RESEARCH PAPER

Evaluation of the Effect of Retraction Cord Medicaments on Polymerization Inhibition & Surface Detail Reproduction on Three Different Elastomeric Impression Materials

Dr Anusha R[1*], Dr Bharanija K.S[2], Dr Sandeep P R[3], Dr Priyadharshini J[4], Dr. H. Annapoorni[5]

[1*]Final Year Postgraduate, Department of Prosthodontics, Meenakshi Ammal Dental College, Meenakshi Academy of Higher Education & Research, Chennai, Tamil Nadu, India. ORCID: 0009-0005-8777-2293 Email: anunandini26@gmail.com (Corresponding Author)

[2]Professor, Department of Prosthodontics, Meenakshi Ammal Dental College, Meenakshi Academy of Higher Education & Research, Chennai, Tamil Nadu, India. ORCID: 0000-0003-2869-0229 Email: drbharanija.prostho@madch.edu.in

[3]Second Year Postgraduate, Department of Prosthodontics, Meenakshi Ammal Dental College, Meenakshi Academy of Higher Education & Research, Chennai, Tamil Nadu, India. ORCID: 0009-0002-0403-9335 Email: sandeepravi13@gmail.com

[4]First Year Postgraduate, Department of Prosthodontics, Meenakshi Ammal Dental College, Meenakshi Academy of Higher Education & Research, Chennai, Tamil Nadu, India. ORCID: 0009-0005-5395-9324 Email: Priyaa8951@gmail.com

[5]Professor & HOD, Department of Prosthodontics, Meenakshi Ammal Dental College, Meenakshi Academy of Higher Education & Research, Chennai, Tamil Nadu, India. ORCID: 0000-0003-1175-5882

***Corresponding author: Dr Anusha R, Final Year Postgraduate, Department of Prosthodontics, Meenakshi Ammal Dental College, Meenakshi Academy of Higher Education & Research, Chennai, Tamil Nadu, India**

Email: anunandini26@gmail.com

Received: 25th May, 2026; **Revised:** 8th June, 2026; **Accepted:** 12th June, 2026; **Available Online:** 14th June, 2026

ABSTRACT

Background

Gingival retraction is an essential step in fixed prosthodontics for accurate impression making. Retraction cord medicaments, used to control bleeding and tissue management, may interfere with the polymerization of elastomeric impression materials, potentially compromising surface detail reproduction and marginal accuracy.

Aim

To evaluate the effect of different retraction cord medicaments on polymerization inhibition and surface detail reproduction of three different elastomeric impression materials.

Materials and Methods

Three elastomeric impression materials (addition silicone, condensation silicone, and polyether) were tested with four retraction cord medicaments (aluminum chloride, ferric sulfate, epinephrine, and placebo control). Standardized metal dies were prepared, and impressions were made following manufacturer instructions. Setting time was recorded, and surface detail reproduction was evaluated using a stereomicroscope according to ISO 4823 specifications. Statistical analysis was performed using one-way ANOVA and post-hoc Tukey test ($p<0.05$).

Results

Results indicated that epinephrine-containing medicaments significantly delayed polymerization of addition silicone ($p<0.05$), while aluminum chloride showed minimal interference across all materials. Polyether was least affected by all medicaments tested. Surface detail reproduction was significantly compromised when polymerization inhibition occurred, particularly in condensation silicone with ferric sulfate medicaments.

Conclusion

Retraction cord medicaments have variable effects on polymerization and surface detail reproduction of elastomeric impression materials. Aluminum chloride demonstrated the most compatible profile across all

materials tested. Clinicians should consider the interaction between retraction medicaments and chosen impression material to ensure optimal marginal accuracy and prosthesis fit.
Keywords: Gingival retraction, Elastomeric impression materials, Polymerization inhibition, Surface detail reproduction, Retraction cord medicaments, Addition silicone, Polyether.
How to cite this article: Anusha R, Bharanija KS, Sandeep PR, Priyadharshini J, Annapoorni H. Evaluation of the Effect of Retraction Cord Medicaments on Polymerization Inhibition & Surface Detail Reproduction on Three Different Elastomeric Impression Materials. Int J Drug Deliv Technol. 2026;16(60s):426-437. DOI: 10.25258/ijddt.16.60s.51
Source of support: Nil.
Conflict of interest: None

INTRODUCTION:

The accuracy of dental impressions is fundamental to the success of indirect restorations and prostheses, as any discrepancy during impression making may be transferred to the final restoration, resulting in marginal inaccuracies, and compromised clinical outcomes. Elastomeric impression materials are widely used in contemporary dentistry because of their superior surface detail reproduction, elastic recovery, and dimensional stability [1].

Impression making has evolved considerably from the early use of beeswax, plaster of Paris, and thermoplastic materials to the development of advanced impression techniques and materials. The introduction of elastomeric impression materials, including polysulfide, condensation silicone, polyether, and addition silicone, represented a major advancement in prosthodontics. Among these, addition silicone (polyvinyl siloxane) is considered the material of choice because of its excellent dimensional stability, minimal polymerization shrinkage, and absence of volatile by-products [2–4].

