

Comparison of efficacy of ozonated water, normal saline, and povidone-iodine after surgical removal of impacted mandibular third molars: A cross-sectional study

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ABSTRACT

Background: Surgical extraction of mandibular third molars is an important and one of the most frequently performed operative procedures in dentistry. There are a variety of postoperative complications that may follow this procedure. These include pain, trismus, infection, dry socket, or alveolar osteitis. Numerous techniques have been used for reducing these morbid conditions. These range from flap designs, suture placement, use of various irrigating solutions, etc., **Aim:** The present study aimed to compare the effectiveness of three irrigating solutions: Ozonated water, normal saline, and povidone-iodine in reducing postoperative complications following surgical removal of impacted mandibular third molars. **Materials and Methods:** A total of 100 study participants formed the sample size of this study. Study subjects were categorized into three groups: Group I (third molar surgeries using ozonated water), Group II (third molar surgeries with normal saline irrigation), and Group III (third molar surgeries using povidone-iodine irrigation). Parameters studied postoperatively were alveolar osteitis (dry socket), pain, trismus, and infection after a week interval. All data obtained were entered in Microsoft Excel 2007 worksheets and Analysis of Variance (ANOVA) as a statistical tool was employed. A *P* value of < 0.01 was considered statistically significant. **Results:** It was found that ozonated water provided the best statistically proven results with comparison to normal saline and povidone-iodine in reducing the incidence of alveolar osteitis or dry socket and pain. No statistically significant difference was observed in the incidence of trismus and infection rate among three studied groups. **Conclusion:** Ozonated water is the best irrigating solution when compared to normal saline and povidone-iodine in terms of reduction in pain and dry socket after a 1-week duration.

Keywords: Dry socket, infection, mandibular third molars, normal saline, ozonated water, pain, povidone-iodine, trismus

Introduction

Mandibular third molars are the most commonly impacted teeth. Various theories that have been suggested are: a) insufficient

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retromolar space infection, b) path of eruption, c) malpositioned tooth germ, d) hereditary, e) lack of sufficient erupting force, and f) phylogenetic jaw size regression.^[1] Usually, third molars erupt in the age group between 18 to 24 years. Thus, there are variations in eruption and also, failure in eruption is very common.^[2]

Surgical extraction of impacted mandibular third molars is one of the most commonly performed dental procedures. The most

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common morbidity inducing conditions associated with this procedure include pain, swelling, trismus, wound infections, and alveolar osteitis. Of these, alveolar osteitis has been demonstrated to affect 25%–30% subjects who undergo surgical molar extractions.^[3] Dry socket (alveolar osteitis) is the result of blood clot disintegration 2 to 4 days following the extraction of the tooth. Clinically dry socket appears as a dry alveola covered with necrotic, yellowish-gray tissue accompanied by halitosis, and severe intensity pain radiating to ear and neck. Other symptoms that may accompany dry socket include insomnia, headache, trismus, and lymphadenitis. Multiple etiologies in the causation of dry socket include trauma, bacteria, vascular defects, toxic end products, and enzymatic and metabolic defects.

Irrigating solutions used during surgical removal of mandibular molars prevent injury to the bone, irrigate the site of surgery, and significantly, cause improvement in the dentist's vision. Bone cutting without water spray produces a significant amount of inflammatory exudate and debris, thereby increasing postoperative discomfort. Different irrigating systems show variations in the efficacy of the removal of microorganisms.^[4] Povidone-iodine is a potent antiseptic agent first discovered by Shelanski and Shelanki in 1956. It is an iodophor formed by binding of iodine molecule to polyvinyl-pyrrolidone. This binding reduces iodine toxicity. Its mechanism of action involves its irreversible binding with tyrosine residue of proteins which interferes with hydrogen bond formation with few amino acids and nucleic acids, oxidation of sulfhydryl groups, and binding with unsaturated sites in lipids.^[5]

Normal saline is an isotonic fluid with physiologically identical properties. It is frequently used in irrigation during third molar surgeries. It possesses no antibacterial activity.^[6] Normal Saline irrigation is routinely used in mandibular third molar surgeries: a) during osteotomy (buccal trough or crown/root sectioning) to decrease the heat generated by surgical drill while contacting bone and b) at end of extraction for removing bone debris from the socket after osteotomy.

Ozone gas possesses powerful antimicrobial activity. It can be used as a disinfectant in medicine and dentistry. Treatment protocols combining ozone with a remineralizing solution or either alone show high effectiveness in treating initial fissural caries. Ozone can be used in three forms, i.e. gas, water, and oil, for treatment purposes. It has several actions as an antibacterial, antiinflammatory, and immunostimulatory agents by utilization of oxygen metabolism and stimulating humoral system. Its antimicrobial activity is due to its ability to form oxidizing free radicals and microbial destruction. It acts by destroying bacterial cell membranes and cell walls and by blocking an enzyme. This causes an increase in permeability of cell membranes resulting in immediate termination of cell functions ultimately leading to microbial death.

