

Comparing the Accuracy of Silicone and Polyether in Reproducing Gingival Height for Implant Supported Crown: an in vitro study

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ARTICLE INFO

Article History

Received 25 October 2014

Accepted 25 January 2015

Key words:

Implant
Polyether
Silicone
Gingival Sulcus

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Abstract

Statement of Problem: Accurate impressions are one of the most critical factors in achieving acceptable restorations. When pouring the impressions of implant supported restorations, soft materials like silicone and polyether are used to reconstruct the gingival form around the implants. To the best of our knowledge, no study has been conducted on the comparison of the accuracy of these soft materials.

Objectives: To evaluate the accuracy of polyether and silicone in reproducing the correct depth of gingival sulcus around the implants by probing.

Materials and Methods: By the use of a periodontal probe, the gingival height was measured in six marked areas of one maxillary partial edentulism model on which two fixture analogs were attached and three points were marked around each analog for measurements, which was considered as an index height. Addition silicone impression material (putty and wash) was used to simultaneously take 10 impressions of the model. The samples were randomly divided into two groups of 5 and each impressions was poured twice; for the first group, the impressions were first poured with silicone, and for the second one they were poured with polyether material for reproducing the gingival contour; in the second group, the procedure was performed in reverse. Therefore, there were 10 casts in each group and because each cast contained two analogues, and each analogue was marked in three points for measuring gingival height, 60 numbers were achieved for each group as the gingival height. The mean gingival heights were compared by paired t-test using SPSS software, version 18 ($p = 0.05$).

Results: Comparison of the mean gingival height of the silicone and control groups revealed that there was no significant difference between the two groups ($p = 0.090$), whereas, a significant difference was found between the mean gingival height of the polyether and control groups ($p = 0.034$).

Conclusions: Within the limitation of this study, it was concluded that for reproducing the gingival height around the implants, silicone materials are more appropriate than polyether ones.

Cite this article as: Derafshi R, Sabouri AA, Kazemeini J. Comparing the accuracy of silicone and polyether in reproducing gingival height for implant supported crown: an in vitro study. *J Dent Biomater*, 2015;2(1):24-28.

Introduction

Tooth loss causes impairment in the mastication system and subsequently in digestion; hence, the missing teeth must be replaced to improve the mastication and

digestion. Throughout the human history, various systems have been used for replacement of the lost teeth. In the last three decades of the 20th century, the approaches have moved towards using implant because it preserves the jaw bone and makes up and completes

the mastication system [1]. However, all patients prefer to have their natural teeth as far as possible [2]. In order to attain the utmost ideality, the implant should be aesthetically acceptable in addition to stable [3].

One of the clinical stages in appropriate reconstruction of the teeth and the surrounding structures is taking impression [4,5]. Accuracy of the impression is essential, especially in fixed prosthesis and implant supported restorations, because any inaccuracy in fabricating the impression would be transferred to the next stage which is making the prosthesis. Inaccurate impression can cause laboratory error and improper seating of the prosthesis, followed by mechanical complications such as screw loosening, implant fracture, and occlusal inaccuracy [6-8]. Misfitting of the margins which is caused by improper seating of the prosthesis can lead to increased plaque accumulation and would affect the implant surrounding the soft and hard tissues [9,10]. It is almost impossible to achieve a quite accurate seating [11] and the relation between the behavior of supporting bones and prosthesis misfitting is not clear [12-14]. Yet, the globally accepted concept is that misfitting of the prosthesis should be the minimum [15].

Researchers have evaluated the factors that influence the accuracy of implant impression including the impression coping, direct or indirect impression technique, impression materials, and angled implant [16-18].

Unlike natural teeth, implant has no periodontal ligament to compensate for inaccuracy; it only shows subtle movements due to the elasticity of the bone tissue [5]. Thus, in order to create the accurate relation of the poured cast, recording the 3D status of the implant in the oral cavity in prostheses that are supported by implant is more important compared to those supported by natural teeth [19].

In order to achieve better conformity of the crown made to the patient's gum and esthetics, the patient's gingival form should be reconstructed; to do this, soft material is used to let the dentist have the patient's gingival form in laboratory [3]. The gingival tissues can be reproduced by injecting an elastomer to represent the soft tissue around the implant analog before pouring. This facilitates removal of the impression coping from the stone cast and the placement of subsequent abutments without breaking the stone and loosening the reference point of the soft tissue. Several

materials are used as soft tissue reproducing material, such as polyether impression material [20] and silicone material [3]. However, none of the previous studies has compared the accuracy of these materials.

Periodontal probing of the sulcus reveals the space available for subgingival extension of the crown [20]. The purpose of this study was to evaluate the accuracy of polyether and silicone in reproducing the correct depth of the sulcus (gingival height) around the implants by probing. It is hypothesized that there is no difference between silicone and polyether in reproducing the gingival height.

