

<https://doi.org/10.48047/AFJBS.6.6.2024.6510-6521>



African Journal of Biological Sciences

Journal homepage: <http://www.afjbs.com>



Research Paper

Open Access

ORIGINAL RESEARCH

A Comparative Study of Different Gingival Retraction Systems: An in Vivo Study

¹Dr. Priya, ²Dr. A Sudheer, ³Dr. Harendra Shahi, ⁴Dr. Shivam Sulok, ⁵Dr. Rupa Singh, ⁶Dr. Ankita Kumari

^{1,6}Post Graduate student, ²Principal and Head of Department, ³Professor, ⁴Associate Professor, ⁵Assistant Professor, Department of Prosthodontics, MMDCH, Darbhanga, Bihar, India

Corresponding Author: Dr. Priya, Post Graduate Student, Department of Prosthodontics, MMDCH, Darbhanga, Bihar, India **Email:** chaudharypriya030@gmail.com

Article Info

Volume 6, Issue 6, June 2024

Received: 27 April 2024

Accepted: 03 June 2024

Published: 29 June 2024

doi: 10.48047/AFJBS.6.6.2024.6510-6521

ABSTRACT

Background: When the finish line is at or inside the gingival sulcus, gingival displacement is necessary to produce precise imprints for the creation of fixed prosthesis. For the sake of tissue management effectiveness and dimensional accuracy, a comparative study of these novel gingival displacement materials was judged essential.

Materials and Methods: A total of five different gingival retraction agents namely Stay put gingival retraction cord, 15% Aluminium chloride, 0.05% Oxymetazoline hydrochloride, 0.05% Tetrahydrozoline hydrochloride and 20% Ferric sulphate were used in this study. A total of 20 participants were used in this study on which all these five gingival retraction materials were used at a regular interval of seven days on right mandibular first molar. The pre retraction and post retraction impression were taken using addition silicone and poured using die stone. The sectioned die stone models were studied under stereomicroscope to measure the amount of gingival retraction in horizontal direction.

Result: Preliminary findings indicate that 0.05% Oxymetazoline hydrochloride demonstrated superior efficacy in achieving Mean Displacement 14.9 (μm) gingival retraction compared to traditional methods Mean Displacement 4.9 (μm) in 15% aluminium chloride group. New retraction methods namely 0.05% Oxymetazoline HCL (Nasivion) and 0.05% Tetrahydrozoline HCL (Visine) have better horizontal displacement in comparison to the traditional retraction methods.

Conclusion: 0.05% Oxymetazoline HCL found to be superior on 0.05% Tetrahydrozoline HCL Retraction method including the traditional methods.

Keywords: Gingival displacement, Fixed partial denture, Ferric sulfate, Retraction agents, Chemo-mechanical retraction, Retraction cord, Oxymetazoline HCL, Tetrahydrozoline HCL.

INTRODUCTION

The goal of prosthodontics is the restoration of function, facial appearance, and the maintenance of the patient's health.¹ Over the past decades, there has been enormous

improvement in the field of fixed prosthodontics. There has been introduction of improved procedures and a wide range of materials.²

When a tooth is lost, the structural integrity of dental arch is disrupted and there is a subsequent realignment of teeth until a new state of equilibrium is achieved. Hence, it is very essential to replace this lost tooth as early as possible. This can be achieved with the help of fixed partial denture. The fixed partial denture is a dental restoration used to replace missing teeth and that is permanently attached to adjacent teeth or dental implants. The dental arch is in state of dynamic equilibrium with the teeth supporting each other. For the success of any restoration, restoration must have healthy, harmonious relation with the periodontium.³ From periodontal point of view, it is preferable to place the margins of restoration supragingival, because it is easier to prepare accurately without trauma to soft tissues and facilitates impression making.⁴

Fixed partial denture commonly have subgingival margins or finish lines either for structural durability or for the esthetic reasons.⁵ The marginal integrity of fixed partial denture plays an important role for the longterm clinical success. Lack of marginal integrity causes inflammation of surrounding periodontal tissues and it also increases the risk of secondary caries.⁵

