

EVALUATION OF THE SURFACE DETAIL REPRODUCTION OF IMPRESSION MATERIALS USED FOR OCULAR PROSTHESES

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ABSTRACT

Objective: To evaluate the surface detail reproduction of four types of impression materials compatible for the socket impression in the fabrication of ocular prosthesis.






Material and Method: Three alginate impression materials (orthoprint(OP), Ca37(C), Ophthalmic Alginate (OA) and a polyvinyl siloxane material (Affinis (P)) have been tested. A total of 40 impressions were made of stainless steel metal dies (ADA specification 19). The dies had 2 vertical and 3 horizontal lines inscribed on their superior surfaces. The measurements have been conducted on the 20-50-75 µm horizontal lines on the surface of the impression. Surface detail reproduction was evaluated using a microscope at

80X magnification. Statistical analysis was performed (one-way ANOVA and Bonferroni, alpha=0.05).

Results: Polyvinyl siloxane material resulted in the highest values and showed the most accurate surface at all of the 20-50-75 µm lines; whereas, lowest values were observed with Orthoprint.

Conclusion: Polyvinyl siloxane impression material showed the highest surface detail necessary for the construction of an ocular prosthesis among other impression materials tested.

Keywords: Ocular prosthesis, impression materials, surface detail.

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OKÜLER PROTEZLERDE KULLANILAN ÖLÇÜ MADDELERİNİN YÜZEY NETLİKLERİNİN DEĞERLENDİRİLMESİ

ÖZET

Amaç: Oküler protez yapımında socketin ölçüsünün alınmasında kullanılan dört farklı ölçü materyalinin yüzey netliğinin karşılaştırılması amaçlanmıştır.

Materyal ve Metot: Çalışmada 3 farklı aljinat ölçü maddesiyle Orthoprint (OP), Ca37(C), Ophthalmic Alginate (OA) ve bir polivinil siloksan ölçü maddesi olan Affinis (P) karşılaştırılmıştır. Paslanmaz metal güdükler üzerinden (ADA specification 19) 40 adet ölçü alınmıştır. Güdüklerin üst üzerinde 2 vertikal ve 3 horizontal çizgi yer almaktadır. Ölçümler

yüzeydeki 20-50-75 µm'lik yatay çizgiler üzerinden yapılmıştır. Yüzey netliği 80X büyütmede mikroskopla değerlendirilmiştir. İstatistiksel analizler için Tek Yönlü Varyans Analizi ve Bonferroni Testi yapılmıştır $\alpha=0,05$.

Bulgular: Polivinil siloksan ölçü maddesi 20-50-75 µm olmak üzere tüm derinliklerde en yüksek netlik değerini göstermiştir. En düşük değer ise Orthoprint için ölçümlenmiştir.

Sonuç: Polivinil siloksan ölçü maddesinin oküler protezler için kullanılan diğer ölçü materyalleriyle karşılaştırıldığında çok daha yüksek yüzey netlik değerleri gösterdiği saptanmıştır.

Anahtar kelimeler: Oküler protezler, ölçü maddeleri, yüzey netliği.

INTRODUCTION

The loss of the parts of the facial tissues have physical, social and psychological impacts on the patients. Maxillofacial prostheses, which restore and replace associated facial structures with artificial substitutes, aim to improve the patient's esthetics, restore and maintain health of the remaining structures.¹

The disfigurement associated with eye loss can cause significant functional, physical and emotional disorders. Psychological distress can be reduced by replacement with an artificial eye. The custom-made acrylic resin ocular prosthesis provide close contact with the tissue bed. The close adaptation of the prostheses distribute pressure equally compared with prefabricated prostheses.^{2,3}

Several techniques have been used in fitting and making ocular prosthesis. Empirically fitting a stock eye, modifying a stock eye by making an impression of the ocular defect, and the custom eye technique are the most commonly used techniques. The fabrication of a custom acrylic resin ocular prosthesis provides more esthetic and functional results. The impression establishes better contours in restoring the defect. The iris and the sclera are custom made and painted.^{1,3,4}

