MEASUREMENT OF IMPLANT RECIPIENT SITES USING COMPUTERIZED TOMOGRAPHY [CT] AND DENTAL PANORAMIC TOMOGRAPHY [DPT]

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ABSTRACT

The overall objective of this study was to compare between the accuracy of panoramic (DPT) images and CT images for measurement of implant recipient sites with a radiographic guide incorporating glass sphere which represent the control measurements. This study was conducted at Princess Haya Hospital during the periods 2-2-2005 to 2-12-2005. The clinical experiment included 12 subjects requiring implants in compromised ridges. DPT and CT scan were used for imaging. Acrylic template incorporating a metal sphere was constructed for each patient. Every patient was subjected to both CT [dental software 4D] and two DPTs one of them taken with acrylic template incorporating the metal spheres in place. The diameter of the glass sphere was measured using the caliper. The measurements taken in this study are control, CT and DPT group. For the CT group and the control group the readings have some differences ranging from 0.1 mm to 0.2 mm, for the control group the highest reading was 14.5 mm and the lowest one was 3 mm, for the CT group the highest reading was 14.4 while the lowest reading was 3.1 mm. For the DPT group the highest reading was 18 mm while the lowest reading was 5 mm. This study highlighted the significant effects of positional variations on the distortion of panoramic images. There were clear advantages with CT scanning as an adjunct to treatment planning, including its inherent accuracy (0-1mm).

Key words: CT Scan, Dental Panoramic Tomography, Metal sphere, Implant.

INTRODUCTION

The use of implants has become a routine method of replacing missing teeth. However, the placement of implants requires sufficient volume of sound bone in which to place the fixtures.

The primary objectives of implant planning are to determine the available bone quantity and quality, identify nearby anatomical structures, and diagnose pathology such as buried roots.

Success in implant placement largely depends on presurgical evaluation and treatment planning. One can use a number of tools for this purpose.

No single radiographic procedure provides ideal images for all of the steps in the implant planning process. Most patients will undergo a series of imaging studies including intra-oral x-rays, lateral skull films, and dental panoramic tomography (DPT).

Increasingly however computed tomography (CT) is being regarded as the modality of choice for detailed planning prior to the surgery itself.

MATERIALS AND METHODS

This study was conducted at Princess Haya Hospital during the periods 2-2-2005 to 2-12-2005.

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The clinical experiment comprised of 12 subjects requiring implants in compromised ridges. Alginate impression was made for each patient to construct a partial acrylic template; a metal sphere inserted into the acrylic template before processing keeping that surface of the sphere in contact with the soft tissue covering the alveolar ridge where the implant fixture planned to be inserted.

The acrylic template incorporating a metal sphere [Fig 4] was constructed for each patient. Every patient was subjected to both CT [dental software 4D] Fig 2 and two DPTs one of them the patient was exposed with the acrylic template incorporating the metal in place [Fig 1 and Fig 4]. The diameter of the glass sphere was measured using the caliper.

The DPT with the metal sphere for each patient was considered the control group by using the following formula to eliminate the magnification:

\[ \frac{D_1 \times V}{D_2} \]

Where

- \( D_1 \) stands for the diameter of glass sphere measured by the caliper.
- \( D_2 \) stands for the diameter of glass sphere measured on the x-ray by the caliper.
- \( V \) stands for the vertical bone depth measured on the x-ray by the caliper.

The second group [DPT] each patient has been exposed to x-ray using the panoramic machine, the vertical bone depth measured in mm using the caliper.

The third group [CT] group, each patient was exposed to mandibular CT scanning using the Philips machine. The vertical bone depth was measured by the software 3D dental software provided with the Philips machine.

RESULTS

Measurements taken in this study were control, CT and DPT group. The results for the groups are presented in Table 1

The readings for the three groups were recorded in mm. For the CT group and the control group the readings were almost the same or with some differences ranging from 0.1 mm to 0.2 mm, for the control group the highest reading was 14.5 mm and the lowest one was 3 mm, for the CT group the highest reading was 14.4 while the lowest reading was 3.1 mm. For the DPT group the highest reading was 18 mm while the lowest reading was 5 mm.

