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Triton all in one irrigation solution in endodontics

Abstract:
Endodontic success hinges on effective irrigation to disinfect canals and remove organic tissue and smear layer. To achieve the same objectives, traditional irrigation employs a series of sequential solutions - sodium hypochlorite (NaOCl) to dissolve organic tissues and disinfect the area, then a chelator such as ethylenediaminetetraacetic acid (EDTA) to remove inorganic smear - since no single irrigant can accomplish all its objectives. This is a multistage procedure, which is chemically complicated and time-consuming because NaOCl and EDTA or chlorhexidine (CHX) can not be mixed without deactivating each other or precipitation. Purpose: This review is a critical evaluation of one novel all-in-one endodontic irrigation solution called Triton, which was created to make the irrigation procedure easier through the combination of a single product containing NaOCl with chelating and surfactants agents. We integrate the latest peer-reviewed articles relating to the Triton composition, effectiveness in disinfection and smear layer removal, safety profile, and clinical implications. Findings: Laboratory experiments show that Triton can have similar or even better antimicrobial efficacy and smear layer elimination than traditional multi-step regimens due to the presence of continuous chelation concept and additional surfactants which increase the penetration of NaOCl and its stability. Its cytotoxicity in vitro is comparable to NaOCl and low than EDTA. Conclusion: Triton is a good all-in-one irrigant with potential to simplify the process of root canal irrigating without affecting the cleaning effect. The existing evidence, however, is mostly in vitro. Its safety and effectiveness in the in vivo setting should be continued to be verified in clinical studies.

Key-words: Endodontic irrigation; continuous chelation; sodium hypochlorite; smear layer; Triton irrigant; surfactants.

Introduction:

Root canal irrigation is important to remove the microbes, disperse the pulp remnants, as well as eliminate the dentin debris smear layer formed during instrumentation. Traditional procedures are based on a series of irrigants, since none of the solutions is sufficient to disinfect, dissolve organic tissues, and chelate inorganic debris at the same time. Sodium hypochlorite (NaOCl) is the largely used irrigant due to its extensive antimicrobial and proteolytic action and the effective dissolution of organic substances such as pulp tissue and biofilms. [1] But NaOCl cannot be used on its own and a chelating agent like 17% EDTA or citric acid is needed to soluble inorganic dentin and expose dentinal tubules. Clinicians traditionally use NaOCl and EDTA interchangeably during equipment use and use final EDTA rinse to remove the smear layer. It is a multi-step methodology which is bulky. It involves a series of syringes and a strict sequence of usage to prevent deleterious chemical reactions - e.g. EDTA neutralizes NaOCl when it comes in contact, and will quickly remove its chlorine and lower its capabilities to dissolve tissues[2] Similarly, a combination of NaOCl and CHX forms an insoluble precipitate (parachloroaniline) that has the possibility of toxic and discoloration effects. Consequently, incompatible irrigants should be changed by intermediary rinses of water. These complications add time and error risk to the chair time. It is an obvious incentive to streamline irrigation without compromising its effectiveness. [3]

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In the last 10 years, manufacturers and researchers investigated all-in-one or dual-action irrigants in order to simplify it.. As recently introduced products such as QMix (EDTA, CHX, and a detergent) or MTAD (doxycycline, citric acid and a detergent) could be used concurrently, as final irrigants, in removing the smear and disinfecting products. Nevertheless, it was still impossible to incorporate NaOCl in such mixtures along with EDTA since they inactivate each other. Etidronic acid (HEBP) is a weak chelator, in contrast to EDTA, it can be used with NaOCl without an instant loss of the available chlorine. Continuous chelation with NaOCl+HEBP has been demonstrated to have the same or greater canal cleanliness and disinfection than sequential NaOCl/EDTA, and milder dentin erosion as a result of the less vigorous demineralization by HEBP.[4]

