Current Science International
Volume: 12 | Issue: 01| Jan. - March| 2023

EISSN:2706-7920 ISSN: 2077-4435
DOI: 10.36632/csi/2023.12.1.4
Journal homepage: www.curresweb.com
Pages: 27-34

Role of Material and Technique in Reduction of Maxillary Obturator Weight

[1]Khaled K. El-Din Amin, [2]Magdy M.M. Mostafa, [3]Emad A. Awad and [4]Tarek R. Abdelrehim

[1,4]Associate Professor, Oral and Maxillofacial Prosth. Dept., Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia.
[2]Professor, Oral and Maxillofacial. Dept., Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia.
[3]Professor, Oral and Maxillofacial Prosth. Dept., Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia and Prosth. Dept., Faculty of Dentistry, Alexandria University, Egypt.

Received: 15 Dec. 2022 **Accepted:** 20 Jan. 2023 **Published:** 30 Jan. 2023

ABSTRACT
This study was conducted to evaluate the effect of weight of the obturators on the supporting structures of acquired maxillary defects. Twelve maxillectomy patients class I Aramany classification were selected and were divided into two equal groups, six patients each. Hollowed maxillary obturators were constructed for each patient with same design. group I from titanium and group II from cobalt chromium. The acrylic resin used in both groups was visible light polymerized resin. Bone height and density of the supporting abutments were evaluated using the Digora com- puterized system the results showed that there was no significant difference between the two groups after six months regarding bone height and density, however. there was a highly significant difference after twelve months.

Keywords: overdenture, Locator attachment, OLS attachment, CBCT, Digital occlusal analysis**.**

1. Introduction
Rehabilitation of patients with intraoral defects due to partial maxillectomies for neoplasm forms a highly heterogeneous group. Each situation requires individual assessment of the most appropriate protocol for rehabilitation. The presence of natural teeth together with the size of the resection and the extent of soft tissue loss, have major implications on prosthesis design (Desjardins, 1978 and Shahi, 2021)

The main principles of prosthesis design are to reduce the potential damage to the abutment teeth and supporting periodontal tissues while enabling acceptable functional levels of speech, mastication and deglutition (Beumer, 1996)

The design of the obturator must consider the movement of the prosthesis during function, without exerting much stress upon the teeth (Aramany, 1987)

It is critically important that prosthesis weight be minimized to reduce the likelihood of damage to the abutment (Schwactzman *et al.,* 1990 and Parameswari and Parthepan, 2016). The most common way of weight reduction was to hollow the obturator to overcome the cantilever action of solid obturator (Chalian and Barnet, 1972, Kanwa *et al.,* 2000 and Karthikeyan *et al.,* 2022)

The second approach to reduce the weight of the obturator was to choose a lighter weight matal. With recent advances in dental technology, and materials titanium has rapidly become popular. Through research and studies its advantages as a material include its light weight, fatigue resistance and corrosion resistance (Lautenschlager and Monaghan, 1993). The thermal conductivity of titanium is good in a manner that would imply better tissue response (Salah, 1999). It is less dense than conventional alloy which is important for the large size obturator prosthesis. Titanium framework have been reported to be approximately 40% lighter than cobalt chromium frameworks (Mori *et al.,* 1997) and approximately 60%

Corresponding Author: Magdy M.M. Mostafa. Oral and Maxillofacial Prosth. Dept., Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia.

lighter than Nickel chromium frameworks (Al-Mesmar *et al.,* 1999 and Karthikeyan *et al.,* 2202)

Because of its advantages, many studies were conducted to compare between titanium and cobalt chromium in removable partial denture constrution (Jang *et al.,* 2001) compared the casting accuracyand roughness of titanium and cobalt chromium denture frameworks. The results of the study showed that the clinical fit, porosity, and surface roughness of the titanium and cobalt-chromium frameworks were comparable in another study, Au*et al.* (2000) examined the success of titanium removable partial dentures compared with that of cobalt-chromium using a randomized controlled clinical trial. Patients were reviewed for. 24 months following denture insertion, incidence of failure was analyzed. Fracture of retainers in both metals occurred only in the first 12months but there were no significant differences between the two in all the criteria examined between the 12 and the 24 month reviews.

Several studies compared the flexibility of titanium clasps and cobalt chromium clasps, showed that titanium clasps were significantly more flexible than cobalt chromium clasps making them suitable for construction of short retentive arms or clasps engaging deep undercuts and in teeth with compromised periodontal support (Jay *et al.,* 1997; Salah, 1999 and Essopp *et al.,* 2000).

