

Comparative evaluation of Fluid Absorbency of Two Different Sizes of retraction Cords after Immersion in Five Different Medicaments: An In Vitro Study

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ABSTRACT

Aim: To determine the effect of cord thickness and their immersion in different retraction medicaments on the fluid absorbency of gingival retraction cords.

Materials and Method: Two different retraction cords of sizes 000 and 0 were selected and cut into 30mm length. The study included 120 samples divided into 2 equal groups for each size. Amongst these, dry weight of 10 samples were measured (Gp. I), 10 samples immersed in 10% aluminium chloride (Gp. II), 10 samples immersed in 15.5% ferric sulphate (Gp. III), 10 samples immersed in alum (Gp. IV) 10 samples immersed in Tannic acid (20%) (Gp. V) and 10 samples in 0.05% Tetrahydrozoline Hydrochloride (Gp. VI) for a time period of 20 minutes. Initial dry weight was noted and five cords from each set were immersed in plasma solution and rest in the saliva substitute for 10 minutes. The cords post immersion weight was recorded.

Results: There was a clear relationship between the thickness of the cord used and fluid absorbed with a significant difference seen in the fluid absorbency amongst different medicament groups.

Conclusion: Ferric sulfate (15.5%) was proved to be a better hemostatic medicament for fluid absorption in plasma but is more toxic than sympathomimetic amines such as 0.05% oxymetazoline Hydrochloride which absorbs more fluid when dipped in saliva. The fluid absorbency increased in linear proportionality with increase in the cord thickness.

Keywords: Artificial, saliva, retraction, agents, human, plasma.

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INTRODUCTION

Achieving aesthetic and functional restoration of missing teeth is the prime goal of prosthodontics.¹ Integrity of the surrounding periodontium plays a vital role in success of fixed prosthodontic restoration. Marginal integrity is a fundamental criterion in the principles of tooth preparation. The three types of finish lines include sub-gingival, equi-gingival, and supra-gingival.² Evidence-based research has shown that 0.2 mm minimum horizontal displacement of the gingiva is necessary to record precise preparation margin without distortion of the recording material.³

The Various techniques are: Mechanical; Mechanico-chemical; Rotary gingival curettage; Electro surgery.² The medicaments are soaked in the available varieties of retraction cords. Gels & pastes are placed into the gingival sulcus. These medicaments should fulfil the following criteria⁴

- 1) It must be an effective hemostatic agent
- 2) No significant irreversible tissue damage
- 3) No detrimental systemic effects on living cells.

The two different pharmacological action categories are:⁵

Class 1 includes vasoconstrictors

Class 2 includes hemostatics/ astringents.

Medicaments used for retraction include epinephrine, alum (aluminum potassium sulfate), aluminium chloride (AlCl₃), tannic acid, zinc sulphate, aluminium sulfate, ferric sulphate, zinc chloride and Sympathomimetic amines such as 0.05% Tetrahydrozoline HCl, 0.05% oxymetazoline HCl and 0.25% HCl- phenylephrine.^{6,7,8}

Aluminum chloride causes the least irritation and systemic side effects as it works on multiple mechanism including vascular constriction and precipitation of tissue. It is used in 5 to 25% concentration.^{8,9} Its essential failing is the interference in the setting of elastomeric impression material.¹⁰

After removal of the cord medicated with aluminum chloride, 80% of its displacement remains patent for a minimum of 12 minutes.¹¹ Ferric sulphate, an astringent used in concentrations of 13% -20%, is known to cause shrinkage of gingival tissue within 3 minutes due to transient ischemia. In order to avoid tissue rebound the impression needs to be recorded quickly. In addition, ferric sulphate controls the gingival crevicular fluid seepage.¹² However it does cause a significant damage to the gingival tissue, which takes about 21 days to heal and hence not indicated for gingival retraction.¹³ Alum (Aluminium potassium sulphate), Aluminium sulphate, and Aluminum chloride are astringents, who inhibit trans capillary movement of plasma proteins by precipitation and causes vasoconstriction.¹⁴ Alum at high concentration is known to cause severe inflammation and tissue necrosis.¹⁵ Being a sulphate compound, it inhibits polymerization of silicone impression materials.¹⁰

