Dentistry
ISSN: 2161-1122
OPEN ACCESS Freely available online
Research Article

Radiographic Bone Changes Surrounding Implants of Different Attachment Systems

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ABSTRACT

This study was conducted to compare the effect of GPS attachment, OT Equator attachment and Ball and Socket attachment on crestal bone around implants in implant retained mandibular overdenture cases.

Materials and Methods: Following two stage surgical protocol eighteen completely edentulous patients received two implants placed bilaterally in the canine region (36 implants) to retain mandibular overdentures. Inclusion Criteria: Patients were all healthy men, non-smokers, Following Misch rules of bone classification patients with bone density ranging from 850-1250 HU (D2) and bone height and width more than 10 mm and 5 mm respectively. Four months following the surgery patients were randomly divided into three equal groups; the first group received OT Equator attachment (Group OT), the second group received GPS attachment (Group GPS) and the third Group received Ball and Socket attachment (Group BS). Patients were then placed on zero, three, six and twelve months follow-up periods using cone beam computed tomography. Measurements were taken on crestal bone height surrounding the implants till its apex and then the results were statistically analyzed.

Results: All three groups showed statistically significant bone changes. The GPS attachment showed the least bone changes around the implants, followed by equator attachment, whereas ball and socket showed more bone changes than the other two attachment types, with the highest signifcant increase ($p<0.001$) in bone change found in group BS. Group BS showed a statistically significant difference from Groups OT and GPS at 3 months, at 6 months and at 12 months, while Group OT showed a significant difference from Group GPS at 6 and 12 months.

Conclusion: GPS attachment is least destructive to bone surrounding the implants, followed by the equator attachment, while ball and socket attachment showed the greatest bone changes surrounding the implant.

Keywords: GPS attachment; Equator; Ball and socket; Implant overdenture; Cone beam computed tomography

INTRODUCTION

Implant-retained overdentures are now a common method of restoration for edentulous patients, overcoming many of the problems of conventional removable dentures [1-7]. Yet an implant-retained overdenture requires more thorough and critical planning.

When considering an implant-retained overdenture, one of the main factors affecting success of the treatment is the available interarch distance. This is a critical factor as insufficient interarch space would result in an over contoured prosthesis, excessive occlusal vertical dimension, fractured teeth adjacent to the attachments, attachments separating from the denture, fracture of the prosthesis and overall patient dissatisfaction. As such, limited interarch space often restricts the restricts the prosthetic armamentarium to low-profile attachments and prevents using O-ring attachments and bars [8-11].

Low profile attachments like OT Equator and GPS offer multiple solutions for overdenture treatment planning where inter-occlusal space limitations are considered. Whereas Ball and Socket attachments are not low profile, they do have considerable advantages, including optimizing stresses and minimizing denture movement. Patient's appreciation of their ball retained mandibular overdenture remained high over ten years follow-up period and clinical parameters revealed healthy mucosal conditions, high retentive measures and stable marginal bone levels [12-14].

Three dimensional visualization of jaw areas has improved the clinical success of implants and their associated prostheses, and led

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Received: May 28, 2020; **Accepted:** June 16, 2020; **Published:** June 23, 2020

Citation: Rizk FN, Shafei SFE (2020) Radiographic Bone Changes Surrounding Implants of Different Attachment Systems. Dentistry 10:557. doi: 10.35248/2161-1122.20.10.557

to more accurate outcomes. Cone Beam Computed Tomography (CBCT) accurately pinpoints vital structures and evaluates the surgical site underneath the soft tissues making it possible to pre-surgically determine with a high degree of accuracy and with 3D views the best position and inclination for implant placement based on the final prosthetic outcome [15-20].

In general, the main motivation of the patients who look forward mucous supported implant rehabilitation is to increase the retention of the lower denture and to improve the masticatory capacity [21,22].

This study was thus carried out to compare between GPS, Equator and Ball and socket attachments regarding their effect on crestal bone changes in Implant-retained mandibular overdentures.

MATERIALS AND METHODS

This study was conducted at the Removable Prosthodontics Clinic, at the British University in Egypt. None of the authors or participants in this study has any conflict of interest with the types of attachments used.