An accurate impression is required for the fixed partial denture that records the finish line of the prepared tooth structure. Gingival displacement is defined as the deflection of marginal gingiva away from the tooth.³ Gingival tissues are displaced both laterally and vertically.² The gingival displacement procedure allows the impression material to flow apical to the subgingival finish line thereby registering it and an area apical to it.⁵

Gingival displacement can be achieved by mechanical, chemical, or surgical means. Mechanical displacement is most effectively achieved by placement of cord. Chemical means of gingival displacement includes Aluminium chloride, Epinephrine, Ferric sulfate etc while the surgical techniques are Curettage, Electrosurgery and Laser.⁴

Various studies have been done on various retraction methods and various chemicals. Moreover there is no conclusive evidence regarding the efficacy of the newer materials. Hence a study has been designed to compare the efficacy of different gingival retraction systems.

MATERIALS AND METHODS

The study was carried out in the Department of Prosthodontics and Crown and Bridge, Mithila Minority Dental College and Hospital, Darbhanga, Bihar. The study involved the subjects who were the students of Mithila Minority Dental College and Hospital. Written informed consent was obtained from those students who agreed to participate voluntarily and the ethical clearance was obtained from the ethical committee of Mithila minority dental college and hospital, Darbhanga, Bihar.

PREPARATION OF SUBJECTS

The right mandibular first molar were used for the study. The subjects were assessed clinically for the healthy mandibular right first molar free of any inflammatory change, dental caries, rotation or malalignment as mentioned in the inclusion and exclusion criteria.

SELECTION OF SUBJECTS

INCLUSION CRITERIA

1. Age between 20 to 30 years.
2. The right mandibular first molar should be healthy and unprepared.
3. The tooth should be free of caries and any periodontium- related diseases.
4. The respective tooth should not be rotated, tilted or misaligned.

5. The tooth should be of normal size and contour (no developmental anomaly or any regressive age changes).
6. The gingiva should be free of any inflammatory changes around the respected tooth.

EXCLUSION CRITERIA

1. Age less than 20 years.
2. Caries prone and periodontally compromised tooth.
3. Rotated, tilted or misaligned tooth.
4. Tooth with any developmental anomaly.
5. Any gingival inflammatory changes present.

RECORDINGS

A total 20 participants of age group 20-30 yrs were selected for the study and were numbered as 1 to 20. Five different types of gingival retraction materials were used which were designated as

- A. Gingival retraction cord (Roeko stay put)
- B. 15% Aluminium chloride (3M ESPE Astringent retraction paste)
- C. Oxymetazolinehydrochloride 0.05% (Nasivion)
- D. Tetrahydrozoline hydrochloride 0.05% (Visine)
- E. Ferric sulfate 20% (Haemostat gel). (FIG.1)

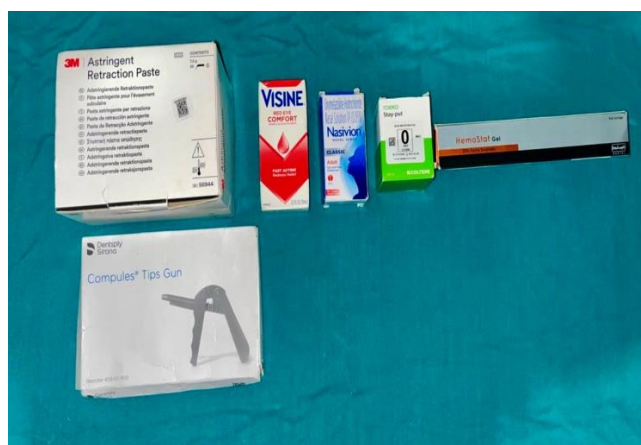


FIG 1:Gingival Retraction Agents used for the study

Keeping in mind the code of ethics, as teeth were not prepared, each tooth was subjected to retraction on their buccal aspects only once. The pre retraction impression and cast were designated as pre retraction impression and pre retraction cast while the post retraction impression and cast were designated as post retraction impression and post retraction cast respectively. Ex-If gingival retraction material A was used for participant 1, then it is designated as 1A-PRE for pre retraction sample and 1A-POST for post retraction sample. Each material was used on each participant at a regular interval of 7 days. A total of 100 samples were pre retraction and other 100 samples were post retraction. For each participant the diagnostic impression was taken using Alginate and perforated stock trays of appropriate size. Then the casts were poured using dental stone and two custom trays were fabricated in a conventional manner for pre retraction and post retraction impression.