A new all in one irrigation system known as Triton (Brasseler USA) is the most recent innovation in this field. It is composed of 2 parts that are combined in the chairside; one part is 8% NaOCl, and the other part of a proprietary combination of "gentle" chelators (instead of EDTA), surfactants, detergents, and lubricants. When mixed 1: 1 the resulting working solution is 4% NaOCl containing the added agents in a stable cocktail. The chelators (presumably a blend of 11 different polyaminocarboxylic and other acids) are selected due to a low buffering of NaOCl due to which the chlorine remains effective over a few hours. Through constant chelating in the instrumentation process, Triton is intended to dissolve organic tissue as well as eliminate smear layer without step-by-step stages. Part A contains surfactants that lower the surface tension of the solution to enhance wettability and accessibility to canal complexities. NaOCl is stored separately in a dual-barrel bottle whereby when the product is required, it is combined with the barrell to enable the use of the product.[5]

Methodology:

We identified the peer-reviewed studies that were published until January 2026 on PubMed, Scopus, and Google Scholar on the topic of Triton or all-in-one endodontic irrigants. The keywords were Triton endodontic irrigation, continuous chelation irrigant and all in one irrigant endodontics. In vitro and ex vivo studies, reviews, and product reports, which were relevant, were included. The findings were summarized as key points that are summarized in Table 1. Due to the novelty of the introduction of Triton, the evidence was limited to the laboratory studies and a single scoping review; no trials of the intervention were identified. The methodology and findings of these studies were critically evaluated to bring forth an objective evaluation.

Critical Analysis of Recent Studies:

Composition and Physicochemical Properties: A preliminary research by Aranda et al. (2025) described the chemistry of Triton and compared it with the traditional irrigants. They did verify that the mixed solution of Triton is strongly alkaline (pH of about 12.5) and does actually have a present concentration of about 4% available chlorine, as desired. Notably, Triton possessed noticeably reduced surface tension and contact angle on dentin as compared to 4% NaOCl and NaOCl and HEBP

Antimicrobial Efficacy: The major purpose of any irrigant is disinfection. Sheng et al. (2023) of UBC examined the capability of Triton to eliminate biofilms within dentin relative to conventional irrigants. With confocal microscopy of 3-week biofilms, they observed Triton (4% NaOCl with chelators) killed E. faecalis and multispecies biofilms in 3 minutes, a major increase above the 6% NaOCl (which killed biofilms in 3 minutes at most). Furthermore, with an extended exposure (6 minutes total), Triton eliminated an average of 71-72 percent of biofilm cells, which is better than 6 percent NaOCl (5 min) and sequential 6 percent NaOCl and EDTA. It is interesting to note that when applied in a short period (3 minutes) Triton was as effective as NaOCl 6% in the absence of a smear layer and was even more effective in the presence of a smear layer on dentin.

Smear Layer Removal: The all-in-one nature of Triton is based on removing smear layer equally as EDTA. This has been taken care of in a number of studies. Chen et al. (2025) compared Triton with the traditional NaOCl-EDTA regimen regarding the removal of smear layers in root canals with and without activation methods. They compared scoring of scanning electron microscopy at coronal, mid, and apical thirds and discovered that the syringe irrigation with Triton gave a much cleaner canal wall (lower smear score) than sequential 17% EDTA + 6% NaOCl protocol at all levels. In another independent study, Oraim and Al-Zaka (2024) specifically studied the effect of smear removal by Triton versus EDTA on instrumented premolars (where chitosan nanoparticles were used as an extra experimental irrigant). They found no considerable differing results when Triton and 17% EDTA were used to clear a smear in coronal and middle canal levels with both solutions leaving slight smear and all groups had similar results (differences were not statistically significant) (Oraim& Al-Zaka, 2024 exposing to the open dentinal tubules, compared to NaOCl alone that produced a thick coating of smear. Also, Chen et al. and Oraim and Al-Zaka both found that agitation or longer duration of time intensifies the smear-removing activity of Triton, which can

again be attributed to the principles of chelation dynamics: the longer or more excited the contact, the more smear will be demineralized and tubules opened up.