Patients eligible for the study were men, completely edentulous patients with age ranging between 55 to 65 years and for whom a decision had already been made to incorporate dental implants for the treatment of complete edentulism. All patients were informed of the details of the procedures and signed an informed consent prior to performing any steps.

Inclusion criteria

Patients were all healthy men, non-smokers, Following Misch [23] rules of bone classification patients with bone density ranging from 850-1250 HU (D2) and bone height and width more than 10 mm and 5 mm respectively.

Exclusion criteria

Severe maxillomandibular skeletal discrepancy, clenching habits, bruxism, tempromandibular joint disorders, smokers, drug abuse, history of head and neck radiation and systemic disorders that may prevent surgery, affect bone quality or contribute to bone resorption.

Following these criteria, 18 patients were selected for this study.

Prosthetic procedures

Complete dentures were constructed for all 18 patients following the same technique, prior to implant placement. For each patient upper and lower primary impressions were taken using alginate (Alginmax, Major Prodotti, Dentari SPA, Moncalieri, Italy) in stock trays and upper and lower secondary impressions were taken using medium body rubber base (Swiss TEC, Coltene, Whaledent, Altstatten, Switzerland) in specially constructed special trays. Occlusion blocks were fabricated on the poured master casts. Centric occluding relation was recorded following the conventional wax wafer technique. Upper casts were mounted on semi-adjustable articulator (Dentatus type ARH, AB, Dentatus, Stockholm, Sweden) according to face bow record (Dentatus face bow, Dentatus, Stockholm, Sweden) while the lower casts were mounted using the wax wafer centric occluding record. Setting up of modified anatomical cross linked acrylic resin teeth (Vita-pan acrylic teeth, Vita Bad Sackingen-Germany) was done following modified lingualized occlusion scheme. 38 Waxed up denture was tried in the patient's mouth, and then flasked and processed into high impact heat cure acrylic resin (Lucitone 199, Dentsply, York, PA-USA). Laboratory remounting was done before finishing the denture and occlusal discrepancies were adjusted.

Any necessary adjustments were carried out to eliminate occlusal interference and the denture was delivered to the patient. It was checked after twenty four and seventy two hours for any needed adjustment and to ensure that the patient was satisfied with esthetics, stability and retention of the denture. Following denture placement and patient adaptation, the mandibular denture was duplicated in clear acrylic resin (Vertex Rapid Simplified; Vertex-Dental BV, Zeist, The Netherlands) to act as a surgical guide for implant positioning to assure proper implants installation beneath the planned position which was determined by ideal denture contour and esthetics.

Surgical procedures

For each patient two implants (Legacy I Implant Direct LLC, USA, Canada), were inserted bilaterally in the canine region at equal distance from the mid line, parallel to each other and perpendicular to the occlusal plane. All implants were placed by the same oral surgeon using surgical guide and following two stage surgical protocols. Covering screws were threaded into the implants which were left to heal for four months.

During the initial healing period (two weeks after surgery) no prosthesis was used over the implants so that early healing can occur without functional loading. After the two weeks period the tissue surface of the existing denture was relieved in the area overlying the installed implants. Resilient relining material (Permsoft Myerson Chicago IL. USA) was placed into the relieved areas to assure intimate tissue contact. All implants were allowed to integrate for four months.

Following four months healing period patients were randomly divided into three equal groups according to the type of attachments they received.

Group OT: Received OT Equator profile attachment (Rhein 83 USA) in the form of

Male part: Consisting of titanium +tin OT Equator Profile abutment of cuff height 2 mm (Figure 1a). The male part was screwed onto the implant using hex screw driver, hexagon 1,3. Complete seating of the abutments on their corresponding implants was verified by radiographing the implant abutment interface.

Female part: Consisting of white cap of standard retention. Using retentive cap inserting tool, the cap was inserted into stainless steel cap's housing to be picked-up in the fitting surface of the denture (Figure 1b).

Group GPS: Received GPS attachment (Implant Direct LLC, USA, Canada) in the form of

Female part: Consisting of metallic GPS abutment of cuff height 2 mm (Figure 2a). The female part was screwed onto the implant using hex screw driver. Complete seating of the abutments

on their corresponding implants was verified by radiographing the implant abutment interface.

Male part: Consisting of male clear cap of standard retention (4.5 Ibs). Using male seating tool, the male cap was firmly pushed into the empty metal housing to be picked-up in the fitting surface of the denture (Figure 2b).

