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Original Article

Dimensional accuracy of two rubber base impression materials as a function of spacer design and techniques in custom trays for fixed partial dentures

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ABSTRACT

Background: A prostheses can't be better than the cast over which it has been fabricated. To make accurate casts, accurate impressions are mandatory. To get an accurate and dimensionally stable impression, various techniques and materials have been advocated. This study compares the most commonly used techniques and materials for dimensional accuracy. Two types of spacers were designed to compare the addition silicon and polyether and their techniques.

Methods: A metal die was used to make the impressions. A total of 60 impressions were made using multiple mix and monophasic techniques for addition silicon and polyether in custom trays. A travelling microscope was used to measure the dimensional accuracy of die stone casts retrieved from impressions.

Results: The results were compared using paired t test and SPSS software. The study was highly significant ($p < 0.001$). The polyether was more accurate than the addition silicon and spacer design I (adapted to the edentulous area) was more accurate than the design II (spacer over the abutments, not adapted to edentulous area). The multiple mix technique was more accurate than the monophasic for addition silicon.

Conclusion: The combination of multiple mix technique with spacer design I for addition silicon gave the best accurate results.

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Introduction

Numerous impression materials and techniques have been advocated in order to obtain, as accurate casts, as the

preparations in the oral cavity so as to fabricate accurately fitting prostheses.^{1,2} The literature has preferred the use of custom trays over the stock trays for uniform thickness of material as well as economy and the amount of material

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used.³ This study has compared the most commonly used rubber base materials i.e polyether and polyvinyl siloxane (addition silicon) and two types of spacer designs which affect the bulk of these materials in the interpreparation space, which in turn affects the polymerization shrinkage of these materials causing inaccuracies in casts obtained. Hence, this study was undertaken to evaluate the accuracy of two rubber base materials as a function of their bulk and polymerization shrinkage by altering the spacer designs and corresponding custom trays and their techniques.

The study was undertaken to compare and evaluate most commonly used rubber base impression materials for fixed partial dentures as a function of dimensional accuracy occurring due to change in their bulk and resulting polymerization shrinkage using different spacer designs and custom trays and their techniques.

Materials and methods

This study was conducted to quantitatively evaluate the dimensional accuracy of polyether and addition silicon impression materials. The impression techniques compared were single mix for polyether and monophasic addition silicon and the multiple mix technique using heavy body and light body addition silicon. Two types of spacers were designed for the custom trays to evaluate the linear changes

Commercial names	Batch number	Expiry date	Manufacturer
Impregum™ (polyether)	322468	Jun 2015	3M ESPE
Aquasil™ (heavy body addition silicone)	061229	Oct 2015	DENTSPLY
Aquasil™ (light body addition silicone)	0805081	Oct 2015	DENTSPLY
Aquasil™ (monophasic addition silicone)	080502	Oct 2015	DENTSPLY
RR Cold Cure™ (auto polymerizing acrylic)	786540	Jan 2016	DPI

in the interpreparation distance and the mesiodistal width of the molar abutment on recovered stone die

The materials used

The master die (Figs. 1 and 2)

A machined metal die was fabricated to serve as a model simulating a three unit fixed partial denture situation replacing the mandibular first molar.

The designed abutments had a uniform 6° apical convergence and were firmly luted to the heavy metal platform for easy impression making.

To evaluate the dimensional change, reference lines in the shape of '+', were inscribed on the occlusal surfaces of the two abutments. The interpreparation distance between points A and B and mesiodistal width of molar abutment between C and D, was measured using travelling microscope.

Fig. 1 – The metal master die with “+” mark on the occlusal surfaces of abutments.

The spacers (Figs. 3 and 4)

Two types of spacers were machined on metal with a uniform thickness of 2 mm. The spacer I was adapted to the edentulous area and spacer II was fabricated over the abutment preparations without adapting to the edentulous space indicating that spacer I will have less bulk of the material as it is closely adapted in the edentulous area where as spacer II will have more bulk as it is not adapted to edentulous area.

The custom trays (Fig. 5)

The custom trays were fabricated over the master die with spacers in position by sprinkle on technique using auto polymerizing acrylic resin (DPI). The trays and spacers were removed after 24 h to eliminate the changes occurring due to polymerization of acrylic. The tray adhesive, for retention of the material, supplied by the manufacturer, was applied on the custom trays and kept for drying for 10 min according to manufacturer's instructions.