Tissue Dissolution: NaOCl plays a vital role in the dissolution of tissue in the pulp hence an all-in-one irrigant should not jeopardize that. Velagala et al. (2024) have explicitly compared the ability of Triton with 3% NaOCl and Twin Kleen (NaOCl/HEBP mix in powder form) to dissolve tissue in a range of temperatures. Bovine muscle samples were immersed in each solution in room temperature (RT), pre-warmed or heated continuously and the weight loss was determined with time. Triton showed comparable efficacy in tissue dissolution as 3% NaOCl and much more efficacy than Twin Kleen under all conditions. At room temperature Triton dissolved tissue significantly more than the HEBP-containing Twin Kleen which dissolved least. In the pre-warmed (or continuously warmed) solutions in use (strategies that are known to speed up the action of NaOCl), Triton and NaOCl had significant increases in the rate of dissolution, but Twin Kleen did with the smallest increases. Actually, under constant heating, Triton could dissolve almost all tissue in 15 minutes (approximately 100% weight loss), which is similar to the behaviour of NaOCl, but Twin Kleen yielded much lower percentages dissolution. Triton use should not compromise the power of tissue dissolution NaOCl expected to have.

Cytotoxicity and Biocompatibility: Although efficacy is the main factor of interest, irrigant toxicity to periapical tissues is also a pertinent issue, particularly in regards to novel formulations. In vitro cytotoxicity and genotoxicity test of Triton on the human periodontal ligament fibroblasts was done by Hwang et al. (2025). They compared Triton to simple NaOCl (4% and 6%), and EDTA, evaluated by cell viability analysis and indicators of the DNA double strand breakage. The cytotoxicity of Triton was similar to that of 4-6% NaOCl, which produced an identical amount of fibroblast viability loss, but 17% EDTA was actually more toxic as compared to Triton and NaOCl in this model. Further,. Cytotoxicity was also reported by Aranda et al. (2025): in their experiment, Triton and NaOCl +HEBP combination exhibited lower fibroblast viability (reduction of approximately 60 percent as compared to 40 percent with pure NaOCl or sequential NaOCl+EDTA) when compared to Triton and NaOCl+HEBP combination

We have reviewed the article by Sheng et al. which gives substantial evidence to the idea that the multi-pronged chemistry of Triton produces palpable antimicrobial benefits over the conventional irrigation protocol, particularly with smear-positive canals. This implies that Triton may be able to lower bacterial loads in a clinical environment more effectively which may be translated into better treatment outcomes such as increased disinfection rates in lateral canals or isthmuses. Nonetheless, it should be stressed that actual teeth with complicated structures and unequal conditions of tissues might not be a perfect replica of the conditions of the test.

The shelf-life of the uncombined solution is approximately one year on the room temperature (longer with refrigeration), which is reasonable enough to use on clinical products. The fact that mixing fresh is necessary per patient is a slight inconvenience that is compensated with the advantages.

Figure 1 shows that Triton would make the protocol of irrigation simpler than the conventional multi-step method. Triton uses a single syringe and single solution instead of alternating individual syringes of NaOCl and EDTA (with a water rinse between) - and, optionally, CHX instead of a water rinse at the end - and can perform the functions of all solutions simultaneously. This simplified process minimizes the possibility of errors (like forgetting a rinse or using a wrong order) and reduces the amount of handling of caustic chemicals, which also is a safety enhancement to the members of a dental team.

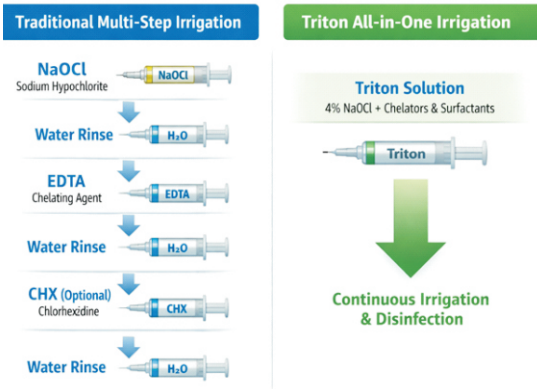

Figure 1. Comparison of traditional multi-step irrigation vs. **Triton all-in-one** irrigation.