Dental impression materials, such as dental compound, dental waxes, the irreversible hydrocolloid and elastomeric materials, have been successfully used to provide precise defect contours of the eye socket. These materials have also been used to modify the tissue surface of a stock ocular prosthesis, so that it might adapt well to tissue bed of the socket.²

A lack of surface detail reproduction on the die is one manifestation of a compatibility problem. If prosthesis does not fit accurately to the socket, it may cause irritation on surrounding tissue and adversely affect the retention and stabilization. From this point of view, selection of suitable impression material for ocular prosthesis is critically important. The purpose of this study was to compare the compatibility of polyvinyl siloxane materials and alginate impression materials, according to detail reproducibility. The null hypothesis was that there were no significant difference between the compatibility among impression materials.

MATERIAL AND METHOD

The impression materials used in this study included three alginate impression materials: Ca37 (C) (Cavex, Haarlem, Netherland), Ophthalmic Alginate (OA) (Factor II, Lakeside, USA), Orthoprint (A) (Zhermack, Rovigo, Italy), one polyvinyl siloxane material: Affinis (P) (Coltène Whaledent, Altstätten, Sweden). The tests were made according to the ADA standards specifications number 19.⁵ 20 replicas were prepared from each impression materials.

A stainless steel die was fabricated according to the American Dental Association, Standards Specification No.19 consisting of a detail reproduction test block, a ring mold (this simulated a tray or container for the impression material), and a riser (Figure 1).⁵ The riser was 29.97 mm in diameter and 3 mm in height, whereas the ring was 30 mm in diameter and 6 mm in height. This allowed the riser to fit impression materials inside the ring. The riser made pressure on the impression materials and the excess impression material was allowed to flow outward around the riser. There were three horizontal lines and two

vertical lines on the top surface of the die. The width of horizontal lines were 20µm, 50µm and 75µm. The reproducibility of these lines were used to test the ability of the impression material to reproduce fine detail.

Each impression material was prepared according to the manufacturers instructions in correct powder/water-base/catalyst ratios and working times. The alginate impression materials were mixed using an electric mixer (ALGIMAX AM505, GC Co., Japan) for 10 sec, and the dies placed in the impression material. The alginate impression materials and metal dies were separated after 2 min. Surface detail reproduction was evaluated immediately after the impressions were separated from the dies. The poly vinyl siloxane impression materials were ejected onto the die. The polyvinyl siloxane material and metal die were separated after 2 min. Impressions were divided into three parts vertically and their surfaces assessed by the examiner at 80X magnification with a microscope (Leica dfc 280, England) (Figure 2a, 2b, 2c, 2d). The resulting data were evaluated by Image J software. The rising

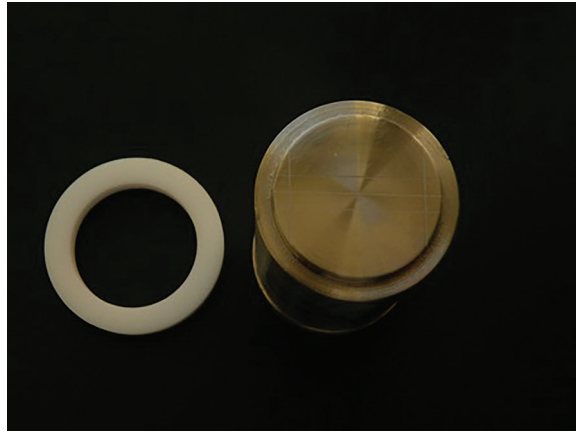


Figure 1. American Dental Association, Standards Specification No.19 reproduction of test block and a ring mold.

amount of the impression materials in the notch were calculated with the program.

SPSS 15.0 software was used for the statistical analysis. One way analysis of variance (ANOVA) was used to test differences between the impression materials. A conservative post- hoc test correction was applied (Bonferroni multiple comparisons test) to evaluate the difference between the mean values of subgroups.



Figure 2a. X80 magnification microscope view of Ca37 sample.

