



## Comparative evaluation of the amount of gingival displacement produced by three different gingival retraction systems: An in vivo study

Mehraj ud din bhat<sup>1</sup>, Gazalla Altaf<sup>2</sup>, Aquib Hussain<sup>3</sup>

*Department of prosthodontics*

*Department of Pedodontics and preventive dentistry*

*Department of oral and maxillofacial surgery*

Date of Submission: 07-10-2020

Date of Acceptance: 25-10-2020

### **ABSTRACT : Statement of Problem:**

Tetrahydrozoline has been introduced as new gingival retraction agent but its clinical efficacy with widely used conventional retraction agents has not been tested.

**Purpose:** The study was designed to clinically evaluate efficacy of newer retraction agent tetrahydrozoline with two widely used retraction systems i.e., Expasyl retraction system and medicated retraction cords on basis of amount of gingival retraction.

**Materials and Methods:** 30 subjects were selected according to inclusion and exclusion criteria. Maxillary Impressions were made with irreversible hydrocolloid for all subjects. Tray material was used for making the special tray. Latin Block Design was Used in the Study to avoid tissue fatigue. Retraction was done with aluminium chloride; Tetrahydrozoline and Expasyl according to Latin block design. Impressions were poured with die stone. Casts were retrieved and sections were made with die cutter. 3 mm thin slices were obtained. Each slice was used to measure the amount of retraction under stereomicroscope under 20x and images were transferred to image analyser. Results: The amount of gingival retraction obtained by using aluminium chloride as gingival retraction agent was maximum (148238.33  $\mu\text{m}^2$ ) compared to tetrahydrozoline (140737.87  $\mu\text{m}^2$ ) and Expasyl (67784.90  $\mu\text{m}^2$ ).

**Keywords:** Aluminum chloride, expasyl, gingival displacement, tetrahydrozoline

### **I. INTRODUCTION**

In fixed prosthodontic treatment, deflection of gingival tissues before making an impression is one of the important phases. The glossary of prosthodontic terms ninth edition

defines gingival displacement as “displacement of the marginal gingiva away from a tooth.” Success of fixed prosthodontics restorations is largely dependent upon the long- term health and stability of the surrounding periodontal structures. In 1986, Benson<sup>[2]</sup> described the significance of lateral and vertical gingival retraction. Lateral retraction displaces the tissues so that an adequate bulk of impression material can be interfaced with the prepared tooth. Vertical retraction exposes the uncut portion of the tooth apical to the finish line. As described by Ferrari et al.<sup>[3]</sup> in 1996, the effective management of gingiva before impression making is necessary so that the restoration has a suitable emergence profile with well-adapted and smooth gingival margins which in turn helps maintain the healthy periodontium. Several clinical methods are available for adequate gingival displacement, including mechanical displacement, chemico- mechanical displacement, electrosurgery, and rotary gingival curettage.[6,7] The chemico- mechanical method of using a retraction cord impregnated or soaked in various chemicals is the most frequently used method.[8,9] The retraction cord mechanically displaces the gingival tissue and absorbs moisture contamination in the gingival sulcus, while the chemical agents control hemorrhage and shrink the gingival tissues. The pH of gingival displacement agents is commonly in an acidic range. Prolonged exposure to these agents causes alteration and instability in smear layer and produces etching up to several degrees, which usually happens as the recommended time for a chemico- mechanical displacement is 7–10 min.[10,11] An answer for this would be to use the agents at a neutral or alkaline pH solution, but these agents are highly unstable and do not exert their astringent effect at an alkaline pH. Nasal decongestants like tetrahydrozoline and oxymetazoline have been introduced as gingival displacement solutions. However, studies to test clinical efficiency of these agents have not yet been



reported. Hence this clinical study was planned in Department of Prosthodontics of Sudha rustagi college of dental sciences and research Faridabad india, to evaluate the level of gingival displacement produced by three different gingival displacement systems such as aluminum chloride retraction cords, expasyl, and tetrahydrozoline soaked retraction cord. Materials and Methods

### Selection of participants

The study was approved by the Ethics Committee of Pt BD Sharma university rohtak. The total number of participants selected for study is 30. The participants were selected which are having healthy periodontium and gingival index of score 0 within age group of 20–25 years were included in the study. Pregnant and lactating women, patients having malocclusion, gingival recession patients were excluded from the study. Participants undergoing orthodontic treatment and allergic to tetrahydrozoline and aluminum chloride were also

not included for the study. The Loe H and Silness J[12] gingival index was followed. Consent for participation in the study was sought through proper consent form.

