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A comparative evaluation of peri-implant tissue in implants restored using conventional cement retained crowns and crowns fabricated using conometric concept: an in - vivo study

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Abstract

The Conometric concept of prosthesis retention poses so many advantages over the conventional cement retained prothesis, not many conclusive studies are present to prove the same. So, the current research was done to assess the clinical efficacy of peri-implant tissue between conventional cement retained prosthesis and prosthesis fabricated using Conometric abutments with Cone Beam Computed Tomography (CBCT). The objectives of current research was to assess marginal bone loss, bleeding during probing, and probing pocket depth at approximately 18 implant sites, which were alienated into 2 groups of nine implants each, after two different methods of prosthesis retention: Group 1 consisted of conventional cement-retained crowns, and Group 2 consisted of conometric crowns. Both groups underwent measurements on the buccal and lingual sides using CBCT to determine the marginal bone loss and Hu-friedycolor vue plastic probe scans to measure the depth of the probing pocket at six sites (mid-buccal, mesio-buccal, disto-buccal, mesio-lingual/palatal, mid-lingual/palatal, and disto-lingual/palatal). For marginal bone loss, measurements were made at two time points: immediately following implant implantation and three months following functional loading; similarly, for probing pocket depth, measurements were made at two time points: immediately following functional loading and three months following. Statistics were applied to the values that were found. The Shapiro-Wilk test was used to determine whether the numerical data was normal. Wilcoxon Signed rank test (up to two observations) and Friedman's test (more than two observations) were used for the intragroup comparison, and Wilcoxon Signed rank test was then used for the pairwise comparison. Mann Whitney U test was used to compare two groups intergroup (P<0.05).At the disco-buccal site, there was a statistically considerable discrepancy (P<0.01) in the data among the groups for the probing pocket depth. For the probing pocket depth at the mid-buccal and mesio-lingual sites, there was a statistically considerable discrepancy among the groups (P<0.05) with greater values. Probing pocket depth showed highly statistically considerable variation seen for the values between the group for cement retained crowns over Conometric crowns at the areas specific to the disto-buccal, mid-buccal and mesio-lingual positions.

Keywords: Peri-implant tissue, restored, conventional, cement retained crowns

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1. Introduction

Since its introduction into the contemporary dental age, implant dentistry has developed into a first-rate therapeutic modality. It offers a stable basis for treating entire edentulism in addition to allowing for a conservative and aesthetic option to treating partial edentulism. Implant dentistry has moved from just being surgically driven to prosthetically driven and now esthetically driven field. This brings the situation in the present age to design and plan the final prosthesis of the implant well in advance before the surgical procedure, which comprises mainly the type of retention system used for the prosthesis. Choosing the retention of implant restoration is controversial, yet the best remains debatable amongst the practitioners. The prosthesis's retention type influences a number of factors, including cost and manufacturing simplicity, aesthetics, accessibility, occlusion, retention, loss of retention incidence, retrievability, passivity of fit, implant position restrictions, provisionalization, immediate loading, impression procedures, porcelain fractures, and clinical outcomes [1]. Due to their simplicity, lack of prosthesis screw loosening, passivity of fit, enhanced aesthetics, ease of occlusion control, and cost-effectiveness in comparison to screw-retained prostheses, cement-retained prostheses have grown in popularity. Although peri-implant illness has been linked to the ease with, which excess cement can be left on the implant or in the surrounding soft tissues [1].One of the most frequent biological consequences that follow the delivery of implant restorations is bone loss related to peri-implantitis. It is not a novel problem that dental cement can cause peri-implant illness. According to clinical accounts, if cement is not thoroughly cleaned, early peri-implant disease may appear within a few weeks or months. Therefore, too much cement has been linked to the quick development of inflammation or bone loss, but it hasn't been mentioned as a reason for the delayed development of peri-implant disease. Plaque accumulation, overloading, and periodontal infections were blamed for late bone loss [1].The Acuris-Conometric concept is a revolutionary approach to prosthesis retention, allowing clinicians to retrieve single crowns that are fastened. In addition to preserving retrievability and removing the possibility of submucosal leftover cement, friction-based retention provides a fixation method that mimics the aesthetics of a cement-retained crown [2].Conometric restorations are held in place without the use of fasteners or cement by a cone-in-cone connection between an abutment and a matching coping. Prefabricated components are used to fit the restoration into the abutment. This method results in a fixed restoration that is readily removed using a spring-loaded partial denture remover and lacks access holes, unlike screw retained prosthesis. The final crown is cemented onto the final cap extra orally and attached intra orally to the abutment to give a conometric friction retention. This is the primary distinction between the AcurisConometric Concept and other solutions. The last cap has an index that corresponds to the index above the abutment. This prevents rotation and enables proper crown seating and alignment [3].The objectives of this research was to assess the peri- implant tissue by comparing the probing pocket depth, marginal bone loss, bleeding on probing around implants of conventional implant supported cement retained crowns and crowns fabricated using Conometric concept.

