A COMPARATIVE EVALUATION OF THE DEPTH OF REDUCTION ACHIEVED FOR A METAL CERAMIC CROWN PREPARATION BY USING THREE DIFFERENT TECHNIQUES – AN IN VITRO STUDY

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Abstract

Statement of the Problem

Inadequate preparation of teeth for metal ceramic crowns can significantly influence the ultimate form and longevity of the definitive restoration, as well as adversely affect the supporting tissues.

Purpose

The purpose of this study was to determine the effect of 3 different tooth preparation techniques on an operator's ability to appropriately prepare teeth for metal ceramic crowns.

Material and Methods

Thirty typodont maxillary left central incisor teeth were mounted individually and randomly allocated to 3 equal groups (A, B & C). Each tooth was prepared by the operator for a metal ceramic crown. A freehand approach was used to prepare the teeth in group A while Groups B and C were prepared with the help of a silicone putty index and suitable depth gauge burs, respectively. A silicone index of the unprepared tooth, into which contrasting silicone was injected to occupy the space created by tooth preparation was sectioned in the midline. The left side of this section was then viewed under an optical stereomicroscope measured at five points (labial cervical, midlabial, incisal, mid palatal and palatal cervical). The data was then analyzed by ANOVA test.

Results

The mean depths of preparations for group A, B and C at the five points were statistically significant expect labial cervical preparation between group A and B and palatal cervical preparation between group B and C.

Conclusion

Within the limitations of this study, it was concluded that use of depth gauge burs provided the closest to ideal preparation for metal ceramic crowns. Free hand technique was the least desirable as it resulted in significant under reduction of the tooth structure.

Key Words: Metal Ceramic, Depth Gauge Burs, Typodont, Polyvinyl Siloxane.

INTRODUCTION

In spite of the increasing popularity of All ceramic restorations, general dental practitioners still consider the metal ceramic crown an established treatment for extensively restored teeth, particularly where a combination of durability and esthetics are required[1]. Tooth preparations for metal ceramic crowns must be accomplished without compromising the pulp or the supporting structures[2]. In vitro studies evaluating preparation completed by clinicians for metal ceramic crowns have reported a tendency for clinicians to under prepare teeth, when a free hand approach was used[3]. **Dunne S. M.** reviewed the limitation of visual perception in restorative dentistry and stated that accurate judgment of size, depth and angle is required in the practice of restorative dentistry. Most assessments are made simple by visual examination and these judgments are therefore often subjective .The limitation of visual perception renders such judgments in accurate and subject to variation. He proposed the use of standardized objects to allow size and angle judgment[4]. The use of indexes or depth gauge burs are two recognized methods of improving the accuracy of the preparation features[5]. However few studies to date have investigated the effect these have on an operator's ability to appropriately and consistently prepare teeth for metal ceramic crowns. The purpose of this study was to investigate the effect a free hand, an index and a depth gauge bur have on accuracy of preparations for metal ceramic crowns prepared by one operator.

Aims and Objectives

Aim

Aim of the study was to investigate the effect of freehand, a silicone index and depth gauge bur on the accuracy of preparations for metal ceramic crowns, prepared by one operator.

Objectives

1. To evaluate the amount of reduction achieved by each of the three different techniques for a metal ceramic crown preparation.
2. To compare the three techniques for their effectiveness in achieving a near ' ideal ' preparation.
3. To determine the most suitable technique of tooth preparation which would yield consistently good results.

METHODOLOGY

Preparation of Master Model Block

The master model block was prepared to standardize the dimensions of the mounting block on which typodont teeth were mounted. The block was first prepared in wax using baseplate wax to standard dimension (3 cm X 5 cm).

A typodont tooth was placed in the centre of the wax block. V-shaped notches were placed on the block on the facial and lingual aspect to stabilize the putty and to evaluate the completeness of the reseating during subsequent impression procedure. U shaped troughs were placed on the mesial and distal aspect of the tooth. These troughs provided a stable seat for the cartridge of the syringe from which light body polyvinylsiloxane would be injected for impression after the tooth preparation. This block was invested in a dental flask and dewaxed. The mould space was then filled with self cure resin.