### Impression for custom trays

Alginate impression material were used for making Maxillary Impressions for all 30 participants custom trays were fabricated so that they would be kept 2 mm short of sulcus. Impressions were made using a custom tray after 24 h of fabrication.

### Gingival displacement and impression making

The schedule for gingival displacement and impression making followed a Latin block design which is presented in tabular form in Table 1. On day 1 – the baseline impression was made. On day 2, day 17, and on day 32 impressions was taken after displacement with anyone of 3 displacement agents according to Latin block design.

Table 1: Latin block design used in the study

Subject	Day 2	Day 17	Day 32
1	1	2	3
2	2	3	1
3	3	1	2
-	-	-	-
-	-	-	-
-	-	-	-
14	2	3	1
15	3	1	2
16	1	2	3

### Baseline impression

Baseline impressions were made for the control group in which no gingival displacement was done. The impressions were made after removing the spacer from the custom tray. Perforations were made in the custom tray with round bur. Impressions were made with addition silicon, Type 2 medium body (Monophase). Impressions were made and removed from participant's mouth after the material was set. Once the impressions were made, they were disinfected with glutaraldehyde solution.

### Aluminum chloride displacement and impression

Isolation was done on right central incisor with cotton rolls to maintain dry working area. The required dimension of the retraction cord was selected according to the gingival biotype of the subject. Retraction cord impregnate with aluminum

chloride looped around the labial surface of the tooth and gently pushed into the sulcus with the gingival cord packer instrument [Figure 1a]. Retraction cord was removed after keeping for 10 min in the gingival sulcus.

Impressions were made in similar way as the baseline impressions.

### Tetrahydrozoline displacement and impression

Participants were recalled for evaluation of gingival health after 15 days. The gingival index was reconfirmed to be zero in right central incisor. Same impression procedure was repeated with tetrahydrozoline solution and retraction cord of same size and type [Figure 1b] (Visine, Johnson and Johnson Health Care Products, USA). Impressions were made in similar way as the baseline impressions.

### Expasyl displacement and impression

Participants were recalled for evaluation of gingiva. The index was reconfirmed to be zero in right central incisor. The expasyl displacement paste was injected slowly into the sulcus resting on the tooth [Figure 1c].

#### Pouring of impression and sample preparation

Each of the four impressions was poured immediately with die stone. Mesio- distal width of right central incisor was measured with help of vernier caliper and the center point of the tooth was marked on the cast, a second marking was made 3

mm distal to the first marking for the secondary cut. Cast was positioned and stabilized on platform of die cutter, and primary cut was made on the marked central portion of incisal edge in the buccolingual direction through the entire length of the cast. A second cut was made distal to the primary cut along the entire length of the cast such that a 3 mm thick buccolingual slice was obtained. At the end of 2 min expasyl paste was washed away from sulcus using air and water spray. Impressions were made in similar way as the baseline impressions.

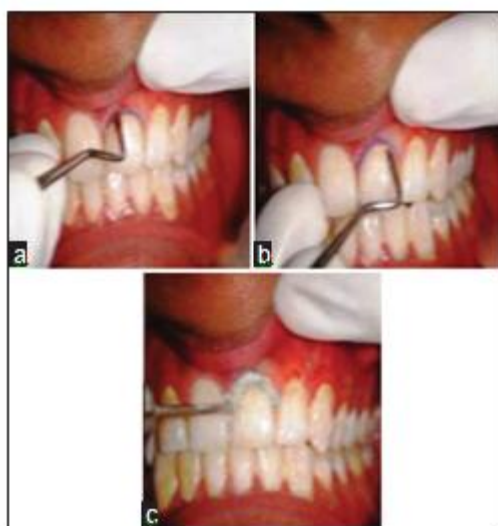


Figure 1: (a- c) Gingival displacement procedures with different agents

#### Evaluation of the amount of displacement

For determining the amount of displacement, sample was studied under a microscope having magnification of  $\times 20$ . Image was captured and transferred to the MIC 3.0 image analyzer. Perpendicular line was drawn from the most prominent point of the crest of marginal

gingival to the tooth surface. This area was automatically selected, and the area value was obtained from the software as the measured amount of displacement. The svalues of gingival displacement for all the specimens in  $\mu\text{m}^2$  tabulated [Table 2] and subjected to statistical analysis.

