# CRESTAL BONE LOSS AROUND DENTAL IMPLANT "COMPUTERIZED ANALYSIS"

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## Abstract

The present study evaluates crestal bone loss around dental implants (retrospectively and prospectively) and determines the prognosis of dental implant through bone level estimation. Bone level was measured around 354 implants in 88 patients retrospectively and 97 implants in 31 patients prospectively, digital panoramic radiograph were taken during recall appointments, and analysis with a computer software associated method to measure the actual bone loss in mesial and distal side of the implant during these periods.

Over all, the studied implants, experienced most of its crestal bone loss during the preloading period, followed by dramatic decrease in bone loss rate through the subsequent study intervals. The result of the present study showed that there is significant positive correlation between crestal bone loss and age, female showed significantly higher amount of bone loss than male in stage-1, while the apposite figure found in stage-2. Data analysis during preloading time indicates significant bone loss with implant location, while highly significant bone loss had been detected with maxillary arch, fine trabecular bone density, immediate implant, complete edentulous cases, While implant length, implant diameter and implant stability had a non significant effects on crestal bone loss.

**Key words: - Dental implant, bone level crestal bone.**

## Introduction

During the past decade, implant have become one of the most exciting and rapidly developing topics in dental practice and nowadays they provide a proper treatment alternative to conservative prosthodontics,[1] dental implant treatment has also been discussed as a specific mean to preserve alveolar bone after tooth loss and well accepted as a means of dental rehabilitation. Even with a high integration success rate, crestal bone loss may occur.

Osseointegration depends on the relationship between biologic factors of bone and various clinical factors associated with dental implant treatment.[2, 3] External pressure on the mucoperiosteum is believed to result in external resorption[4]**.** It appears that to preserve all of the alveolus, the load transmission into the mandible or maxilla should be similar to the natural relationship of teeth in the dentate patient. Endosseous implants appeared to be the solution to both maintaining alveolar bone by osseointegration and preserving that bone by allowing functional stress distribution into the medullary space [5, 6].

Pham et al.[7] in 1994 confirmed that more crestal bone loss accrued during the first six-months (during healing period). The mean rate of bone loss for all measurable implant sites



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during the preloading phase was 0.16 ± 0.01mm/month which if extrapolated to six months produces an average bone loss of 0.96mm prior to loading. No significant differences were noted for bone loss for either jaw or implant type for the observations made during the 12-24 months period. Regardless of any other factor, all implants exhibit more bone loss in the first 6 months, and over all the marginal bone level remain stable around implants and never surpassing 2.2 mm, even after 15 year.[8]

Early crestal bone loss around dental implant is a common radiographical finding, the oral implantologist usually uses a panoramic radiograph for the evaluation of bone tissue around implants [9,10] Hermann et al.[11] in 1997 compared between radiographic and heptametrical level which showed that radiographic measurement of peri-implant crestal bone level is more accurate.

Earlier studies tended to assess and report bone loss following loading, some of the more recent studies have given attention to the period immediately following implant insertion. [8,12, 13] The purpose of this study is to evaluate crestal bone loss around dental implants (mesial and distal) retrospectively and prospectively and to determine the factors affecting crestal bone loss during preloading time

## Material and method

The sample was collected from Maxillofacial Surgery unit at Specialized Surgeries Hospital and AL-Karkh General Hospital.

The total sample was (119) patient with (451) implants, 31 patients with 97 implants fulfilled the criteria for the study prospectively, while retrospectively only 88 patients with 354 implants selected for the present study. Special case sheet forms included questions and information concerning the disease state have been adopted and filled for every patient. Also dental and radiographic evaluation was made for every patient.

The total implants consists of 188 implants in maxilla (41.7 %) and 263 implant in mandible (58.3 %); 137 implants in anterior region (30.4 %) and 314 implants in posterior region (69.6 %); 22 cases with complete denture (18.5 %), 74 cases with partially edentulous (62.2 %) and 23 as single (19.3 %).The distribution of implants by age, sex, arch and anterior/posterior are illustrated in Table (1).