The impression techniques (Fig. 6)

- Addition silicon** – Two operators and two automixing guns were used⁴ so that the materials were mixed at the same time. One operator mixed the light body and applied it over the metal die where as the second operator loaded the tray with heavy body and the tray was secured on the master die. 1 lb of pressure was applied for seating the tray using digital pressure plunger. The impressions for monophasic materials were also completed in same manner only difference was that the operators had same material (monophasic).
- Polyether** – Only one operator was involved. The same material was used as light body over the die and as the tray material. The material was automixed and dispensed by **Pentamix** polyether system (3M ESPE). The manufacturer's instructions were strictly followed for mixing and setting time. The impressions were poured after 15 min and were stored at a temp of 22 °C and humidity of 55%, away from

Fig. 2 – Diagrammatic representation of the master die.

sunlight as recommended. Once completely polymerized the impressions were taken out after 6 min i.e 3 min as recommended by manufacturer, to ensure complete setting, additional 3 min were given as impressions were made extra orally. Impressions were removed and were analysed and improper impressions having voids or incomplete flow were discarded.

The dies (Fig. 7)

The impressions were boxed and poured after 15 min as recommended, with type IV gypsum (Kalrock – Kalabhai). The die stone was mixed in automixer to ensure uniform mix and

1.	Spacer design I with polyether	PE 1	10
2.	Spacer design II with polyether	PE 2	10
3.	Spacer design I with monophasic	MP 1	10
4.	Spacer design II with monophasic	MP 2	10
5.	Spacer design I with multiple mix	MM 1	10
6.	Spacer design II with multiple mix	MM 2	10
	Total		60

to control the mixing time, with recommended water powder ratio provided by the manufacturer. The casts were retrieved after 1 h from pouring as recommended.

10 impressions were made for each combination which is as follows:

The travelling microscope and readings

The measurements were made using travelling microscope of calibration 0.001 cm. The distances between A to B were measured as interpreparation distance and between C to D as width of molar abutment by sliding the table top of the

microscope manually using the moving screws. To avoid the error, all the measurements were made by the same observer, and each measurement was recorded thrice, the mean of three values was considered for data collection. To avoid the eye fatigue of the observer, only 10 readings were made at a time.

Results

The measurements were made using travelling microscope and the mean and standard deviations were calculated for each group and were evaluated statistically. The student's paired 't' test was applied to evaluate the significant differences between the materials and the spacer designs. The results were tabulated and analysed using the SPSS software.

Table 1 shows the means of the interpreparation distance and the mesiodistal diameter of the molar abutment, measured on stone casts for multiple mix (MM), monophasic (MP) and polyether (PE) with both the spacer designs and were compared with master die measurements.

When polyether and addition silicones were compared independent of spacer designs, the polyether was found more accurate and the results were highly significant ($p < 0.001$).

When multiple mix technique was compared with the single mix technique for addition silicon, the results were highly significant ($p < 0.001$) and multiple mix was found more accurate than single mix or monophasic technique.

Graph 1 – When two spacer designs were compared independent of materials and the technique, the spacer design I was more accurate than the design II ($p < 0.001$). The percentage change in interpreparation distance for design I and design II was -0.23% and -0.46% respectively

Fig. 3 – Spacer design I.

Fig. 4 – Spacer design II.

and change in width of molar abutment was +0.60% and +1.20% respectively.

When comparison was made between the spacer designs, the materials and the techniques all together, the most accurate combination was multiple mix technique for addition silicon with spacer design I and least accurate was monophasic addition silicon with spacer design II.

Discussion

Findings of this study indicated that the interpreparation distance was reduced for all the materials, techniques and the tray design when measured by a quantitative method. The possible explanation for this could be the polymerization shrinkage which occurs towards the bulk of the material in the interpreparation area.⁴ However, all appeared to be comparable with reported values for elastomeric impression materials and were considered to be within clinically acceptable limits of accuracy.⁵

The mesiodistal dimensions of the molar abutment was increased because from the periphery the material was adhered

to the tray by the tray adhesive and the polymerization shrinkage occurred in between the abutment region where the bulk of the material was more and increased the dimensions of the individual abutments. The expansion of the die material could also contribute to the same.

When multiple mix technique was compared with monophasic single mix technique, the former was more accurate than the later. The percentage of change for interpreparation distance was –0.06% and –0.52% respectively. The change in the mesiodistal dimension of the molar abutment was +0.70% and +1.30%. The monophasic polyvinyl siloxanes which are pseudoplastic impression materials are used both as tray and syringe material in a single mix impression technique, which is clinically simpler. However, it was found that there was increased distortion in the interpreparation distance and size of the individual abutments, in impression made with these materials.⁶

This inaccuracy of monophasic material can be explained as the bulk of the single viscosity material which may have more polymerization shrinkage than a bulk of heavy body materials that have higher filler contents.^{6,7}

Fig. 5 – The custom trays corresponding to spacer designs.