Rodingues*et al.,* 200 acompared circumferential removable partial denture clasps made ofcomercially pure titanium and identical clasps made of two different cobalt chromium alloys subjected to an insertion /removal test simulating 5 years of framework use. The results suggested that commercially pure titanium clasps maintained retention over a simulated 5-year period.

Obturator prostheses are typically large. and their weight and size are often important desig factors. The apparent advantages of titanium as regards its light weight and flexibility encouraged it use as a base for maxillaryobturators (Gary *et al.,* 1992). Rilo *et al.* (2002) described the fabrication of an obturator prosthesis with a titanium framework and visible ligh polymerized denture base resin. It was speculated that these low-density materials may produce prostheses lighter than similar ones made with conventional materials. An added advantage is that visible light-polymerizing resins facilitate relining.

Visible light polymerized resins are clearly advantageous for patient with intraoral defects. The resins allow good fit, are free of methyl methacrylate, and procluce stable color (Fischman, 1989 and Alfaraj, 2202). Visible light polymerized resins are also up to 25% lighter than conventional denture base resins (Benignton, 1991 and Benignton *et al.,* 1996)

The use of visible light polymerized resins not only reduces weight but also improves oral hygien since. These resins demonstrate low porosity (Ogle *et al.,* 1986). Furthermore, visible light-polymerization greatly facilitates fabrication and final adjustment in the mouth (Caputo and Ryan, 1989; Meyer *et al.,* 1990 and Shifman, 1990).

Accordingly, this study was conducted to evaluate obturators weight reduction by using visible light cured resin in conjunction with either titanium or cobalt chromium alloys on abutment teeth bone height and density.

2. Materials and Methods

Twelve maxillectomy male patients 37-50 years old, Aramany class I, were selected. The intact side had no missing teeth. They did not and will not receive chemotherapy or radiotherapy (Fig. 1). The patients were divided into two groups, six patients each:

Fig. 1: One of the selected cases

Group I*:* Received hollowed definitive maxillary obturators constructed from titanium and visible light cured resin (Fig. 2).

Group II: Received hollowed definitive maxillary obturators constructed from cobalt chromium and visible light cured resin (Fig. 3).

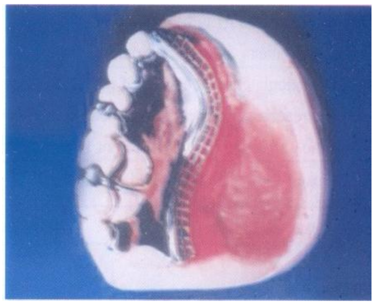

Fig. 2: Titanium frame work design

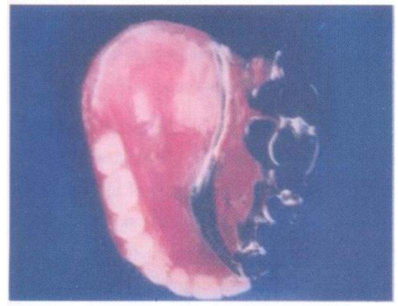

Fig. 3: Cobalt chromium obturator design

For all patients, definitive obturators started to construct at least six months after maxillary resection, to give enough time for wound healing to reach a relatively stable dimension. This was judged by following up the case several times after surgery.

Fabrication of the obturator

Study casts were made after preliminary alginate impressions. that were surveyed. The design of the obturators framework was the same for both groups.

Two double Aker clasps were planned to provide "cross tooth" retention and reciprocation, on the premolars and molars. Lingual retentive clasp arms with buccal reciprocating arms were planned for the molars, while buccal retentive clasp arms were planned for the premolars.

I bar retainer was planned on the anterior abutment. Complete palatal coverage was used as a major connector to gain direct and indirect retention as much as possible.

Multiple rounded rest seats were prepared on the occlusal surface of the molars and premolars. Mesial surface of anterior abutment was made parallel to the path of insertion and abutment contours were modified, if needed, to receive the retentive clasp terminals in their proper position.

For both groups, rubber impressions were made and master casts were poured, surveyed, modified, and duplicated into the refractory casts on which the metal frameworks were casted.

According to the type of metal, the investment materials used were differed. For group 1, (Re matitan system, Dentaurm, Pforzheim. Fed. Rep. Germany) was used while BeGo Bremer Goldsch lagerer with Herbst GmbH and Co. Germany was used for group II.

Titanium was casted in titanium cylindrical casting ingots which is a closed unit consisting of two chambers connected to one another that ensures efficient casting. Both melting and casting of the metal took place in the double chamber system, which was evacuated and flooded with argon. An electric arc is used to melt the titanium ingots. Cobalt chromium was casted using the centrifugal casting machine.

The metal frameworks were finished and polished, and tried in the patient mouth to ensure passive and proper seating and any needed adjustment were done.