A. STAY PUT GINGIVAL RETRACTION CORD

The pre retraction impression was taken using custom tray and multiple mix impression technique in which the heavy body (AVUE GUM) was used as the tray material and light

body (AVUE GUM) as the syringe material. Tissue displacement was preceded with isolation and drying of the gingival tissue around the selected tooth. The non impregnated roeko Stay put gingival retraction cord of adequate size (#0) and length was chosen based on clinical situation of gingival sulcus. The size #0 was chosen since the retraction was done on normal gingival. The cord of adequate length i.e., slightly more than required to encircle the buccal gingival sulcus was cut and looped around the buccal gingival sulcus.(FIG.2) Cord packing was started from the mesial interproximal area by gently pushing the cord between the tooth and gingival with the help of cord packer (GDC).The instrument was slightly angled towards the root to facilitate the subgingival placement of the cord. The cord placement was continued from the mesial interproximal area to distal interproximal area on the buccal side only. It was kept into the gingival sulcus for 10 minutes and the time was record using the stop watch. After that gingival retraction cord was removed gently from the sulcus. The post retraction impression was also taken using custom tray and multiple mix impression technique as described earlier.



FIG 2: Stay put gingival retraction cord placed inside patient's mouth

B. 3M ESPE ASTRINGENT RETRACTION PASTE -15% ALUMINIUMCHLORIDE

The pre retraction impression was taken using custom tray and multiple mix impression technique in which the heavy body (AVUE GUM) was used as the tray material and light body (AVUE GUM) as the syringe material. The astringent retraction paste comes with a capsule and compatible with most composite dispensers. First a small amount of paste was discarded. After that the retraction capsule tip was inserted directly into the buccal gingival sulcus. The tissue was mechanically retracted. Then the material was slowly and steadily injected into the sulcus and the buccal gingival sulcus was filled completely.(FIG.3) The material was leaved into the sulcus for ten minutes and after that the astringent retraction paste was removed using the air-water spray. The post retraction impression was also taken using custom tray and multiple mix impression technique as described earlier.



FIG 3: 3M-ESPE astringent retraction paste applied inside patient's mouth

C. OXMETAZOLINE HYDROCHLORIDE-0.05% (NASIVION NASAL DROPS)

The pre retraction impression was taken using custom tray and multiple mix impression technique in which the heavy body (AVUE GUM) was used as the tray material and light body as the syringe material. The stay put gingival retraction cord of appropriate size and length was impregnated with 0.05% Oxymetazoline hydrochloride solution by dipping the retraction cord into the solution in a dappen dish. (FIG.4) The impregnated retraction cord was placed into the buccal gingival sulcus in a conventional manner as described for stay put gingival retraction cord earlier. The impregnated cord was left into the sulcus for 10 minutes and after that it was removed. The post retraction impression was also taken using custom tray and multiple mix impression technique as described earlier.



FIG 4: Gingival retraction cord dipped in 0.05 % Oxymetazolinehydrochloride

D. TETRAHYDROZOLINE HYDROCHLORIDE-0.05% (VISINE EYE DROPS)

The pre retraction impression was taken using custom tray and multiple mix impression technique in which the heavy body (AVUE GUM) was used as the tray material and light body as the syringe material. The Stay put gingival retraction cord of appropriate size and length was impregnated with 0.05% Tetrahydrozoline hydrochloride solution by dipping the retraction cord into the solution in a dappen dish. (FIG.5) The impregnated retraction cord was placed into the buccal gingival sulcus in a conventional manner as described for stay put gingival retraction cord earlier. The impregnated cord was left into the sulcus for 10 minutes and after that it was removed. The post retraction impression was also taken using custom tray and multiple mix impression technique as described earlier.