Tannic acid (C₇₆H₅₂O₄₆) is a vegetable poly-phenol and despite good tissue recovery is less effective than epinephrine nor is it a powerful hemostatic agent. It's use in dentistry is limited to controlling small/ temporary intraoral bleedings as home remedy.^{5, 16, 17}

Vasoconstrictors such as tetrahydrozoline, oxymetazoline, and phenylephrine belonging to the alpha agonist's family are effectively prescribed as eye and nasal drops with minimal systemic effects. Bowles et al⁹ concluded that tetrahydrozoline exhibits powerful retraction and is a better agent than even epinephrine.^{18, 19} An earlier study compared the toxicity of certain chemical agents on primary human gingival fibroblasts (HGFs) and showed that: 0.01% HCl-epinephrine < 0.1% HCl-epinephrine < 5% aluminum sulphate < 20% aluminum sulphate < 15.5% ferric sulfate.²⁰

One factor that has not been considered in earlier studies is the influence cord thickness on the fluid absorbency. Retraction cords should be able to absorb both blood and saliva present around a prepared tooth. Thus, this study was to evaluate the medicaments used and dimension of retraction cords on fluid absorbency.

MATERIAL AND METHODS

This in vitro study was conducted in Department of Prosthodontics & Crown and Bridge. The materials used:

1. Retraction cords sizes 000 and 0 (Prime cord, plain cord)
2. Retraction medicaments; 10% aluminum chloride; 15.5% ferric sulfate; 100% alum; 20% tannic acid and 0.05% HCl oxymetazoline

3. Fluids used: Artificial saliva (wet mouth), human plasma
4. Electronic analytical balance for weight measurement (Mettler Toledo, India)
5. Blotting paper & Pipette

The retraction cords were measured with a ruler and cut into 60 samples and equal length of 30 mm and distributed into 6 groups of 10 samples each.

Grouping

Group 1: 10 untreated Cords to measure the dry weight.

Group 2: 10 Cords immersed in 10% aluminum chloride

Group 3: 10 Cords immersed in 15.5% ferric sulphate

Group 4: 10 Cords immersed in 100% alum

Group 5: 10 Cords immersed in 20% tannic acid

Group 6: 10 Cords immersed in 0.05% HCl oxymetazoline

The cords were immersed in the medicaments for 20 minutes and blotting paper was used for removing excess fluid. Initial weight was determined by electronic analytical balance.

Further, 5 pieces from each group were immersed in saliva and plasma each for 10 minutes. The fluid absorbency of the dry retraction cord was calculated by deducting the weight of the dry cord post fluid immersion. The weight was measured after removal from solutions again.

1. Amount of fluid absorbed = weight after fluid immersion - weight before fluid immersion.
2. Amount of fluid absorbed after medicament treatment = Final weight after plasma/saliva immersion - weight after medicament immersion.

Figures:

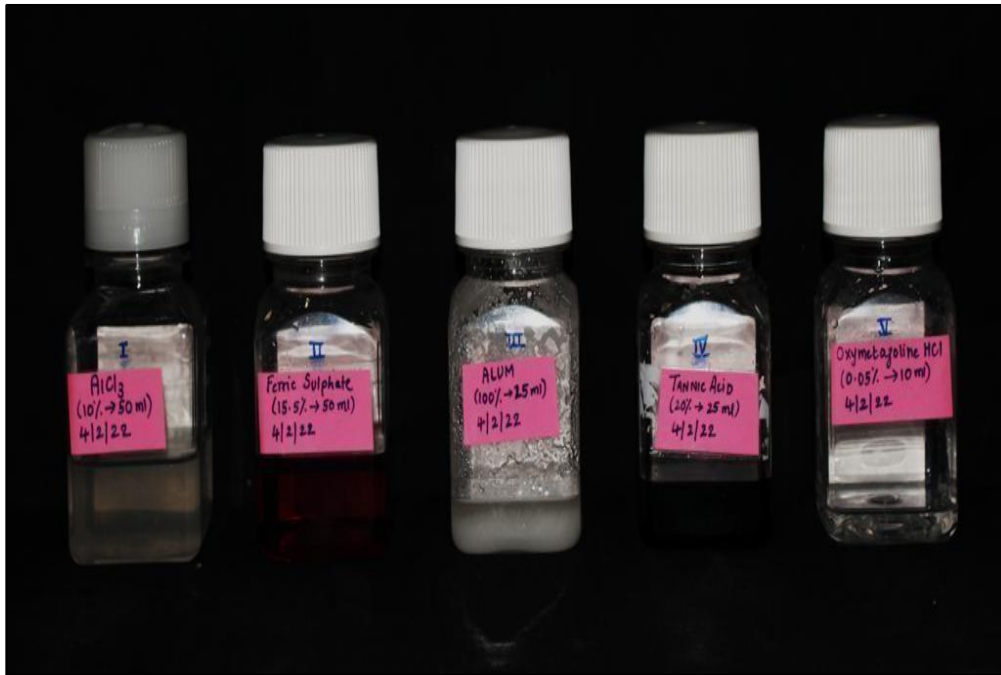


Figure 1: Retraction medicaments: I-10% Aluminum chloride; II-15.5% Ferric sulfate; III-100% Alum; IV-20% Tannic acid; V- 0.05% HCl oxymetazoline



Figure. 2: Fluids used: Artificial saliva & human plasma

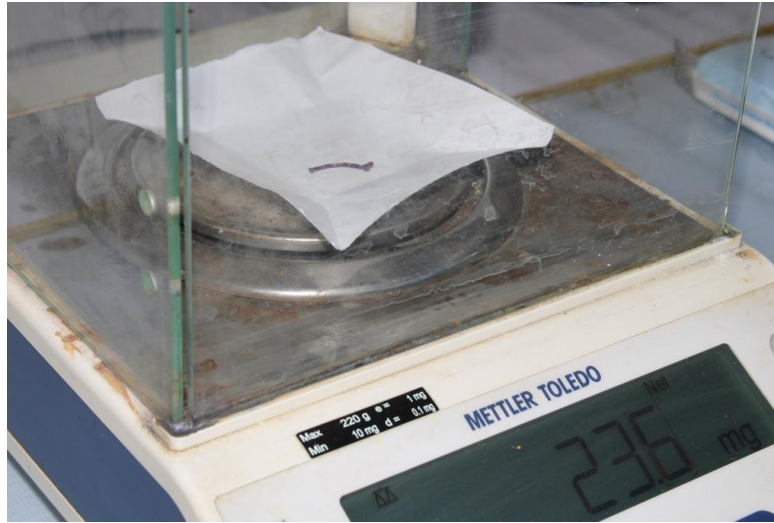


Figure. 3: Electronic analytical balance to measure weights



Figure. 4: Grouping of samples

RESULTS

Table 1

One-way ANOVA analysis between a dry cord, aluminum chloride, ferric sulphate, alum, tannic acid and 0.05% oxymetazoline HCl at room temperature.

<u>000 cord</u>	N	Mean	SD	Std. Error	95% Confidence interval for mean		F	Significance
					Lower Bound	Upper Bound		
Dry Cords	10	2.54	0.20	0.065	2.39	2.68	6.85	0.0007
AlCL3	10	2.16	1.35	0.42	1.19	3.12		
FeSO4	10	1.12	0.43	0.13	0.80	1.43		
Alum	10	1.62	0.46	0.14	1.29	1.95		
Tannic Acid	10	1.65	0.62	0.19	1.20	2.09		
Oxymetazoline	10	0.27	0.20	0.06	0.12	0.41		
Total	60	1.56	0.42	0.13	1.16	1.94		
<u>0 cord</u>	N	Mean	SD	Std. Error	95% Confidence interval for mean		F	Sig.
					Lower Bound	Upper Bound		
Dry Cords	10	5.05	0.36	0.11	4.79	5.31	4.06	0.004
AlCL3	10	7.45	2.74	0.86	5.48	9.41		
FeSO4	10	5.96	2.66	0.71	4.33	7.58		
Alum	10	5.36	1.80	0.57	4.06	6.65		
Tannic Acid	10	5.47	2.44	0.77	3.71	7.22		
Oxymetazoline	10	1.99	1.38	0.43	0.99	2.98		
Total	60	5.21	0.91	0.11	3.89	6.52		

Table 2: Bonferroni Post-hoc comparisons to detect the significant differences in retraction immersed cord and dry cord.