After polymerization of self cure, it was then deflasked and a prototype master model block was derived. The model was then finished and polished. It was then invested in a polyvinylsiloxane putty impression material and was removed after the material was set. This hardened putty then provided the mould space into which individual tooth could be placed and plaster poured into it. Thus, each of the 30 typodont teeth were subsequently mounted.

Thirty maxillary left central incisor typodont teeth were mounted in individual plaster blocks of standardized dimensions (3 X 5 cm). The teeth were then divided into three equal groups (A, B, and C) of ten each **(figure 1)**

A suitably experienced clinician, unaware of the purpose of the study, was selected to participate in the study and asked to prepare the teeth for metal ceramic crowns, requiring a shoulder finish line on the labial aspect and chamfer finish line on palatal aspect. The clinician was requested to prepare each tooth with the use of standard crown reduction burs.

Three techniques of Metal ceramic crown preparation were allocated to the three groups A, B, & C of ten teeth each. The three techniques were

A → Freehand preparation

B → Use of a silicone Putty index

C → Use of depth gauge burs

Teeth in Group A were prepared free hand whereas those teeth in Group B were prepared with the aid of a sectioned index made from addition – cured silicone impression material. The index was sectioned in the midlabial aspect and the incisal half was then sectioned in the midline to provide enough guidance to the operator to facilitate the reduction. The teeth in group C were prepared by the use of a depth gauge burs (1.5 mm) for labial reduction and incisal reduction was facilitated by use of another bur (2.0 mm).An addition reaction silicone putty index was prepared before proceeding with the tooth preparation. The index was then replaced over the tooth after preparation and a light body

addition reaction silicone of a contrasting colour was injected into the index by means of a syringe through the channel prepared on the mounting block, till excess material extruded from the outlet channel, indicating that the material had occupied the space created by tooth reduction**. (figure 2)**

After the light body polyvinyl siloxane has set, the index was then sectioned in the midline. Then the left handed side of the sectioned index was removed from over the tooth and a thin section made from the left sided part of index. This is then viewed under the optical stereomicroscope at 10 X magnification and 1.5 mm zoom. The mounted section of the index is viewed under the stereomicroscope at 5 different points of the impression corresponding to 5 different areas on the tooth where reduction was achieved **(figure 3).** The five points are labial cervical, mid labial, incisal, mid palatal and palatal cervical. The thickness of light body polyvinyl siloxane is measured under the stereo microscope using eye pieces that have calibrations on them. These calibrations are reffered to as units and the no. of calibrations, correspond to no. of units to be measured. These units are then converted into mm readings using the formula :

Reading in mm = No. of units / eyepiece magnification x zoom.

In this study, the eye piece magnification and zoom was standardized at **10 x** and **1.5 x** respectively. The readings were then noted down and converted into mm scale using the above mentioned formula. This was carried out with all the samples and the appropriate readings in mm was noted. The readings in Group A, B and C were then subjected to ANOVA test for statistical analysis.