Ozonated water has an antioxidant property against bacteria, fungi, and viruses. It causes less cytotoxic effect than chlorhexidine (0.2% and 2%), sodium hypochlorite (2.5% and

5.25%), and hydrogen peroxide. *In vitro* studies have shown that ozonated water can effectively destroy *Staphylococcus aureus*, *Enterococcus faecalis*, and *Pseudomonas aeruginosa*.^[7]

Factors affecting the clinical outcomes of the extraction of impacted mandibular third molar include female gender, age exceeding 26 years, removal of bone, and debris collection at the site of surgery.^[8]

This study aimed to compare the efficacy of three irrigation solutions: ozonated water, normal saline, and povidone-iodine following surgical extraction of mandibular third molars.

Materials and Methods

A total of 100 study participants comprised the study group. All subjects were within the age range of 18 to 25 years. Each subject was clinically examined and necessary radiographic evaluations along with hematological parameters were assessed. All subjects signed an informed written consent form after explanation of the procedure and study purpose. The study was approved by institutional ethical committee with reference number MS/09/18.

The inclusion criteria for the study were 1) absence of any systemic disorders, 2) no antibiotic/antimicrobial or antiinflammatory drug use 1 week before surgery, 3) mesioangular impactions, and 4) nonsmokers.

Exclusion criteria for the study included 1) previous history of radiation therapy, 2) had undergone organ transplantation, 3) allergic response to povidone-iodine or anesthetic agent, 4) subjects with systemic diseases, and 5) pregnant or lactating female subjects.

The irrigating solution was continuously delivered in the single-stream during the surgical procedure. Irrigating solutions selected for the study were ozonated water, normal saline, and povidone-iodine.

Study participants were categorized into three groups:

Group I: Third molar surgeries with ozonated water irrigation ($n = 35$)

Group II: Third molar surgeries done with normal saline irrigation ($n = 25$)

Group III: Third molar surgeries performed using povidone-iodine ($n = 40$)

Primary closure of flaps was done using a 3-0 surgical silk suture. All subjects were prescribed amoxicillin 625 mg twice daily, paracetamol 500 mg two to three times daily, and ranitidine 150 mg twice daily for 7 days. Patients were followed-up at durations of 24 h and seventh day.

Parameters evaluated were a) pain, b) infection, c) alveolar osteitis, and d) trismus. The pain was assessed by providing the subjects with a visual analogue scale (VAS) rated on a scale of 0 to 5 (0 = absence of pain; 5 = Severe pain).

Statistical analysis was performed after entering all study data into Microsoft Excel Worksheet 2007. Analysis of Variance (ANOVA) was the statistical tool used to calculate the significance. P value < 0.05 was considered significant. Alveolar osteitis was evaluated on the seventh day.

Results and Observations

Most cases ($n = 20$) of alveolar osteitis were observed in Group III (third molar surgeries using povidone-iodine irrigating solution), while a minimum number of cases were found in Group I (utilizing ozonated water) [Graph 1]. A highly significant difference ($P < 0.01$) was found in comparing three study group findings. On comparing three groups for assessing pain after 24 h and 7 days, again, an extremely significant difference ($P < 0.01$) was found.

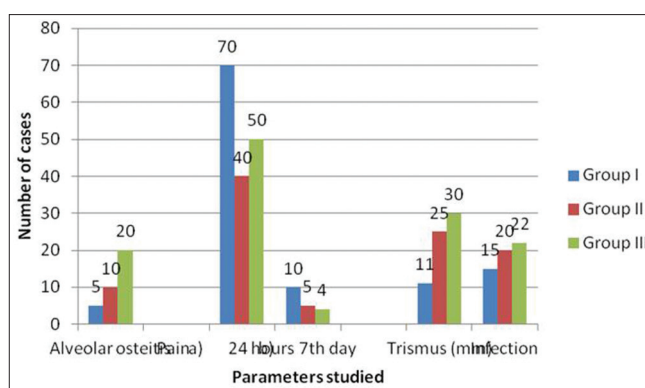
Trismus assessment in three groups did not show any significant difference ($P = 1$). For the assessment of infection, no significant difference ($P = 2$) was noted between three study groups [Table 1].

