



# Radiographic Evaluation of the Effect of Ball and Socket versus Magnetic Attachments on Bone Height of Implant Supported Maxillary Obturator

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## KEYWORDS

Acquired maxillary defects, obturator, implant, attachments

## ABSTRACT:

**Aim:** radiographically evaluate the performance of implant assisted maxillary obturators retained by magnetic versus ball-and-socket attachments on bone height of implant supported obturator.

**Material and Methods:** Ten patients having Armany class I healed partial maxillectomy were selected for this study. According to the type of implant attachment used, the patients were randomly divided into two equal groups: five patients each, Group I: Ball and socket attachments were used with the long advent implants to retain maxillary obturators. Group II: Magnetic attachments were used with the long advent implants to retain maxillary obturators. Following final adjustments, follow-up visits to examine the supporting tissues, eliminate any complaint and for data collection were scheduled after one week after loading (baseline), three, six, nine and twelve months thereafter. Digital images from the canon drum scanner and Digora system were used to analyze and evaluate bone height.

**Results:** The mean value of the decrease of bone height of the three implants in the ball and socket and magnet group were statistically significant ( $P \leq 0.05$ ) for the magnetic group.

**Conclusion:** bone height at the crest of the ridge along the implants of the magnet group showed a decrease than that of the ball and socket group and this difference was statistically significant.

## 1. Introduction

Maxillectomy defects leave behind sizable deformities, along with functional, cosmetic, and psychological impairment that greatly affect the patient's quality of life.<sup>1</sup> Patients having maxillary defects can be rehabilitated with either tissue grafting or using obturator prostheses.<sup>2</sup> However, surgical reconstruction may not always be recommended; hence, prosthetic rehabilitation becomes a viable option for rehabilitation of these patients.<sup>3</sup>

The provision of a prosthesis is a crucial strategy for regaining physical and psychological make up.<sup>4</sup> With edentulous patients, retention, support, and stability of maxillectomy, obturator prostheses are usually problematic. For this reason, several attempts were advocated to enhance the mechanical properties of these prostheses. The use of Osseointegrated implants together with different types of attachments were among the recommended solutions.<sup>5</sup> The implant supported obturator offered a treatment alternative; it provides

better chewing, masticatory performance, less complaints, and higher satisfaction. The use of osseointegrated implant assisted prostheses has increased based on the successful outcomes in maxillectomy patients.

The introduction of different types of dental attachments has raised the expectations of prosthodontists as they play a viable role in augmenting the retention and stability of implant assisted overdentures.<sup>7</sup> Ball and socket attachments are widely used due to their simplicity, cost, and ease of handling. Magnetic attachments are also among the acceptable resilient attachments providing stress breaking effect by elimination of the excessive loads on implants.<sup>8</sup> They also allow some freedom during prostheses insertion and removal and ease of manipulation by patients. However, corrosion affects their long-term durability.<sup>9</sup> The hypothesis is that ball and socket attachments are more liable to be used with implant supported obturator than magnetic attachments.



Hence, this study aimed to radiographically evaluate the effect of implant assisted maxillary obturators retained by magnetic versus ball-and-socket attachments on bone height at the crest of the ridge.

## 2. Material and Methods

According to statistical sample size calculation using Minitab software (Minitab 22.1.0, Minitab Inc., Pennsylvania, United States) with a power 0.9 and  $\alpha$  0.05 based on a previous study.<sup>8</sup>

Ten patients having Army class I healed partial maxillectomy were selected for this study (Figure 1).



The criteria of selecting the patients included age between 50 to 65, all the cases were completely edentulous, nonsmoking cases, the absence of lesion recurrence, and no post-surgery radiotherapy was required as evidenced by their surgeon or the dose below 5, 000 centigray. Patients with history of obturator construction were excluded. The defect side met the following requirements:

- ❖ Nasal mucosa on the sinus side of the orbit's floor was removed before a skin graft was applied.
- ❖ Split thickness skin graft was used to line the reflected cheek flap.
- ❖ The soft palate was intact and allowed normal velopharyngeal closure and not block access to the proper level of velopharyngeal closure.
- ❖ Turbinate and bands of oral mucosa were removed during surgery.

The patients were given detailed information of the rehabilitation strategy, and the importance of implant treatment. They also received a thorough explanation of any potential discomforts, or hazards, as well as any

potential advantages, aftercare requirements, and follow-up instructions.

All the selected patients showed evidence of seeking therapy and were willing to follow the clinical follow up, oral hygiene instruction and medical and oral advice.