The mean for the control group was 9.808 while the mean for CT group was 9.758 this mean both control and CT group have same mean with very small difference, the correlation coefficient equal to 0.996 and this mean a very strong relation between the groups. :  The value of \( T \) equal to 0.491 and comparing this value with P value which is 0.633 > 0.05 this mean that there is no significant difference between the two groups.

The mean for the control group was 9.808 while the mean for DPT group was 12.025 this indicates 22% distortion in DPT, the correlation coefficient equal to 0.970 and this mean a very strong relation between control group and DPT group :  The value of \( T \) is 7.631 comparing this value with P value which is 0.000< 0.05 mean that there is a highly significant difference between the two groups.

<p>| TABLE 1: THESE RESULTS WERE SUBJECTED TO STATISTICAL ANALYSIS USING A T-TEST. |</p>
<table>
<thead>
<tr>
<th>Control group (mm)</th>
<th>CT group (mm)</th>
<th>DPG group (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.0</td>
<td>14.0</td>
<td>16.0</td>
</tr>
<tr>
<td>8.0</td>
<td>8.2</td>
<td>9.5</td>
</tr>
<tr>
<td>7.0</td>
<td>7.1</td>
<td>10.0</td>
</tr>
<tr>
<td>12.0</td>
<td>12.0</td>
<td>13.2</td>
</tr>
<tr>
<td>12.2</td>
<td>12.0</td>
<td>12.6</td>
</tr>
<tr>
<td>8.0</td>
<td>8.0</td>
<td>11.0</td>
</tr>
<tr>
<td>14.0</td>
<td>14.2</td>
<td>17.0</td>
</tr>
<tr>
<td>14.0</td>
<td>14.0</td>
<td>18.0</td>
</tr>
<tr>
<td>5.0</td>
<td>5.2</td>
<td>8.0</td>
</tr>
<tr>
<td>6.0</td>
<td>4.9</td>
<td>8.0</td>
</tr>
<tr>
<td>3.0</td>
<td>3.1</td>
<td>5.0</td>
</tr>
<tr>
<td>14.5</td>
<td>14.4</td>
<td>16.0</td>
</tr>
</tbody>
</table>
Measurement of Implant Recipient sites using computerized

Fig 1: 4D CT scan

Fig 2: Philips CT scan machine

Fig 3: Metal spheres used in this study

Fig 4: Acrylic template incorporating the metal spheres

Fig 5: DPT showing the metal spheres
PAIRED SAMPLES TEST

<table>
<thead>
<tr>
<th>Paired Differences</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>Std. Error Mean</th>
<th>95% confidence interval of the difference</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1: control group(mm) - ct group(mm)</td>
<td>.050</td>
<td>.3529</td>
<td>.1019</td>
<td>-.174</td>
<td>.274</td>
<td>.491</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 4: The value of T equal to 0.491 and comparing this value with P value which is 0.633 > 0.05. This mean that there is no significant difference between the groups.

PAIRED SAMPLES STATISTICS

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1: control group(mm)</td>
<td>9.808</td>
<td>12</td>
<td>4.0860</td>
<td>1.1795</td>
</tr>
<tr>
<td>ct group(mm)</td>
<td>9.758</td>
<td>12</td>
<td>4.1408</td>
<td>1.1953</td>
</tr>
</tbody>
</table>

Table 2: The mean for the control group was 9.808 while the mean for CT group was 9.758 this mean both control and CT group have same mean with very small difference. Both Std. Deviation and Std. Error mean were approximate. These results indicate a 0.5% distortion in CT images.

PAIRED SAMPLES CORRELATION

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1: control group(mm) &amp; ct group(mm)</td>
<td>12</td>
<td>.996</td>
<td>.000</td>
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</tbody>
</table>

Table 3: The correlation coefficient equal to 0.996 and this mean a very strong relation between the groups.