Clinical Implications:

Triton is stored at 4 per cent, clinicians do not need to compromise on disinfecting power; 4 per cent is in the range of commonly used (usually 1-6 per cent NaOCl) and has demonstrated antimicrobial and tissue-dissolving efficacy. It may be the concern of some clinicians that integrating functions into a single solution appears to be too good to be true, but the current evidence already suggests

that Triton keeps up with its components. Even then precautions should be observed against extrusion - Triton is fundamentally a solution of hypochlorite, and will lead to sodium hypochlorite accidents on being forced beyond the apex. Basic precautions (leaving the needle unlocked in the canal, side-vented needles, slow injection, and potentially negative pressure irrigation in the high-risk cases) are still of the primary priority. The other clinical aspect is the irrigation volume endodontists may administer 15-20 mL or greater irrigant in each canal. The manufacturer of Triton suggests approximately 6 mL/canal (like in case with conventional irrigants), and considering that this product is more effective, this amount might be enough. There is no limit to the amount of higher volumes used, however, other than cost. Triton is pricier by the mL than regular NaOCl, though, supporters claim that the price is compensated by removing EDTA and lessening the consumption of auxiliary products (needles, syringes, etc.), and by saving time in the chair. Dentists will be forced to consider the cost-benefit in their practice.

Among the clinical questions that have been noted is whether the use of Triton has any potential to influence obturation or bonding. Chelating agents Dentin surface may be affected by chelating agents such as EDTA and may have better sealer penetration (as demonstrated by HEBP which provides higher sealer penetration depth compared to EDTA). The open tubules also get revealed in Triton and this may enhance sealer penetration and might also enhance obturation seal.. The research in the future should focus on whether there is any difference between sealer penetration or bonding between canals irrigated with Triton and conventional irrigation.

Limitations of Available Evidence:

Although the in vitro results are encouraging, it is prudent to regard them with a lot of caution when it comes to directing them towards clinical success. Controlled experiments with extracted teeth or dentin are commonly used in the laboratory, which may not be representative of real life scenarios (such as continuous pulp tissue influx in vital cases, changing canal morphology, or buffering by blood and fluids). The reviewed studies did not assess the actual rates of infection elimination or the healing of patients. Therefore, we cannot directly tell that the application of Triton will increase the effectiveness of the root canal procedures and decrease the number of postoperative complications in comparison with the standard form of irrigation. There is a possibility that optimum traditional irrigation already has a high degree of disinfection that the benefits of Triton would not significantly alter clinical outcomes but instead would increase the efficiency of the process.

Future Scope:

The presentation of Triton creates a number of research prospects in the future. First of all, there is a requirement of clinical trials or at least of clinical observational studies. A comparison of Triton versus regular irrigation concerning postoperative pain, disinfection (e.g., bacteria culture or molecular test before obturation), and long-term treatment outcome would be a good evidence of clinical effectiveness. Adoption would also be useful in patient-centered outcomes such as time taken to treat and any cost-benefit analysis. Secondly, further examinations of the impacts of Triton on the dentin and root morphology might be performed. As such, does the continuous use of Triton have different effects on dentin micro-hardness or flexural strength compared to individual use of NaOCl and EDTA? Does it change the smear layer composition so as to affect sealer bonding or penetration? As stated, it would be nice to have bonding research (push-out tests or microtensile strength of resin sealer after Triton irrigation). The other field is the study of the changes or alternatives of all-in-one solutions. This is the first Triton of its size; it may happen that other manufacturers will come up with similar multi-functional irrigants. It can be experimented using perhaps different chelator combinations (adding borate or other weak acids) or lower concentrations of NaOCl to cause minimal invasive endo. Retreatment might also be undertaken with continuous chelation - e.g., is it possible to maintain all-in-one solution, and dissolve the remaining obturation material? The initial news says that the high alkalinity of Triton may help saponify gutta-percha (Nasseh, 2022), but these are anecdotal and not studied.