A rational theater maneuver was followed strictly before surgery.

Regardless of surgery performed in maxilla or mandible, anterior or posterior, the same principles were taken up. The placement of implant was then done in ordinary manner including the following steps:

1-Flap design and reflection.
2-Preparation of the alveolar crest.
3-Pilot preparation.
4-Widening the pilot channel with the twist drill.
5-Implant length.
6-Parallel indicator.
7-Selecting the simultaneous bur.
8-Implant in, suturing.
9-Post operative instruction.

A digital panoramic radiograph was obtained. Radiographs were taken by using dimax system at each of the clinical procedure appointments including immediately after implant placement (surgical day), uncovering surgery (gingival former placement), final prosthesis insertion, after 4-6 months of loading and at follow up appointments. Each radiograph was subjected to image scanning and setting, all measurements required



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appear at one screen with the (real distances in mm).

**Measurements:**

Vertical measurements of bone level adjacent to the implants were made at the implant insertion, a base line measurements were established so that any loss in bone level at subsequent appointments can be accounted. Calibration of the measured increments of bone loss is necessary in determining actual bone loss from radiographic measurements. The measurement from the apex of the implant to the point of the bone implant interface is calibrated using the "known" and "radiographhically" measured length of the implant. This calibration involves multiplying the vertical bone height measurements by ratio of the known implant length to the measured implant length, these calibrated (i.e. actual) measurements from baseline and follow – up appointments were compared for a given implant to determine vertical bone height loss at the mesial and distal site, figure (1,2,3,4)

**Statistical analysis:**

Data were translated into codes using a special designed coding sheet and then entered into a computerized database structure. Statically analyses were done using SPSS. Version 10 (statistical package for social sciences) and Microsoft Excel XP computer soft wares.

Statistical methods used to analyze and assess the result were:

1-Descriptive statistics: Mean, Standard Deviation (SD), Range (min / max).

2-Inferential statistics: T- test, ANOVA test, Correlation coefficient (r- values).

## Result

The difference of bone loss between stages are shown in Table (2) which illustrates that the maximum mean of crestal bone loss occur in stage-2 (between implant uncovering and prosthesis placement) which is 1.07mm, followed by stage-1 (between implant placement and uncovering) which is 0.68mm then in stage-3 (after 4-6 months of loading) the mean bone loss was 0.09 mm, while in the second year of placement, the mean bone loss was 0.07 mm.

Table (3) shows a positive significant correlation of vertical bone loss with age in stage-1 of healing, but with the time in stage-2 of healing a non-significant correlation was found. Concerning gender Table (4) illustrates a highly significant difference in vertical bone loss between male and female in both stages of healing in which females has more vertical bone loss during 1$^{st}$ stage of healing and the apposite picture found in stage-2 of healing. The mesial side of implant has highly significant higher amount of vertical bone loss than the distal side in stage-1 of healing and non-significant in stage-2 of healing (Table 5). The implants in maxillary jaw show a highly significant vertical bone loss than implants in mandibular jaw during stage 1 of healing while there is non-significant difference in stage 2 of healing (Table 6). The same table shows that during stage-1 of healing the amount of vertical bone loss around implant in anterior region of both jaws were higher than the posterior region, these differences were highly significant around implants in maxillary jaw, while non significant around implants in mandibular jaw. Concerning 2$^{nd}$ stage of healing, the opposite figure were shown for the implant in mandibular jaw as the amount of vertical bone loss around implants in posterior region was higher than the anterior region, these differences as well as for implants in maxillary jaw were not significant.

Bone quality (as evaluated during the implant placement for prospective



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cases only) have highly significant effect on the amount of vertical bone loss in stage-1 of healing as the D4 bone density (Fine trabecular bone) has the greatest amount of bone loss and D1(Dense compact bone) have the lowest, while during stage-2 of healing, D2 bone density (Dense to thick porous compact and coarse trabecular bone) shows higher bone resorption than other types, but these differences were not significant (Table 7). In Table (8) the study shows that the amount of crestal bone loss was highly significantly differ between different case type (complete, partial fixed prosthesis and single) in the first stage of healing while this difference was not significant in stage-2 of healing. The single prosthesis shows that the lowest value of bone loss in 1st stage of healing and highest value in the 2nd stage.