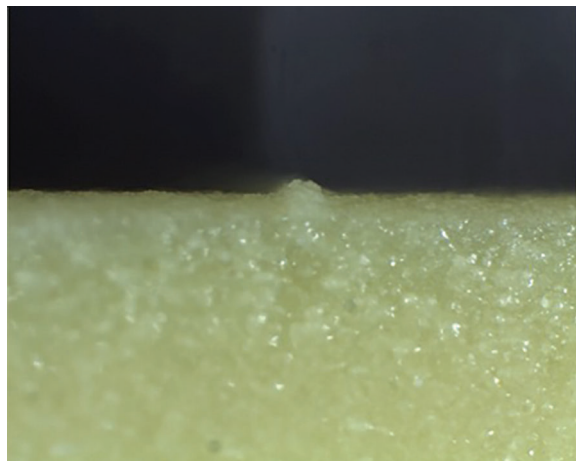


Figure 2b. X80 magnification microscope view of Orthoprint sample.

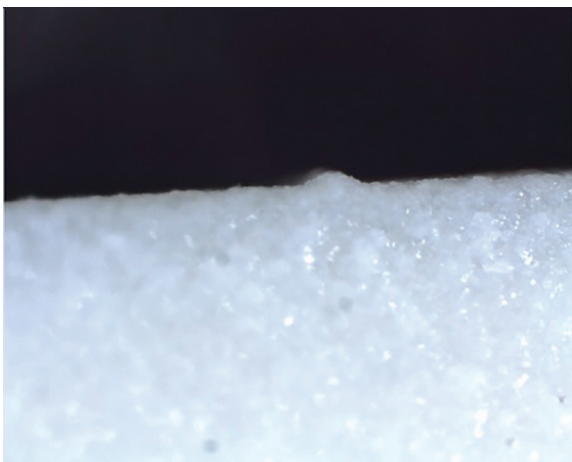


Figure 2c. X80 magnification microscope view of Ophthalmic alginate sample.



Figure 2d. X80 magnification microscope view of Affinis sample.

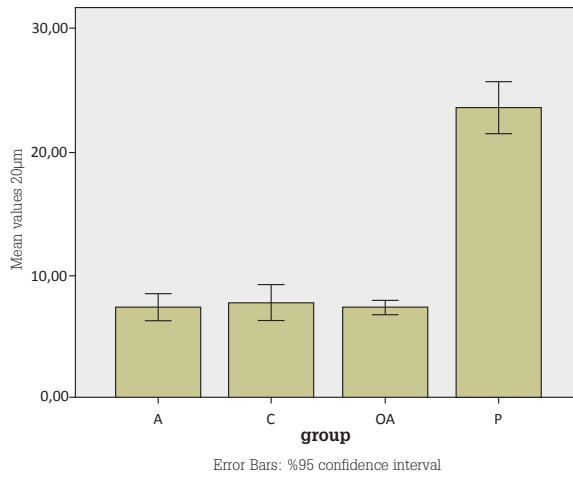


Figure 3. Mean values 20 µm notch height.