For 000 cord

Medicament	Medicament	Mean - diff	Std. error.	Sig. (P value)
Dry cord	Aluminium Chloride	0.38	1.15	0.0002
	Ferric Sulphate	1.42	1.15	0.0001
	Alum	0.92	1.15	0.0001
	Tannic Acid	0.89	1.15	0.0001
	Oxymetazoline	2.27	1.15	0.0172
Aluminium Chloride	Dry cord	-0.38	1.15	0.0002
	Ferric Sulphate	1.04	1.15	0.0404
	Alum	0.54	1.15	0.2624
	Tannic Acid	0.51	1.15	0.3036
	Oxymetazoline	1.89	1.15	0.0007
Ferric sulphate	Dry cord	-1.42	1.15	0.0001
	Aluminium Chloride	-1.04	1.15	0.0404
	Alum	-0.5	1.15	0.0078
	Tannic Acid	-0.53	1.15	0.0185
	Oxymetazoline	0.85	1.15	0.0001
Alum	Dry cord	-0.92	1.15	0.0001
	Aluminium Chloride	--0.54	1.15	0.2624
	Ferric sulphate	0.5	1.15	0.0078
	Tannic Acid	-0.3	1.15	0.8796
	Oxymetazoline	1.35	1.15	0.0001

Tannic Acid	Dry cord	-0.89	1.15	<i>0.0001</i>
	Aluminium Chloride	-0.51	1.15	0.3036
	Ferric sulphate	0.5	1.15	<i>0.0185</i>
	Alum	0.3	1.15	0.8796
	Oxymetazoline	1.38	1.15	<i>0.0001</i>
	Oxymetazoline	Dry cord	-2.27	1.15
Aluminium Chloride		-1.89	1.15	<i>0.0007</i>
Ferric sulphate		-0.85	1.15	<i>0.0001</i>
Alum		-1.35	1.15	<i>0.0001</i>
Tannic Acid		-1.38	1.15	<i>0.0001</i>

Significant difference was noted at $p \leq 0.05$ between all parameters except aluminum chloride and alum, aluminum chloride and tannic acid, alum and tannic acid.

For 0 cord

Medicament	Medicament	Mean difference	Std. error.	Sig.
Dry cord	Aluminium Chloride	-2.4	2.57	<i><0.0001</i>
	Ferric Sulphate	-0.91	2.57	<i><0.0001</i>
	Alum	-0.31	2.57	<i><0.0001</i>
	Tannic Acid	-0.42	2.57	<i><0.0001</i>
	Oxymetazoline	3.06	2.57	0.0009
Aluminium Chloride	Dry cord	2.4	2.57	<i><0.0001</i>
	Ferric Sulphate	1.49	2.57	0.2188
	Alum	2.09	2.57	0.0828
	Tannic Acid	1.98	2.57	0.1222
	Oxymetazoline	5.46	2.57	<i><0.0001</i>

Ferric sulphate	Dry cord	0.91	2.57	<0.0001
	Aluminium Chloride	1.49	2.57	0.2188
	Alum	0.6	2.57	0.5755
	Tannic Acid	0.49	2.57	0.6624
	Oxymetazoline	3.97	2.57	0.0003
	Alum	Dry cord	0.31	2.57
Aluminium Chloride		-2.09	2.57	0.0828
Ferric sulphate		-0.6	2.57	0.5755
Tannic Acid		-0.11	2.57	0.9507
Oxymetazoline		3.37	2.57	0.0003
Tannic Acid		Dry cord	0.42	2.57
	Aluminium Chloride	-1.98	2.57	0.1222
	Ferric sulphate	-0.49	2.57	0.6624
	Alum	0.11	2.57	0.9507
	Oxymetazoline	3.48	2.57	0.0013
	Oxymetazoli	Dry cord	-3.06	2.57
Aluminium Chloride		-5.46	2.57	<0.0001
Ferric sulphate		-3.97	2.57	0.0003
Alum		-3.37	2.57	<0.0001
Tannic Acid		-3.48	2.57	0.0013

Significant difference was noted at $p \leq 0.05$ between oxymetazoline with all other medicaments and dry cord with all medicaments.