Table (9) represents the crestal bone loss for mobile and immobile implants (for prospective cases only) in which the mobile implant has a higher bone loss in the first stage and the opposite in stage-2 but this was non significant in both stages. The immediate type of implant in the present study shows a higher amount of crestal bone loss than the conventional case when compared the amount of bone loss between conventional cases during "stage 2" of healing with "4-6 month" after placement of immediate cases (Table 10).

## Discussion

The data showed loss of crestal bone immediately after implant insertion, this agree with Jung et al [12] who found bone loss around implant in the first 3 months. This period (stage-1) is followed by a relatively rapid bone loss in stage-2 after uncover the implant( the bone loss reach 1.75 mm) this agree with Herman et al [13] in1997 who stated that the bone loss of implant after uncovering is about 1.5-2mm epically as well as agree with Pham et al [7] 1994 who confirm more crestal bone loss occurred during the first six – months (healing period), these could be attributed to that during the uncovering procedures, micro damage and inflammation will happen, that well activate the repair processes, just like the manifestation of the first response to clinical loading [14]. These periods followed by dramatically decrease in the amount of bone loss in which it reach 0.09 mm , this agree with Testori et al [15] 2001 and Astrant et al [16] 2000 who found significant bone loss before loading while the mean bone loss after loading was 0.1 mm. While bone loss stabilized significantly in the second year of placement which agrees with criteria proposed for implant success by Albrektsson et al.[17] 1986, who suggested that the annual bone loss is less than 0.2, after the first year of service, bone loss should be less than 0.2 mm annually [18].

The present study showed a highly significant difference in bone loss between mesial and distal side of implant, this is in agreement with Eliasson and Palmquists [19] 2000. Females in the present study has a significant higher value than males in 1st stage and this agree with Schliephoke et al [20] 1997 and disagree with Dao et al [21] 1993 who stated that osteoporosis should not affect the process of osseointegration, but Williamson [22] 1996 suggested that the osteoporosis may have some definite influence on remodeling.

More rate of bone loss appears to be associated with implants placed in the maxilla than the mandible with a highly significant difference, this is in agreement with Pham et al [7] 1994, this may be due to the difference in



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bone density(the mandible bone more dens than maxillary bone). In the maxilla the differences by anterior/posterior show highly significant more dramatic differences in the interval up to 6 months follow up, and this is in agreement with Kopp [23] 1989; Jaffin and Berman [24] 2000. While in mandible there is more bone resorption in anterior than posterior but with a non significant difference value, although the anterior mandible is the best area for implantation and high success rate and survivability , this could be attributed to that always the patient loss his posterior teeth early in life so the remodeling process is complete, while the lower anterior teeth always are the last teeth to be lost so the normal remodeling process continuous and relatively more bone loss was observed, while in the second stage it was found that the posterior teeth have more bone loss than anterior, this could be partially explained by the bone quality score that may interrelated with implant placement location variable in which in anterior mandible (with bone density D1 to D2) have the lowest mean value of bone loss.

In stage -1 the largest value of bone loss were detected among patient with complete denture cases and this could be attributed to that wearing removable complete denture during the submerged period may cause trauma from occlusion to the implant–bone interface that may compromise implant success or increase bone loss around the implants during initial bone healing [25], while in stage -2 after decovering the highest level of bone resorption is detected in single tooth this may be due to that the unsplinted implants are subject to rotational forces that create shear stresses at the bone implant interface [26].

The present study showed a high rate of bone loss around mobile implant in stage –1, this results disagree with Orenstein et al in 2000 [26].