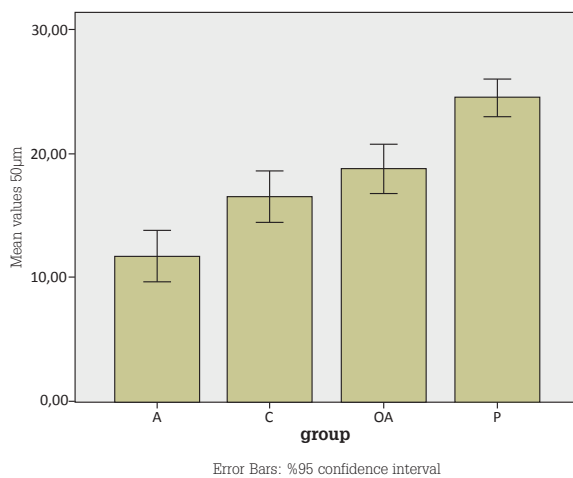


Figure 4. Mean values 50 µm notch height

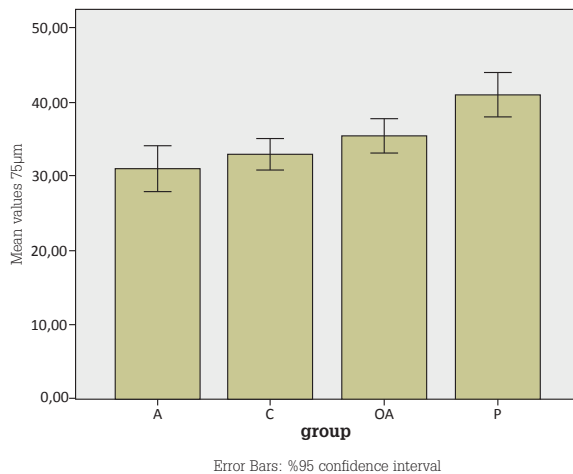


Figure 5. Mean values 75 µm notch height

RESULTS

The definition property of 4 different impression materials were evaluated in 20-50-75 µm. Percentage is used in the statistical analysis (the height evaluated/ maximum height value).

As the 20 µm notch width definition values between the impression materials were statistically evaluated. The highest mean value was obtained from P (23.47±2.98) group. P impression material was followed by C (7.69±2.02) group. The lowest mean values were obtained from A (7.31±1.51) and OA (7.31±0.81) groups. The difference between the P group and C, A, OA groups were found statistically significant ($p<0.05$)(Figure 3, Table 1).

As the 50 µm notch width definition values between the impression materials were statistically evaluated, the highest mean value was obtained from P (24.71±2.12) group. P group was followed by the groups OA (18.93±2.76) and C (16.70±2.85) respectively. The lowest mean definition percentage value was observed in group A (11.85±2.93). The difference between P group and A, C, OA groups were found statistically significant ($p<0.05$), whereas the difference between C and OA groups were not found statistically significant ($p>0.05$)(Figure 4, Table 2).

The definition values of 75 µm notch width between the impression materials were statistically evaluated and the highest mean value was obtained from P (41.00±4.20) group. P group was followed by OA (35.46±3.21) and C (32.99±2.94) groups respectively. The lowest mean definition percentage value was observed in A (30.99±4.38) group. The difference between P group and A,C,OA groups were found statistically significant ($p<0.05$), whereas the difference between OA, C and A groups were not found statistically significant ($p>0.05$) (Figure 5, Table 3).

DISCUSSION

Restoration of ocular defects is a very important constituent of facial integrity. It is very crucial also for the psychological and social well being of the patients. Ocular defects were restored in several ways in the history.¹⁻⁴ The better the impression, the better became the fit, retention and stability of the prosthesis. Currently custom made ocular prosthesis are fabricated for the restoration of ocular defects. A custom-made ocular prosthesis restores the tissue loss, simulates the natural color, contour, size of the pupil and iris. It provides beauty and symmetry to the patient's face, instead of a sad and helpless appearance. In addition, intimate tissue adaptation improves the fit of the prosthesis. A well-made ocular prosthesis maintains its orientation when patient performs various movements.²⁻⁴ With the development of newer materials and techniques, the impression of the ocular socket can be taken properly. Better impression provide to obtain a better-fitting custom-made ocular prosthesis.³ Surface detail reproduction,

dimensional stability and the biocompatibility take great importance for impression materials to fabricate accurately fitted ocular prosthesis.