2. Materials and Methods

2.1. Subject selection

Patients were selected based on inclusion and exclusion criteria from the Department of Prosthodontics' Out-Patient Department (OPD) to receive 18 implants (nine implants with cement-retained crowns and nine implants with Conometric crowns) between January 2021 and July 2022. The formula was used to calculate the sample size based on estimates of the mean and standard deviation values from the literature.

$$n = \frac{2\,(Z_\alpha + Z_\beta)^2\ [s]^2}{d^2}$$

Notation of the formulas

Z_α is the z variate of alpha error i.e. a constant with value 1.96. Z_β is the z variate of beta error i.e. a constant with value 0.84

Approximate estimates

80% power
Type I error to be 5%
Type II error to be 20%
True difference of atleast 0.20 units between the groups
Pooled standard deviation of 0.15

Before commencing any procedure, The treatment procedure was informed to the patients and all subjects participating in the study signed the informed consent and ethical committee clearance was obtained from institutional board (BV(DU)MC&H/Sangli/IEC/Dissertation 2020-21/D-42 Date-02/03/2021). Every procedure carried out for this investigation complied with ethical guidelines of ICMR 2006, ICMR 2017, DCG(I) Guidelines scheduled Y and all future guidelines.

2.2. Inclusion and exclusion criteria

Participants had to be between the ages of 18 and 65 years with maxillary and /or mandibular partially edentulous arches, good oral hygiene (Oral Hygiene Index - Simplified: John C Greene and Jack R Vermillion, 1964) and willing to follow recommended plaque control, follow up regimen, and sign informed consent. Patients with systemic diseases that contraindicate implant placement, chronic periodontitis, tobacco chewing and smoking habits and not willing to undergo implant surgery were excluded from the study.

2.3. Primary outcome

Primary outcome measure was to evaluate marginal bone loss, probing pocket depth and bleeding on probing by either of two techniques of prosthesis fabrication i.e., cement retained crowns and crowns fabricated using Conometric concept.For conducting the study, the pre-operative photographs were taken. Impressions of both maxillary and mandibular arches were made with alginate and poured in Type III dental stone (kal stone) for fabrication of diagnostic casts. Tentative jaw relation was recorded to know the inter arch relationship. Cone Beam Computed Tomography (CBCT) of desired edentulous region was taken before the implant placement.