PAIRED SAMPLES STATISTICS

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>N</th>
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Table 5: The mean for the control group was 9.808 while the mean for CT group was 9.758 this mean both control and CT group have same mean with very small difference. Both Std. Deviation and Std. Error mean were approximate. These results indicate a 0.5% distortion in CT images.

PAIRED SAMPLES CORRELATION

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1: control group(mm) &amp; dpt group(mm)</td>
<td>12</td>
<td>.970</td>
<td>.000</td>
</tr>
</tbody>
</table>

Table 6: The correlation coefficient equal to 0.970 and this mean a very strong relation between control and DPT groups.
The volume of the bone available and the quality of the bone are two factors that determine the type of surgical procedure and the type of implant. Both of these factors contribute to the success of the dental implant surgery.3

Success in implant placement largely depends on presurgical evaluation and treatment planning. One can use a number of tools for this purpose. Imaging is an irreplaceable part of this armentarium.4

All radiographic systems have inherent errors, technique peculiarities and different radiation dosages. The operator should be aware of these factors when making the choice of the most appropriate diagnostic technique.

A good diagnostic orthopantomography (OPT/OPG) otherwise known as dental panoramic tomograph (DPT) provides the clinician with a good overview of the mouth1, but the main problem with DPTs, as with other plain films, is that they are two-dimensional in nature. Bone height may appear to be adequate on the DPT, but there may be insufficient bone width to support an implant. They display image slices through the jaws by producing a single image of the maxilla and mandible and their supporting structures in a frontal plane. [A 10%-20% image magnification occurs, which is nonuniform. This magnification is undesirable for both implant selection and implant site assessments4.]

Approximately 63.8% of the dentist prescribe only panoramic radiography for dental implant assessment and 28.9% ordered panoramic radiography plus periapical radiography and or conventional and or computed tomography. Only 7.2% of the dentists ordered conventional tomography (CT) as a single examination, although 10.1% ordered it in combination with other imaging modalities.5 The main reason given for prescribing panoramic radiography were board coverage and cost5, and there are large variations in frequency of use of both conventional and computed tomography for dental implant. A substantial factor influencing the technique chosen was its availability rather than clinical need.6

More reliability is anticipated regarding the insertion of implants by establishing both clinical and radiological examination.7 This study demonstrated the characteristic distortions [0.22%] associated with DPT radiography and its effect on implant length selection table 1.5: the mean for the control group was 9.808 while the mean for DPT group was 12.025 this indicates 22% distortion in DPT, and this is because the magnification in the vertical plane depends on the focus-film distance (which is constant for each exposure) whereas the magnification in the horizontal plane varies with the changing position of the film and the x-ray beam.

Computed tomography (CT) scans provide the implant dentist with a substantial amount of valuable information. Accurate measurements can be made, which is particularly important when working within the posterior mandible.1,5 This study demonstrated the inherent accuracy of CT scan (0-1mm), table 1.4: the value of T equal to 0.491 and comparing this value with P value which is 0.633 > 0.05 this mean that there is no significant difference between the groups.

CT scans are more precise, panoramic radiography is sufficiently accurate for routine clinical purposes. CT

**Table 7:** The value of T equal to 0.491 and comparing this value with P value which is 0.633 > 0.05. This mean that there is no significant difference between the groups.

**DISCUSSION**
scans have, however, an additional advantage in presurgical planning, since they reveal the horizontal dimension and shape of the mandible, and the topography and buccolingual location of the inferior alveolar canal.

CONCLUSION

This study highlighted the significant effects of positional variations on the distortion of panoramic images, but panoramic radiography is sufficiently accurate for routine clinical purposes.

The CT scans are more precise, there were clear advantages with CT scanning as an adjunct to treatment planning, including its inherent accuracy (0-1mm). CT scans have, however, an additional advantage in presurgical planning, since they reveal the horizontal dimension and shape of the mandible, and the topography and buccolingual location of the inferior alveolar canal.

REFERENCES

1 Anthony Reynolds and Sean Goldner. The CAD and CAM of dental implants, Dentist; 2001; issue 53.