Accurate recording of subgingival finish lines often requires gingival displacement to provide adequate access and visibility. Early mechanical methods using copper bands and plain retraction cords were associated with limited hemorrhage control and potential tissue trauma. Consequently, chemico-mechanical retraction techniques were introduced, in which retraction cords are impregnated with medicaments to improve tissue displacement and hemostasis. Commonly used agents include epinephrine, aluminum chloride, and ferric sulfate [5,6].

The performance of elastomeric impression materials is influenced not only by their inherent properties but also by clinical variables. Studies have demonstrated that environmental contamination, particularly moisture and chemical residues, can adversely affect surface detail reproduction and dimensional accuracy [7,8]. Gingival retraction medicaments may remain on tooth surfaces and interact with impression materials during setting, potentially affecting their physical properties and clinical performance [9,10].

Several investigations have reported that gingival retraction medicaments can interfere with the polymerization of elastomeric impression materials, particularly polyvinyl siloxanes. Residual medicament traces may inhibit or delay polymerization, resulting in compromised surface detail reproduction and reduced dimensional accuracy [11]. Surface detail reproduction is a critical property because it determines the ability of an impression material to accurately record fine anatomical structures and preparation margins. Adverse interactions between retraction medicaments and impression materials may therefore negatively influence the quality of definitive restorations [12].

Dimensional stability may also be affected by medicament contamination. Variations in medicament composition and concentration have been associated with surface irregularities and dimensional changes in elastomeric impressions, suggesting that chemical interactions during setting may compromise clinical accuracy [13]. Furthermore, comparative studies have shown that different elastomeric materials exhibit varying levels of resistance to these effects, emphasizing the importance of evaluating multiple impression materials under standardized conditions [14].

The effectiveness of gingival retraction is also influenced by the absorption characteristics of retraction cords. Differences in cord composition, medicament concentration, and exposure time can affect the amount and distribution of medicament delivered to the gingival sulcus, thereby

influencing both tissue displacement and potential interactions with impression materials [15,16]. Clinical studies have further demonstrated that the choice of gingival displacement system affects tissue response, hemostasis, handling characteristics, and overall clinical effectiveness [17–19].

Recent systematic reviews have emphasized the importance of gingival retraction systems in achieving accurate impressions for fixed prosthodontic procedures. Although chemical retraction agents provide effective hemorrhage control and sulcular enlargement, residual medicaments may adversely influence impression material performance when not adequately removed from prepared tooth surfaces [20,21].

Despite continuous advancements in gingival displacement systems and elastomeric impression materials, most studies have evaluated these factors independently. Limited evidence exists regarding the combined influence of commonly used gingival retraction cord medicaments on polymerization behaviour and surface detail reproduction of different elastomeric impression materials. Therefore, a systematic evaluation of these interactions is necessary to improve material selection and clinical outcomes, forming the basis of the present in vitro study.

AIM

To test and compare the influence of gingival retraction cord medicaments on the polymerization inhibition and the reproduction of surface detail of elastomeric impression materials.

OBJECTIVES

1. To check the influence of the gingival retraction cord medicaments on the polymerization inhibition addition silicone, condensation silicone, and polyether impression materials.
2. To determine the Surface reproduction of addition silicone, condensation silicone, and polyether impression materials after medicament exposure.
3. To make a comparison in the behaviour of the three elastomeric impression materials in the presence of the gingival retraction medicaments.

MATERIALS AND METHODS

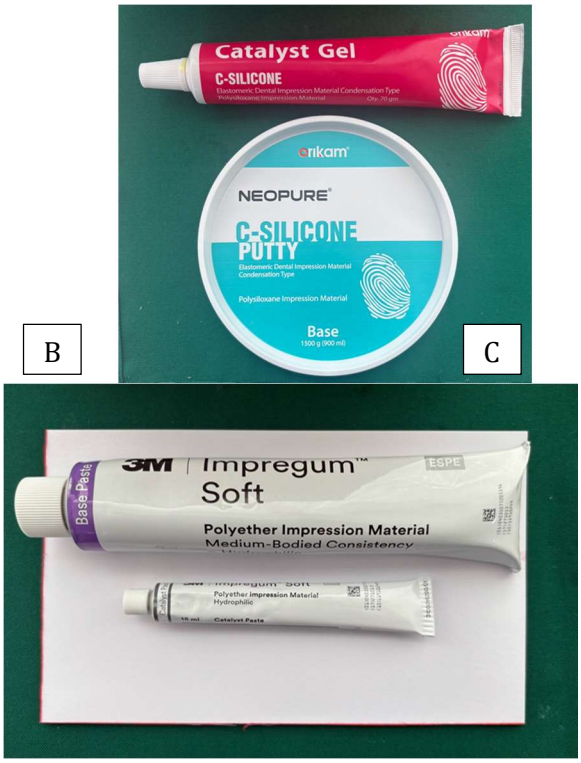
The study was approved by the Institutional Ethical Committee, Meenakshi Ammal Dental College & Hospital, MAHER University, Chennai, Tamil Nadu (MADC/IEC/II/64/2024).