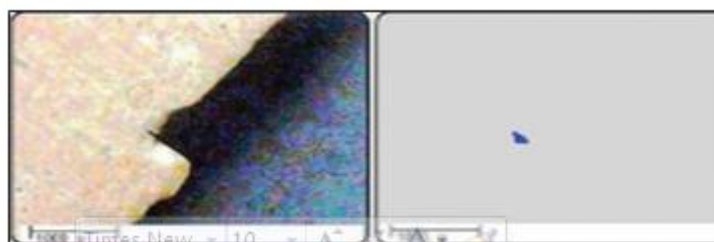
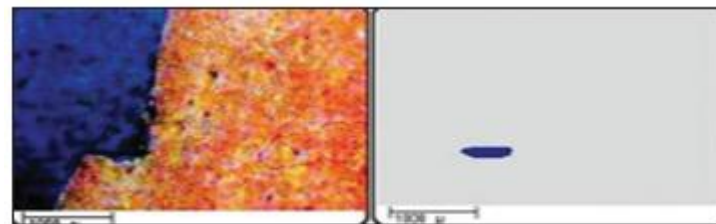


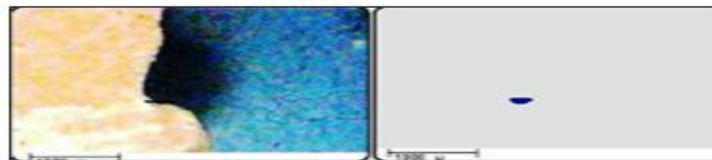
Figure 2: Gingival displacement evaluated with stereo microscope and image analyzer for control group



**Figure 3:** Gingival displacement evaluated with stereomicroscope and image analyzer for aluminum chloride group.



**Figure 4:** Gingival displacement evaluated with stereomicroscope and image analyzer for tetrahydrozoline group



**Figure 5:** Gingival displacement evaluated with stereomicroscope and image analyzer for Expasyl group

**Table 2: Amount of retraction in the four groups**

Subject no	Control	Aluminum chloride	Tetrahydrozoline	Expasyl
1	25860	148860	142230	48736
2	26760	156870	149380	52450
3	23730	139780	123478	41370
4	30840	169003	158302	59340
5	24790	138405	131002	69470
6	23870	143322	130023	43780
7	32453	163745	154033	74308
8	33213	139730	132730	82319
9	27139	142820	134390	81234
10	24450	146730	140210	79300
11	28370	140930	133319	80454
12	25680	144130	138144	52540
13	26730	138430	130430	62410
14	28430	140340	131403	72480
15	25380	143420	136344	48340
16	28430	143234	138430	54380
17	31730	159230	148320	60130
18	25930	147377	141402	63472
19	26790	161375	153430	72304
20	24394	146147	139477	55740
21	25400	153247	143233	80940
22	24344	147329	140204	73409
23	24002	133011	129002	80530
24	27300	140113	136711	77322
25	28701	155314	149453	88932
26	25739	147092	139573	79345
27	24131	148704	140330	89340
28	26700	158300	153110	80930
29	24790	160251	158332	48940
30	30430	149911	145711	79302



**Table 3: Comparison of the amount of retraction between Group II and Group III (cord with aluminum chloride and retraction cord with Tetrahydrozoline) Mann-Whitney Test**

Ranks				
	Groups	N	Mean rank	Sum of ranks
Var1	Aluminium	30	37.42	
	Tetrahydrozoline	30	23.58	
	Total	60		

**Test statistics**

	Var1
Mann-Whitney U	242.500
Wilcoxon W	707.500
Z	-3.068
Asymp. Sig. (2-tailed)	.002

**Table 4: Comparison of the amount of retraction between Group II and Group IV (cord with aluminum chloride and Expasy) Mann-Whitney Test**

Ranks				
	Groups	N	Mean rank	Sum of ranks
Var1	Aluminum	30	45.50	1365.00
	Expasy	30	15.50	465.00
	Total	60		

**Test statistics**

	Var1
Mann-Whitney U	.000
Wilcoxon W	465.000
Z	-6.653
Asymp. Sig. (2-tailed)	.000

**Table 5: Comparison of the amount of retraction between Group III and Group IV (cord with tetrahydrozoline and Expasy) Mann-Whitney Test**

Ranks				
	Groups	N	Mean rank	Sum of ranks
Var1	Tetrahydrozoline	30	45.50	1365.00
	Expasy	30	15.50	465.00
	Total	60		