2.4. Surgical protocol

Complete measure of asepsis was maintained during the surgery and all sterilization protocols were followed. The patients were made to carry out a betadine mouth rinse following which the site of implant placement was anaesthetised using local anaesthetic solution with lignocaine (2%) with epinephrine (1:100,000). Standard surgical protocol was followed for the placement of Ankylos dental implant. A point was marked with a probe to check the location of the pilot drill over the site according to the planned placement of the implant. The twist drill was used to transfer the implant position to the bone. The implant site was prepared in two stages: first, using a motor to drive the preparation until the designated implant-specific diameter was reached, and then, using the same motor to drive the last stage of preparation. Using motor-driven tools, the implant's orientation and depth were selected. The 1000 rpm suggested speed was applied. During preparation, the effective drilling depth was 0.5 mm below the implant's stipulated length. The conical reamer (maximum speed of 15 rpm, maximum torque of 60 Ncm) and the tap (maximum speed of 15 rpm, maximum torque of 60 Ncm) were used to prepare the final implant site. Depending on the quality of the bone, both can be motor-driven utilising the contra-angle handpiece. The implant was placed into the jawbone after the implant site had been prepared, with a maximum speed of 15 rpm and a maximum torque of 50 Ncm. Care was taken to ensure that no fibrous or epithelial tissue was transferred to the implant site. Cover screw was placed over the implant, after which the flaps were sutured (Silk Suture Ethicon LOT V9019, BN - 348956) to achieve primary closure. Surgical site was cleaned using irrigation. Patients were recalled seven days after surgery for suture removal and evaluation. All patients had received oral and written post-operative instructions and were prescribed with standard recommended dose of antibiotics and analgesics, whenever required the antacids were prescribed. For two weeks, patients were told to rinse with 0.2% chlorhexidine twice a day.

2.5. Prosthetic protocol

After three months of submerged healing, second stage surgery with minimal invasive uncover was done and gingival formers were placed suitable for the respective abutment.Patients were recalled after one week for impression making following the stage two surgery. The transfer post was correctly fitted in the connection taper and an open tray implant impression(Aquasil Ultra - BN 110500) was made. Master cast was prepared using dental stone class IV(Ultrarock). Once the abutment was customised on the master cast(Group 1) and Lab caps were seated onto Conometric abutments(Group 2), they were scanned(Medit T600 scanner) in the laboratory and the monolithic zirconia crowns(Cercon Dentsply Sirona - SN 0018044390 - 1027) were designed using Exocad software and were milled(Roland 52DCI).Conventional cement retained crowns were cemented using extra-oral cementation technique(Fig. 1) and Conometric crowns were cemented extra-orally using zinc-oxide non eugenol cement and then fitted onto the respective abutments intra-orally by Conometric retention in functional occlusion [4-6] (Fig. 2).

2.6. Sampling of patients

The Crown Height Space(CHS) was calculated according to the tentative jaw relations. CHS required for the Conometric crown was calculated(Table 1). The Conometric abutments were selected according to the size of the corresponding implants.

2.7. Assessment of crestal bone levels and probing pocket depth

CBCT Cone Beam Computed Tomography (CBCT) was taken to access the bone height 3 months after functional loading. The marginal bone level (MBL) on the buccal and lingual side was calculated by taking the implant platform as the point of reference.(Fig. 3) Probing pocket depth was checked around the implant with controlled pressure at six sites namely- mesio-buccal, mid-buccal, mesio-lingual/palatal, disto-buccal, mid-lingual/palatal and disto-lingual/palatal. The depth was evaluated based on the markings on the probe [5](Fig. 4).

2.8. Statistical analysis

A coding method was used to enter each item of data into a computer, ensuring that there were no errors in entry. The data was assembled onto a Microsoft Office Excel sheet (2019, Microsoft edition). The data was analysed using IBM's SPSS v 26.0 statistical software for social sciences. The t test was used to perform an intergroup comparison between two groups. The frequencies of different variable categories were compared between groups using the chi square test. The data did not follow a normal curve when the Shapiro-Wilk test was used to evaluate whether numerical data was normal; as a result, non-parametric tests were used for comparisons. With two groups, an intergroup comparison was conducted using the Mann Whitney U test. Wilcoxon Signed rank test was used for intragroup comparison (up to two observations). Friedman's method was used for intragroup comparisons (for more than two observations), and the Wilcoxon Signed rank test was used for pairwise comparisons. The study's power was 80% since $P<0.05$ was deemed statistically considerable for all statistical tests, maintaining α and β errors at 5% and 20%, respectively.