An intraoral examination was carried out both digitally and visually to detect any inflammatory reactions, or ulcers of the lips, remaining part of the palate, alveolar ridge, cheeks, or tongue. Also, the presence of any attached mucosa at the prospective implant site. Only class I maxillary mandibular relationship was considered. Radiographically, the bone density of the intact part of the premaxilla was division (D3) and the available bone height and width was division (A) for all the selected cases.

### Patient's sincerity:

The plan for rehabilitation was discussed with the patients. Patients underwent an extensive introduction to implant treatment designed to inform them of the procedure and risks., benefits, follow up and required maintenance.

### Processing, delivery, and follow up:

The obturator and lower dentures were processed in the standard manner with heat -cured methyl methacrylate. The extended part of the obturator in the defect side was hollowed to decrease its weight.

On delivery, the resin extensions into undercut areas or the height of the superior surface were relieved to permit setting of the prosthesis without perforation of the hollow obturator. The superior surface of the obturator was well polished and slightly convex contour and slope medially and posteriorly to help direct nasal secretions into the oral pharynx.

Delivery and adjustment were performed in a conventional manner. Pressure indicator paste was used to delineate areas of excessive tissue displacement on the unresected side. Also, disclosing wax was used for checking peripheral extensions and monitoring tissue displacement in skin -lined areas and where access was difficult.

Titanium root form Advent implant system (Paragon implant company USA 1158211/ENTTURA Boulevard-RO, SUITE 420, ENCINO.) With implant extender that



keeps tissue opening even when top of implant is positioned below the soft tissue was used, the implants were 10 mm in length and 3.7 mm in diameter with an apical vent and were SMB-blasted.

The impression for the surgical stent was made under palatal support to ensure proper positioning in the patient's mouth during use. Also, an additional support was provided by the lateral surface of the defect. The implants' positions were marked on the stent to facilitate the proper placement of the implants in the bony ridge after surgery,

According to the type of implant attachment used, the patients were randomly divided into two equal groups. Group I five patients rehabilitated by implant supported obturator and retained by ball and socket attachments and group II rehabilitated by implant supported obturator and retained by magnetic attachments.

Group I: Ball and socket attachments (Paragon implant company USA 1158211/ENTTURA Boulevard-RO, SUITE 420, ENCINO) used with the long advent implant were utilized to retain the was carried out joined to the obturator base, and the male ball was fastened to the implant (Figure 2).



A pick-up technique was made to assemble the ball and socket attachment components. The depressions present on the obturators fitting surface in the sites opposing the balls on the implants were slightly ground. An auto-polymerizing acrylic resin was applied to both the dried stainless-steel housing and the depressions on the fitting surface of the ball and socket retained obturators (Group I). The obturator was placed in position intra orally and the patients were asked to close in centric occluding relation for 20 minutes to ensure polymerization of the resin. The maxillary obturator was

removed perpendicular to the implant and attachment once the acrylic had dried. The obturator's fitting surface took up the metal housing with the rubber ring lining. A smooth surface was achieved by removing the excess acrylic resin. The obturator was examined for retention in the patient's mouth.

Group II: Magnetic attachments; the Dyna magnet system (Dyna, Prostbus 70, 4600 AB Bergen OP Zoom, the Netherlands) were used to retain the overdenture obturator prostheses (Figure 3).



The keeper of the magnet was attached to the implant while the magnets (60% palladium, 2% platinum, and 38% cobalt) were incorporated into the obturator fitting surface. Magnetic keepers attached to the implants supporting the obturator prostheses in Group II

were opposed and magnetically attached to the magnets in the fitting surface of the obturators. Auto - polymerizing acrylic resin was then added to the base of the magnet and to the opposing location of each implant. The patients were asked to close in centric occluding relation for 20 minutes until setting of the acrylic resin. The maxillary obturator was removed, and excess resin was removed.

Obturators were delivered to the patients who were given strict emphasis on following instructions for oral and prostheses hygiene necessary to preserve the remaining tissues and prevent infection and tissue inflammation. They were also instructed to brush the implants using a soft nylon brush with a tufted end and clean the defect with a plastic syringe and a solution of saline, hydrogen peroxide, and chlorohexidine mouth washes. Patients were also taught how to insert and remove the obturators along the path of planned insertion to avoid trauma to the tissues and frictional wear of the attachments.



Following final adjustments, follow-up visits to examine the supporting tissues, eliminate any complaint and for data collection were scheduled after one week after loading (baseline), three, six, nine and twelve months thereafter.

Marginal bone height (linear analysis) was the recorded parameters for each follow-up visit.