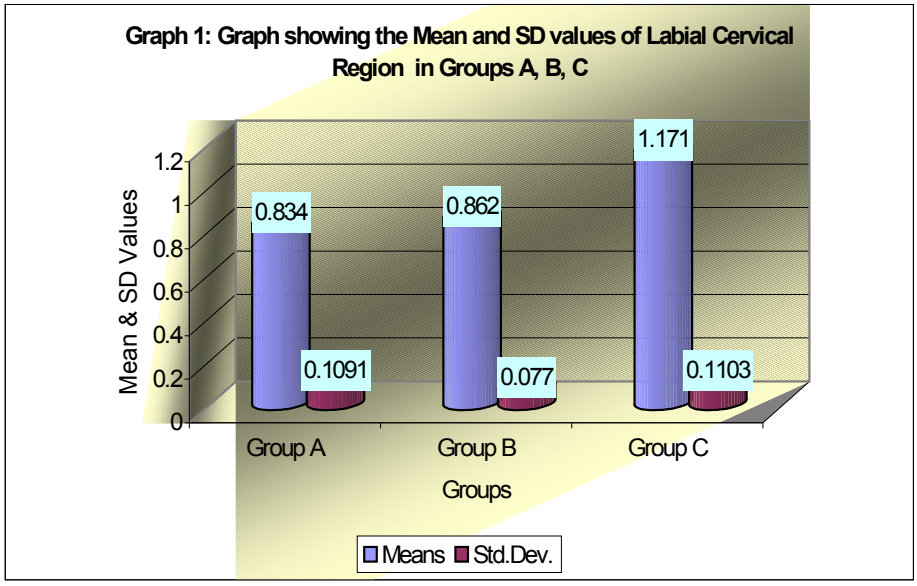
Results

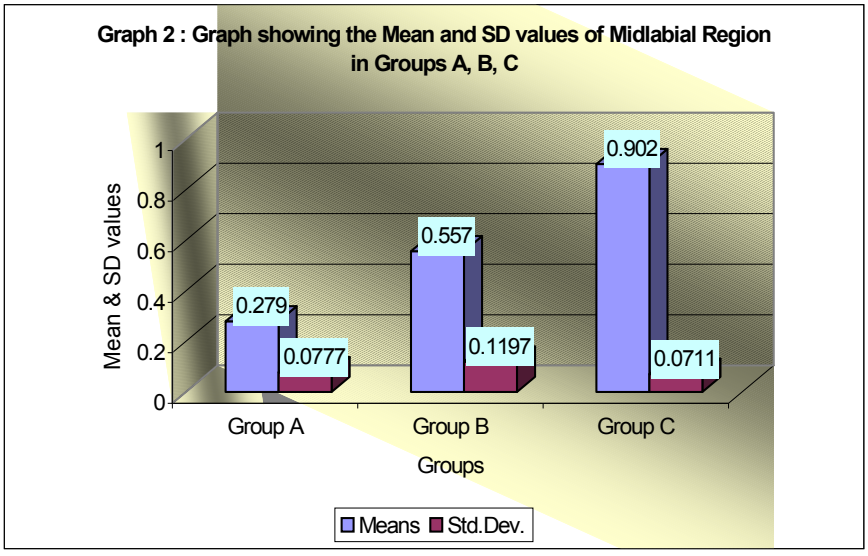
Readings recorded and subjected to statistical analysis reveal that there is a significant difference between the 3 groups (group A; group B; group C) at five points (i.e. labial cervical, mid labial, incisal, palatal, palatal cervical). A tabulation of the results of the analysis are as under:

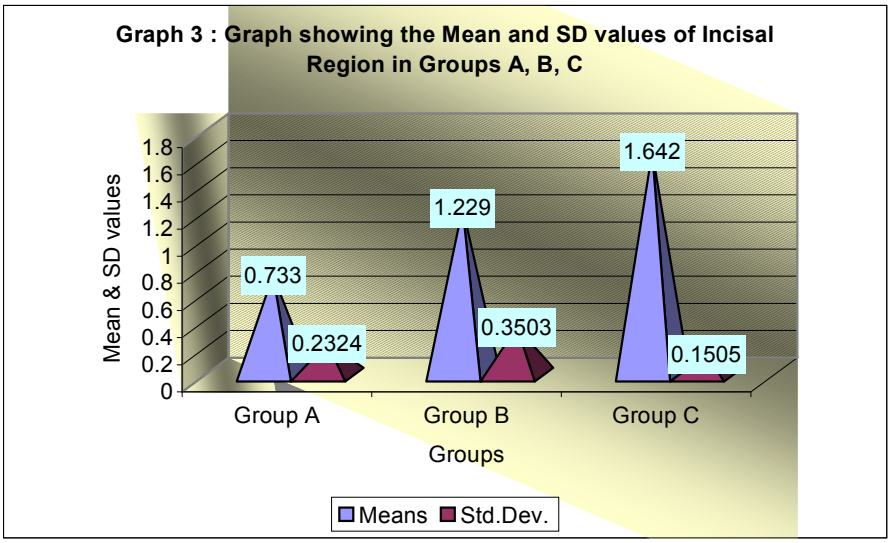
Table 1: Mean and SD values of Labial cervical, mid labial, Incisal, mid palatal and Palatal cervical regions (Group wise)