The method described by Rilo *et al.* (2002) to secure the obturator portion of the prosthesis was used. The visible light cured denture-base resin core (Triad; Dentsply, York, Division) was applied over the retentive loops, the hand-held visible light source model XL 1500; 3M Dental Products, St Paul, Minn) was applied for 2 minutes to obtain an initial set. The initial set allowed the obturator material to remain able enough to be removed from the cast without interfering with tissue undercuts. The denture was removed from the mouth and placed in the visible light curing unit Dentsply/York Division, Triad II (Fig. 4) for 8 minuts.Wax rims were then constructed over the obturator base. Jaw relations was recorded and transferred to the articulator. Setting up of teeth was carried out and tried in the patient's mouth to ensure light occlusion. Any adjustment were made especially those requiring additional layers of visible ligh cured resin.

An occlusal index was constructed over the teeth using silicone the teeth were removed and placed in their corresponding imprints in the index. Wax was eliminated, bonding agent was applied on the base and necks of teeth and were replaced on the base with aid of the index. The cast was then removed with the ring and placed in the curing unit for 8 minutes to cure the resin, attaching the teeth.

Fig. 4: The visible light curing unit

The hollow obturator base was refined and the roof portion of obturators was closed as described by Wang and Hirsch, 1997. A functional reline was made by adding small quantities of visible light polymerized resin over the core in the patient mouth. The patient was instructed to speak and swallow for 3 minutes; and a hand-held visible light source was applied for 1 minute to obtain an initial set.

The prosthesis was removed from the mouth, air barrier coating was applied over the visible light cured resin (Triad) e Air Barrier Coating ABC Dentsply national corporation York PA and the prosthesis was polymerized in the unit for 8 minutes. To ensure complete polymerization the prosthesis was finished and polished then delivered to the patients.

After obturator delivery the patients were priodically recalled every month for one year and were instructed for proper home care.

X-rays were done at delivery, six months and twelve months after insertion using the Digora computerized system (Orion Corporation, Sorede ,Medical Systems, Helsinki Finland)An electronic imaging plate (sensor), and a Rinn XCP periapical film holder (Rinn corporation, XCP instruments for extension cone paralleling technique, USA) were uacrylic sed. Individually constructed radiographic templates were used for making standardized digtal images for the abutment. The template was designed to receive the Rinn XCP periapical filmholder in a position just palatal to the abutment andparallel to their long axes.

2.1. Radiographic evaluation

1. Bone height measurements

The linear measurement system supplied by the software of the Digora machine was used for assessing the mesial and distal marginal bone height around the abutments. A line was drawn the from cernento-enamel junction at the mesial and distal surfaces of the abutments to the highest point of the alveolar crest (Fig 5). Measurements were used to evaluate the changes that occurred in the alveolar ridge height during the study periods.

2. Bone density measurements

The software of the Digora system was again used for evaluating changes in bone density mesial and distal to the abutment. In this study, the linear density measurement system was used. A line was extended from the crest of the alveolar ridge to the apex of the abutment and parallel to the root surface of each abutment (Fig 6). Bone density was recorded and the mean value of the readings was calculated. To calculate the accuracy of the measuring techniques, each radiograph was measured five times by the same operator at different time intervals.
All results were tabulated and statistically analyzed.

Curr. Sci. Int., 12(1): 27-34, 2023
EISSN: 2706-7920 ISSN: 2077-4435 **DOI: 10.36632/csi/2023.12.1.4**


Fig. 5: Bone height measurements **Fig. 6:** Bone Density measurements

3. Results

The results of this study were summarized at table (1-4). Table (1): Represent the changes at the crestal bone height of the abutment teeth for the studied groups during the follow-up periods. It was found that in group I there was reduction in bone height after six months but this reduction has no significant value but the reduction was significant after 12 months of wearing the obturators.

Regarding group II there was significant reduction after 6 months with highly significant reduction after 12 months at P < 0.0 I.

Comparing the mean difference change between the two groups in table (2) no significant difference in bone height between the two groups was detected after 6 months but there was highly significant difference between the groups after twelve months of wearing the obturators.

Table 1: Mean standard deviation and paired t-test for the crestal bone height changes of the abutment teeth for the studied groups during the follow-up period.

	Mean	SD	T	P
Group I				
0-6	1.3-1.5	± 0.173	0.627	NS
0-12	1.3-1.9	± 0.392	3.72*	0.05
Group II				
0-6	1.4-1.8	± 0.429	3.14*	0.05
0-12	1.4-2.1	± 0.523	7.24**	om

SD = Standard deviation

Table 2: Mean difference. standard deviation and student t-test for changes in crestal bone height between the studied groups.