Table 3: Spearman correlation test was done to see which cord absorbed maximum fluid and which fluid among plasma and saliva got maximum absorbed.

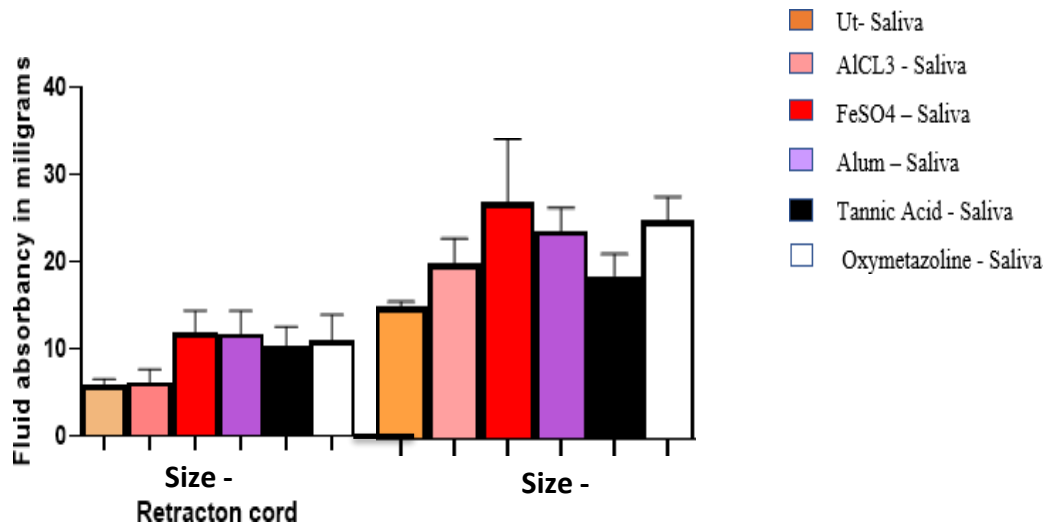
For 000 cord

		Size of cord	Weight after final incubation
Size of cord	Correlation Coefficient	1.000	0.994**
	Sig. (2-tailed)	-	0.000
Spearman's rho	N	60	
Weight Incubation	Correlation Coefficient after final	0.994**	1.000
	Sig. (2-tailed)		
	N	60	60