Materials and Methods

In this *in vitro* study, a model of maxillary partial edentulous (Ker-model, Dentium, Seoul, Korea) in which the outer surface of the model was covered with one elastic layer as the soft tissue representation was selected. First, the model was placed on a surveyor milling machine (Marathon 103, Daegu, Korea) and then two holes were created on the areas of the maxillary first and second molars, using carbide bur with 6mm diameter (milling machines bur C79G, Jota, Ruthi, Swiss).

The holes were deep enough to receive two wide fixture analogues (Intra-lock, Boca Raton, Florida, USA) so that the platforms of the analogues were at the same level with the crystal bone part of the model; therefore, the distance between the platforms and outer surface of the soft tissue representation layer of the model could be considered as Gingival Height (GH).

The fixture analogues were placed at the center of the holes by using dental surveyor and fixed in that parallel position by cold cure acrylic resin (Marlic, Tehran, Iran).

After the analog fixtures were fixed, the corresponding impression copings were attached to them (Figure 1A). Using a high speed hand piece diamond bur (Tees Kavan, Tehran, Iran), we marked the mesial, midbuccal and distal points on each impression coping (Figure 1B). For each impression coping, the height of the artificial gingiva was measured in these three points with the use of periodontal probe (Dena Puya, Karachi, Pakistan).

The gingival height in the first molar mesial, midbuccal and distal points was 5, 3, and 3 millimeter (mm), respectively, and these measurements for the



Figure 1: a) The model after the impression copings were installed. b) Marked on each of the impression copings (red lines show the marked point) c) Injecting silicone by gun.

second molar were 4, 2, and 4mm, respectively. The obtained measurements were considered as the control group.

The screw access channels of the impression copings were filled with cotton pellets to prevent penetration of the impression materials into them. All impressions were taken with one maxillary custom tray (Taksan, Tehran, Iran). The outer surface of the model was lubricated by Vaseline to prevent adhesion of the impression material to it. All impressions were obtained through putty and wash technique. The impression material used in the study was a polyvinylsiloxane type material (Han DAE chemical co., Seoul, Korea) in both putty and light consistency (wash) parts.

Putty base and catalyst were mixed according to the manufacturer's recommendation and put in the tray; at the same time, the wash material was injected around the impression copings and on the teeth and anatomic outer surface of the model with injecting gun (Applyfix® dispensing gun, Aarbergen, Germany).

After 10 minutes and completion of the setting phase, the impressions were separated from the model and impression copings were detached and connected to their corresponding analogues and put in their holes in the impression. Ten impressions were obtained with the same method. The impressions were randomly divided into two groups, each one containing five impressions.

Each impression was poured twice. For the first pour in the first group, the Trennmittle separating agent (Fegura^R sil, Buchen, Germany) was rubbed over the considered area of the impression in two stages with 1 min interval and then silicone gingival mask (Fegura^R sil, Polyvinylsiloxane, Germany) was injected with a gun (Figure 1C) around the fixture analogues. The height of pouring the gingimask was 7mm that was marked on the impressions with pencil. After 10 minutes (setting time of the gingimask), the impression was poured with standard pouring technique and by using vel-mix (Improved dental stone, Gc fujirock^R EP, Type IV, USA) and dental stone (Fluid dental stone, GC Fujirock^R Optiflow, Type IV, USA).

The second pour of the impression was exactly the same as the first pour unless in this time the polyether material (ImpregumTM soft, 3m espe ag, Polyether, Seefeld, Germany) was used as the gingival reproducing material.

For the second group of impression, the pouring method and materials were the same as the first group, but for these impressions the first pouring was done using polyether and the second pouring by silicone gingimask. Since 10 impressions were taken from the model and each impression was poured 2 times, a total number of 20 casts were obtained, half of which contained silicone and the other half contained polyether gingimask. For measuring the gingival height on the casts, the two impression copings were attached to their corresponding analogues in each cast, and in the

location of each marked line on the impression copings, the gingival height was measured with the same periodontal probe used on the model and by the same person who had done measuring the GH of the model.

The mean gingival heights were compared by paired t-test. SPSS Software, version 18 (Chicago, IL, USA) was used for data analysis (P = 0.05).

Results

The mean of gingival height in the silicone samples for the first molar area was 5 mm in the mesial, 3 mm in midbuccal, and 3 mm in distal points. For the second molar area, these measuring were 3.7 mm, 1.9 mm and 3.8 mm, respectively (Table 1). The mean of gingival height in the polyether samples for the first molar was 5.2 mm in the mesial, 3.2 mm in midbuccal, and 3.4 mm in distal points. For the second molar area, the measures were 4 mm, 2 mm and 3.9 mm, respectively (Table 1).

