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Assessment of digital panoramic radiograph magnification on vertical measurement accuracy in posterior mandibular regions

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Abstract
Panoramic radiography is often the first choice method for the placement of implants because it provides information on the overall shape of the jaws, the position of the maxillary sinus floor and the nasal cavity floor, and the proximal distal as well as vertical position of the mandibular canal and the mental foramen. The measurements on digital radiography are quite acceptable and reliable for clinical use as long as the structures do not traverse the midline. Repeated measurements lead to a reduction in the systematic error and magnification to a loss of accuracy.
The study was planned on the Department of Dentistry Anugrah Narayan Magadh Medical College and Hospital, Gaya.on 30 implants in the posterior mandibular regions. The digital panoramic radiographic images were taken using implants in the posterior mandibular regions. The digital panoramic radiographic equipment used. All digital panoramic radiographs were taken by technicians according to standard protocol provided by the manufacturer.
This study is aimed to determine the accuracy of the vertical and horizontal measurements on digital panoramic radiographic images using implants in the posterior mandibular regions.

Keywords: panoramic radiography, implant, dental, etc

Introduction
The mandible, lower jaw or jawbone is the largest, strongest and lowest bone in the human face. It forms the lower jaw and holds the lower teeth in place. The mandible sits beneath the maxilla. It is the only movable bone of the skull (discounting the ossicles of the middle ear). The bone is formed in the fetus from a fusion of the left and right mandibular prominences, and the point where these sides join, the mandibular symphysis, is still visible as a faint ridge in the midline. Like other symphyses in the body, this is a midline articulation where the bones are joined by fibrocartilage, but this articulation fuses together in early childhood.
The body of the mandible is curved, and the front part gives structure to the chin. It has two surfaces and two borders. From the outside, the mandible is marked in the midline by a faint ridge, indicating the mandibular symphysis, the line of junction of the two pieces of which the bone is composed at an early period of life. This ridge divides below and encloses a triangular eminence, the mental protuberance, the base of which is depressed in the center but raised on either side to form the mental tubercle. On either side of the symphysis, just below the incisor teeth, is a depression, the incisive fossa, which gives origin to the mentalis and a small portion of the orbicularis oris. Below the second premolar tooth, on either side, midway between the upper and lower borders of the body, is the mental foramen, for the passage of the mental vessels and nerve. Running backward and upward from each mental tubercle is a faint ridge, the oblique line, which is continuous with the anterior border of the ramus; it affords attachment to the depressor labii inferioris and depressor anguli oris; the platysma is attached below it [1-4].
The use of implants has reached a place of distinction in dentistry and provides a safe alternative for conventional prosthetic rehabilitations. Clinical success in oral rehabilitation depends on a thoroughly pre-surgery evaluation concerning implant location, which allows identifying possible bone alterations, location of anatomical structures, and support quality and amount of available bone tissue [5-6].
Several imagining techniques have been investigated, ranging from conventional intraoral radiographs to the most advanced digital imaging methods, such as computed tomography (CT). Images generated either conventionally or digitally must allow acquiring measurements that reproduce the real conditions in order to determine whether there is sufficient alveolar bone structure for implant placement without causing damage to vital structures [7].
Panoramic radiography is a very popular and most widely accepted that conveniently provides the clinician with a comprehensive view of maxillofacial complex with relatively reduced radiation dose. However, the limitation being is its inability to confirm the dimensions of the structures shown on the radiographs correspond to real dimensions of the exposed structures. The inherent property of panoramic radiographs is magnification and distortion. Distance of the object between the X-ray source and film is responsible for the magnification of the filmed structures.

Panoramic radiography is often the first choice method for the placement of implants because it provides information on the overall shape of the jaws, the position of the maxillary sinus floor and the nasal cavity floor, and the proximal distal as well as vertical position of the mandibular canal and the mental foramen. In addition, it provides information on the presence or absence of residual dental roots or asymptomatic lesions in the dental root apex, lesions within the bone, the interval between remaining teeth, etc [8].

However, the sophisticated imaging systems are still restricted to large urban centers. The high cost of exams, the need of trained dentists for interpretation of complex images, and the elevated radiation dosages from CT procedures lead the surgeon to elaborate a clinical planning based on conventional radiographic images.