Group BS: Received Ball and Socket attachment (Implant Direct LLC, USA, Canada) in the form of

Male part: Consisting of metallic ball abutment of cuff height 2 mm (Figure 3a). Ball abutment was screwed onto the implant using hex tool. Complete seating of the abutments on their corresponding implants was verified by radiographing the implant abutment interface.

Female part: Consisting of resilient nylon cap snapped in metal housing to be picked-up in the denture fitting surface (Figure 3b).

Pick-up procedures

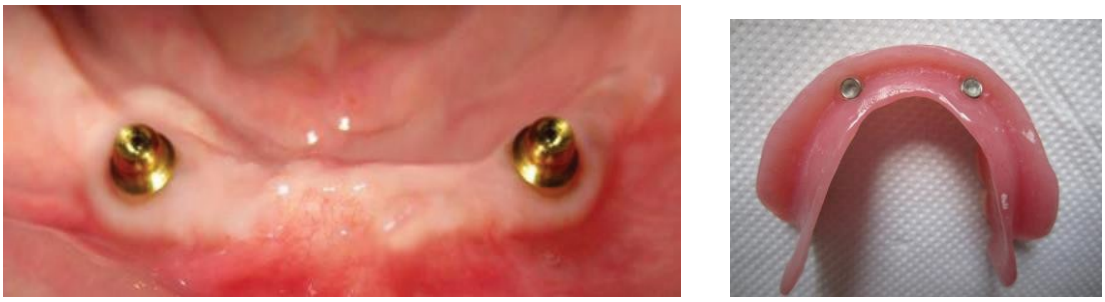
The mandibular overdenture base was relieved to accommodate the newly inserted attachments. The denture was tried in the patient's mouth to ensure complete seating. Any undercuts were blocked out using temporary filling (Litark, Lascod SpA-Vita L. Longo, Sesto F, no Firenze, Italy). A mix of self-cure acrylic resin (Lucitone 199; Dentsply) was applied in the relieved region for direct pick- up of the female part of OT Equator profile attachment, the male part of GPS attachment and the nylon caps of the Ball attachment using close-mouth technique.

Follow-up evaluation schedule

Evaluation was scheduled at the denture insertion, three, six and twelve months following denture insertion. At these intervals, patients return for assessment of implant, prostheses' function and standardized evaluation of his oral health. CBCT was used to identify peri-implant radiolucencies and bone level.

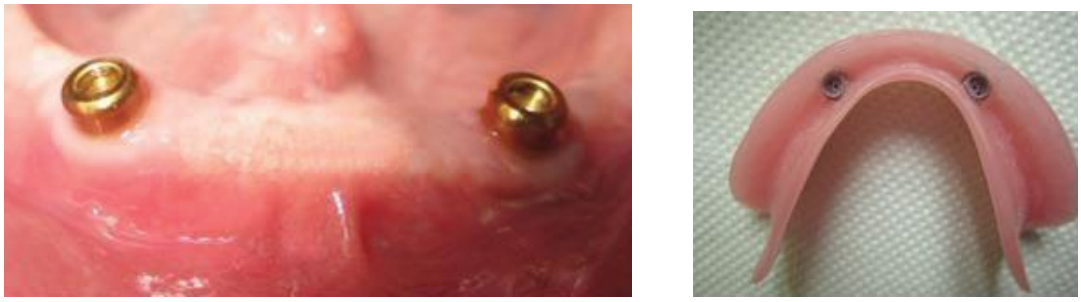
Radiographic evaluation using Cone Beam Computed Tomography (CBCT)

Images were acquired using the Scanora 3D Imaging system



(a) (b)

Figure 1: (a): OT Equator abutment (male part); (b): OT Equator female cap.



(a) (b)

Figure 2: (a): GPS abutment (female part); (b): GPS male cap.