The interaction of the activation methods with Triton also deserves a more detailed study. Chen et al. showed that lasers and high-tech ultrasonics could be used to enhance the smear removal of Triton. It would be intriguing to experiment whether frequently used equipment such as Endo Activator or Gentle Wave have better performance using Triton as compared to conventional irrigants. Assuming that continuous chelation chemistry can improve the performance of these irrigation systems, it has the potential to inform the way we mix technologies in future. In its turn, it can be investigated whether the benefits of Triton can still be achieved without any sort of activation (as a great number of general practitioners do not have the use of special activation). Up to now, it appears that Triton is the only method that outperforms the traditional method, without activation, which is positive when it comes to the use of the Triton among a broad spectrum of clinicians.

Lastly, when all-in-one-irrigants gain more popularity, the older combinations could be rediscovered in future study with new perspective. As an example, is it safe to include CHX in a multi-part system but store it separately until mixing (so that it does not get in contact with NaOCl)? Triton decided not to add CHX at all, which does not cause any precipitate changes, whereas another product may seek to add a substantive antimicrobial to be effective after drying the canals. Nevertheless, as CHX does not play any significant role in tissue dissolution or biofilm penetration, its role can be reduced in the presence of effective NaOCl-based combos.

Study (Year)	Study Focus & Design	Key Findings Regarding Triton
Hwang et al. (2025)	Cytotoxicity and genotoxicity in vitro on human fibroblasts; compared Triton, 4–6% NaOCl, and 17% EDTA (exposure 1–10 min).	Triton's cytotoxicity was equivalent to 4–6% NaOCl and significantly lower than EDTA. No DNA damage (double-strand breaks) was induced by Triton or NaOCl, whereas EDTA caused significant genotoxicity. Suggests Triton is as biocompatible as NaOCl and less harmful to cells than full-strength EDTA.
Aranda et al. (2025) (in press)	Physicochemical properties: measured pH, free chlorine, surface tension, contact angle; dentin penetration of dye; and L929 cell cytotoxicity for Triton vs 4% NaOCl, 4% NaOCl+HEBP, and sequential 4% NaOCl+17% EDTA.	Triton had alkaline pH (~12.5) and ~4.2% available chlorine (as intended). Surface tension and contact angle were markedly lower for Triton than for NaOCl or NaOCl+HEBP, indicating superior wettability. Triton penetrated deeper into dentin (coronal/middle thirds) than other solutions. Cytotoxicity: Triton and NaOCl+HEBP caused more cell viability reduction than NaOCl alone, but all were in similar range. Concluded Triton's additives improve wetting and penetration without greatly altering NaOCl's chemistry, though care to avoid extrusion is still needed.
Sheng et al. (2023)	Antibiofilm efficacy and smear removal in dentin blocks. Formed *E. faecalis* and multispecies biofilms in human dentin, with/without smear layer. Tested 3 min and 6 min treatments of: Triton, 6% NaOCl, 2% NaOCl, and sequential NaOCl+EDTA. Assessed live/dead biofilm by confocal microscopy and smear layer by SEM.	Triton consistently achieved higher biofilm kill percentages than all other groups. In 3 min, Triton killed ~64% (mono-species) to 72% (multi-species) of biofilm cells, versus ~50% by 6% NaOCl. With two-stage application (3+3 min), Triton's kill rate exceeded 71%, significantly outdoing 6% NaOCl (5 min) and NaOCl+EDTA. Notably, Triton was equally effective in presence of smear layer, whereas smear hindered NaOCl. Triton also completely removed smear layer, revealing open tubules, unlike 6% NaOCl which left smear-covered walls. Concluded Triton provides simultaneous potent antibiofilm action and smear layer removal, simplifying the procedure.
Chen et al. (2025)	Smear layer removal efficacy in instrumented canals. Compared groups irrigated with: (1) 17% EDTA + 6% NaOCl (traditional sequential), (2) Triton (single solution), and also evaluated Triton with various activation methods (laser-activated irrigation, photon-induced streaming, ultrasonic). SEM scoring of smear at coronal, middle, apical thirds.	Triton used with conventional syringe irrigation produced significantly cleaner canal walls (lower smear scores) than the NaOCl+EDTA sequence across all canal levels. In coronal, middle, and apical thirds, Triton outperformed or equaled EDTA/NaOCl in smear removal. When activated, Triton's performance improved further: laser activation (Er:YAG SWEEPS) with Triton achieved the best smear removal, superior to ultrasonic activation. Demonstrated that Triton alone is more effective for smear layer elimination than the traditional two-step irrigants, and its efficacy can be enhanced with advanced irrigation techniques.
Velagala et al. (2024)	Tissue dissolving ability (TDA) of irrigants at different temperatures. Bovine muscle tissue samples were immersed in: normal saline (control), 3% NaOCl, Twin Kleen (NaOCl+HEBP mixture), and Triton. Each was tested at room temperature (RT), prewarmed (PW), and continuous warming (CW) conditions. Tissue weight loss measured at 5, 10, 15 min.	Triton showed high tissue dissolution capacity, comparable to 3% NaOCl and markedly greater than Twin Kleen (NaOCl/HEBP). At RT, Triton and NaOCl dissolved significantly more tissue than Twin Kleen (which had the least TDA). Heating enhanced dissolution for Triton and NaOCl: under continuous warming, Triton dissolved ~92% of tissue by 5 min and ~100% by 15 min, similar to NaOCl, whereas Twin Kleen reached much lower dissolution (data ~75% by 15 min). Twin Kleen's TDA was not improved by prewarming, whereas Triton benefited from heating (as did NaOCl). Concluded that Triton retains NaOCl's potent tissue solvent action (especially when agitated or heated) and outperforms the other all-in-one (Twin Kleen) in dissolving organic matter.