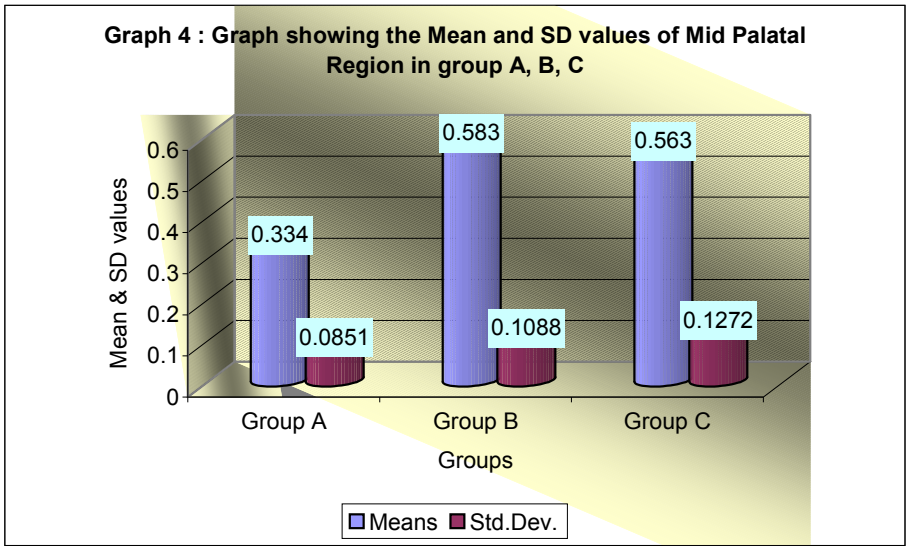
Variable	Summary	Group A	Group B	Group C	Total
Labial cervical	Mean	0.8340	0.8620	1.1710	0.9557
	Std.Dev.	0.1091	0.0770	0.1103	0.1828
Mid labial	Mean	0.2790	0.5570	0.9020	0.5793
	Std.Dev.	0.0777	0.1197	0.0711	0.2740
Incisal	Mean	0.7330	1.2290	1.6420	1.2013
	Std.Dev.	0.2324	0.3503	0.1505	0.4525

Mid palatal	Mean	0.3340	0.5830	0.5630	0.4933
	Std.Dev.	0.0851	0.1088	0.1272	0.1554
Palatal cervical	Mean	0.7330	0.9000	1.0300	0.8877
	Std.Dev.	0.0944	0.1326	0.0316	0.1543






Graph 3 : Graph showing the Mean and SD values of Incisal Region in Groups A, B, C
Mean & SD values
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.733
0.2324
1.229
0.3503
1.642
0.1505
Group A
Group B
Group C
Groups
Means
Std.Dev.


Graph 4 : Graph showing the Mean and SD values of Mid Palatal Region in group A, B, C
Mean & SD values
0.6
0.5
0.4
0.3
0.2
0.1
0
0.334
0.0851
0.583
0.1088
0.563
0.1272
Group A
Group B
Group C
Groups
Means
Std.Dev.