This study is aimed to determine the accuracy of the vertical and horizontal measurements on digital panoramic radiographic images using implants in the posterior mandibular regions.

Methodology

The study was planned on the Department of Dentistry Anugrah Narayan Magadh Medical College and Hospital, Gaya. on 30 implants in the posterior mandibular regions. The digital panoramic radiographic images were taken using implants in the posterior mandibular regions.

The digital panoramic radiographic equipment used. All digital panoramic radiographs were taken by technicians according to standard protocol provided by the manufacturer.

Results & Discussion

The data was collected from the 30 implants and presented as below.

Table 1: Number of implants in each length of the implant

Implant length	No. of Implants
7 mm	0
8 mm	3
8.5 mm	0
9 mm	4
10 mm	11
11 mm	6
11.5 mm	5
12 mm	0
13 mm	1
Total	30

Table 2: Number of implants in each Width of the implant

Implant Width	No. of Implants
3.3 mm	2
3.5 mm	3
3.75 mm	2
4 mm	6
4.2 mm	4
4.5 mm	3
4.75 mm	5
5 mm	3
5.5 mm	2
Total	30

Table 3: Mean difference of width and length in implant radiographic images

Radiographic Measurement	No. of Cases
Width	0.35 – 0.83 mm
Length	0.27 – 0.78 mm

The goal of our study was to evaluate the precision of dimensional measurements of the dry human mandible on digital panoramic radiographs and to evaluate their dimensional stability. Numerous studies have been performed to evaluate the dimensional precision on panoramic radiographs using various methodologies. Catic *et al.* [9] in their study found that there was no statistically significant difference observed between dry human mandibles and radiographic measurement methods with respect to all the linear measurements.

Schulze *et al.* [10] assessed the precision and accuracy of panoramic measurements using digital panoramic software (Sidexis version 2.1). They concluded that vertical measurements were less reproducible than horizontal.

The lack of significant differences between values obtained in the dry hemi-mandibles and those obtained before and after digitizing radiographic images for the three distances are in accordance with the experiments of others authors [11].

Radiographs taken from dry mandibles lead to superior results compared to the clinical situation [12]. The accuracy in the present experiment could be reached due to the use of a dry hemi-mandible and a plastic film-holder for the radiographic film [13], manufactured and tested for laboratory studies whose purpose is to radiograph only dry hemi-mandible and to obtain the parallelism with the radiographic film. This fact permitted eliminating physical distortions in the film and standardization of periapical radiographs. It is possible that the lack of differences in results would not so evident in patients [14]. In a clinical situation, periapical films are very difficult to be positioned exactly parallel to the mandible when the floor of the mouth is shallow, which may refrain the film to reach the mandibular canal, letting it out of the visualization area.

Even with no significant differences found between the methods, PVA calculation revealed that periapical radiography (conventional and digitized), on average, overestimated the actual measurements from dry hemi-mandible, while panoramic radiography (conventional and digitized) underestimated the real values. Larger distances than the real ones, measured in periapical radiographs have also been found by Sonick *et al.* [15], who identified magnification degrees between 8 and 24% for the periapical radiograph. However, it is necessary to observe that such study used only one mandible, thus one image may not produce the same data variability.

The overestimation of real values of the anatomical specimen when using periapical radiography may be due to the use of the bisecting angle technique and not the paralleling technique. Paralleling technique prevents image distortions and provides more accurate linear measurements both in vertical and horizontal dimensions [16].

Wakoh *et al.* [17], when investigating implant length accuracy in periapical radiographs, observed that their precision were equivalent to measurements made on CT scans and even

superior to them when located in the first molar region.

Although Dharmar (1) mentions that due to the magnifying problems originated from the panoramic image, vertical measurements from the upper limit of the alveolar ridge until the upper limit of the mandibular canal are not reliable for selecting the exact implant lengths, this fact was not observed in the present study. The wide visualization of mandibular canal trajectory provided by this type of technique may be of great help for surgeons when choosing the appropriate implant if the radiograph magnification index is known in advance to the surgery. The greatest disadvantage of panoramic radiography is its insufficient resolution for anatomical details, which can be overcome by the use of complementary periapical radiographs (1).

Conclusion

The measurements on digital radiography are quite acceptable and reliable for clinical use as long as the structures do not traverse the midline. Repeated measurements lead to a reduction in the systematic error and magnification to a loss of accuracy.

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