Study Design

This in vitro experimental study evaluated the effect of gingival retraction cord medicaments on polymerization inhibition and surface detail reproduction of elastomeric impression materials. The protocol was standardized according to ADA Specification No. 19. The impression materials evaluated were addition silicone (polyvinyl siloxane), condensation silicone, and polyether(Fig A-C).

Fig (A-C): Impression materials used in the study (A-Addition silicone, B- Condensation silicone,C-Polyether)

A



Preparation of Stainless-Steel Test Die

A stainless-steel test die was fabricated according to ADA Specification No. 19. The die consisted of a 38-mm ring-shaped metallic block with a central 30-mm raised test surface. Three horizontal and two vertical reference lines (2 µm width) were engraved using an Nd:YAG laser to evaluate surface detail reproduction [59]. A custom metal ring was fabricated to contain the impression material during testing. (Fig D,E).

(D-Stainless steel die-According ADA19; E-Die assembly for impression material containment)

Sample Size Calculation

Sample size was calculated using the likelihood-ratio test with an alpha error of 5% and study power of 90%. Based on assumed proportions (p1=0.73, p2=0.27), a total sample size of 96 specimens (24 per group) was obtained.

Grouping of Samples

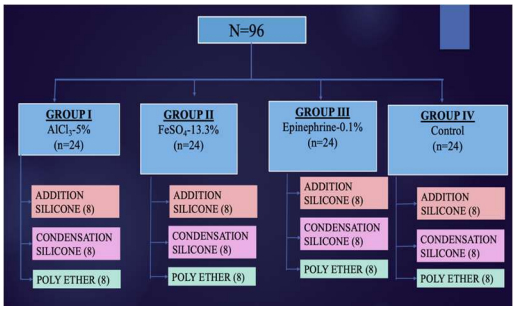
Ninety-six samples were divided into four groups (n=24):

- Group I – Aluminium chloride (5%)
- Group II – Ferric sulphate (13.3%)
- Group III – Epinephrine (0.1%)
- Group IV – Control (no medicament)

Each group was further subdivided into:

- Subgroup A – Addition silicone
- Subgroup B – Condensation silicone
- Subgroup C – Polyether

Each subgroup contained eight samples, resulting in 12 subgroups (4 × 3) (Figure F).



(F- Grouping of samples)

Application of Medicaments

The die surface was cleaned before each procedure. Gauze moistened with aluminium chloride (5%), ferric sulphate (13.3%), or epinephrine (0.1%) was applied to the die surface for 30 seconds and subsequently removed (Fig G) The surface was dried with oil-free compressed air for 1 minute before impression making. These concentrations were selected because they represent commonly used commercial gingival retraction preparations [22–24].

(G- Medicaments used in the study)

Impression Making Procedure

Addition silicone (Neopure Hydrophilic A-Silicone Putty Fast Set), condensation silicone (Neopure C-Silicone Putty), and polyether (Impregum Soft, 3M ESPE) were used. Materials were proportioned and mixed according to manufacturers' instructions. The mixed material was placed within the metal ring over the test die ensuring complete coverage of the engraved lines.

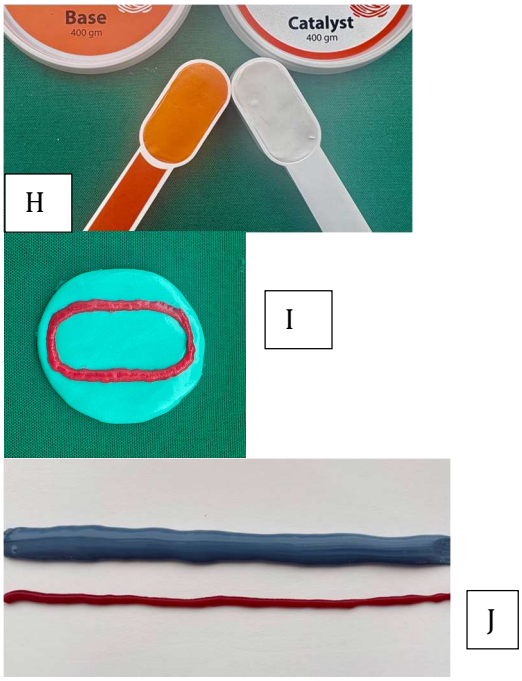


Fig (H-J):Dispensing of Impression materials (H-Addition silicone, I- Condensation silicone, J-Polyether)

Standardization of Pressure During Setting

A polyethylene sheet and flat metal plate were placed over the impression material. A constant load of 500 g was applied throughout polymerization to standardize specimen thickness and pressure .

Setting Conditions

The assembly was transferred to a thermostatically controlled water bath maintained at 32 ± 2°C. Specimens were allowed to set according to manufacturers' recommendations with an additional 3-minute period, as recommended by ADA guidelines, to ensure complete polymerization and dimensional stability. All samples were processed under identical environmental conditions.