Although the immediate implants have relatively a higher value of bone loss than conventional implant but this value is small comparing with the amount of bone loss that the residual ridge resorbed before and after implant placement for conventional implant. This indicate an excellent small bone loss for the immediate implant, on the other hand for immediate implant, primary stability may some time be difficult to achieve [26], since the coronal aspect of the extraction site is often wider than the implant being placed, but the present study used bicortical implant for immediate placement so the implant is engaged at least by one cortical layer so the study have relatively good stability at placement. The amount of bone resorption after healing time was found in the present study to be 1.4 ± 1.17 mm which is relatively higher than that found by Chow in 2001 [27].

## Conclusions

1- The maximum mean of bone changes occur in stage 2 (between implant uncovering, and prosthesis placement) followed by stage 1 (between implant placement and uncovering).
2- The amount of bone loss after loading not exceeds 0.1 mm annually.
3- Age and implant location affect significantly vertical bone loss.
4- Highly significant difference of vertical bone loss found with gender, bone density, implant design, case type, modification type of surgery (sinus lift, bone filler bone splits).
5- Implant length, diameter and implant stability found to have no affect vertical bone changes.



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6- Immediate implant is a good procedure for preserving alveolar bone from resorption
7- The higher effect of smoking (tobacco effect) appears after uncovering and exposes the implant to oral environment.
8- Mandible has better response to dental implant(less bone loss) than maxilla in both anterior and posterior segment.
9- Number of implant in partial fixed prosthesis did not seems to affect crestal bone loss
10- Modification type of surgery like bone expansion and bone splits did not affect crestal bone loss.

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Table (1) Distribution of implant by age, sex, arch and anterior/posterior among all patients (retrospective and prospective patients).

| | | **Maxilla** | | | **Mandible** | | | **Ant** | | | **Post.** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Age.** | **M** | **F** | **Both** | **M** | **F** | **Both** | **M** | **F** | **Both** | **M** | **F** | **Both** |
| **Retrospective** | **21-30** | 12 | 27 | 39 | 16 | 1 | 17 | 14 | 18 | 32 | 14 | 10 | 24 |
| | **31-40** | 19 | 32 | 51 | 6 | 51 | 57 | 11 | 21 | 32 | 14 | 62 | 76 |
| | **41-50** | 5 | 21 | 26 | 20 | 43 | 63 | 9 | 7 | 16 | 16 | 57 | 73 |
| | **51-60** | 1 | 15 | 16 | 16 | 16 | 32 | 6 | 4 | 10 | 11 | 27 | 38 |
| | **61--** | 14 | 0 | 14 | 23 | 16 | 39 | 13 | 8 | 21 | 24 | 8 | 32 |
| | **All ages** | 51 | 95 | 146 | 81 | 127 | 208 | 53 | 58 | 111 | 79 | 164 | 243 |
| **Prospective** | **21-30** | 0 | 2 | 2 | 2 | 2 | 4 | 0 | 2 | 2 | 2 | 2 | 4 |
| | **31-40** | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| | **41-50** | 2 | 7 | 9 | 10 | 11 | 21 | 4 | 4 | 8 | 8 | 14 | 22 |
| | **51-60** | 1 | 13 | 14 | 4 | 10 | 14 | 2 | 4 | 6 | 3 | 19 | 22 |
| | **61--** | 0 | 14 | 14 | 0 | 16 | 16 | 0 | 10 | 10 | 0 | 20 | 20 |
| | **All ages** | 3 | 39 | 42 | 16 | 39 | 55 | 6 | 20 | 26 | 13 | 58 | 71 |
| **Both** | **21-30** | 12 | 29 | 41 | 18 | 3 | 21 | 14 | 20 | 34 | 16 | 12 | 28 |
| | **31-40** | 19 | 35 | 54 | 6 | 51 | 57 | 11 | 21 | 32 | 14 | 65 | 79 |
| | **41-50** | 7 | 28 | 35 | 30 | 54 | 84 | 13 | 11 | 24 | 24 | 71 | 95 |
| | **51-60** | 2 | 28 | 30 | 20 | 26 | 46 | 8 | 8 | 16 | 14 | 46 | 60 |
| | **61--** | 14 | 14 | 28 | 23 | 32 | 55 | 13 | 18 | 31 | 24 | 28 | 52 |
| | **All ages** | 54 | 134 | 188 | 97 | 166 | 263 | 59 | 78 | 137 | 92 | 222 | 314 |