**Test statistics\***

	Var1
Mann-Whitney U	0.000
Wilcoxon W	465.000
Z	-6.653
Asymp. Sig. (2-tailed)	0.000



**Table 6: Comparative evaluation between the three experimental groups Group II, Group III and Group IV (Aluminum chloride, tetrahydrozoline, Extpasyl) Kruskal-Wallis Test**

Ranks			
	Groups	N	Mean rank
Var1	Aluminum	30	67.42
	Tetrahydrozoline	30	53.58
	Extpasyl	30	15.50
	Total	90	

Test statistics	
	Var1
Chi-Square	63.547
Df	2
Asymp. Sig.	0.000

## II. RESULTS

The area of amount of lateral space between marginal gingiva and the tooth structure was observed under a stereomicroscope at  $\times 20$ . The images were imported into the image analyzer and the area was calculated. The prepared specimens of the control group were measured for the amount of gingival displacement as shown in Figure 2. Gingival displacement with aluminum chloride was measured with a similar method as shown in Figure 3. Tetrahydrozoline as gingival displacement agent was evaluated with stereomicroscope and image analyzer as shown in Figure 4 and expasyl group was also analyzed similarly as shown in Figure 5. Statistical analysis were done between control group and test groups and among test groups using Mann-Whitney Test [Tables 3- 5] and Kruskal-Wallis test was done for statistical analysis among all test groups [Table 6]. The results suggest that all 3 displacement agents produced statistically significant amount of displacement. The mean ( $\pm$ standard deviation [SD]) of gingival displacement achieved by four groups namely control, aluminum chloride, tetrahydrozoline and expasyl are  $26883.53 \pm 2657.674 \mu\text{m}^2$ ,  $148238.33 \pm 8793.289 \mu\text{m}^2$ ,  $140737.87 \pm 9097.293 \mu\text{m}^2$ ,  $67784.90 \pm 14289.945 \mu\text{m}^2$ , respectively. According to acquired data displacement cord with aluminum chloride produces the highest amount of displacement when compared with two other test

groups. The least amount of displacement was found with expasyl that is,  $67784.90 \mu\text{m}^2$ .

## III. DISCUSSION

Fixed prosthodontics treatment involves the replacement and restoration of teeth by artificial substitutes to improve patients comfort, masticatory ability, maintain health and integrity of the dental arches and elevate the patients self-image.[13]

The marginal integrity is one of the most basic criteria of the principles of tooth preparation.[14] The placement of margin or finish line in relation to the gingival margin has direct bearing on fabrication of restoration and health of the periodontal tissue of the prepared abutment teeth.[15] From the periodontal point views, it is preferable to place the gingival finish lines of restoration supragingivally or equigingivally.[16] For esthetics or other reason such as caries existing restoration and need for additional retention, the dentist may be forced to place them subgingivally. This requires some form of gingival displacement, for making the impression.[14,16,17] The mechanical effect of the cord itself will be considered equal for all materials. However, the action of the medicament is different according to their mechanism of action. Chemical impregnated cords are the most commonly used technique of gingival tissue displacement.[18,19] Use of the cord impregnated with aluminum chloride (5–10%)



is referred to be the safest and most effective method of gingival displacement.[20,21] Aluminum chloride solution (10%) acts as hemostatic agent and astringent. It has ability to precipitate protein, constrict blood vessels and extract fluid from tissues.[22] It is highly soluble in water, freely soluble in alcohol and soluble in glycerine.[23] Aluminum chloride has no contraindications and minimal side effects when used in lower concentration.[24] The results of this study prompted us to include aluminum chloride as the first experimental group in the study.

Sympathomimetic amines like oxymetazoline and tetrahydrozoline can also be used as a gingival displacement agent. However, it has been reported in the previous studies that pH of tetrahydrozoline is alkaline so causes less damage to the gingival tissues and also to the tooth structure. It is safe to use tetrahydrozoline as gingival displacement solution, which was the agent used in the study. Expasyl displacement technique provides excellent hemorrhage control as compared to medicated displacement cord technique. This may be attributed to the increased concentration of aluminum chloride in expasyl displacement system (15%) as compared to medicated displacement cord (10%). Hence expasyl was included as the third experimental group to evaluate if the increase in concentration and the medium of dispensing aluminum chloride in the gingival sulcus as a paste have a role in the amount of displacement. The patients with anterior malocclusion, gingival recession, patient under orthodontic treatment, known allergic to tetrahydrozoline and aluminum chloride and systemic condition such as pregnancy and lactating women were excluded for the study. The participants with anterior malocclusion may raise difficulty in measurement, making impression and placement of gingival cord due to rotated teeth or crowding of teeth and thus were excluded from the study. Participants with systemic condition such as pregnancy and lactating women were excluded to avoid giving unwanted stress to the participants. Latin block design was used in sequence of gingival displacement to avoid the tissue fatigue in this study. It may be logical to think that the amount of displacement produced during the first displacement be the least where compared to the last displacement or vice versa. This would mean that the first agent and the last agent may give results not true to their chemistry but by virtue of the amount of tissue fatigue that occurs during the procedure of displacement. Though 15 days has been advocated as the minimum time needed for the gingival tissues to recover if traumatized, a Latin block design that gives equal chance for each