Patients were requested to refrain from eating, drinking, brushing their abutments, and cleaning their obturators for at least 30 minutes before the evaluation.

The radiographic template with the film holder bite block was seated in place in the patient's mouth. The Orix x-ray machine (Orix-AET, Ardet, S.V.R, Milano, Italy) set at 65 kilo volt, 10 milliamperere for 0.04 second, exposed the imaging plate. The exposure parameters were fixed in all cases and during all the follow-up periods. The film holder block was then removed from the patient's mouth. The sealed envelope containing the imaging plate was disinfected to minimize risk of scanner contamination. The imaging plate was placed in the scanner. The readout started automatically, and the image was displayed gradually on the computer screen and the image was automatically stored on the active patient file. The stored images of each patient were interpreted at the end of the follow-up periods. Interpretation was done by one examiner at two different times to decrease observer errors and the mean of the two trials was recorded.

Digital images from the canon drum scanner (Umax astra 1220 scanner, data system Inc, USA) and Digora system were used to analyze and evaluate marginal bone height measurements (linear analysis).

The developed periapical radiographs were digitized in the bitmap format using a flatbed full color Umax at 4800 dot per inch (DPI), connected to IBM Pentium equipped with SCSI card (Adaptic 961 south mile, California, USA).

### **Marginal bone height measurements:**

The software of the Digora system was used for evaluating changes in the marginal bone height mesial and distal to each implant. The measurements were obtained from the alveolar crest to the implant end at each follow-up interval.

For all measurements, the start and end readings were fixed for each point of evaluation of each implant along the different follow up periods for standardization.

### **Data handling and statistical analysis**

Data was collected, tabulated, computer saved and statistically analyzed using SPSS statistical package. Excel computer program was used to tabulate the results and represent them graphically.

The means of mesial and distal were calculated since there was no significant difference between them. The change between the base line (one week after insertion) and each of the follow up periods was calculated and statistically analyzed.

Quantitative variables from normal distribution were expressed as means  $\pm$  S.D.

The significant difference between the two groups was tested by using independent t-test at  $P \leq 0.05$ .

The significant difference between implants within each group was tested by using one-way ANOVA followed by Duncan t-test at  $p \leq 0.05$ .

### **3. Results**

Clinical observations and patient follow up revealed that patients participating in the study had no complaints with the acceptability, function, and retention of their overdentures, whether ball and socket or magnet retained overdentures. However, it was noted that some patients expressed a preference for the ball attachment. The basic problem with magnet corrosion was not evident during the study period.

#### **The results are statistically described as follows:**

Table (1) shows that the comparison of the mean value of the change of bone height between the base line and end of the follow up period (after 12 months) of the ball and socket and magnet groups was statistically significant for the first, second, and third implants of the magnet group indicated that the difference of the decrease of bone height around implants of the ball and socket and magnetic groups was statistically significant for the magnetic group. (Figure 4)

Table (1): A comparison of the change of bone height of the implants from base line to 12 months each of the two groups. (Figure 4)

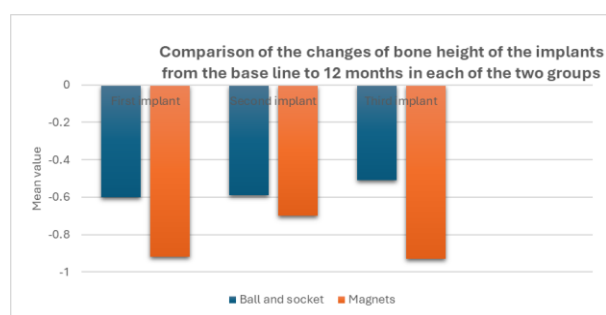


Implant	Ball and Socket	Magnet	t-value	p-value
First implant	-0.60±0.04	-0.92±0.03	16.00	0.000*
Second implant	-0.59±0.07	-0.79±0.14	7.28	0.019*
Third implant	-0.51±0.27	-0.93±0.06	3.35	0.010*

All values are represented as Mean ± Standard deviation.