In the literature, it is reported that evaluation of the surface accuracy of the impression material, a test device is used with the notches of different width and depth. The impression definition is evaluated with the transmission of impression to the gypsum surface.⁶ The data for the statistical evaluation is subjective. In this study, a test device is used with 3 notches of 20-50-75µm of width. The surface definition is evaluated without distortion and with the direct use of the impression surface in 80 magnification of a light microscope. The raise amount of the impression materials that were used in the 20, 50 and 75 µm notches was measured with the aid of a computer program. As the numerical data is obtained using this technique, an objective evaluation could be done differently compared to the previous studies. ISO 1563 specification states that the alginate impression and resultant cast will be able to reproduce the 50 µm line without interruption when testing for reproduction of detail and compatibility with gypsum products, while ISO 4823 specification states that elastomeric impression materials should be able to reproduce the 20 µm line and the resultant gypsum cast the 50 µm line.^{7,8} Ahmad *et al* evaluated effect of disinfectant on surface detail impression materials and reported that immersion in Perform-ID (Schülke and Mayr GmbH, Germany) adversely affected the reproduction of the 50 µm line in all alginate specimens.⁹ All alginate impression materials complied with the specified minimum detail reproduction of 50 µm-line. Tokuso AP-1/New Plastone and Tokuso AP-1/New Sunstone combinations produced better surface detail (20 µm-line) than the other combinations.¹⁰ Owen reported that no alginate impression materials, which were powder-type, could reproduce a 20 µm-line.¹¹ The powder-type alginate impression materials used in this study also did not reproduce a 20 µm-line, which was in accordance with Owen's findings. There was no statistically significant difference between powder type materials. The better surface detail reproduction was found with polyvinyl siloxane (PVS) impression materials.

Chen *et al.* reported that the alginate impression materials had accuracies close to the elastomeric impression materials that are polysulfide, condensation polymerizing silicone, addition polymerizing silicone, and polyether. However, after 24 h, the alginate impression materials were relatively unstable compared to the elastomeric impression materials. In addition, under magnified conditions, some of the stone cast surfaces which were made using alginate

| Table 1. Mean values 20 µm notch height. | | |
|--|-------|--------------------|
| | Mean | Standart Deviation |
| A | 7,31 | 1,51 |
| C | 7,69 | 2,02 |
| OA | 7,31 | 0,81 |
| P | 23,47 | 2,98 |

A: Orthoprint, **C:** Ca37, **OA:** ophthalmic alginate, **P:** a polyvinyl siloxane material (Affinis (P))

| Table 2. Mean values 50 µm notch height | | |
|---|-------|--------------------|
| | Mean | Standart Deviation |
| A | 11,85 | 2,93 |
| C | 16,7 | 2,85 |
| OA | 18,93 | 2,76 |
| P | 24,71 | 2,12 |

A: Orthoprint, **C:** Ca37, **OA:** ophthalmic alginate, **P:** a polyvinyl siloxane material (Affinis (P))

| Table 3. Mean values 75 µm notch height | | |
|---|-------|--------------------|
| | Mean | Standart Deviation |
| A | 30,99 | 4,38 |
| C | 32,99 | 2,94 |
| OA | 35,46 | 3,21 |
| P | 41 | 4,2 |

A: Orthoprint, **C:** Ca37, **OA:** ophthalmic alginate, **P:** a polyvinyl siloxane material (Affinis (P))

impression materials were rougher than those made using rubber elastomeric impression materials.¹² In 1989, Peutzfeldt and Amusen studied the accuracies of alginate and elastomeric impression materials. They found that one kind of alginate impression material (Blueprint, Dentsply, USA) was as good as the elastomeric impression materials.¹² In 1997, Federic and Caputo compared the accuracies of two agar agar and three elastomeric impression materials. They also reported that the accuracies of agar agar were the same as polyether impression materials. In this study, three alginate impression materials and one polyvinyl siloxane material were used. Alginate impression materials without loss of water were evaluated under the microscope. The accuracies of polyvinyl siloxane impression material was better than alginate impression materials.

Koski compared mixing techniques and devices with different alginate impression materials. The study showed that vacuum mixing produced fewer surface defects and had better detail reproduction.¹³ Inoue *et al.* showed that the high speed rotary mixing instruments, greatly reduced the number of air bubbles with alginate materials.¹⁴ Culhaoglu *et al.* reported that mechanical mixing improve the consistency of the alginate after mixing, the bubble-

free texture and the ease of use, when compared with hand mixing.¹⁵ In this study, to reduce air bubble with alginate materials, the high-speed rotary mixing device was used.

Huynh *et al.* evaluated that dimensional stability of polyvinyl siloxane, polyether and polysulfide impression materials with similar die test. The polyvinyl siloxane and polysulfide impression materials have a better long term dimensional stability than polyether impression material when stored at ambient conditions.¹⁶ Karthikeyan used similar die test to evaluate dimensional stability of interocclusal recording material that were polyvinylsiloxane, bite registration wax, zinc oxide eugenol paste.¹⁷ In this study, the die test is used for surface detail reproduction of impression materials at different depths. This method is preferred to optimize the results and get objective measurements.