Table 1: Mean (mm) ±SD in polyether and silicone sample in three points of fixture analog that was installed over the first and second molar (N=10)

	Cast	Silicone	Polyether
Meisal (first molar)	5±0	5±0.67	5.2±0.79
Midbuccal (first molar)	3±0	3±0	3.2±0.42
Distal (first molar)	3±0	3±0	3.4±0.51
Meisal (second molar)	4±0	3.7±0.48	4±0
Midbuccal (second molar)	2±0	1.9±0.74	2±0.82
Distal (second molar)	4±0	3.8±0.42	3.9±0.57

The mean value for the silicone group was 3.78 and that for the polyether group was 3.55. The mean value for the original model (control group) was 3.66. The p-value for the sample groups was 0.090 for the silicone and 0.034 for polyether groups (Table 2).

Table 2: Comparison of gingival height in silicone and polyether samples with laboratory cast (N=10)

	Model	Silicone	Polyether
Gingival Height	3.66±1.01	3.78±1.15	3.55±1.11
P value*		0.090	0.034

*: The result of comparison of mean gingival height with model

No significant difference was found between the mean gingival height of silicone and control groups; however, a significant difference was found between the mean gingival height of the polyether and the control groups.

Discussion

This in-vitro study focused on accuracy in reproducing the gingival height (GH) with one silicone and one polyether material. When GH was compared between the samples of each material and original model, it was shown that the accuracy of silicone and polyether in reproducing GH is not the same; as a result, the null

hypothesis of this study was rejected.

The importance of obtaining accurate impression for prosthetic treatment has been emphasized in many studies [4-8]. Lindhe *et al.* [9] stated that misfitting of the margins which is caused by improper seating of the prosthesis can lead to increased plaque accumulation and would affect the implant's surrounding soft and hard tissues. Other factors like the type of the impression copings, direct or indirect impression technique, used materials and the angulation of implants were evaluated by researchers [16-18]. Sorrentino *et al.* [18] evaluated the effect of implant angulation, connection length, and impression material on the dimensional accuracy of implant impressions. They concluded that the angulation of the implants may cause strain of impressions, probably because of the higher forces required for the impression removal.

Moreover, undercuts negatively affected the impression accuracy. More accurate casts were obtained using the addition silicon in the presence of non-parallel implants and using a standard length connection of the copings in the presence of parallel implants, respectively. Lee *et al.* [21] studied the effect of subgingival depth of the implant placement on the dimensional accuracy of the implant impressions. They used a stone master model with five implant analogs embedded parallel to each other; the vertical position of the shoulders of the implants was intentionally different among the implants. They used two different impression materials, polyvinyl siloxanes (PVS) and polyether material, and concluded that there was no effect of implant depth on the accuracy of the PVS group.

However, for the polyether group, the impression of an implant placed 4mm subgingivally showed a greater horizontal distortion compared to an implant placed more coronally. Adding a 4mm extensions to the retentive part of the impression coping eliminated this difference. After taking accurate impression, an accurate pouring technique should be followed to obtain acceptable casts. When pouring the impressions of implant supported restorations, a soft material is used to reproduce the gingival form around the implants.

The benefits of these soft materials include having the patient's GH in laboratory and eliminating the risk of breaking the stone when changing the impression copings and abutments [3,20]. Elian *et al.* [3] described one method form accurate transferring of peri-implant soft tissue emergence profile from the provisional crown to the final prosthesis, using an emergence profile cast. The emergence profile cast was obtained from an impression of the implant-supported provisional restoration and poured with a silicone soft tissue model material. It was used for the fabrication of the emergence profile of the implant abutment and the cervical section of the crown. The reproduction of the soft tissue contour from the provisional to the final restoration results in an improved esthetic outcome of the final restoration. It seems that this is an important

step in achieving accurate casts, which has not been studied by others.

The periodontal probe was used in this study, because it is the clinical tool used for this purpose, and periodontal probing of the sulcus was suggested by Rosenstiel *et al.* [20] to reveal GH.

The main limitations of the current study were using a partially edentulous model instead of patients and measuring GH only in three selected points of each sulcus. Therefore, in-vivo evaluating the GH, comparing with GH on the corresponding casts, and considering the shape and contour of the gingival margin in the mouth and on the casts are recommended.

Conclusions

Within the limitations of this study, it was concluded that for reproducing the gingival height around the implants, silicone material are more accurate than polyether ones.

Acknowledgements

This present article was extracted from the thesis written by Dr. SJ Kazemeini (DDS) and was financially supported by Shiraz University of Medical Sciences (Grant # 8692005).

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