 8, Corel Corporation, Ontario, Canada.

with implants. Dental implants were added, removed or displaced, bone levels were reduced or increased and prostheses or dental elements were eliminated to favour the placement of implants. All alterations were carried out by radiologists (Figs. 1 and 2).

Seventy dentists in different specialities, such as implantology, surgery, periodontology, radiology, prosthodontics and forensic dentistry were invited to identify the alterations in the images. The radiographs were analyzed on a computer monitor S-VGA, flat-screen, 17 inches, screen configuration

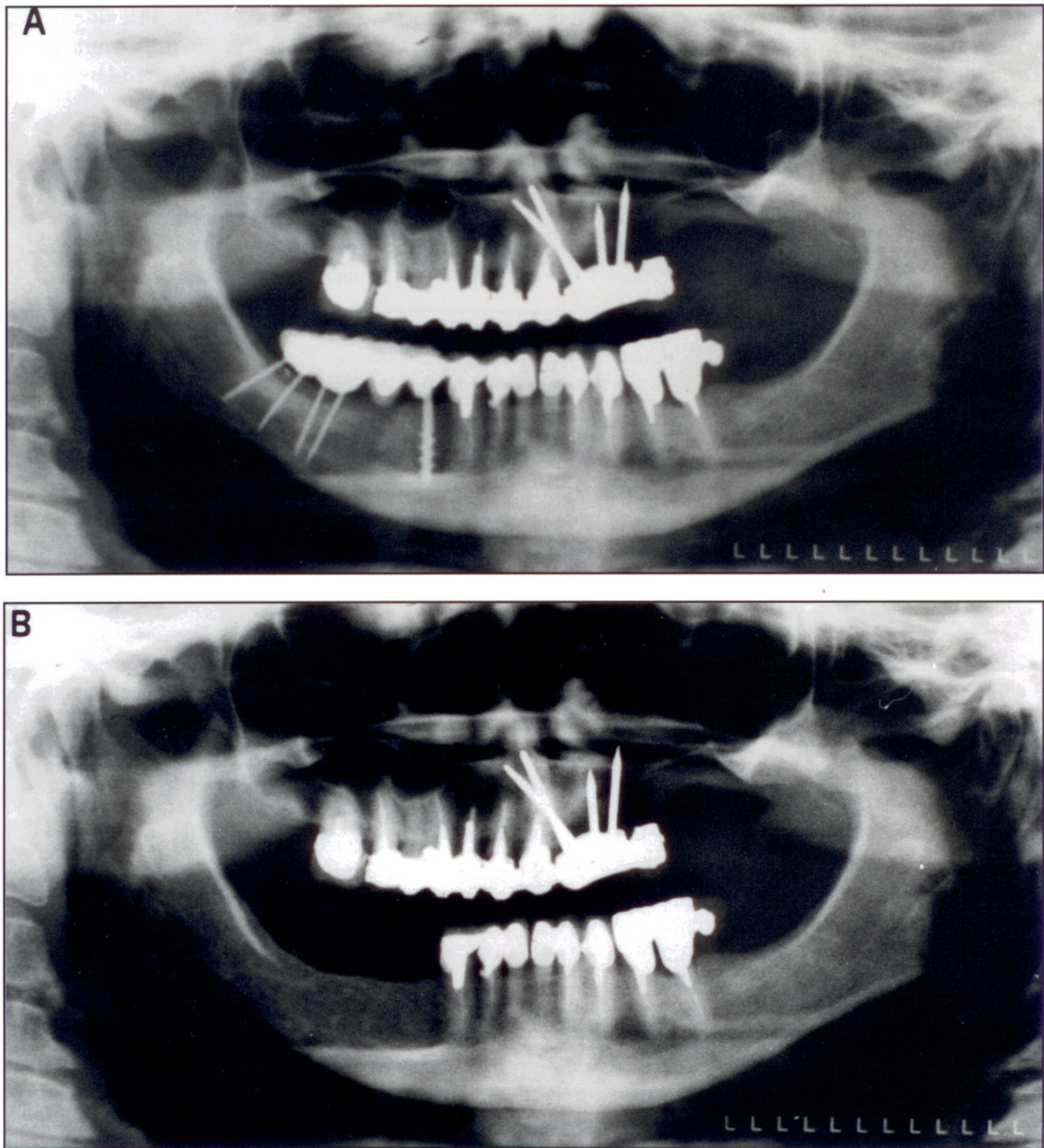


Fig.2: Original (A) and manipulated (B) images, showing the removal of implants in the right side of mandible.

of 1024 x 768 resolution pixels and using a Power Point 97[†] software. Two files were created: one containing the altered images, and another containing the original radiographs in the same sequence as in the first file. Each image was given an identification number (1 to 10), and they were analyzed individually because each slide in the file corresponded to a single radiograph that was exhibited on a black background. Using the "zoom" was permitted, as well as the "brightness and contrast" tool, for any examiner who considered that they needed to enhance the images. The lighting in the analysis room was dimmed.