\*= There is a significance difference between the groups by using an independent t-test at  $p \leq$

(Figure 4)



#### 4. Discussion

This study was conducted to evaluate the effect of ball and socket versus magnetic attachments of implant supported obturator on bone height radiographically. The design of an obturator attachment system should provide optimum force distribution around supporting implants to allow bone loading within physiological limits, transmit the occlusal forces in the direction of the long axes of the implant keeping the obturator from dislodging from the patients mouth to be able to enjoy a normal, comfortable chewing function.<sup>10</sup>

The long cone parallel technique using Rinn, XCP periapical film holders together with a radiographic template was employed to ensure standardization of the film focal distance, angulation, and elimination of any superimposition of any other structures than that to be received.<sup>11</sup>

The computed Digora digital intra-oral radiographic system was used because it provides immediate sharp images with no necessity for darkroom processing. It also provides accurate recording of the qualitative and quantitative changes of bone around fixtures and manipulating the radiographic information through image processing.<sup>12</sup> Bone height measurements were the radiographic monitored parameters used in this study, as

they considered important evaluation in determining the prognosis of any prosthetic therapy.<sup>13</sup>

Mesial and distal marginal bone height was measured utilizing predetermined fixture threads as a reference point. The presence of distinct bone margins indicates successful osteointegration.<sup>14</sup>

Bone height changes was detected at the end of the study period because in the first year of observation, bone height changes around implants were very slight, and since Digora system is only sensitive to bone height change values up to one decimal places, it was thus expected that measurable bone height changes could only be detected at the end of the study period.<sup>15,16</sup>

All images were stored and interpreted by one examiner at two different times and the meanings of the two trials were calculated and recorded to eliminate observers' errors. All implants did not show any detected mobility or peri-implant radiolucency.<sup>17, 18,19</sup>

The results of the comparison between the two groups as related to crestal bone height loss changes revealed that there was increased in crestal bone height loss in the group of magnetic attachment rather than the group of ball & socket attachment and this difference was statistically significant. The ball and socket attachment have a small stress on peri-implant bone and good stability in an anterior – posterior direction. They function as a resilient universal hinge attachment and allows for pivoting and rotational movement.<sup>20</sup>

The ball attachment could be advantageous for implant supported obturator regarding optimizing stress and minimizing obturator movement.<sup>21,22</sup> Also, the ball attachment has a high degree of peak load (resistance to dislodging force).<sup>23</sup>



On the other hand, retentive forces generated by the magnetic attachment are limited against lateral masticatory forces.<sup>23,24</sup>

The ball attachment transfers a considerable amount of load to the bearing area, whereas in the magnet attachment, the applied force is transferred directly to implant and denture bearing area.<sup>25,26</sup>

The corrosion problems initially associated with magnetic retainers, although they have been somewhat resolved through non – corroding coating and seals, they persist in many cases of overdentures that with magnetic attachments.<sup>27,28</sup> Also, the ball attachment system is well suited to the overall objectives of treatment, simplification, and limited complication for an expanded use of implant retained overdentures.<sup>29,30</sup>

The results agreed with the conclusion and reported that, at the end of the study period, the crest of bone height adjacent to the implants of the magnet group showed a decrease than that of the ball and socket group and this difference was statistically significant.

## 5. Conclusion

Within the limitation of this study, it could be concluded that the crest of bone height along the implants of the magnetic group was decreased more than that along the implants of the ball and socket group and this clinical difference was statistically significant. The difference between the two groups is related to the difference of attachments which influence force transmission to the implants and the movements of the maxillary obturator under load. So, the selection of the suitable type of attachment is important to increase the survival rate of the implants. The maxillary obturator supported by implants placed in the premaxillary region is a successful treatment modality for edentulous hemimaxillectomy patients.

Ethical approval number: BUC-IACUC-240623-100 (Badr University in Cairo)

## Funding

This study was self-funded, and the author declares that there was no external funding for this study.

## Data Management

- All the patient's data obtained from medical and dental history were recorded then transferred into digital form.
- Data will be saved in a specific folder with passwords known only by the main operator on his personal computer.
- The data obtained from the study were first recorded manually and then transferred and saved in digital format till the end of the study to be digitally compared and statistically analyzed.
- Data Availability: The data presented in this study are available on request from the corresponding author.

## Ethical Considerations

- **Risks and Discomfort for Patients:** There were no serious risks regarding this study.
- **Minimization of Risk:** Continuous follow up was carried out to eliminate any complaint and achieve patients' comfort.
- **Benefits to the Patients and to the Community:** Prosthetic reconstruction of maxillary defects helps patients to continue their life.
- **Privacy:** Privacy for participants was protected. Data was saved in a specific folder on a computer with passwords known only by the main operator.
- **Confidentiality:** Confidential data of the patients was privately known by the main operator.

## Conflict of interest:

The author declare that they have no competing interests.

**Consent Procedures:** Before the provision of the treatments, each patient signed a consent form supplied by the ethical committee of the Faculty of Dentistry, Ain Shams University, written in the Arabic language. The consent described the steps of each procedure, their rights, and their role in the study.

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