agent to be placed at different rank order of treatment was used in this study. The sequence of displacement with aluminum chloride, tetrahydrozoline and expasyl was not similar for each subject and was ordered according to the Latin block design, thus eliminating the bias.

Gingival displacement cord selected was of a nonimpregnated variety. Preimpregnated aluminum chloride cords are available, but cords impregnated with the tetrahydrozoline are not commercially available. Therefore to use a preimpregnated aluminum chloride cord and impregnate a plain cord with the tetrahydrozoline at the time of use was found unfit for the study design. Hence, plain nonimpregnated cords were used for both the solutions.

Further the results of a study by Runyan et al.[25] indicated that soaking displacement cords in aluminum chloride solution does not lessen the cords ability to absorb fluid. Because aluminum chloride solution does aid in hemorrhage control, soaking cords before placement may be a useful adjunctive technique. They advocated a 20 min soak period for successful displacement. Hence, this soaking time was used for both the solution.

In 1978, Van der Velden and De Vries[26] studied the forces applied to the sulcus during various dental procedures. The principal investigator was the same person who was calibrated and was trained in the use of the cord packer with the recommended force. He performed the displacement in all the participants. They reported that with expasyl displacement technique it is possible to achieve adequate opening of the sulcus without damaging the epithelial attachment. Laufer et al.[27] investigated the length of the time medicated displacement cords should remain in the gingival crevice prior to impression making. They concluded to achieve a crevicular width of 0.2 mm, cord should remain in the gingival crevice for an optimum time of 4 min prior to impression making when using materials evaluated in this study. However, contemporary textbooks recommended that the cord should remain in the gingival crevice for an optimum time of 10 min. Hence, the displacement cord was allowed to remain in the sulcus for 10 min.

For impression making single step technique was used to avoid discrepancy that may creep in due to the use of two materials, tray positioning and the time that elapses in the two-stage procedure between removal of the cord and the impression making. Furthermore, in double mix single step technique it is difficult to control the burn out effect. Putty may displace the light body and show an error so single step impression



technique, therefore medium body consistency monophasic material was used. In the present study, a method of pouring the impression of retracted gingival and measuring this amount of displacement on the sectioned part of the cast under microscope with image analyzer system was followed. This method in part is similar to the technique used by Bowles et al.,[28] Casts were made and compared with the pretreatment casts.

Sections of the casts were sawed out, and the teeth under investigation were sectioned buccolingually at the buccal eminence, followed by quantitative measurement of the width of the retracted sulcus, under a low-power microscope equipped with a 0.25-mm grid. The width was measured as the distance from the tooth to the crest of the gingiva. However, the 0.25-mm grid may not be a suitable grid measure for measuring gingival displacement as the minimum amount of displacement in human gingiva has been reported to be 0.2 mm. Further digital measurement of the amount of displacement, as followed in this study, gives measurement with at least count of about 1  $\mu$ . Yet another technique of measuring the amount of displacement has been reported in the study done by Raja and Nair.[29] The results suggest that all three displacement agents produced statistically highly significant amount of gingival displacement when compared with baseline. The mean ( $\pm$ SD) for the four groups namely control, aluminum chloride, tetrahydrozoline and expasyl are 26883.53  $\pm$  2657.674, 148238.33  $\pm$  8793.289, 140737.87  $\pm$  9097.293, 67784.90  $\pm$  14289.945), respectively.

Comparison of the means of the experimental groups, with the control group, shows a highly significant amount of difference. This means that all the three agents are capable of producing some amount of displacement, with the group II (displacement cord with aluminum chloride) showing the highest amount of displacement that is, 148238.33  $\mu$ m<sup>2</sup>, next in line the group III, (displacement cord with tetrahydrozoline) showing 140737.87  $\mu$ m<sup>2</sup> displacement, the least amount of displacement was found with group IV (expasy) that is, 67784.90  $\mu$ m<sup>2</sup>.