Conclusion:

Triton all-in-one irrigation solution exemplifies a shift in endodontic therapy towards chemistry An example of an endodontic change in the direction of chemistry is Triton all-in-one irrigation solution, which making clinical protocols less complicated and effective or equally effective. Triton binds together synergistic chelating and surfactant agents with sodium hypochlorite, eliminating the necessity of three steps of irrigation washing, achieving the triadic goal of root canal irrigation - organic tissue dissolution, removal of the smear layer, and disinfection - in a single step. The available peer-reviewed literature, though restricted to laboratory and ex vivo testing, shows that Triton works as well as or even better than the conventional multi-solution irrigation in the most critical parameters. It has been shown to be highly antimicrobial to tough endodontic biofilms and capable of removing the smear layer as well as EDTA without losing the tissue-dissolving property of NaOCl. These advantages are attributed to its uninterrupted chelation process and enhanced wettability that unite to eliminate shortcomings of unipotentirrigants. Notably, the launch of Triton did not demonstrate any safety issues other than those inherent to NaOCl; its cytotoxicity is equivalent to comparable bleach solutions, and its correct usage should not cause mishaps at a higher rate than existing irrigants that it is supposed to replace. When implemented wisely, Triton would facilitate the root canal practices by cutting back the number of irrigant washes and making sure that the canals are perpetually bathed in an active solution that is optimally working.

With that said, there should be caution when transferring in vitro success to clinical results. The absence of published clinical trials also translates to the fact that we are not yet in a position to know whether the use of Triton will have a great effect on the healing rates or postoperative pain as compared to the conventional irrigation. This technology should be viewed by clinicians not as a replacement of good endodontic principles such as proper canal shaping, the required amount of irrigation, and a controlled technique, but rather as an addition to them. Triton is a development of irrigating solutions according to evidence-based trends (including continuous chelation), and it has a possibility of enhancing efficiency and potentially efficacy in endodontic disinfection. With the continued developments of studies, particularly in vivo, we will have a better way of determining its role. To this day, Triton can be regarded as a welcome innovation which has a critical comment to make in terms of our increased knowledge that the simpler, smarter irrigation techniques could be designed to address the long-standing issue of cleaning root canals.