Removal and Post-processing of Samples

Following polymerization, specimens were carefully removed, labelled, and dried. The die surface was cleaned with alcohol for 2 minutes before reuse. Standardized handling procedures were followed for all samples.

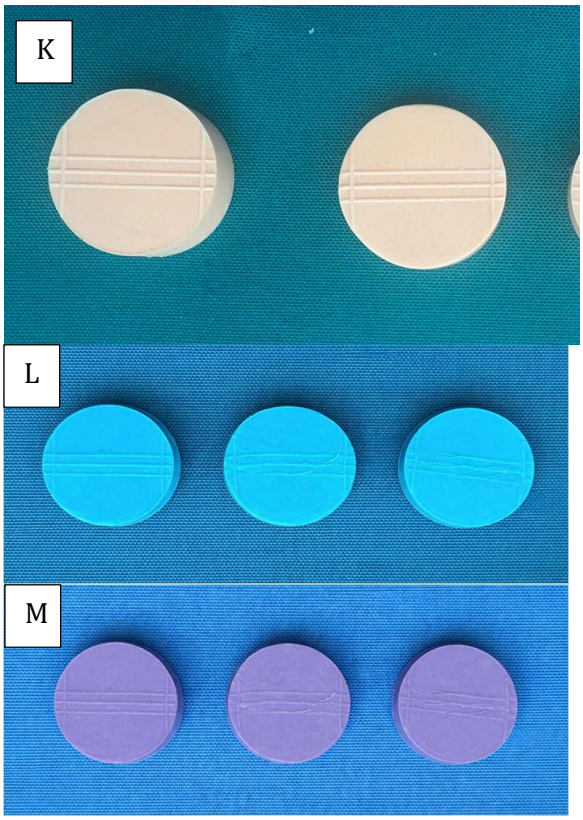


Fig (K-M):Gross image of processed sample (K-Addition silicone, L- Condensation silicone, M-Polyether)

Evaluation of Surface Detail Reproduction

Surface detail reproduction was evaluated under a stereomicroscope at 10× magnification.

Acceptable: Continuous reproduction of at least two of the three horizontal lines over a minimum length of 25 mm between the vertical reference lines.

Unacceptable: Blurred, discontinuous, flattened lines or surface irregularities affecting line reproduction.

Evaluation of Polymerization Inhibition

Polymerization inhibition was assessed by three blinded calibrated examiners through visual inspection of specimen surfaces for unpolymerized residues.

Scoring criteria:

- **Score 0:** Completely polymerized
- **Score +:** Oily uncoloured residue removable with cotton swab
- **Score ++:** Oily coloured residue readily collected by cotton swab
- **Score +++:** Unpolymerized material adherent to the specimen surface and collected on swab

The majority score of the three examiners was considered the final score for each specimen.

RESULTS

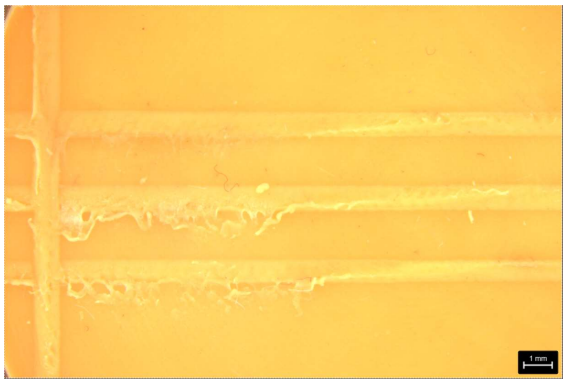
Statistical Analysis

Data were analyzed using SPSS Version 27.0 (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as frequency and percentage. Intergroup comparisons were performed using Chi-square or Fisher's exact test where appropriate. The association between polymerization inhibition and surface detail reproduction was assessed using Spearman's rank correlation. Examiner reliability was evaluated using Cohen's kappa statistics. Statistical significance was set at $p < 0.05$.

A total of 96 specimens were evaluated and allocated into four groups (n = 24): Group I (aluminium chloride), Group II (ferric sulphate), Group III (epinephrine), and Group IV (control).

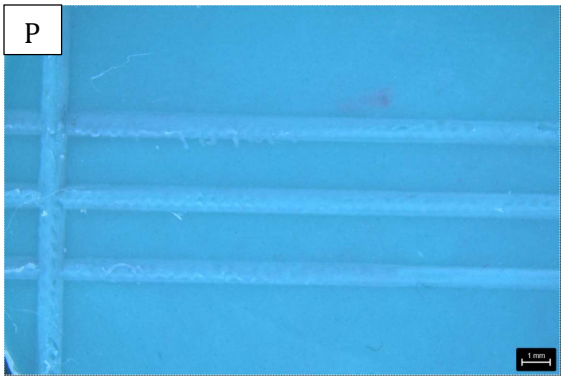
Figures N–S illustrate stereomicroscopic evaluation of surface detail reproduction in the control and medicament-exposed specimens.