The study done by Raja and Nair[29] measured displacement in the vertical direction Whereas; we measured the horizontal displacement. Hence, a comparison of these studies is not appropriate. The result of displacement produced by tetrahydrozoline in this study is comparable to the results obtained by Bowles et al.[28] Any medicament used for displacement should satisfy the following criteria; it must be effective, use of medicament in a cord must result in sufficient lateral displacement of the gingival tissue

contaminated with tissue shrinkage and control of hemorrhage and fluid seepage to allow the dentist to make an adequate impression of gingival finish line of the prepared tooth. Use of material should not cause significant irreversible tissue damage (tooth and gingiva). Use of the material should not produce potentially harmful systemic effect. With respect to the criteria mentioned above, displacement cord with tetrahydrozoline shows excellent displacement, has negligible harm to tissue and has no potentially harmful systemic effects. Hence, the use of tetrahydrozoline in conjunction with displacement cord can be recommended as a safe and efficient displacement system.

#### Limitation of the study

Being in vivo study most limitations of in vitro design are eliminated as the measurements are obtained from the mouth. The measurement made by direct means in the patient's gingival sulcus is considered full proof. But in present study measurements are the indirect measurement made from the casts which in turn are made from the impression of displaced gingiva. Therefore uncontrollable parameters like that of material flow and die material stability could have altered the result. However in the absence of such a direct measurements methodology the present study holds good. Further research into developing such a direct measure should be done for more accurate representation.

#### IV. CONCLUSIONS

The conclusions that were drawn from this study are: All three displacement systems namely (aluminum chloride, tetrahydrozoline, expasyl) show clinically and statistically significant amount of displacement. Among the three displacement agents tested, displacement cord with aluminum chloride showed the maximum displacement. Expasyl shows the least amount of displacement. Considering the result that displacement cord with the tetrahydrozoline produce comparable displacement as aluminum chloride and can be a good alternative to it.

#### REFERENCES.

- [1]. Ferencz JL. Maintaining and enhancing gingival architecture in fixed prosthodontics. J Prosthet Dent 1991;65:650-7.
- [2]. Weir DJ, Williams BH. Clinical effectiveness of mechanical-chemical tissue displacement methods. J Prosthet Dent 1984;51:326-9.
- [3]. Bishop K, Briggs P, Kelleher M. Margin





- design for porcelain fused to metal restorations which extend onto the root. *Br Dent J* 1996;180:177-84.
- [4]. Trivedi SC, Talim ST. The response of human gingiva to restorative materials. *J Prosthet Dent* 1973;29:73-80.
- [5]. Nemetz H, Donovan T, Landesman H. Exposing the gingival margin: A systematic approach for the control of hemorrhage. *J Prosthet Dent* 1984;51:647-51.
- [6]. La Forgia A. Mechanical-chemical and electrosurgical tissue displacement for fixed prosthesis. *J Prosthet Dent* 1964;14:1107-14.
- [7]. Benson BW, Bomberg TJ, Hatch RA, Hoffman W Jr. Tissue displacement methods in fixed prosthodontics. *J Prosthet Dent* 1986;55:175-81.
- [8]. Donovan TE, Gandara BK, Nemetz H. Review and survey of medicaments used with gingival retraction cords. *J Prosthet Dent* 1985;53:525-31.
- [9]. Gardner FM, Walton JN. Gingival displacement techniques. In: *Clinical Aspects of Dental Materials*. Washington, DC: United States Army Institute of Dental Research; 1986. p.165-75.
- [10]. Land MF, Rosenstiel SF, Sandrik JL. Disturbance of the dentinal smear layer by acidic hemostatic agents. *J Prosthet Dent* 1994;72:4-7.
- [11]. Land MF, Couri CC, Johnston WM. Smear layer instability caused by hemostatic agents. *J Prosthet Dent* 1996;76:477-82.
- [12]. Soben P. *Essential of Preventive and the Community Dentistry*. 2<sup>nd</sup> ed. Arya (Medi) Publishing House: New Delhi; 2007. p. 153.
- [13]. Shillinburg HT, Sumiya H, Whitsett LD, Richard J, Brakette SE. *Fundamental of Fixed Prosthodontics*. 3<sup>rd</sup> ed. Chicago