3. Results and discussion

Intra group pair wise comparison of lingual bone level for Group 1 and Group 2 with difference in the mean value between baseline and 3 months of functional loading and for Group 2 was 0.011 ($P<0.05$)which is statistically considerable variation.(Table 4,5). Intra group pair wise comparison of probing pocket depth at mesio-buccal site for Group 1 and Group 2 with difference in the mean value between baseline and 3 months of functional loading for Group 2 was 0.020 ($P<0.05$), at mid-buccal site for Group 2 was 0.023 ($P<0.05$), at disto-buccal site for Group 2 was 0.014 ($P<0.05$), at mesio-lingual site for Group 1 was 0.023 ($P<0.05$), at mid-lingual site for Group 2 was 0.024 ($P<0.05$), at disto-lingual site for Group 1 was 0.046 ($P<0.05$) which were statistically considerable diversity(Table 4,5).

Table 1. The Crown Height Space (CHS) required for the Conometric crown was calculated

Diameter of Conometric abutment	3.3 mm	4.5 mm
Gingival collar height	1.5mm	1.5mm
Abutment height from the finish line	4.1mm	4.1mm
Conometric final cap thickness at occlusal surface	1.0mm	1.0mm
Prosthesis thickness at occlusal surface	2.0mm	2.0mm
Required CHS	8.6mm	8.6mm

Table 2. Inter group comparison of values

	Group	N	Mean	Std. Deviation	Std. Error Mean	Mann-Whitney U value	Z value	p value of Mann-Whitney U test
PPD BL MESIO B	1	9	2.44	1.014	0.338	22.500	-1.821	0.069#
	2	9	1.67	0.500	0.167			
PPD BL MID B	1	9	2.67	1.000	0.333	17.500	-2.129	0.033*
	2	9	1.67	0.707	0.236			
PPD BL DISTO B	1	9	2.89	1.167	0.389	12.500	-2.612	0.009**
	2	9	1.44	0.527	0.176			
PPD BL MESIO L	1	9	2.22	0.667	0.222	16.500	-2.318	0.020*
	2	9	1.44	0.527	0.176			
PPD BL MID L	1	9	2.22	0.833	0.278	21.500	-1.802	0.072#
	2	9	1.56	0.527	0.176			
PPD BL DISTO L	1	9	2.33	0.866	0.289	23.000	-1.681	0.093#
	2	9	1.78	0.441	0.147			

* = statistically considerable variation ($p<0.05$), ** = statistically highly considerable variation ($p<0.01$), # = non considerable variation ($p>0.05$), PPD: Probing Pocket Depth, BL: Baseline, 3M: three months, B: Buccal, L: Lingual

Table 3. Inter group comparison of values

	Group	N	Mean	Std. Deviation	Std. Error Mean	Mann-Whitney U value	Z value	p value of Mann-Whitney U test
PPD 3M MESIO B	1	9	2.78	1.093	0.364	33.000	-0.698	0.485#
	2	9	2.44	0.726	0.242			
PPD 3M MID B	1	9	2.67	0.866	0.289	37.000	-0.335	0.738#
	2	9	2.56	0.882	0.294			
PPD 3M DISTO B	1	9	3.11	0.782	0.261	21.500	-1.802	0.072#
	2	9	2.44	0.726	0.242			
PPD 3M MESIO L	1	9	2.11	0.782	0.261	35.500	-0.466	0.641#
	2	9	2.33	1.000	0.333			
PPD 3M MID L	1	9	2.44	1.014	0.338	36.000	-0.422	0.673#
	2	9	2.56	0.882	0.294			
PPD 3M DISTO L	1	9	2.78	0.833	0.278	26.500	-1.375	0.169#
	2	9	2.33	0.707	0.236			

* = statistically considerable variation ($p<0.05$), ** = statistically highly considerable variation ($p<0.01$), # = non considerable variation ($p>0.05$), PPD: Probing Pocket Depth, BL: Baseline, 3M: three months, B: Buccal, L: Lingual

Table 4. Pair wise comparison using Wilcoxon Signed Ranks Test for Group 1

Time pairs	Z value	p value of Wilcoxon Signed Ranks Test
PPD 3M MESIO B - PPD BL MESIO B	-1.134	0.257#
PPD 3M MID B - PPD BL MID B	0.000	1.000#
PPD 3M DISTO B - PPD BL DISTO B	-0.552	0.581#
PPD 3M MESIO L - PPD BL MESIO L	-0.378	0.705#
PPD 3M MID L - PPD BL MID L	-0.632	0.527#
PPD 3M DISTO L - PPD BL DISTO L	-2.000	0.046*
BBL 6M - BBL BL	-1.450	0.147#
LBL 6M - LBL BL	-2.555	0.011*

* = statistically considerable variation ($p<0.05$), ** = statistically highly considerable variation ($p<0.01$), # = non significant difference ($p>0.05$), PPD: Probing Pocket Depth, BL: Baseline, 3M: three months, B: Buccal, L: Lingual, BBL: Buccual Bone Level, LBL: Lingual Bone Level.