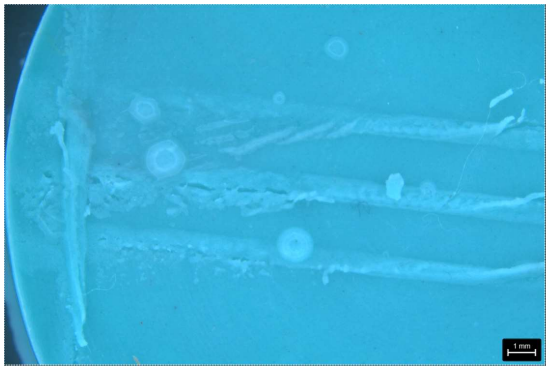
Stereomicroscopic evaluation of Addition silicone -control(N) & Test(O)



Stereomicroscopic evaluation of Condensation silicone -control(P) & Test(Q)

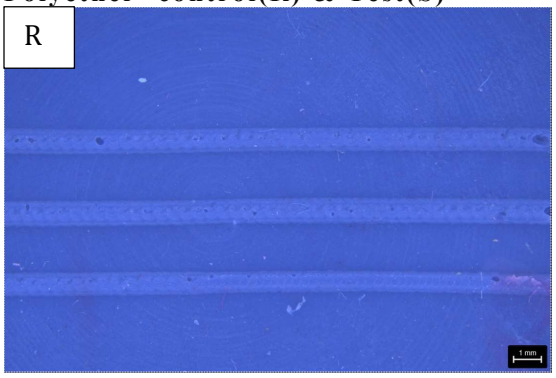
P

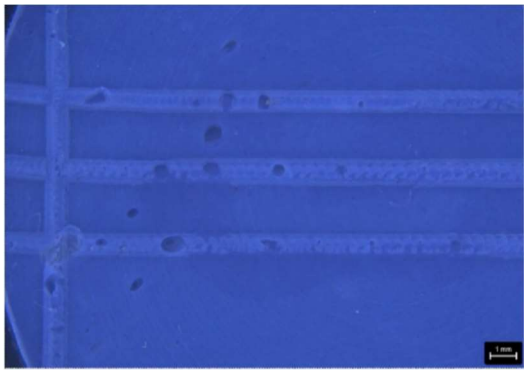




Stereomicroscopic evaluation of Polyether -control(R) & Test(S)

R





Q

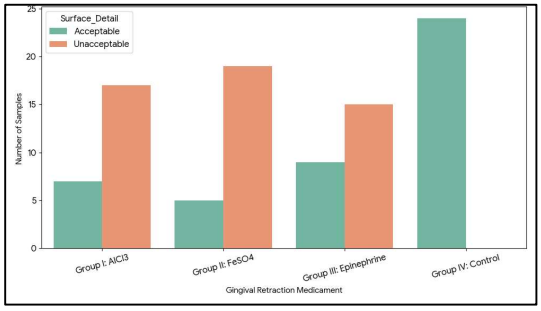
SURFACE DETAIL REPRODUCTION

Surface detail reproduction was assessed as acceptable or unacceptable (Table1,Graph 1).

Table 1: Effect of Retraction Medicaments on Surface Detail Reproduction

Impression Material	Medicament Group	Acceptable n (%)	Unacceptable n (%)	p-value (vs. Control)	Significance
Addition Silicone	Group I: $AlCl_3$	3 (37.5%)	5 (62.5%)	0.025	Significant
Addition Silicone	Group II: $FeSO_4$	2 (25.0%)	6 (75.0%)	0.007	Significant
Addition Silicone	Group III: Epinephrine	4 (50.0%)	4 (50.0%)	0.076	Not Significant
Addition Silicone	Group IV: Control	8 (100%)	0 (0.0%)	-	-
Condensation Silicone	Group I: $AlCl_3$	2 (25.0%)	6 (75.0%)	0.007	Significant
Condensation Silicone	Group II: $FeSO_4$	2 (25.0%)	6 (75.0%)	0.007	Significant
Condensation Silicone	Group III: Epinephrine	3 (37.5%)	5 (62.5%)	0.025	Significant
Condensation Silicone	Group IV: Control	8 (100%)	0 (0.0%)	-	-
Polyether	Group I: $AlCl_3$	2 (25.0%)	6 (75.0%)	0.007	Significant

Polyether	Group II: $FeSO_4$	1 (12.5%)	7 (87.5%)	0.001	Significant
Polyether	Group III: Epinephrine	2 (25.0%)	6 (75.0%)	0.007	Significant
Polyether	Group IV: Control	8 (100%)	0 (0.0%)	-	-



Graph 1: Surface Detail Reproduction Across Different Gingival Retraction Medicaments

The control group demonstrated 100% acceptable reproduction in all impression materials. Medicament exposure reduced surface detail reproduction, with ferric sulphate showing the greatest adverse effect, followed by aluminium chloride and epinephrine.