Table 1. Key studies on Triton all-in-one irrigant and their findings

References:

1. Stojicic S, Zivkovic S, Qian W, Zhang H, Haapasalo M. Tissue dissolution by sodium hypochlorite: Effect of concentration, temperature, agitation, and surfactant. J Endod. 2010;36(9):1558–1562.

2. Grawehr M, Sener B, Waltimo T, Zehnder M. Interactions of ethylenediaminetetraacetic acid with sodium hypochlorite in aqueous solutions. IntEndod J. 2003;36(6):411–415
3. Rossi-Fedele G, Prichard JW, Steier L, de Figueiredo JAP. The effect of surface tension reduction on the clinical performance of sodium hypochlorite in endodontics. IntEndod J. 2013;46(6):492–498
4. Basrani B, Haapasalo M. Update on endodontic irrigating solutions. Endod Top. 2012;27(1):74–102.
5. Aranda J, de Souza EON, Aranda Garcia AJ, Leonardo RT, Ramos AP, Rossi-Fedele G, Faria G. Physicochemical and biological properties of the "all-in-one" endodontic irrigant Triton. J Endod. 2025 Oct 17.
6. Sheng X, Yu J, Liu H, Deng S, Shen Y. Dual effectiveness of a novel all-in-one endodontic irrigating solution in antibiofilm activity and smear layer removal. Front BioengBiotechnol. 2023;11:1254927.
7. Chen Y, Watanabe S, Myint PYA, Mochizuki S, Okiji T. Comparisons of the smear layer removal efficacy of dual-action irrigants and different activation techniques. J Dent Sci. 2025;20(2):877–884.
8. Oraim HW, Al-Zaka IM. Effectiveness of Triton irrigation solution in smear layer removal: An in vitro study. EurEndod J. 2024;9(2):139–145.
9. Hwang J, Askar M, Smoczer C, Young L, Ferracciolo J, Paurazas S. Cytotoxicity and genotoxicity of Triton all-in-one irrigation solution: An in vitro study. J Endod. 2025. [Epub ahead of print].
10. Velagala LD, Vanga HR, Kadali N, Divve S, Sravya V, Kapa RS. Effect of prewarming and continuous warming on tissue dissolving ability of Triton™ versus Twin Kleen™: An in vitro study. J Conserv Dent Endod. 2024;27(1):100–104.
11. Hofpeter K, Zehnder M, Solomonov M, Deari S. Continuous chelation reduces instrumentation time and straightening of double-curved simulated root canals in bovine dentin. J Endod. 2025;51(3):367–372.
12. Iglesias JE, Pinheiro LS, Weibel DE, Montagner F, Grecca FS. Influence of surfactants addition on the properties of calcium hypochlorite solutions. J Appl Oral Sci. 2019;27:e20180157.
13. La Rosa GRM, Plotino G, Nagendrababu V, Pedullà E. Effectiveness of continuous chelation irrigation protocol in endodontics: A scoping review of laboratory studies. Odontology. 2024;112(1):1–18.
14. Rossi-Fedele G, Doğramaci EJ, Guastalli AR, Steier L, de Figueiredo JAP. Antagonistic interactions between sodium hypochlorite, chlorhexidine, EDTA, and citric acid. J Endod. 2012;38(4):426–431.
15. Zehnder M. Root canal irrigants: A review. J Endod. 2006;32(5):389–39
16. Zhang K, et.al Effects of different exposure times and concentrations of sodium hypochlorite/ethylenediaminetetraacetic acid on the structural integrity of mineralized dentin. J Endod. 2010;36(1):105–109.
17. Bandoo C, Suliman S, Trestrail E, Marchan SM. The effectiveness of Triton used with XP-3D adaptive files and active irrigation on smear layer removal during root canal preparation: A qualitative scanning electron microscopy (SEM) study. Cureus. 2024;16(11):e73057.