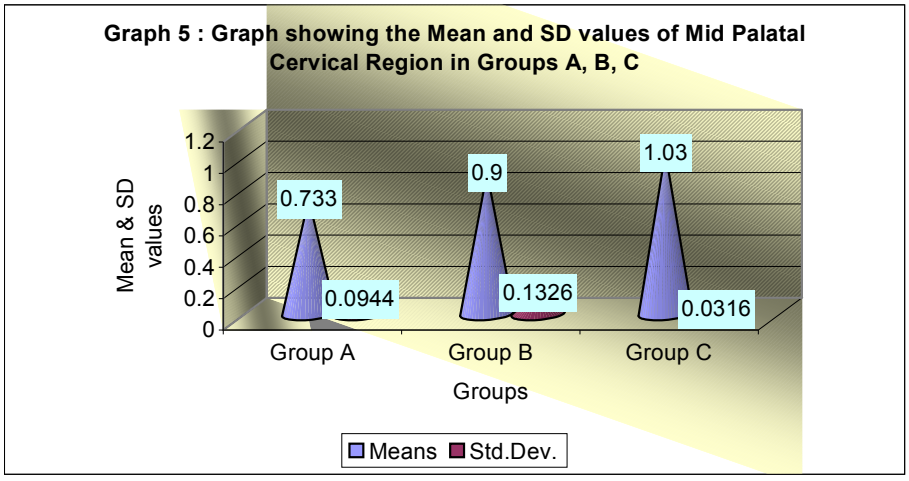

Graph 5 : Graph showing the Mean and SD values of Mid Palatal Cervical Region in Groups A, B, C
Mean & SD values
1.2
1
0.8
0.6
0.4
0.2
0
0.733
0.0944
0.9
0.1326
1.03
0.0316
Group A
Group B
Group C
Groups
Means
Std.Dev.

Table 2: Comparison of three groups (A, B, C) by ANOVA test- Labial cervical

SV	DF	SS	MSS	F-value	P-value	Significant
Between Groups	2	0.6994	0.3497	34.9866	0.0000	S
Within Groups	27	0.2699	0.0100			
Total	29	0.9693				

Table 3: Pairwise comparison of groups by t-test -Labial cervical

Groups	Mean	SD	t-value	p-value	Significant
Group A	0.8340	0.1091	-0.6632	0.5156	NS
Group B	0.8620	0.0770			
Group A	0.8340	0.1091	-6.8706	0.0000	S
Group C	1.1710	0.1103			
Group B	0.8620	0.0770	-7.2642	0.0000	S
Group C	1.1710	0.1103			

Table 4: Comparison of three groups (A, B, C) by ANOVA test- Mid labial

SV	DF	SS	MSS	F-value	P-value	Significant
Between groups	2	1.9481	0.9741	114.9161	0.0000	S
Within groups	27	0.2289	0.0085			
Total	29	2.1770				

Table 5: Pair wise comparison of groups by t-test - Mid labial

Groups	Mean	SD	t-value	p-value	Significant
Group A	0.2790	0.0777	-6.1601	0.0000	S

Group B	0.5570	0.1197			
Group A	0.2790	0.0777	-18.7040	0.0000	S
Group C	0.9020	0.0711			
Group B	0.5570	0.1197	-7.8335	0.0000	S
Group C	0.9020	0.0711			

Table 6: Comparison of three groups (A, B, C) by ANOVA test- Incisal

SV	DF	SS	MSS	F-value	P-value	Significant
Between groups	2	4.1429	2.0714	31.1676	0.0000	S
Within groups	27	1.7945	0.0665			
Total	29	5.9373				

Table 7: Pair wise comparison of groups by t-test – Incisal

Groups	Mean	SD	t-value	p-value	Significant
Group A	0.7330	0.2324	-3.7311	0.0015	S
Group B	1.2290	0.3503			
Group A	0.7330	0.2324	-10.3802	0.0000	S
Group C	1.6420	0.1505			
Group B	1.2290	0.3503	-3.4255	0.0030	S
Group C	1.6420	0.1505			

Table 8: Comparison of three groups (A, B, C) by ANOVA test- Mid palatal

SV	DF	SS	MSS	F-value	p-value	Significant
Between groups	2	0.3828	0.1914	16.2789	0.0000	S
Within groups	27	0.3175	0.0118			
Total	29	0.7003				