Among the materials, addition silicone exhibited the highest proportion of acceptable samples, whereas polyether showed the greatest reduction in surface detail reproduction. Fisher's exact test demonstrated significant reductions in acceptable surface detail reproduction in most medicament-treated groups compared with controls ($p < 0.05$). No significant difference was observed between epinephrine and control in addition silicone.

POLYMERIZATION INHIBITION

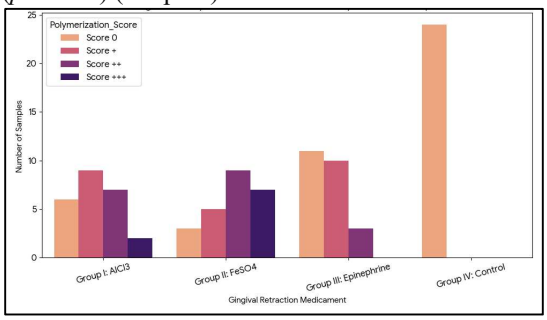
Polymerization inhibition was evaluated using scores ranging from 0 to +++. Complete polymerization (Score 0) was observed in all control specimens (Table 2).

Table 2: Polymerization Inhibition Scores Across Groups

Impression Material	**Medicament Group**	**Score 0**	**Score +**	**Score ++**	**Score +**	**p-value (vs. Control)**	**Significance**
Addition Silicone	Group I: $AlCl_3$	2	4	2	0	0.008	Significant
Addition Silicone	Group II: $FeSO_4$	0	2	4	2	<0.001	Significant
Addition Silicone	Group III: Epinephrine	4	3	1	0	0.076	Not Significant
Addition Silicone	Group IV: Control	8	0	0	0	-	-
Condensation Silicone	Group I: $AlCl_3$	4	3	1	0	0.076	Not Significant
Condensation Silicone	Group II: $FeSO_4$	3	3	2	0	0.025	Significant
Condensation Silicone	Group III: Epinephrine	5	3	0	0	0.200	Not Significant
Condensation Silicone	Group IV: Control	8	0	0	0	-	-
Polyether	Group I: $AlCl_3$	0	2	4	2	<0.001	Significant
Polyether	Group II: $FeSO_4$	0	0	3	5	<0.001	Significant

Polyether	Group III: Epinephrine	2	4	2	0	0.008	Significant
Polyether	Group IV: Control	8	0	0	0	-	-

Ferric sulphate produced the highest degree of polymerization inhibition, followed by aluminium chloride, while epinephrine demonstrated the least effect. Polyether showed the greatest susceptibility to inhibition, whereas condensation silicone was relatively more resistant. Statistical analysis revealed significant differences among medicament and material groups, particularly with ferric sulphate exposure ($p < 0.05$) (Graph 2).



Graph 2: Distribution of Polymerization Inhibition Scores Among Different Gingival Retraction Medicaments

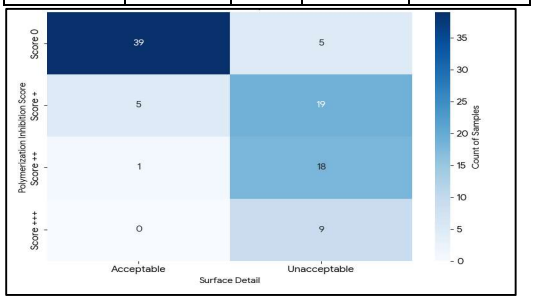
RELATIONSHIP BETWEEN POLYMERIZATION INHIBITION AND SURFACE DETAIL REPRODUCTION

Spearman's rank correlation analysis demonstrated a strong negative correlation between polymerization inhibition and surface detail reproduction ($rs = -0.759$, $p < 0.001$) (Table 3; Graph 3). Increased polymerization inhibition was associated with reduced surface detail reproduction.

The heatmap (Graph 3) further showed that acceptable surface detail reproduction was predominantly associated with complete polymerization (Score 0), whereas higher inhibition scores (++ and +++) were associated with unacceptable surface detail reproduction.

Table 3: Spearman's Rank Correlation Between Polymerization Inhibition and Surface Detail Reproduction

Variables Correlated	Spearman's rho (rs)	p-value	Significance Level	Interpretation
Polymerization Inhibition vs. Surface Detail Reproduction	-0.759	<0.001	Significant ($p < 0.05$)	Strong Negative Correlation



Graph 3: Correlation Between Polymerization Inhibition and Surface Detail Reproduction

DISCUSSION

The present in vitro study evaluated the influence of gingival retraction cord medicaments on polymerization inhibition and surface detail reproduction of addition silicone, condensation silicone, and polyether impression materials. The findings demonstrated that gingival retraction medicaments adversely affected both polymerization and surface detail reproduction when compared with the control group. Among the medicaments evaluated, ferric sulphate produced the greatest adverse effect, whereas epinephrine showed the least interference. Addition silicone exhibited the highest resistance to medicament-induced changes, while polyether was the most susceptible.