Table 5. Pair wise comparison using Wilcoxon Signed Ranks Test for Group 2

Time pairs	Z value	p value of Wilcoxon Signed Ranks Test
PPD 3M MESIO B - PPD BL MESIO B	-2.333	0.257#
PPD 3M MID B - PPD BL MID B	-2.271	1.000#
PPD 3M DISTO B - PPD BL DISTO B	-2.460	0.581#
PPD 3M MESIO L - PPD BL MESIO L	-2.271	0.705#
PPD 3M MID L - PPD BL MID L	-2.251	0.527#
PPD 3M DISTO L - PPD BL DISTO L	-1.667	0.046*
BBL 6M - BBL BL	-0.141	0.147#
LBL 6M - LBL BL	0.000	0.011*

* = statistically considerable variation ($p<0.05$), ** = statistically highly considerable variation ($p<0.01$), # = non significant difference ($p>0.05$), PPD: Probing Pocket Depth, BL: Baseline, 3M: three months, B: Buccal, L: Lingual, BBL: Buccual Bone Level, LBL: Lingual Bone Level

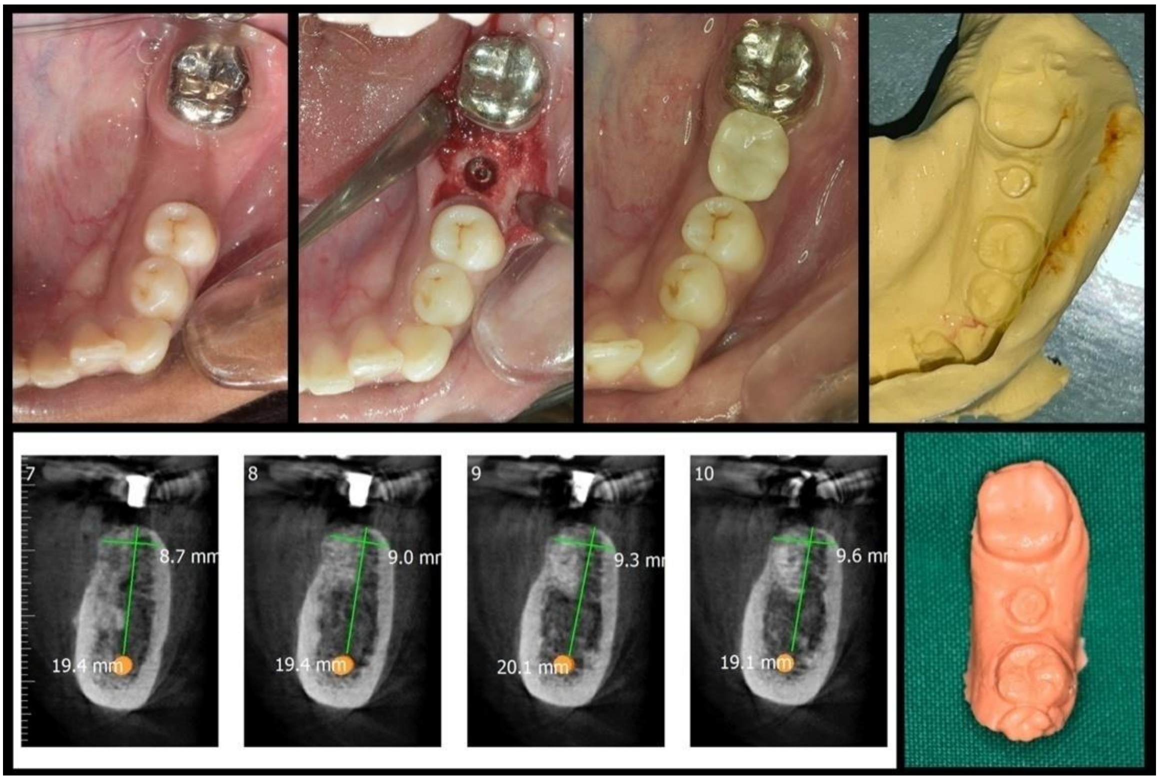

Figure 1. Case of Cement retained Prosthesis

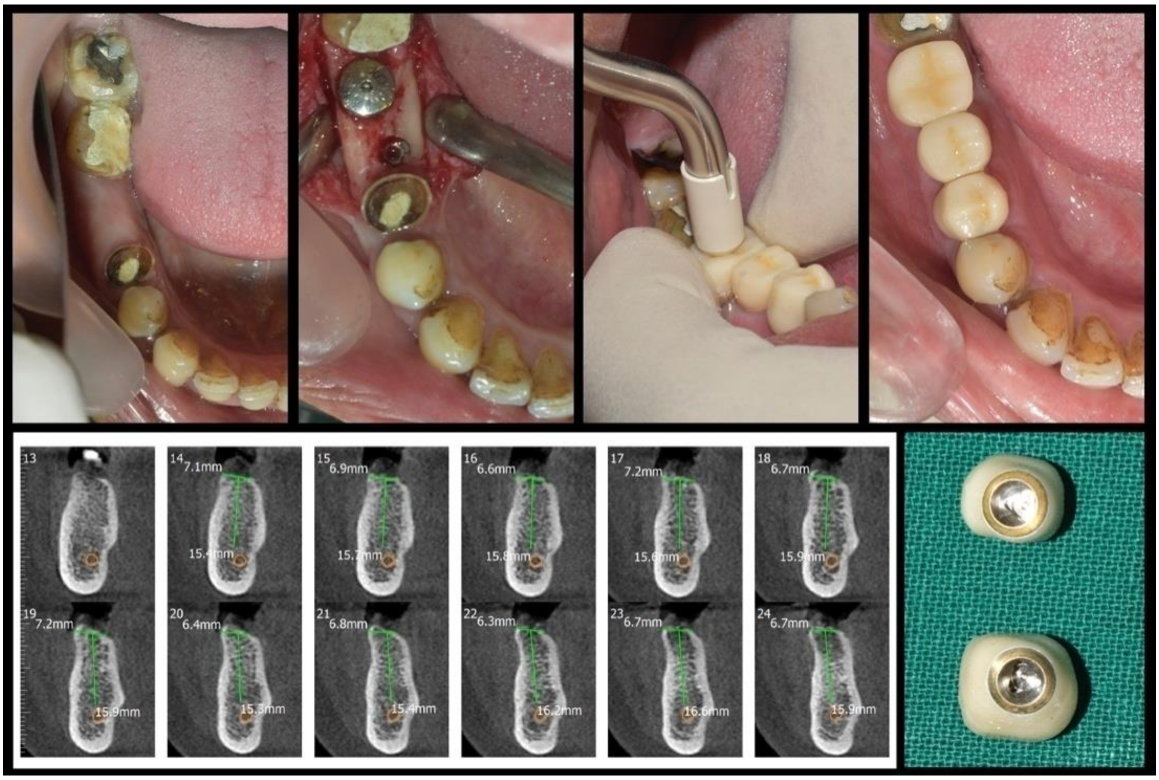

Figure 2. Case of Conometric retained Prosthesis.