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Table (2) Vertical bone changes for five study interval in all patients (retrospective and prospective patients).

| | N | Min | Max | Mean | S.D |
|---|---|---|---|---|---|
| **Stag 1** | 451 | + 1.39 | 3.12 | 0.68 | 0.78 |
| **Stag 2** | 235 | 0.15 | 3.01 | 1.75 | 0.84 |
| **Stag 3** | 306 | 0.21 | 3.62 | 1.84 | 1.0037 |
| **12-24** | 196 | 0.4 | 3.87 | 1.91 | 1.1 |
| **24-36** | 51 | 0.91 | 3.37 | 1.91 | 0.8171 |

Table (3) Crestal bone loss for study interval by age

| | **STAGE (1)** | | | | **STAGE (2)** | | | |
|---|---|---|---|---|---|---|---|---|
| **AGE** | **Min** | **Max** | **Mean** | **S.D** | **Min** | **Max** | **Mean** | **S.D** |
| **21-30** | +0.53 | 2.03 | 0.4 | 0.56 | 0.21 | 2.91 | 1.68 | 0.97 |
| **31-40** | +1.38 | 2.76 | 0.62 | 0.74 | 0.15 | 3.01 | 1.85 | 1.01 |
| **41-50** | +1.39 | 2.96 | 0.81 | 0.91 | 0.74 | 2.47 | 1.26 | 0.74 |
| **51-60** | 0.0 | 2.73 | 0.88 | 0.64 | 0.29 | 2.83 | 1.77 | 0.82 |
| **61-----** | 0.7 | 3.01 | 0.66 | 0.87 | 0.59 | 2.92 | 1.68 | 0.7 |
| | R=0.13 | | P=0.012 * | | R=0.45 | | P=0.67 | |

* **-Significant**

Table (4) Crestal bone loss for study interval by gender

| | **STAGE (1)** | | | | **STAGE (2)** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Min** | **Max** | **Mean** | **S.D** | **Min** | **Max** | **Mean** | **S.D** |
| **Male** | +0.78 | 2.69 | 0.49 | 0.68 | 0.21 | 2.92 | 1.93 | 0.9 |
| **Female** | +1.39 | 3.01 | 0.79 | 0.81 | 0.15 | 3.01 | 1.69 | 0.85 |
| **Both** | + 1.39 | 3.01 | 0.68 | 0.78 | 0.15 | 3.01 | 1.75 | 0.84 |
| | T=3.52 | | P=0.00 ** | | T=1.21 | | P=0.00 ** | |

** **- Highly significant**

Table (5) Crestal bone loss for study interval in mesial and distal site of implant.

| | **STAGE (1)** | | | | **STAGE (2)** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Min** | **Max** | **Mean** | **S.D** | **Min** | **Max** | **Mean** | **S.D** |
| **Mesial** | +2.11 | 3.48 | 0.73 | 0.84 | 0.0 | 2.94 | 1.65 | 0.96 |
| **Distal** | +2.01 | 3.75 | 0.6 | 0.88 | 0.0 | 2.78 | 1.79 | 0.79 |
| | T=2.98 | | P=0.003 ** | | T= 0.815 | | P=0.42 | |

** **- Highly significant**



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Table (6) Crestal bone loss for study interval by arch and Anterior/posterior position.