FIG 5: Gingival retraction cord dipped in 0.05% Tetrahydrozoline hydrochloride**E. 20% FERRIC SULFATE (MEDICEPT HEMOSTAT GEL)**

The pre retraction impression was taken using custom tray and multiple mix impression technique in which the heavy body (AVUE GUM) was used as the tray material and light body as the syringe material. The Stay put gingival retraction cord of appropriate size and length was impregnated with 20% Ferric sulfate (MEDICEPT HEMOSTAT GEL) solution by dipping the retraction cord into the solution in a dappen dish. (FIG.6) The impregnated retraction cord was placed into the buccal gingival sulcus in a conventional manner as described for stay put gingival retraction cord earlier. The impregnated cord was left into the sulcus for 10 minutes and after that it was removed. The post retraction impression was also taken using custom tray and multiple mix impression technique as described earlier.

**FIG 6: Gingival retraction cord dipped in 20% Ferric Sulphate****CAST POURING AND SECTIONING OF DIES**

All the pre retraction and post retraction impressions for each material and for each participant was poured using die stone and labeled. The sectioning of cast was done along the mesio buccal developmental groove of the right mandibular first molar in buccolingual direction vertically. (FIG.7) The samples were analysed with Stereomicroscope under x20 magnification (Olympus SZX10 stereomicroscope, Japan) at Biocorp scientific laboratory, Hyderabad. (FIG.8) Image was captured and transferred to the Olympus cell sens software image analyzer and the values obtained from the software as the amount of displacement.

**FIG 7: Sectioning of the cast with saw**



FIG8: Sectioned sample placed under stereomicroscope

TESTING OF SAMPLES

The amount of gingival displacement was measured using a stereomicroscope as a distance from tooth surface to crest of gingiva in a horizontal direction on buccal side by using mesio buccal developmental groove as reference point. (FIG.9) The test used was stereozoomic analysis of different gingival retraction system with the help of Olympus microscopic analysis detection method (Software-OLYM-STERO^M). The testing was done for each pre retraction and post retraction sample for each participant by using different gingival retraction system. The amount of gingival retraction in horizontal direction was calculated by subtracting the displacement value before retraction from the displacement value after retraction. The amount of gingival displacement for all the specimen was collected and tabulated and subjected to statistical analysis to compare the efficacy of different gingival retraction system.



FIG9: Measurement of gingival displacement under magnification using Stereomicroscope.

STATISTICAL ANALYSIS

Statistical analysis was done using Graph Pad Prism software, Version 5. For qualitative analysis, t-test and one way ANOVA (Followed by Mann whitney U and Tukey and Newman–keuls) was used to find the P values. For quantitative analysis, mean and standard deviations were estimated in the sample for each study group. Mean values were compared using one way ANOVA. (Followed by Tukey and Newman– keuls). $P \leq 0.05$ was considered statistically significant.

RESULTS

Table-1: To evaluate and compare the efficacy of different gingival retractionsystems

Gingival retraction system	Pre (n=20) Mean (μm)	Post (n=20) Mean (μm)	SD	P Value
Retraction Cord	27.96	32.61	± 1.1	Ns
Astringent	33.69	38.59	± 1.2	Ns
Nasivion	35	49.9	± 1.4	0.03
Visine	33.71	40.62	± 1.3	Ns
Haemostat Gel	40.33	44.54	± 1.1	Ns

Table-2: To measure the amount of gingival displacement Produced In Horizontal Direction.

Gingival retraction system	N	Mean Displacement (μm)	SD	P Value
Retraction Cord	20	4.65	± 0.4	Ns
Astringent	20	4.9	± 0.3	Ns
Nasivion	20	14.9	± 0.6	0.03
Visine	20	6.91	± 0.4	Ns
Haemostat Gel	20	4.21	± 0.3	Ns

Table 3: To compare between traditional methods of gingival retraction in comparison to newer ones.

Gingival retraction system	Pre(n=20) Mean (μm)	Post(n=20) Mean (μm)	SD	P Value
Nasivion	35	49.9	± 1.4	0.03
Astringent	33.69	38.59	± 1.2	ns
Retraction Cord	27.96	32.61	± 1.1	ns
Haemostat Gel	40.33	44.54	± 1.1	ns

Table 4: To compare between traditional methods of gingival retraction comparison to newer ones.