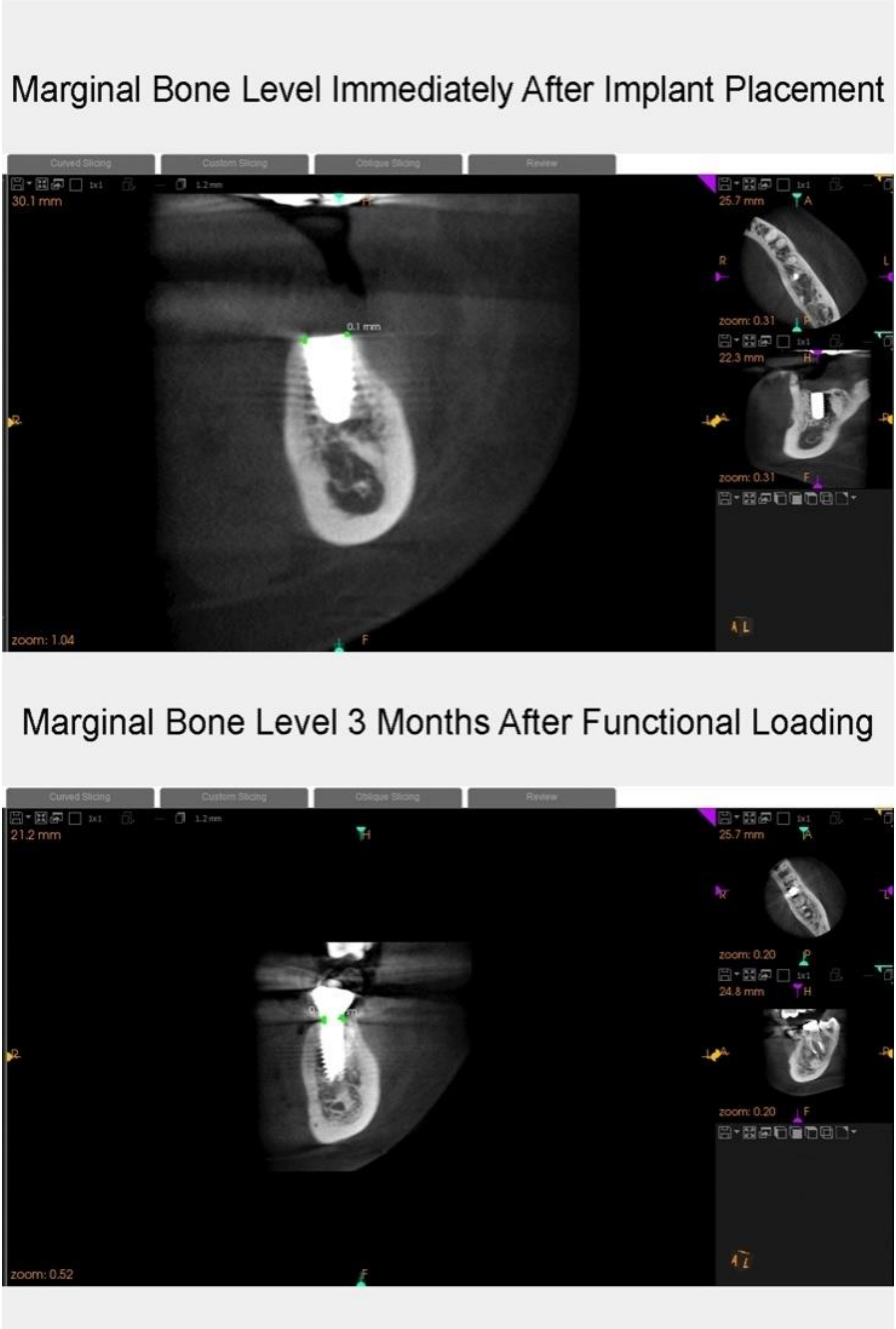

Figure 3. Marginal Bone Level Measurement Immediately After Implant Placement and After 3 Months of Loading