Discussion

Goldberg *et al.* studied 302 study participants who underwent surgical extractions of impacted mandibular third molars. 4.2% of cases developed a postoperative infection, while 1% of subjects developed alveolar osteitis. Delayed infection is caused by food entrapment underneath elevated flaps. Alveolar osteitis has been reported to have an incidence between 1% and 30% mostly affecting older subjects and in females on progestational birth control pills.^[9]

Standard benchmarks of third molar surgical extraction include flap design, amount of bone removed, type of irrigant, surgery time, and suturing techniques.^[10,11] Irrigation is primarily used to flush away organic and inorganic debris.^[12] Numerous irrigating solutions have been used during third molar surgeries. These include normal saline, Ringer's lactate, ozonated water, 1% povidone-iodine, ozone, etc., The primary reason for using irrigating solutions is the prevention of irreversible bone necrosis resulting due to heat generation. Normal saline does not directly contribute to postoperative healing; however, its cleansing activity helps in aiding the wound healing process. The use of ozonated water for irrigation also demonstrates a significant effect on bone metabolism along with the size reduction of the microbial population. It leads to increased TGF- β 1 production which enhances wound healing.^[10] Ozone contains three oxygen atoms and its mechanism of action is based upon its oxidizing action on bacterial cells.^[13]

Povidone-iodine is used as an irrigating agent following tooth extractions. It consists of polyvinylpyrrolidone with water, iodide, and 1% available iodine. It demonstrates bactericidal activity by iodine release.^[14] It is a soluble complex of iodine that slowly releases free iodine. It acts by iodinating



Graph 1: Studied parameters and number of cases in each

Table 1: Study parameters evaluated in the study

Parameters	Group I	Group II	Group III	P
Alveolar osteitis	05	10	20	<0.01
Pain				
24 h	70	40	50	<0.01
7 th day	10	05	04	<0.01
Trismus (mm)	11	25	30	1
Infection	15	20	22	2

along with the oxidization of microbial cells. Iodine is a fast-acting, broad-spectrum antimicrobial agent active against numerous bacteria, fungi, and viruses. 1% povidone-iodine effectively reduces oral microbial counts for up to 1 h after completion of a surgical procedure without any complications postoperatively.

Sabe-Alarab *et al.* (2019) in their study found that 0.5% of povidone-iodine was more effective against edema following surgical extraction of mandibular third molars.^[5]

Delayed-onset infections following mandibular third molar extractions constitute a rare complication characterized by swelling associated with pus discharge from the site of extraction. This complication develops approximately 1 month following the surgical removal. Its incidence has been reported to range from 0.3% to 1.8%. Treatment protocols involve antibiotic therapy which if proven ineffective, should be treated with surgical debridement. Microorganisms identified in these delayed infections include *Peptostreptococcus*, *Prevotella*, *Bacteroides*, and *Fusobacterium*. It has been observed that soft tissue coverage, absence of distal space, and mesioangular inclination. Mechanical factors include longer duration of the procedure and young age.

Cherian *et al.* (2019) in their study on 60 subjects who had undergone third molar surgeries followed by intraoperative dexamethasone 8 mg administration showed that very less or minimal postoperative swelling when compared to subjects who did not receive any.^[15]

Cho *et al.* (2017) in their systematic review demonstrated that combined administration of opioid analgesics with non-steroidal

antiinflammatory agents showed superior analgesia when compared to other drug combinations; while prescribing these agents, side-effects should be kept in mind. Opioid analgesia may show side-effects like constipation, nausea, and drug abuse, while non-steroidal antiinflammatory drugs should be prescribed keeping in consideration various gastrointestinal, hematological, and renal disorders, drug interactions, and toxic effects. Corticosteroids have also been reported to reduce postoperative swelling along with trismus after third molar surgeries. Perioperative antibiotic prophylaxis has been shown to decrease infection and alveolar osteitis by 70% and 38%, respectively. A significant reduction in the incidence of alveolar osteitis has been found in surgeries that use irrigation.^[16]

Gloria *et al.* (2020) in their study showed that ozonized water usage resulted in no cases with postoperative infections. The effectiveness of ozonized water is dependent on pH, total contact time, and temperature of the solution. Postoperative trismus shows significant presentation within 24 h, which was maintained 1 week after the procedure. Trismus is caused by muscle injury, edema, multiple needle penetrations, flap manipulation, and anesthetic or clot presence within muscle fibers.^[7]

Gharminia *et al.* (2017) in their study analyzed 280 subjects who had undergone third molar extractions. They found that the use of tap water following third molar extraction effectively reduces inflammation.^[8]

Other irrigating solutions widely used include hydrogen peroxide (3%) and chlorhexidine (0.12%). Chlorhexidine gluconate is a broad-spectrum antibiotic and has a distinct advantage over antibiotics due to lesser capacity in producing resistant organisms.^[17]

Placement of sutures for secondary closure showed more swelling compared to nonsutured sites. Hence, suture placement is also a contributory factor for the development of swelling post-third molar extraction.^[18]