Gingival retraction system	Pre(n=20) Mean (μm)	Post(n=20) Mean (μm)	SD	P Value
Visine	33.71	40.62	± 1.3	ns
Astringent	33.69	38.59	± 1.2	ns
Retraction Cord	27.96	32.61	± 1.1	ns
Haemostat Gel	40.33	44.54	± 1.1	ns

Table-5: To check for the most accurate method

	Nasivion	Visine	P Value
Post	49.9	40.62	<0.05

Pre	35	33.71	<0.05
-----	----	-------	-------

Preliminary findings indicate that Nasivion demonstrated superior efficacy in achieving Mean Displacement 14.9 (μm) gingival retraction compared to traditional methods Mean Displacement 4.9 (μm) in Astringent group. The group treated with Visine showed promising results with minimal gingival trauma and reduced bleeding. Conversely, challenges were noted in the Retraction Cord, Astringent and Haemostat Gel group, highlighting potential drawbacks that need further investigation.

Table 1 shows the pre and post displacement of different gingival retraction system used in the study. Comparing the efficacy of all the retraction system shows that Nasivion retraction system has the pre displacement of 35 μm while the post displacement of 49.9 μm . Visine retraction system has the pre displacement of 33.71 μm and post displacement of 40.62 μm . Astringent retraction paste has pre displacement of 33.69 μm while post displacement of 38.59 μm . Retraction cord has the post displacement at 32.61 μm in comparison to 27.96 μm . Haemostat gel has pre retraction of 40.33 μm and post retraction of 44.54 μm .

Table 2 shows the mean gingival displacement in horizontal direction in all the study groups. Nasivion retraction method shows the maximum displacement of 14.9 μm in horizontal displacement which is followed by the visine retraction method of 6.91 μm displacement. Astringent method shows the mean displacement of 4.9 μm followed by Retraction cord method 4.65 μm and Haemostat gel 4.21 μm .

Table 3 shows the comparison between Nasivion retraction method and traditional retraction method. Nasivion retraction method shows the maximum displacement of 14.9 μm in comparison to any traditional retraction method.

Table 4 shows the comparison between Visine retraction method and traditional retraction method. Visine retraction method shows the better displacement of 6.91 μm in horizontal direction as comparison to any other traditional retraction method.

Table 5 shows the comparative study between two new methods of retraction i.e. Nasivion retraction method and visine retraction method. In the two new methods Nasivion retraction method found to be better with the mean displacement of 14.9 μm and visine retraction method of 6.91 μm .

DISCUSSION

The results of this study contribute valuable insights into the selection of an optimal gingival retraction system based on clinical performance. The superiority of one method over another may be attributed to various factors, including patient characteristics, operator proficiency, and material properties.

Gingival retraction is a crucial step in various dental procedures, particularly in the field of prosthodontics and restorative dentistry. It involves the displacement of the gingival tissues to expose the tooth's subgingival margins, facilitating accurate impressions and ensuring the success of subsequent restorative work. The gingival retraction can also be used to enhance access and visibility during margin preparation to avoid damage to the surrounding gingival architecture. Therefore, effectively managing the gingiva prior to making an impression is a critical preliminary step in the process of fabricating restorations.

Numerous gingival retraction systems are available, each claiming advantages in terms of efficacy, patient comfort, and overall procedural outcomes. One of the most used methods to obtain gingival retraction is by means of cord packed into the sulcus.⁶ Stay put (COLTENE) is one such non impregnated gingival retraction cord available in market which combines the advantages of braided cord with the adaptability of a fine metal filament. The manufacturer claims that stay put retraction cord is effective and easier to place compared to conventional retraction cord, as the copper filament maintain its shape and position once it is placed into

the gingival sulcus. Stay-put serves quick haemostasis when impregnates with Aluminium chloride, Ferric sulfate or other medicaments available in market. Non medicated cords placed in the gingival sulcus are safe but have limited effect in controlling haemorrhage. Therefore to overcome this problem various medicaments were developed to be used in conjugation with the retraction cord like Aluminium chloride, Ferric sulfate, Aluminium sulfate, Zinc chloride, Racemic epinephrine, Alum solution, Ferric sub-sulfate, tannic acid, Negatol solution etc. A study by Hansen et al in 1991, revealed that, the most common medicaments used with the retraction cord by prosthodontist for finish line exposure are buffered Aluminium chloride, followed by Ferric sulfate.⁷ Various studies have been done in the past on local and systemic side effects induced by medicaments used for gingival retraction. Cords saturated with zinc chloride have been shown to cause tissue damage. Cords saturated with Epinephrine are widely used but can precipitate the “Epinephrine syndrome” in patients.⁸ The major problem associated with these tissue displacement methods include; difficulty in placement, discomfort to the patient, gingival tissue damage, alteration of periodontal attachment etc. 15% Aluminium chloride (3M ESPE astringent retraction paste) is a fast, convenient and effective solution for any dental procedure that requires gingival retraction. This paste can be easily dispensed right into the sulcus through a composite dispenser and can easily retract gingival tissue and controls bleeding without any tissue damage.⁹