Figure 4. Lingual Probing Using Hu-Friedy Plastic Probe

Inter group pair wise comparison of probing pocket depth at mid-lingual site for Group 1 and Group 2 with difference in the mean value between baseline and 3 months of functional loading for Group 1 was 0.033 (P<0.05), at disto-buccal site for Group 1 was 0.009 (P>0.01), at mesio-lingual site for Group 1 was 0.020 (P<0.05) which were statistically significant differences (Table 2,3). Selecting the type of implant/abutment connection between restorations and implant abutments, as well as whether the prosthesis should be screwed or cement retained, is one of the most crucial clinical decisions to make prior to implant installation [4, 5].In contrast to screw-retained implant prostheses, Misch listed the several benefits of cement-retained implant prostheses. Prosthetics with cement retention have numerous, significant benefits. Because of the grouting action of the cement, they are cemented to a well-suited machined abutment, eliminating variability in casting to abutment compatibility and creating a passive and stable environment. The physical strength of porcelain and acrylic resin is increased, and the cemented carbide prosthesis is made to be less prone to fracture since it lacks screw holes. Furthermore, patients value the outstanding aesthetics of cemented prosthesis [6, 7]. Moreover, it has been noted that leftover cement, particularly in cases where the cement edge is relatively deep, may cause peri-implant infection [5].Salvi et al studied the diagnostic parameters for monitoring peri-implant tissue conditions. Evidence from the literature presented indicates that the use of radiological parameters CBCT analysis of marginal bone loss and clinical parameters - bleeding on probing, probing pocket depth in the assessment of peri-implant tissue status [8].The implant is losing its bony anchoring when the degree of crestal bone decreases. During the follow-up period, pathological alterations always begin around the implant's neck. According to a study by Jung et al., the first three months accounted for more than half of the total bone loss that was seen throughout a 12-month period. Stress concentrations from periosteal prominence, surgical trauma, recipient bed preparation, and overtightening of the implant can all lead to rapid early bone loss. This investigation, which measured the marginal bone level at the buccal and lingual sides over a 6-month period, was carried out in light of the previously reported findings [9].According to Clarissa D. Koller et al., long-term clinical and radiographic research is necessary to comprehend the effects of the occlusal parameters on MBL because mechanical stress can have both beneficial and negative effects depending on the amount, frequency, and type of loading during bone remodelling, which involves apposition and deposition.The current study's findings were corroborated by Adnan Abdullah Naji Al-Fahd et al., who reported no significant difference in the MBL[10]. In contrast, a study by Shikha Nandal et al. revealed that bone loss at the mesial and distal aspects remained unchanged after a 6-month period[9], which contradicted the current study's findings.Similar findings were noted in the current investigation, which was backed by Aparna Trivedi et al. The distal surface showed the greatest pre-loading bone loss, whereas the buccal area showed the greatest post-loading bone loss. Prior to implant loading, there was a greater loss of crestal bone than after [11].Similar results were found in a 1986 study by Albertktsson [12], who hypothesised that this was probably because the surrounding bone was able to adapt to the loading and increase in density, particularly in the crestal half of the implant body, during the first six months to a year of loading caused by functional forces applied to the implant.The current study's observations suggest that there is a complementarity between the height of crestal bone and the thickness of soft tissue. Thus, adequate soft tissue thickness contributes to the preservation of the crestal bone's height.The significance of bleeding upon mild (< 0.25 N) mechanical stimulation of the sulcus (bleeding on probing, BoP) in clinical periodontology is widely acknowledged. It has also been demonstrated that BoP has a greater negative predictive value for the course of the disease. Bleeding on probing is a crucial metric for diagnosing inflammation in the peri-implant mucosa when evaluated around dental implants [13]. According to Tomas Albrektsson et al., bleeding during probing or at different depths during probing are not reliable markers of crestal bone loss, which can occur for a variety of reasons other than infection, including implant-, clinician-, and patient-related factors [12]. There was a statistically non-significant difference ($p>0.05$) in the frequencies between the groups within the confines of the current investigation. Additionally, Jun-Yu Shi et al. had demonstrated that the lower BOP-positive sites in cement retained crowns may have been caused by improved soft-tissue lining and relatively flat cement margins of tissue-level implants; this explanation may also account for the statistically non-significant difference observed in the current study [5].

4. Conclusions

Within the realm and purview of this study the following conclusions were drawn- The Conometric crowns showed better performance than cement-retained crowns in terms of peri-implant tissue health. This study concluded that Conometric crowns could be recommended as the choice of retention for the implant restorations, as it exhibited acceptable results in maintaining the peri-implant tissue health post loading of the implants.

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