Table 9: Pair wise comparison of groups by t-test - Mid palatal

Groups	Mean	SD	t-value	p-value	Significant
Group A	0.3340	0.0851	-5.6983	0.0000	S
Group B	0.5830	0.1088			
Group A	0.3340	0.0851	-4.7312	0.0002	S
Group C	0.5630	0.1272			
Group B	0.5830	0.1088	0.3778	0.7100	NS
Group C	0.5630	0.1272			

Table 10: Comparison of three groups (A, B, C) by ANOVA test- Palatal cervical

SV	DF	SS	MSS	F-value	p-value	Significant
Between groups	2	0.4433	0.2217	24.1903	0.0000	S
Within groups	27	0.2474	0.0092			
Total	29	0.6907				

DISCUSSION

Metal ceramic restorations require a thorough knowledge and application of the biomechanics of tooth preparation on the part of the operator. An area of concern caused by inadequate reduction is the lack of adequate thickness of metal coping at the cervical aspect needed to support the bulk of ceramic material. Distortion of ceramometal substructures can occur during crown fabrication. This distortion has been attributed to the temperature related creep of the alloy. A thin metal substructure has less bulk of metal to withstand the high firing temperature of porcelain and with repeated firing of ceramic, may sag, leading to marginal discrepancies in the restoration[6].

In this study, the freehand technique showed significant under preparation at the labial aspect and the incisal aspect. The palatal aspect of the preparation i.e. the mid palatal and the palatal cervical region were also measured and the mid palatal aspect of the preparation showed underpreparation, whereas the palatal cervical region showed adequate preparation.When the index technique was used, the results showed a significant difference in the labial and incisal aspect of the preparations. Though the difference in the labial cervical aspect of the preparation between freehand technique and index technique was not significant, the mid labial aspect had the least amount of reduction among the labial aspect, in group A and group B. This could result in consequences such as esthetic failures of the metal ceramic restoration as this inadequate reduction would have to be compensated either by over bulking the crown in the mid labial aspect or by inadequate addition of ceramic layer thereby creating a dull or lifeless restoration. Inadequate reduction of tooth on the midlabial aspect could affect esthetics by creating an improper emergence profile of the restoration. The most favourable reduction of labial and incisal aspect was noticed with group C. The favourable result of this group can be attributed to the fact that the depth cuts were made to the predetermined depth using burs. **Amin Aminian and Paul A. Brunton** conducted a study on three different tooth preparations techniques and concluded that preparations of teeth for metal ceramic crowns without the use of devices to help gauge reduction depth can result in insufficient labial reduction and incisal over reduction[7]. But however, the variation of the reduction from the ideal requirements for a metal ceramic restoration, especially at the labial cervical and midlabial aspect could be the result of operators visual perception. This result substantiates **Dunne S. M**., who reviewed the visual perception of operator and stated that accurate judgment of size, depth and angle is required in the practice of restorative dentistry.[7]

Also, it was seen in this study that though the operator exhibited consistency over a mean range within the no. of samples in each group, there was a significant variation in consistency among the reading when the three techniques for reduction were compared in between them. **Cherukara G. P., K. G. Seymour D. Y. D. samarawickrama and L. Zou** concluded that even after using techniques designed to produce consistent preparations, a single operator still produced preparations with considerable variation from ideal[8].**Seymour K. G., Samarawickrama DY, Zan L, Lynch E** analyzed ninety six preparations, forty eight in vitro and forty eight in vivo, and concluded that despite recommendations that preparations for metal ceramic crowns should have 1- 1.5 mm and 90°

shoulders, many of the preparations studied fell short of this, indicating a lack of consistency in preparation geometry and adherence to the perceived ideal preparation for a metal ceramic crown[9]. This could be attributed to the fact that though the techniques were different, it was ultimately the visual perception of the operator which decided the adequacy of the reduction in all the three techniques followed. As Dunne has stated,constancy in the field of visual perception is not perfect and objects may be perceived as smaller and larger than they usually are depending on the size of the image formed in the retina.