| | | STAGE (1) | | | | STAGE (2) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Min** | **Max** | **Mean** | **S.D** | **Min** | **Max** | **Mean** | **S.D** |
| **Max.** | **Ant1** | +1.39 | 3.01 | 1.78 | 0.92 | 0.24 | 3.01 | 1.78 | 0.92 |
| | **Pos.** | +1.38 | 2.96 | 0.93 | 0.9 | 1.08 | 2.83 | 1.94 | 0.57 |
| | **Both** | +1.39 | 3.01 | 1.27 | 0.9 | 0.24 | 3.01 | 1.8 | 0.77 |
| | | T=-3.10 P=0.002 ** | | | | T=0.63 P=0.53 | | | |
| **Mand.** | **Ant1** | +0.38 | 2.26 | 0.66 | 0.63 | 0.21 | 1.58 | 1.07 | 0.62 |
| | **Pos.** | +0.78 | 2.76 | 0.63 | 0.69 | 0.15 | 2.92 | 1.78 | 0.97 |
| | **Both** | +0.78 | 2.76 | 0.64 | 0.67 | 0.15 | 2.92 | 1.63 | 0.93 |
| | | T=0.27 P=0.79 | | | | T=-2.0 P=0.053 | | | |
| **Max. / Mand.** | | T=0.99 P=0.002 ** | | | | T=1.13 P=0.26 | | | |

** **- Highly significant**

Table (7) Crestal bone loss for study interval by bone density.

| | STAGE (1) | | | | STAGE (2) | | | |
|---|---|---|---|---|---|---|---|---|
| **Bone density** | **Min** | **Max** | **Mean** | **S.D** | **Min** | **Max** | **Mean** | **S.D** |
| **D1** | +0.49 | 0.78 | 0.28 | 0.37 | 0.56 | 2.83 | 1.51 | 0.97 |
| **D2** | +1.39 | 3.01 | 1.23 | 1.05 | 0.74 | 2.72 | 1.71 | 0.63 |
| **D3** | 0.0 | 1.65 | 0.54 | 0.69 | 1.23 | 1.82 | 1.52 | 0.27 |
| **D4** | 0.56 | 2.63 | 1.61 | 1.03 | 1.23 | 1.95 | 1.57 | 0.29 |
| | F=4.65 P=0.002 ** | | | | F=0.197 P=0.94 | | | |

** **- Highly significant**

Table (8) Crestal bone loss in study interval by case type

| | STAGE (1) | | | | STAGE (2) | | | |
|---|---|---|---|---|---|---|---|---|
| | **Min.** | **Max.** | **Mean** | **S.D** | **Min.** | **Max.** | **Mean** | **S.D** |
| **Comp** | + 0.36 | 2.56 | 0.75 | 0.68 | 0.21 | 2.92 | 1.68 | 0.96 |
| **Part.** | + 1.39 | 3.01 | 0.7 | 0.84 | 0.15 | 3.01 | 1.73 | 0.86 |
| **single** | + 0.27 | 1.22 | 0.33 | 0.38 | 1.55 | 2.88 | 2.02 | 0.48 |
| | F=8.711 p=0.00 ** | | | | F=0.657 p=0.522 | | | |

** **- Highly significant**

Table (9) Crestal bone loss for study interval by implant mobility.

| | STAGE (1) | | | | STAGE (2) | | | |
|---|---|---|---|---|---|---|---|---|
| | **Min.** | **Max.** | **Mean** | **S.D** | **Min.** | **Max.** | **Mean** | **S.D** |
| Mobile | 0.29 | 1.8 | 1.09 | 0.63 | 0.30 | 1.87 | 1.45 | 0.69S |
| Immobile | +1.39 | 3.01 | 0.76 | 0.99 | 0.56 | 3.12 | 1.59 | 0.62 |
| | T=0.88 p=0.38 | | | | T=0.4 p=0.7 | | | |

Table (10) Crestal bone loss for study interval by implant type (immediate implant, Conventional implant).

| | STAGE (2) | | | |
|---|---|---|---|---|
| | **Min.** | **Max.** | **Mean** | **S.D** |
| **Conventional** | 0.15 | 3.01 | 1.01 | 0.84 |
| **Immediate.** | 0.3 | 3.12 | 1.4 | 1.17 |
| | T=1.102 P=0.27 | | | |



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**Fig (1) Storing the scanned radiograph in a special folder.**