Fig. 6 – The impressions corresponding to different techniques.

When the two tray designs were compared, the percentage change in the interpreparation distance and mesiodistal diameter of molar abutment was -0.23% and $+0.60\%$ respectively for spacer design I. For spacer design II the percentage change was -0.46% and $+1.20\%$ respectively. This variation occurred because of more polymerization shrinkage in spacer design II as the thickness of material was more between the abutments.⁸

When multiple mix technique was compared with the polyether impression material, the mesiodistal diameter of the molar abutment was same for both the materials with a percentage change of $+0.70\%$ but the interpreparation distance was recorded more accurately for polyether than the multiple mix with a difference of 0.001 cm between the two.⁹

From the clinical perspective, these deviations in the interpreparation distance from the master model are not of sufficient magnitude to cause difficulty when the inherent elasticity of the relevant intraoral tissues is considered.

Table 1 – The interpreparation distance and mesiodistal widths of each group and the master die.

Group	Interpreparation distance (mean)	Mesiodistal width (mean)	Sample size
Master die	1.743	1.001	Mean of 3 readings
MM1	1.742	1.003	10
MM2	1.734	1.013	10
PE1	1.742	1.007	10
PE2	1.736	1.010	10
MP1	1.734	1.013	10
MP2	1.734	1.015	10

Fig. 7 – The dies obtained from the impressions with alphanumeric coding.

Graph 1 – Comparison of interpreparation distance for spacer design 1 and 2 compared with master die.

Dimensional change in the recovered casts of approximately (+25 μ to –25 μ) or sometimes even more, did not prevent the complete seating of the castings⁹ indicating that such inaccuracies are clinically insignificant. The magnitude of change in this study was small and probably not clinically significant; although difference among the materials and techniques can be demonstrated statistically.

In this study, since all the procedures were standardized and all groups received the same controlled treatments, the differences in the dimensional accuracy among the test groups were assumed to be attributable to the techniques, properties materials and the spacer design or the bulk of the material.

Conclusion

Under the conditions of this investigation and based on the study results, the following conclusions can be made:

- 1 None of the materials and techniques was superior over the other as all the materials behaved differently with different spacer designs and the accuracy was within clinical acceptable limit.
- 2 The spacer which is closely adapted to the abutments and the edentulous area rather than bridging over the abutments resulted in maximum dimensional accuracy.
- 3 Among the materials used, the most accurate was polyether as compared to the addition silicones.
- 4 Among the addition silicones, the multiple mix technique was more dimensionally accurate than the monophasic material.
- 5 The most accurate combination of material, technique and spacer design was the multiple mix technique for

addition silicon when the spacer was closely adapted to the edentulous area.

Conflicts of interest

All authors have none to declare.

REFERENCES

1. Johnson GH, Craig RG. Accuracy of addition silicones as a function technique. *J Prosthet Dent.* 1986;55(2):197–202.
2. Bomberg TJ, Hatch RA, Hoffman W. Impression materials thickness in stock and custom trays. *J Prosthet Dent.* 1985;54(2).
3. Council on Dental Materials and Devices. Revised American Dental association specification no. 19 for non-aqueous elastomeric impression materials. *J Am Dent Assoc.* 1977;94:733–741.
4. Dhiman RK. Dimensional accuracy of putty wash and two step technique using polyvinyl siloxane impression material. *J Indian Prosthodont Soc.* Jun 2001;2:36–43.
5. Kim KN, Craig RG, Koran A. Viscosity of monophase addition silicones as a function of shear rate. *J Prosthet Dent.* 1992;67(6):794–798.
6. Tjan AH, Nemetz H, Nguyen TP. Effect of tray space on the accuracy of monophasic polyvinyl silicones. *J Prosthet Dent.* 1992;68(1):19–28.
7. Philips Anusavice KJ. *Science of Dental Materials.* 10th ed. Philadelphia: W.B. Saunders Co; 1996.
8. Chi Lin Chang, Chong YH. Accuracy of impression materials for complete arch fixed partial dentures. *J Prosthet Dent.* 1988;59(3):288–291.
9. Tjan HL, Nemetz H. Clinically oriented evaluation of the accuracy of commonly used impression materials. *J Prosthet Dent.* 1986;56(1):4–8.