The different methods or techniques of tooth reduction must be selected according to the clinical situation. The presence or absence of tooth surface loss may affect the choice of preparation technique. The replacement of an existing crown would also influence the choice of technique. These clinical situations would necessitate the use of free hand preparation as depth gauging would be of limited use in this situation. The use of index would be more suitable in cases where tooth structure is to be reduced for a crown. Also, depth gauge burs could be used when pre existing tooth structure is remaining.

CONCLUSION

Within the limitations of this study it was concluded that:

1. The amount of reduction achieved by freehand preparation was significantly lower than preparation using silicone putty index and depth gauge burs.
2. Freehand technique was the least effective technique for tooth preparation as it resulted in significant under preparation whereas use of depth gauge burs was the most effective technique
3. Use of depth gauge burs (Group C) was seen to provide the most consistent results among the three techniques evaluated.

Limitations and Scope:

The nature of this study provided conditions different from that expected in a clinical situation in that, there were no adjacent or opposing teeth, with prepared teeth held in plaster blocks. It is questionable if the presence of adjacent teeth would have had any effect on the tooth preparation. The absence of structures such as tongue and cheeks coupled with presence of saliva could also be factors that could have an effect on the preparation features in a clinical situation. A future study can be carried out to investigate the influence on preparation features when other clinical features are present or absent. A suitable in vivo study would also help to evaluate the validity of these in vitro studies that have been carried out.

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LEGENDS FOR PICTURES:

Figure 1: Typodont teeth mounted in plaster blocks

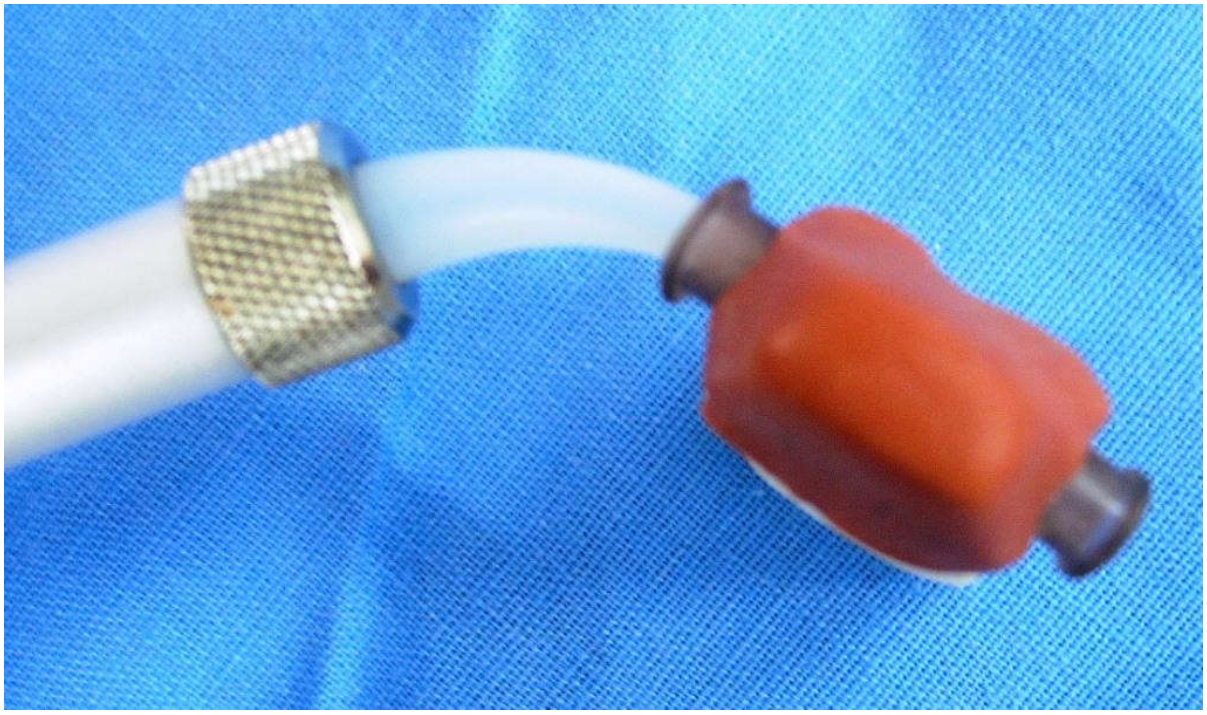

Figure 2: Light bodied polyvinylsiloxane injected through the inlet channel

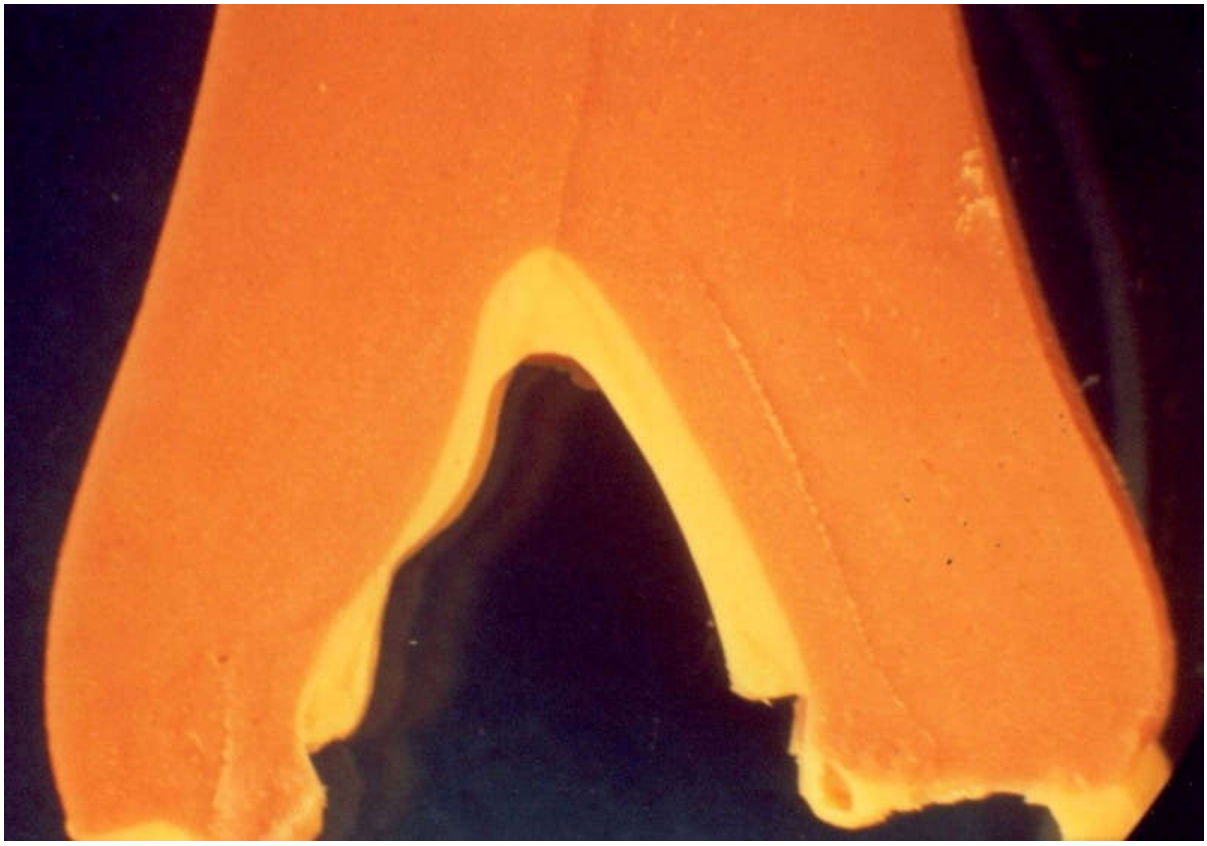

Figure 3: Sectioned index as viewed through the Stereomicroscope

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