D costa V F et al in 2017 reviewed about advances in cordless retraction techniques. Choice of appropriate gingival retraction system is still a dilemma for the operator. Moreover, a particular clinical situation may indicate the specific technique. Hence the type of gingival retraction to be employed should be thoroughly thought over before using, keeping in mind the gingival tissue health and comfort of both patient and the practitioner.¹⁰

Rayyan M M et al in 2018 conducted a study to evaluate the efficiency and gingival response of 4 cordless gingival displacement systems. The study concluded that significant differences were found among the 4 tested systems in both vertical and horizontal gingival displacement. Expasyl, Expazen, and 3M Retraction exceeded the 200-mm requirements for horizontal displacement. Traxodent provided the least displacement in both vertical and horizontal dimensions.¹¹

Vaishnav K et al in 2022 conducted a study to evaluate clinical efficacy of Expasyl and medicated retraction in subgingivally prepared teeth. Expasyl retraction technique was more effective in vertical gingival retraction (mean- 0.32 mm) than medicated retraction cord technique (mean-0.30mm) with at value at 1.175 and P - value of 0.25 mm. The amount of vertical gingival retraction obtained by Expasyl and medicated cord was significantly similar but Expasyl retraction system is not cost effective when compared with cord system.¹²

Katreva I et al in 2015 conducted a study in which α - adrenomimetic decongestants were used as chemical agents for gingival retraction. The purpose of this study was to observe, compare and evaluate the effect of two α -adrenomimetic decongestants which are clinically approved nasal and eye drops. The study concluded that α -adrenomimetic decongestants are effective alternative retraction agents for chemo-mechanical dilatation of the gingival groove. The promising data of the present and many more studies should change the term for these substances from “experimental” to “conventional” for their excellent haemostasis without cytotoxic alternation of periodontal tissues, harmful effect over hard tooth tissues and any risk for the overall health of patients.¹³

Bowles W H et al in 1991 conducted a study to evaluate the efficacy of three gingival retraction agents. Mongrel dogs were used as experimental subjects, in which pulse rate and blood pressure monitored electronically. Visine (Tetrahydrozoline HCl, 0.05%), Afrin (Oxymetazoline, 0.05%), and Neosynephrine (Phenylephrine HCl, 0.25%) were the commercial products studied as gingival retraction agents. Plain, untreated cord was used as a

mechanical control, and as a vehicle for the three experimental agents. Commercially available cords impregnated with both Racemic epinephrine (8%) and Alum were also used as standard retraction agents with which the test solutions were compared. Visine and Afrin produced tissue displacement greater than that of any of the other agents.¹⁴

Mehra N et al in 2019 conducted a study to compare the Naphazoline, Tetrahydrozoline and Aluminium chloride with the control group. The conclusions drawn from this study are Naphazoline, Tetrahydrozoline, and Aluminum chloride show a clinically and statistically significant amount of displacement when compared to control.¹⁵

There is no such study till now in which the conventional methods and medicaments like Aluminium chloride and Ferric sulfate were compared with the newer materials like Oxymetazoline hydrochloride 0.05% and Tetrahydrozoline hydrochloride 0.05% on which the studies are still going on.

The present study was designed and conducted with the purpose to evaluate and compare the efficacy of different gingival retraction system, to measure the amount of gingival displacement produced, to check for the most accurate method and to compare between the traditional methods with the newer ones.

In this study we have found that new retraction method namely Nasivion retraction method and Visine retraction method have better horizontal displacement after gingival retraction in comparison to the traditional retraction method as discussed in the result section. In the two new method of retraction used in the study, Nasivion retraction method found to be superior on other methods including traditional method of retraction.