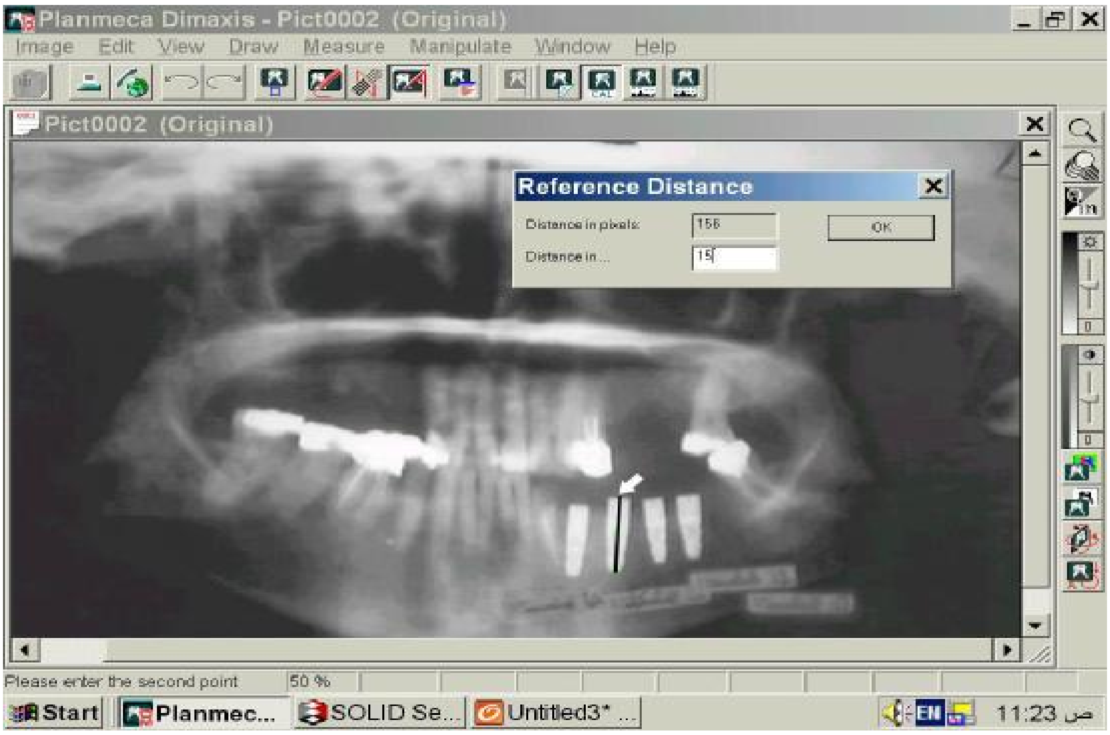


**Fig (2) The radiographic magnification ratio is determined using the measured radiographic implant length to the known implant length.**



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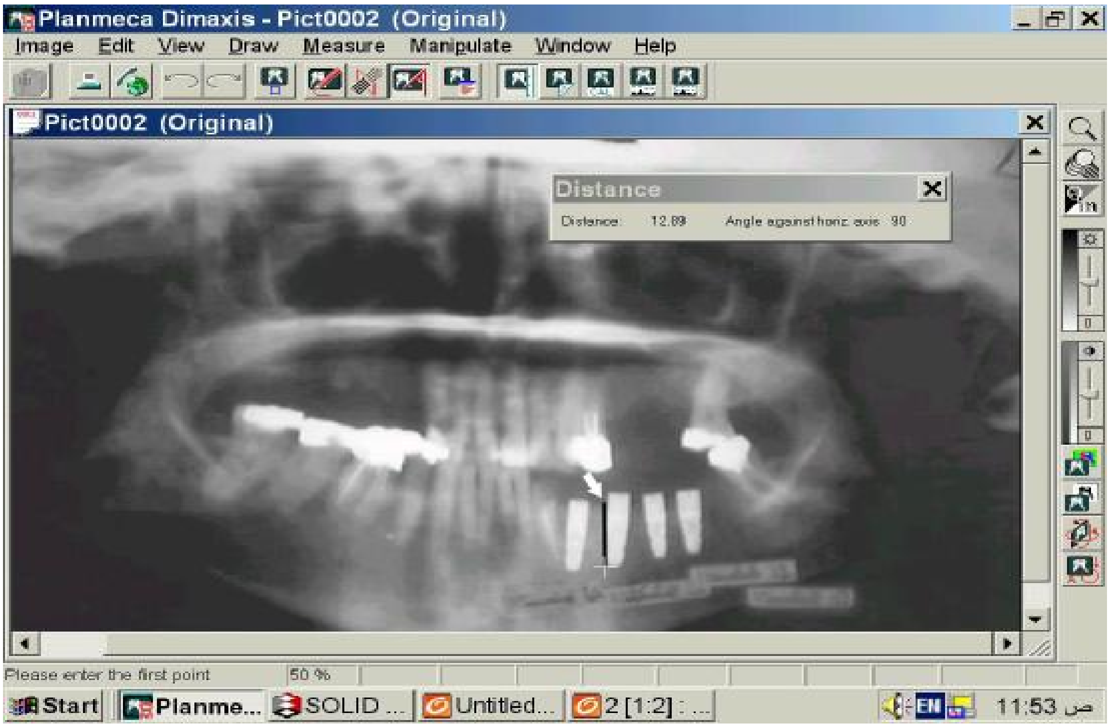