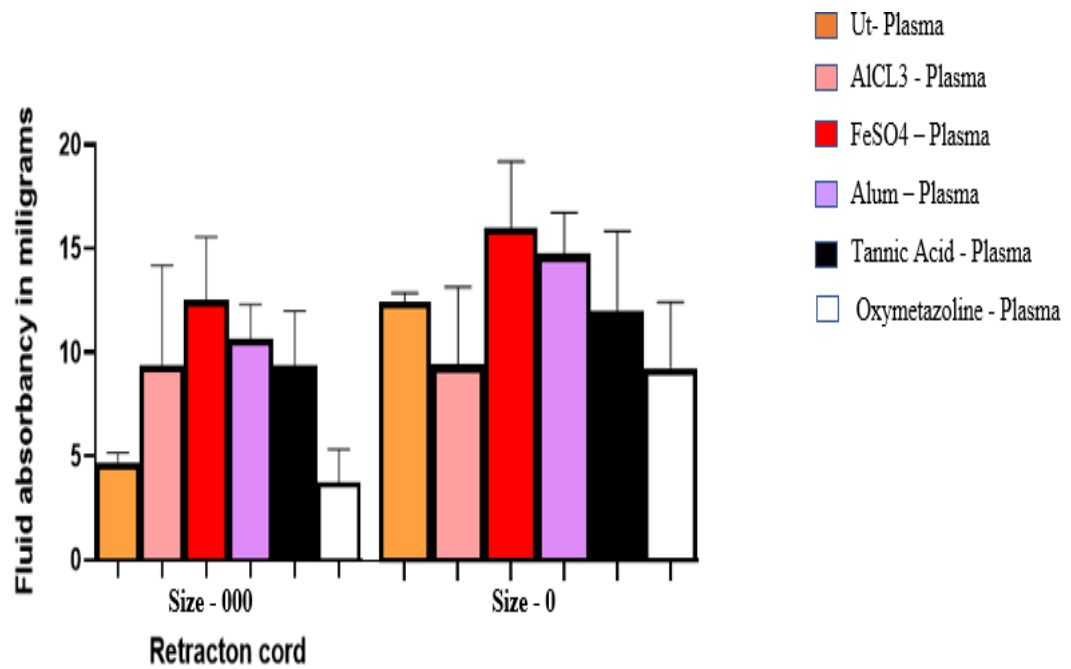
For 0 cord

		Size of cord	Weight after final incubation
Size of cord	Correlation Coefficient	1.000	0.986**
	Sig. (2-tailed)		0.000
Spearman's rho	N	60	
Weight Incubation	Correlation Coefficient after final	0.986**	1.000
	Sig. (2-tailed)	0.000	-
	N	60	60

There is a positive co-relation between size of cord and weight after final incubation and is significant at $p \leq 0.05$



Graph 1: Graphical Results for Plasma



Graph 2: Graphical Results for Saliva

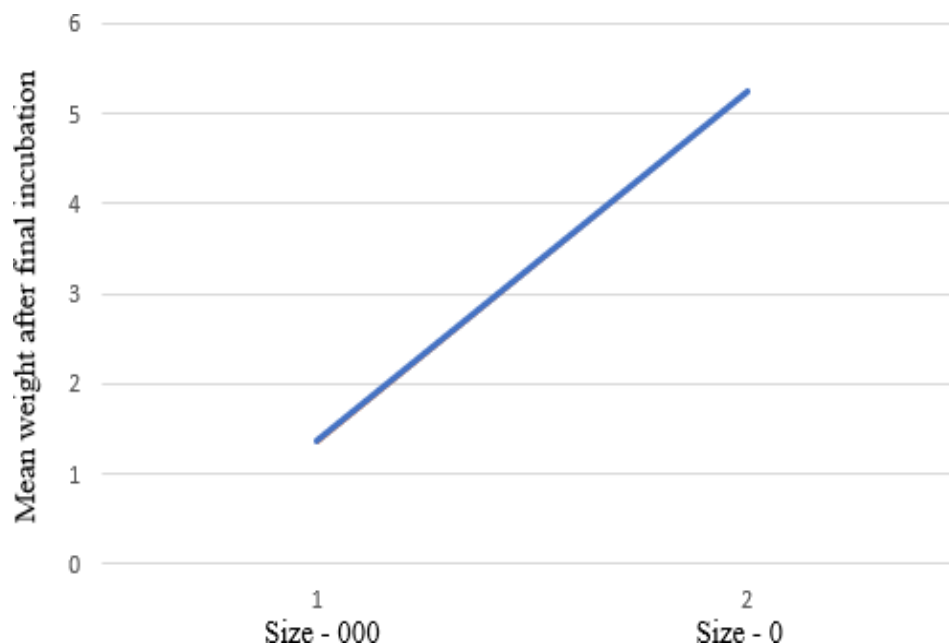


Chart 1: Line diagram

Table 1 presents the results of the one-way analysis of variance, Anova, to determine if any statistically significant difference exists between the dry cord, aluminum chloride, ferric sulphate, alum, tannic acid and 0.05% oxymetazoline HCl [Table 1]

Table 2 presents the results of Bonferroni Post-hoc test showing remarkable dissimilarities in absorbencies between retraction immersed cords and dry cord. Nonetheless, the absorbency with ferric sulfate treatment is higher. It is clear from the line diagram depicted in Chart 1 that the fluid absorbency increases with increase in thickness of the cord.

As indicated in table 3, graph 1&2, Human plasma showed higher absorbency than saliva. The size “0” cord absorbed maximum fluid in accordance with Spearman’s correlation test.