CONCLUSION

The present study was carried out with the purpose to analyse and compare the efficacy of Stay put gingival retraction cord, Oxymetazoline hydrochloride 0.05%, Tetrahydrozoline hydrochloride 0.05%, 15% Aluminium chloride and 20% Ferric sulfate on the basis of the horizontal displacement of the gingiva. The other objectives of this study are to compare between the traditional methods and the newer ones and to also check for the most accurate method.

Within the limitations of this study, it is found that:

1. New retraction methods namely Nasivion nasal drop (Oxymetazoline hydrochloride 0.05%) and Visine eye drop (Tetrahydrozoline hydrochloride 0.05%) have better horizontal displacement after gingival retraction in comparison to the traditional retraction methods.
2. In the two new methods of retraction used in study, Nasivion retraction method found to be superior on Visine including the traditional methods.

The term “experimental” for these newer substances should be changed to “conventional” due to the promising results of current research and many more, as they provide excellent haemostasis without cytotoxic alternation of periodontal tissues, harmful effect over hard tooth tissues, or risk to patients' general health.

REFERENCES

1. Winkler s. Essentials of complete denture prosthodontics: second edition;2009.
2. Sachdev P A, Arora A, Nanda S. A comparative evaluation of different gingival retraction methods-an in vivo study. Oral health case Rep. 2018; 4:142.
3. Gupta R, Aggarwal R, Siddiqui Z. Comparison of various methods of gingival retraction on gingival and periodontal health and marginal fit. Int jour of oral health dent. 2016;2(4):243-247.
4. Rosenstiel S F,L and M F,Fujimoto j. contemporary fixed prosthodontics. fifth edition;2016.

5. Chaudhari J, Prajapati P, Patel J, Sethuraman R, Naveen Y G. Comparative evaluation of the amount of gingival displacement produced by three different gingival retraction systems: An in vivo study. *Contemp Clin. Dent.* 2015;6(2);189-195.
6. Ferencz J L. Maintaining and enhancing gingival architecture in fixedprosthodontics. *J Prosthet Dent.*1991;65:650-7.
7. Lampert S H. Combined electrosurgery and gingival retraction. *J Prosthet Dent.*1969;23:164-72.
8. Donovan TE, Gandara BK, Nemetz H. Review and survey of medicaments used with gingival retraction cords. *J Prosthet Dent.* 1985;53(4):525-31.
9. Kavita K, Sinha RI, Singh R, Singh R, Reddy KRP, Kulkarni G. Assessment of Aluminum Chloride Retraction Cords, Expasyl, and Tetrahydrozoline-Soaked Retraction Systems in Gingival Retraction. *J Pharm Bioallied Sci.*2020; 12(1):440-443.
10. D'Costa F V, Bangera M K. Advancements in Gingival Retraction Techniques in Restorative Dentistry. *International Journal of Science and Research.* 2017;6(4):252-254.
11. Rayyan M M, Hussien ANM, Sayed N M, Abdallah R, Osman E, Saad N A, Ramadan S. Comparison of four cordless gingival displacement systems: A clinical study. *J Prosthet Dent.* 2018;121(2):265-270.
12. Vaishnav K, Rana D, Joshi R, Agnihotri R, Shah D, Patel R. A Study on Clinical Comparison Between Expasyl Retraction System and Medicated Retraction Cord on Gingival Retraction. *JCLM.* 2022;10(3):263-7.
13. Katreva I, Abadjiev M, Simeonov S, Tivchev O, Doychinova M, Tonchev T. Application of α -Adrenomimetic Decongestants as chemical agents for gingival retraction. *Scripta Scientica MedicinæDentalis.* 2015;1(2): 17-23.
14. Bowles WH, Tardy SJ, Vahadi A. Evaluation of new gingival retraction agents. *J Dent Res.* 1991 ;70(11):1447-9.
15. Mehra N, Rathi A, Sharma R, Kaushik M, Sood T. Evaluation of alphaadrenomimetic agents for gingival retraction: A randomized crossover clinical trial. *J Conserv Dent.* 2019; 22(6):533-537.