Each observer received a questionnaire to record any identified alterations for each radiograph. After answering it both the original and the altered images were exhibited side by side so as to show the observers the manipulations that had been introduced and provide some information on the subject for them.

After the observations were concluded, an analysis of both correct true positive and false-positive (presumed, but non-existent manipulations) answers for each examiner was performed.

RESULTS

The radiographs and manipulations carried out are shown in Table 1. The manipulations that were more easily identified and also the ones that were missed are shown in Table 2, and it is evident that manipulations 15, 12 and 13 were more easily detected while manipulations 3, 5 and 14 were more difficult to detect.

The average percentage of correct answers was 12.5%, so it can be concluded that among the 15 manipulations performed and, added to the analysis of the radiograph which was not altered, the average of the correct answers per examiner was 2.0.

[†] Microsoft Corporation, California, USA

Table 1: Description of the manipulations carried out, and their identification and radiograph numbers

Radiographs number	Region	Manipulation number	Description
1	Maxilla	1	Change of bridge in two crowns
		2	Placement of implant in the area
2	Mandible	3	Implant removed
		4	Implant removed
3	Mandible	5	Removal of two pontics
		6	Placement of implant A
4	Maxilla	7	Placement of implant B
		8	Molar removed
5	Mandible	9	Placement of two implants
		10	Implant removed
6	Maxilla	11	Implant removed
		12	Bone level increase in the whole maxilla
7	Mandible	13	Bone level reduction in the whole mandible
		14	Bone level reduction
8	Maxilla	15	Placement of a screw to implant
		non-M	Without alteration
9	Tomograph	15	Placement of a screw to implant
		non-M	Without alteration
10	Tomograph	non-M	Without alteration
		non-M	Without alteration

non-M : non-manipulated - radiograph without manipulation.

Table 2: Numbers and average of examiners' correct answers in decreasing order, according to manipulation.

Manipulation	CA	%
15	47	67,1
12	15	21,4
13	12	17,1
2	11	15,7
9	9	12,8
10	8	11,4
6	7	10
non-M	6	8,5
4	6	8,5
7	5	7,1
11	5	7,1
1	4	5,7
8	3	4,2
3	1	1,4
5	1	1,4
14	1	1,4

non-M : radiograph without manipulation.

CA : correct answers.

The number of false positives for each examiner was calculated and an average of 12.3 observations for each observer noted. That was done in order to verify the number of presumed but non-existent manipulations which means the rate of false positives in relation to correct answers was at a level of 6:1.

DISCUSSION

The use of computers in dentistry is routine for countless professionals who enjoy their benefits. It is common for them to exchange simultaneous information, such as sending radiographs of patients, by Internet. The same is true regarding insurance companies, when authorizations for treatment are requested, and this useful and practical service is used.

The computer monitor has been used to display radiographic images directly which is appropriate for digital radiography, and furthermore provides good conditions for analysis.

The results of this study show that professional observers, in agreement with the studies of other authors,^{4,8} fail to identify alterations such as removed, added or displaced implants and reduced or increased bone levels in radiographs, proving that negligence and malpractice can be disguised in radiographic images which may compromise the legal reliability of this technology. This matter would not be of such importance if all dentists were honest, but unfortunately there will always be those who unscrupulously seek personal interests, not only in dentistry, but also in other professional areas.

The wide range of correct answer rates was no doubt owing to some manipulations being easily identifiable while some were not. Considering that the alterations were performed by dental radiologists, not by computer scientists, it was concluded that the present study shows that alterations can be performed to simulate all levels of difficulty, and it is likely that the more skilled in image editing software the professional who performs the alterations is the higher the difficulty to identify them can be.

Previous studies⁴⁻⁸ have warned that the radiographic equipment industry should be aware of the seriousness of this situation, and that image protection mechanisms should be developed to eliminate the problem of digital radiography image manipulation, also safeguarding professionals and insurance companies. This problem has not been solved yet however a possible solution would be to print the digital images at the moment they were acquired as it happens to the tomographs and magnetic resonance images.

In conclusion, the results of this study have shown that professionals have difficulty in identifying altered radiographs, the seriousness of which demands that dentists be warned of the dangers of the use and abuse of this technology.

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