The detrimental effect of ferric sulphate may be attributed to its acidic and protein-coagulating properties, which can leave residual deposits on the recording surface and interfere with impression material setting. Aluminium chloride demonstrated a moderate effect, whereas epinephrine showed minimal interaction with the impression materials owing to its primarily vasoconstrictive action and limited chemical reactivity [23,24]. Similar observations have been reported by Chiaraputt et al. [14], Abduljabbar et al. [25], and Nowakowska et al. [23], who

reported reduced surface accuracy and material compatibility following exposure to gingival retraction agents.

Polymerization inhibition followed a similar pattern, with ferric sulphate producing the highest inhibition scores and polyether showing the greatest susceptibility. These findings are consistent with previous investigations demonstrating the inhibitory effect of haemostatic agents on elastomeric impression materials, particularly polyvinyl siloxane systems [24,27–31]. Residual medicaments may interfere with catalyst activity and cross-linking reactions, thereby affecting complete material setting.

Among the impression materials tested, addition silicone demonstrated superior performance with respect to both surface detail reproduction and polymerization behaviour. Its dimensional stability, low polymerization shrinkage, and stable setting reaction may explain its greater resistance to chemical contamination [32,33]. In contrast, the hydrophilic nature of polyether may increase its susceptibility to residual medicaments and surface contamination, resulting in greater polymerization inhibition and loss of surface detail [23,34]. Condensation silicone demonstrated intermediate performance, consistent with previous reports [35,36].

A significant finding of the present study was the strong negative correlation between polymerization inhibition and surface detail reproduction ($r_s = -0.759$, $p < 0.001$). This indicates that increased polymerization inhibition is associated with reduced surface detail accuracy. Adequate polymerization is essential for achieving optimal elastic recovery, dimensional stability, and accurate reproduction of fine surface details. Any interference with the setting reaction may result in surface irregularities, distortion, and compromised impression accuracy [33,36,38].

Clinically, these findings emphasize the importance of complete removal of gingival retraction medicaments before impression making. Thorough rinsing, air drying, and proper field isolation are necessary to minimize residual contamination and ensure optimal impression accuracy. Careful selection of both gingival retraction medicaments and impression materials is essential for predictable prosthodontic outcomes. Although digital impression techniques continue to evolve, conventional elastomeric impressions remain indispensable in many clinical situations, particularly where subgingival margins are involved [39–45].

Overall, ferric sulphate demonstrated the greatest adverse effect on polymerization and surface detail reproduction, whereas epinephrine exhibited the least interference. Addition silicone was the most resistant impression material, while polyether was the most vulnerable. The strong association between polymerization inhibition and surface detail reproduction highlights the importance of achieving complete material polymerization to obtain accurate and clinically reliable impressions.

CONCLUSION

Within the limitations of this in vitro study, gingival retraction medicaments significantly influenced the polymerization behaviour and surface detail reproduction of elastomeric impression materials.

Ferric sulphate produced the greatest polymerization inhibition and surface detail deterioration, whereas epinephrine showed the least effect. Addition silicone demonstrated superior resistance to medicament-induced changes compared with condensation silicone and polyether.

A strong association was observed between polymerization inhibition and reduced surface detail reproduction, emphasizing the importance of complete material polymerization for accurate impressions. Careful selection of both gingival retraction medicaments and impression materials is essential to achieve predictable clinical outcomes.

REFERENCES

1. Haralur SB, Saad Toman M, Ali Al-Shahrani A, Ali Al-Qarni A. Accuracy of Multiple Pour Cast from Various Elastomer Impression Methods. Int J Dent. 2016;2016:7414737.

2. Jei J, Anitha KV. Evolution of Impression Tray and Materials- A Literature Review. J Clin Prosthodont Implantol. 2021;3:37-41.

3. Mandikos MN. Polyvinyl siloxane impression materials: an update on clinical use. Aust Dent J. 1998;43(6):428-34.

4. Goyal G, Goyal G, Nagar S. History of impression, impression materials and impression techniques in complete dentures. J Adv Med Dent Sci Res. 2014;2(2).

5. Nowakowska D, Saczko J, Kulbacka J, Więckiewicz W. Chemical Retraction Agents. Mini Rev Med Chem. 2017;17(5):435-444.

6. Vasilescu VG, Qirici I, Constantin ME. Comparative accuracy evaluation of condensing and addition impression materials. Stoma Edu J. 2024;11(1-2):35-41.

7. Pokharkar AB et al. Comparative Evaluation of Dimensional Accuracy and Surface Detail Reproduction. J Clin Diagn Res. 2021;15(9).

8. Tarighi P, Khoroushi M. A review on common chemical hemostatic agents in restorative dentistry. Dent Res J. 2014;11(4):423.

9. Nowakowska D et al. Chemical Retraction Agents–Compatibility with Elastomer Impression Materials. Mini Rev Med Chem. 2017;17(5):435-44.

10. Nowakowska D et al. Polymerization time compatibility index of polyvinyl siloxane impression materials. J Prosthet Dent. 2014;112(2):168-75.