In this study, the patient comfort is also evaluated clinically. During taking impression with polyvinyl siloxane, patients' ocular socket become very sensitive and caused patient's complaints. This may be a result of materials' contents. Under subjective examination this can be said that polyvinyl siloxane impression material use is much more uncomfortable than alginate impression material.

CONCLUSION

Within the limitations of this study, the following conclusions were drawn: Surface detail reproduction of polyvinyl siloxane impression materials were better than alginate impression materials. There is no statistically significant differences between alginate impression materials. The alginate impression materials can be used as PVS for cases that the details are not very crucial.

*The authors declare that there are no conflicts of interest.

REFERENCES

1. Kale E, Mese A, Izgi AD. A technique for fabrication of an interim ocular prosthesis. *J Prosthodont* 2008; 17: 654-661.
2. Ow RK, Amrith S. Ocular prosthetics: use of a tissue conditioner material to modify a stock ocular prosthesis. *J Prosthet Dent* 1997; 78: 218-222.
3. Guttal SS, Patil NP, Vernekar N, Porwal A. A simple method of positioning the iris disk on a custom-made ocular prosthesis. A clinical report. *J Prosthodont* 2008; 17: 223-227.
4. Artopoulou II, Montgomery PC, Wesley PJ, Lemon JC. Digital imaging in the fabrication of ocular prostheses. *J Prosthet Dent* 2006; 95: 327-330.
5. American Dental Association Specification no. 19 for nonaqueous, elastomeric dental impression materials. *J Am Dent Assoc* 1977; 94: 733-741.
6. Butta R, Tredwin CJ, Nesbit M, Moles DR. Type IV gypsum compatibility with five addition-reaction silicone impression materials. *J Prosthet Dent* 2005; 3: 540-544.
7. International Organization for Standardization (1990) ISO 1563, 2nd edn. Dental Alginate Impression Material.
8. ISO 4823 for Elastomeric impression materials. International Organization for Standardization (ISO) Technical committee: TC 106/SC 2; 2000.
9. Ahmad S, Tredwin CJ, Nesbit M, Moles DR. Effect of immersion disinfection with Perform-ID on alginate, an alginate alternative, an addition-cured silicone and resultant type III gypsum casts. *Br Dent J* 2007; 202: E1-7.
10. Murata H, Kawamura M, Hamada T, Chimori H, Nikawa H. Physical properties and compatibility with dental stones of current alginate impression materials. *J Oral Rehabil* 2004; 31: 1115-1122.
11. Owen CP. An investigation into the compatibility of some irreversible hydrocolloid impression materials and dental gypsum products. Part I. Capacity to record grooves on the international standard die. *J Oral Rehabil* 1986; 13: 147-162.
12. Chen SY, Liangb WM, Chen FN. Factors affecting the accuracy of elastometric impression materials. *J Dent* 2004; 32: 603-609.
13. Koski RE. Comparative study of selected alginate materials and devices. *J Am Dent Assoc* 1977; 94: 713-716.
14. Inoue K, Song YX, Kamiunten O, et al. Effect of mixing method on rheological properties of alginate impression materials. *J Oral Rehabil* 2002; 29: 615-619.
15. Culhaoglu AK, Zaimoglu A, Dogan E, Ozkir SE. The influence of different mixing methods on the dimensional stability and surface detail reproduction of two different brands of irreversible hydrocolloids. *Eur J Gen Dent* 2014; 3: 17-21.
16. Huynh L, Xie DX, Tobia D: Long term linear dimensional stability of impression materials. Permlastic. Research. Kerr Corporation. Research and Development. Kerr Dental-University. 2008-poster.
17. Karthikeyan K, Annapurni H. Comparative evaluation of dimensional stability of three types of interocclusal recording materials: An in vitro study. *J Indian Prosthodont Soc* 2009; 7: 24-27.