DISCUSSION

Marginal integrity is an essential criterion in tooth preparation.²¹ Gingival retraction permits access beyond the prepared margins and create a space for the impression material. For a perfect impression, a displacement of 0.2 mm is suggested at the gingival margins with horizontal gingival displacement.^{3,22}

Prime cord Retraction cord was chosen because it is 100% cotton cord knitted into interlocking chains to enable easy cord packing into sulcus. This lessens the chance of the cord unraveling and fraying during

packing. Knitted cords are available in five color codes and can be soaked in any hemostatic agent. They do not entangle diamond burs during crown preparation.

Retraction cords by the same manufacturer (Primecord) were used to maintain standardization. These were trimmed into pieces of equal length (30 mm), immersed in retraction agents for 20 min and later soaked in artificial saliva and plasma for 10 minutes. Fluid absorbency is dependent on length, width, structure, wetting properties of cord and duration of soaking time²³. Ideal retraction requires a minimum of 20 minutes of cord immersed in the medicament.⁴ In the present study, artificial saliva and human plasma were chosen to simulate saliva and crevicular fluid in vitro. Human plasma proteins are analogous to gingival crevicular fluid and blood.²⁴

Astringents form the main variety of gingival retraction agents. Astringent is defined as "a drug that causes cells to shrink by precipitating proteins from their surfaces," according to Concise Medical dictionary.²⁵ Aluminum Chloride and ferric sulphate are highly acidic which irritates the tissues and causes sulcular epithelium desquamation and irritation, post-operative sensitivity, toxic to human gingival fibroblasts and alters dentinal surface properties by making them resistance to acid etching.²⁶ Ferric chloride causes temporary bluish brown staining due to its iron content.²⁷

Alum in 100 % concentration has shown to be just a little behind in its efficacy in shrinking the gingival tissue as compared to epinephrine with a good tissue response. Aluminium Sulphate tends to inhibit or retard the setting reactions of addition silicon impression materials.²⁸

Gingival retraction may cause damage to periodontal tissue^{29,30,31}. Sympathomimetic vasoconstrictors as retraction agent provide desired efficacy without adverse side effects. Astringents are stable and active only in a limited range of acidic pH which causes etching of the enamel or post operative sensitivity.

Oxymetazoline and Tetrahydrozoline belong to group of sympathomimetic vasoconstrictors, that are alpha agonists and commercially available as nasal and eye drops. Systemic reactions to these products are relatively rare, since the maximum recommended doses are significantly higher than required for effective gingival retraction.⁹ Oxymetazoline 0.05% shows impressive results as an impregnating agent for mechano chemical retraction of the gingival margin and the absence of any cytotoxic influence as compared to the astringents and epinephrine.³³

Table 3, graph 1 and graph 2 confirm that Oxymetazoline seems to have a significant impact on the sulcular depth and width as compared to all other medicaments.

While the absorption of plasma is higher with ferric sulfate, it has shown interference with the surface detail reproduction of impression materials. Ferric sulphate also causes visible dentin discoloration due to precipitation of ferric sulphide in the anaerobic environment.³⁴ Aluminum chloride and ferric sulphate both have negative effect on adhesion therefore before cementation of the final restoration with composite resin

cement, the surface needs to be cleaned with slurry of pumice to create dentin smear layer.³⁵

The results obtained through this research aids in inferring that 15.5% ferric sulfate is preferable to improve the fluid absorbency of the retraction cords but considering side effects of ferric sulphate 0.05% oxymetazoline is newer retraction agent which absorbs saliva more than plasma and has no absolute side effects.

CONCLUSION

The retraction cords absorb fluid and moisture present in gingival sulcus to keep the impression making field as dry as possible and also displace the gingiva.

Amount of fluid absorbed rises in linearly with the size of cord. To evaluate the effect of cord diameter on absorbency of fluid, two different sizes (000, 0) were selected. 0 Cord had the most absorbency.

The fluid absorbency is more with 15.5% ferric sulphate amongst all the retraction cords but the many side effects negate its clinical use.

0.05% oxymetazoline absorbs saliva more than plasma and is the better newer medicament for absorption and clinical usage.

LIMITATIONS

This study was done in regards to mechano-chemical methods of gingival retraction. Newer gingival retraction agents are causing less tissue irritation than retraction cords.

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