11. Vohra F et al. Effect of contemporary retraction agents on polymerization of elastomeric impression materials. J Appl Biomater Funct Mater. 2020;18.

12. Singh R et al. Effect of different medicaments on surface reproduction of PVS impression materials. J Clin Exp Dent. 2013;5(3):e138.

13. Vaishnav K et al. Effect of 3 Different Medicament on Dimensional Stability and Surface Detail Reproduction Of Polyvinyl Siloxane Impression Material. 2012.

14. Chiaraputt S et al. Effect of gingival hemostatic agents on surface detail reproduction and dimension stability. Int J Dent. 2023.

15. Shah R et al. Comparative Evaluation of Fluid Absorbency of Retraction Cords. J Prosthodont Dent Mater. 2023;4(1):29-45.

16. Makakova DR et al. Absorptive Capacity of Gingival Retraction Cords in Hemostatic Solutions. Medicina. 2024;60(8):1306.

17. Kumar L et al. Clinical study comparing gingival retraction cord materials. Med Sci Monit. 2023;29.

18. Madaan R et al. Comparative Evaluation of Four Gingival Retraction Systems. Cureus. 2022;14(4):e23923.

19. Diwan V et al. Impregnated retraction cord versus laser: clinical study. J Indian Prosthodont Soc. 2024;24(2):136-143.

20. Acharya A et al. Polyvinyl siloxane foam and retraction cord systems. J Oral Biol Craniofac Res. 2025;15(5):1103-7.

21. Alarcón-Sánchez MA et al. Clinical and immunological aspects of gingival retraction systems. Eur J Inflamm. 2024.

22. Kumari S et al. Evaluation of Effectiveness of Three New Gingival Retraction Systems. J Contemp Dent Pract. 2021;22(8):922-927.

23. Nowakowska D et al. Chemical Retraction Agents. Mini Rev Med Chem. 2017;17(5):435-444.

24. Tarighi P, Khoroushi M. Common chemical haemostatic agents in restorative dentistry. Dent Res J. 2014;11:423-8.

25. Abduljabbar TS et al. Effects of Gingival Retraction Paste on Polymerization of Impression Materials. J Prosthodont. 2019;28:709-714.

26. Chaudhari J et al. Comparative evaluation of gingival displacement systems. Contemp Clin Dent. 2015;6(2):189-195.

27. Machado CE, Guedes CG. Effects of sulfur-based hemostatic agents on polymerization of PVS materials. J Appl Oral Sci. 2011;19(6):628-33.

28. Sábio S et al. Effect of gingival retraction solutions on tensile strength and polymerization inhibition. J Appl Oral Sci. 2008;16:280-285.

29. Vohra F et al. Effect of retraction agents and hydrogen peroxide cleaning. J Appl Biomater Funct Mater. 2020;18.

30. Abdullah AA. Effect of gingival retraction material on physical properties of PVS impression material. Egypt Dent J. 2011;57:899–905.

31. Salman HA et al. Compatibility of Novel Gingival Retraction Pastes with Polyvinyl Siloxane. J Res Med Dent Sci. 2021;9(7):127-

132.

32. Khan SA et al. Linear Dimensional Accuracy of Elastomeric Impression Materials. J Int Soc Prev Community Dent. 2020;10(6):736-742.

33. Gonçalves FS et al. Dimensional stability of elastomeric impression materials. Eur J Prosthodont Restor Dent. 2011;19(4):163.

34. Theocharidou A et al. Evaluation of Elastomeric Impression Materials' Hydrophilicity. Acta Stomatol Croat. 2021;55(3):256-263.

35. Karaaslan G et al. Stability and wettability of impression materials. Niger J Clin Pract. 2018;21(7):912-920.

36. Re D et al. Mechanical properties of elastomeric impression materials. Int J Dent. 2015;2015:428286.

37. Sharma M et al. Elastomeric Impression Materials: A Comparative Review. 2022.

38. Aslan YU, Ozkan Y. Volumetric dimensional stability and accuracy of impression materials. Clin Exp Health Sci. 2019;9(2):94-100.

39. Rau CT et al. Quality of fixed prosthodontic impressions. J Am Dent Assoc. 2017;148(9):654-660.

40. Samet N et al. Clinical evaluation of fixed partial denture impressions. J Prosthet Dent. 2005;94(2):112-117.

41. Abadzhiev M. Subgingival impression quality using one and double cord techniques. J IMAB. 2009;2:52-54.

42. Giachetti L et al. Accuracy of digital impressions in fixed prosthodontics. Int J Prosthodont. 2020;33(2):192-201.

43. Albanchez-González MI et al. Accuracy of Digital Dental Implant Impressions. Int J Environ Res Public Health. 2022;19(4):2026.

44. Ayeen JNU et al. Comparative evaluation of two hemostatic agents used for gingival retraction. J Adv Med Dent Sci Res. 2022;10(7):38-43.

45. O'Mahony A et al. Effect of 3 medicaments on dimensional accuracy and surface detail reproduction of PVS impressions. Quintessence Int. 2000;31(3):201-206.