(a) (b)

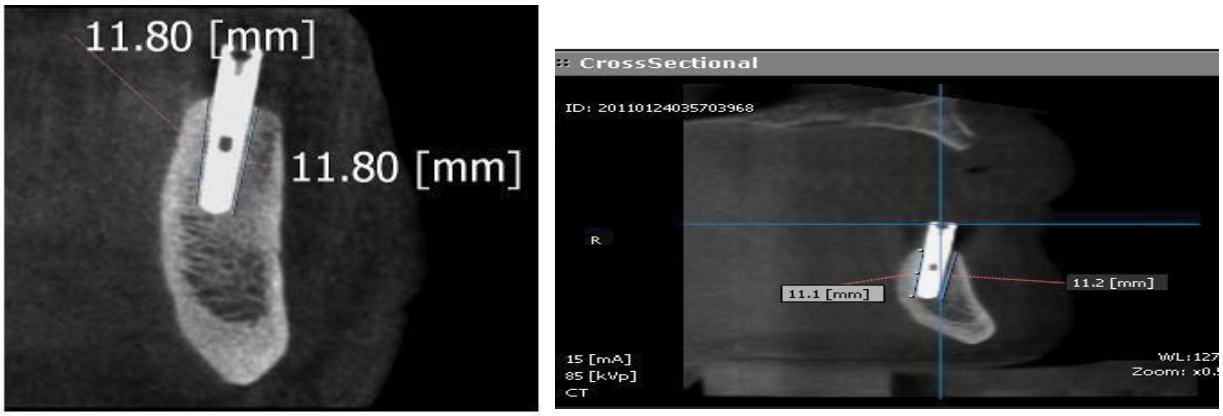
Figure 3: (a): Ball abutment (male part); (b): Nylon cap (female part).

(Scanora 3D, Sorredex-Finland) (voxel size 133 μm-350 μm). The patients were exposed in the sitting position and the mandibles were immobilized by means of a head band to position the head against the head rest and chin cup, with the midsagittal plane perpendicular to the horizontal plane using vertical and horizontal alignment beams as recommended by the manufacture.

The procedure was repeated for each patient to monitor the changes in bone height for each implant.

Measurements for evaluation of crestal bone height

Crestal bone levels at buccal, lingual, mesial and distal were calculated from the reconstructed implant views by drawing a line parallel to the implant serration extending from the crestal bone to the apical end of the implant (Figure 4a and 4b). Average readings of the four surfaces at each interval were calculated and tabulated for statistical analysis.



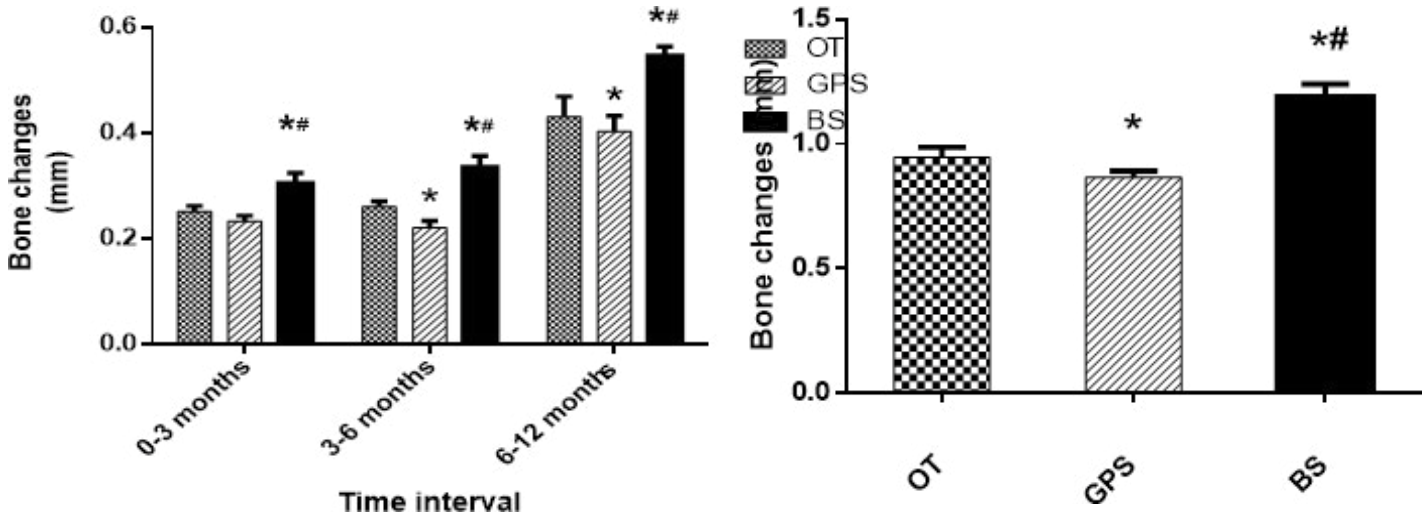
(a) (b)

Figure 4: (a): Cross sectional view for buccal and lingual crestal bone height at insertion; (b): Cross-sectional view for buccal and lingual crestal bone height at 12 months.