	Six months		12 months	
	M.D	S.D.	M.D	S.D.
Group 1	0.2	0.13	0.0	0.04
Group II	0.4	0.093	D.7	Ul71
Gp I. vs Gp Il	1.19 NS		4.63*	

M.D = Mean difference SD = Standard deviation

The effect of wearing the obturators on the bone density and degree of blackening was represented at table 3 and 4.

Table (3) represent the changes of degree of blackening of the crestal bone of the abutment teeth during the study period. It was found that for group I patient there was increase in the degree of blackening in the first 6 months of wearing the obturators but the increase was not significant at P < 0.05. After twelve months there was significant in- crease in the degree of blackening at P < 0.05

But for group II patients there was significant increase after six months at P < 0.05 with highly significant increase in the degree of blackening at P < 0.01 (Table 4). Comparing the two groups together it was found there was no significant difference at the degree of blackening between the two groups after 6 months of weaning the obturators with significant increase after twelve months at $P < 0.05$.

Table 3: Mean. standard deviation and paired t-test or degree of blackening of crestal bone of the abutment teeth or the studied groups during the follow-up period

	Mean	SD	T	P
Group I				
0-6	56.72-64.24	± 10.32	1.29	NS
0-12	56.72-79.52	± 947	4.23	0.05
Group 11				
0-6	61.31· 74.3	± 2.04	3.21	0.05
0-12	61.31-95.17	± 1.02	7.32	o. D I

SD = Standard deviation

Table 4: Mean difference. standard deviation and student t-test of changes in degree of blackening of the crestal bone between the studied groups

	Six months		12 months	
	M.D	S.D.	M.D	S.D.
Group I	7.,IS	± 142	22.XO	± 9.14
Group 11	13.07	± 2.17	33.X6	± 4.29
Gp I vs Gp ll	1.942 NS		3.29*	

M.I = Mean difference SD = Standard deviation

4. Discussion

Preservation of the remaining tissues has a prime importance in prosthodontics especially muxillofacial cases due to its limited amount.

Most of the investigators efforts in maxillofacial prosthodontics have been directed towards techniques and designs that minimize stresses and undue movement of the obturator during function thus maintaining the health of the remaining structures (Beumer, 1996 and Rilo *et al.,* 2002).

In this study to prevent tissue-ward movement to improve support and also stability of the obturators multiple occlusal rest seals were prepared on the occlusal surfaces of premolars and molars (Parr *et al.,* 1989 and Beumer, 1996).

Aramany, 1979 recommended the use of cross teeth" retention and stabilization in cases" with total maxillectorny defect due to the lack of cross-arch stabilization. Accordingly. both buccal and lingual retentive arms were planned in the removable partial denture design. Two double Aker clasps were used with lingual retentive clasp arms and buccal reciprocating arms for the molars teeth to resist the downward displacing forces disengage from the teeth during function **I** bar retain was constructed on the anterior tooth adjacent to the defect. This clasp design offers' several advantages; it minimizes stresses on the abutment tooth, reduces downward rotational forces produced by the obturator extension and produces favorable periodontal health and more favorable esthetics.

Complete palatal coverage was used in this study to provide favorable support and stability for the prosthesis due to the cantilever effect of the obturator extension (Beumer, 1996).

Theoretically speaking heavy obturators apply more stresses on the remaining structures (Blair and Hunter, 1998). The use of titanium in framework construction was due to its lighter weight compared to cobalt chromium (Al-Mesmar *et al.,* 1999 and Awad *et al.,* 2021) that is why it was recommended in maxillofacial cases. At the same time visible light cured resin was used because of its lighter weight compared to heat cured resin (Benigton, 1989 and Benigton *et al.,* 1996).

Light occlusion was established on the resected side to minimize superior displacement of the obturator (Parr and Grander, 1995).

Despite the efforts made to minimize the detrimental stresses transmitted to the remaining structures. movement of the prosthesis during function might induce pathological stresses on the remaining hard tissues leading to tooth loss.

Generally speaking, there was a decrease in the alveolar bone height, and density around all the abutments in all patients that participated in this study. These changes were not the same in the two groups under investigation. The best results with titanium is most probably due to its lighter weight which is in agreement with Schwacizrnan *et al.* (1990) who stated that it is critically important that prosthesis weight be minimized to reduce the likelihood of damage to the abutments.

Although the advantages of titanium and visible light resin was their light weight and their biocompatibilities to the supporting tissues there was reduction in bone height and density in the first group which may be attributed to the movement of the obturators during function.

From the results of this study the titanium as a denture base may help to preserve the supporting structures that recommended its use in maxillofacial cases.

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