**Fig (3) The measurement from the apex of the implant to the point of the bone implant interface.**

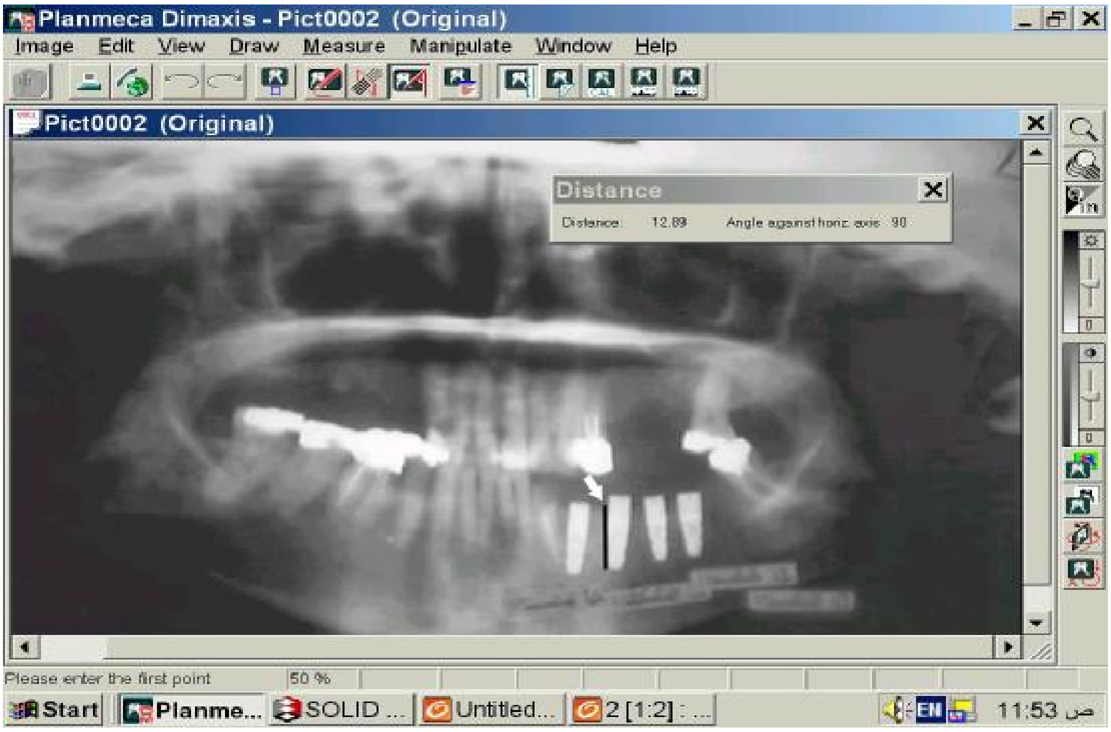


**Fig (4) The actual bone level were determine**



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