Table 1: Comparison between mean difference of crestal bone height surrounding the implants in all studied groups at different intervals of follow-up period.

	Group OT: OT Equator profile attachment		Group GPS: GPS attachment		Group BS: Ball and Socket attachment		p-value
Period	Mean difference (mm)	SD	Mean difference (mm)	SD	Mean difference (mm)	SD	-
0-3 months	0.252	0.01	0.234	0.011	0.306*#	0.019	<0.0001
3-6 months	0.261	0.01	0.221*	0.014	0.336*#	0.021	<0.001
6-12 months	0.431	0.039	0.404*	0.03	0.548*#	0.017	<0.05

p-value<0.05: significant, p-value<0.01: highly significant, ns= P value>.05: non-significant
*Statistically significant difference in comparison to Group OT at the same time interval at p<0.05
#Statistically significant difference in comparison to Group GPS at the same time interval at p<0.05



(a) (b)

Figure 5: (a): Showing mean values of Bone Changes in Group OT, Group GPS and Group BS at 0-3 months, 3-6 months and 6-12 months time; (b): Showing mean values of overall Bone Changes in Group OT, Group GPS and Group BS over 12 months. *Statistically significant difference in comparison to Group I at the same time interval at p<0.05. #Statistically significant difference in comparison to Group II at the same time interval at p<0.05.

Statistical analysis

The data are expressed as the mean ± Standard Deviation (SD). The results were analyzed via two-way (ANOVA) to compare between groups at different time periods, followed by Tukey test for pairwise comparisons (intergroup comparison) and one-way analysis of variance (ANOVA) to compare between different groups at the same time. All tests were done by by GraphPad Prism version 7.00 (GraphPad Software, San Diego, CA). p-values<0.05 considered statistically significant.

RESULTS

Table 1 shows comparison between mean differences of crestal bone height surrounding the implants in all studied groups at different intervals of follow-up period.

Figure 5a showing mean values of Bone Changes in Group OT, Group GPS and Group BS at 0-3 months, 3-6 months and 6-12 months' time.

Figure 5b showing mean values of overall Bone Changes in Group OT, Group GPS and Group BS over 12 months.

DISCUSSION

Only men were recruited for this study to avoid the effect of female hormonal changes on oral mucosa and bone [24,25].

CBCT was chosen in this study to determine the amount of marginal bone loss around implants based on its reported accuracy and precision. It is utilized successfully whenever direct measurements of bone height and density are required due to the fact that periapical and panoramic radiography ignore the bone density and height at the buccal and lingual surfaces [26].

The decreased amount of crestal bone resorption associated with Group GPS in comparison to Group OT and Group BS might be attributed to the difference in the abutment designs of the three groups. In case of GPS attachment the abutment connected to the implant is the female part which transfers the fulcrum point close to the fixture thus reducing lever arm and torque and allowing less crestal bone resorption [27].

Group BS also showed greater bone changes at the end of one year than Group OT, which could be due to the latter's low profile design, creating a favorable effect and causing less crestal bone loss [27].

These results are within the acceptable range of implant success which has shown a mean marginal bone loss around dental implants of 1.5 mm-2 mm in the first year after prosthetic restoration and 0.1 mm-0.2 mm annually after that [28,29].

This bone reduction might be due to surgical trauma, bone osteotomy and healing process. Also it might be considered an immediate bone reaction after insertion of the prosthesis and the functional stresses following prosthesis connection [26].

CONCLUSION

Within the limitations of this study it can be concluded that: GPS is least destructive to crestal bone around implants, however bone changes associated with Equator and Ball and socket implant attachments remained within the permissible range of crestal bone loss. Further studies are required to pursue the outcome of this study.

CONFLICT OF INTEREST

No conflict of interest.

THE ETHICS COMMITTEE'S APPROVAL

The approval of Ethics committee is added in Annexure A.

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