Jadhao *et al.* conducted a study to evaluate the efficacy of three different irrigants on various postoperative symptoms during surgical removal of the impacted mandibular third molar. The study included 48 individuals divided into 3 groups: group I where irrigant used was normal saline, group II as chlorhexidine, and group III as povidone-iodine, and it was concluded that the pain was significantly more in groups I and III in 24 h and 7th day as well. Alveolar osteitis was noted in groups III and I only. The facial swelling was higher in 24 h in groups I and III than in group II. Group I and Group III showed significant results for trismus the 7th day.^[3]

Christian Friedrich Schonbein was first to describe ozone in 1840. Treatment therapy with ozone has shown successful management in gingivitis and periodontitis, oral lichen planus, halitosis, osteonecrosis, post-surgical pain, dentinal hypersensitivity, wound healing, temporomandibular disorders,

and whitening procedure of teeth. Ozone in medicine is prepared using a generation by passing pure oxygen through high-voltage gradient ranging from 5 mV to 13 mV. A gaseous mixture comprised 95% oxygen and 5% ozone. This mixture is highly unstable with a half-life of approximately 40 min at a temperature of 20°C. Thus, the generator should be capable of calculating exact ozone concentrations within this mixture. Ozone can be administered via gas, oil, or aqueous media. However, the intravenous injection can result in an embolism.^[19]

Ozone, in its gaseous or aqueous form, has strong oxidizing power and bactericidal effect. Ozonated water whenever used as an irrigant destroys the cell wall and cytoplasmic membranes of bacteria and fungi due to its oxidation potential. Once the cell membranes are damaged, ozone molecules can easily enter the cells, causing the microorganism to die. Thus, it produces less postoperative symptoms when used as an irrigant in third molar surgeries.^[20]

Ozone has greater potential for reducing the risk of dry socket and has increased healing potential following surgical extraction of third molars.^[21]

Ahmedi *et al.* (2016) in their study on ozone gas efficacy in the incidence of dry socket showed a reduction of 3.3% as compared to 16.67% in the control group with a *P* value of 0.2. Thus, these investigators propagated the use of ozone in dry socket prevention risk. Ozone acts by activating angiogenesis, synthesis of leukotrienes, prostaglandins, and interleukins, therefore, causing a reduction in inflammatory process and pain.^[22]

Ozonated olive oil shows a higher half-life compared to its aqueous preparation. Symptoms of dry socket manifest 2 to 3 days following extraction and are characterized by mild erythema and edema, exposure of underlying bone, halitosis, and tenderness.^[23]

Various advantages of the ozone-based procedure are a) simple, b) good tolerance by patients, c) no side- or adverse reactions, and d) high efficiency. The use of ozone in dentistry relies upon its antimicrobial properties against gram-positive and negative bacteria, viruses, and fungi. Daily application of ozonated water might accelerate epithelial healing, especially on the first 2 postoperative days. It has less cytotoxic effect than ozone gas alone.^[7] Effectiveness of ozonated water depends on numerous factors like time of contact, local pH, and temperature. It acts by progressive oxidation of cellular components.

Shah *et al.* (2014) in their prospective double-blind study compared the effectiveness of 0.5% povidone-iodine with 0.02% chlorhexidine for the control of pain and swelling after mandibular third molar extraction. In this study, 0.02% chlorhexidine was demonstrated to show higher efficacy in pain and edema management following surgical removal.

Chlorhexidine is a cationic antiseptic with a bacteriostatic mechanism of action activity for 12 h.^[24]

Anisuzzaman *et al.* (2013) in their prospective study on 100 subjects following impacted third molar removal evaluated postoperative pain and swelling following irrigation with normal saline and distilled water. Normal saline was demonstrated to have more effectiveness in the management of postoperative pain and swelling as compared to distilled water.^[25]

However, a split-mouth study conducted by Tolstunov (2012) for evaluating the effects of irrigation in comparison with no irrigation during mandibular third molar extraction showed that the absence of irrigation resulted in better clot quality leading to better socket healing. It has been hypothesized that continuous irrigation by normal saline interrupts the coagulation cascade which leads to delayed healing of surgical extraction wounds.^[26]

Chaudhary *et al.* (2012) in their study involving 12 subjects for comparing primary and secondary closure techniques after removal of impacted third molar demonstrated that secondary closure aided in faster postoperative healing.^[27]

Khiavi *et al.* (2010) found that irrigating an extraction socket after third molar surgery with 0.5% bupivacaine hydrochloride provides very effective relief in postoperative pain.^[2]

The current study showed that the use of ozonated water showed statistically significant effects on the incidence of alveolar osteitis and the incidence of pain following mandibular third molar surgery.

Implications for clinical practice

Surgical extraction of the mandibular third molar is a frequently performed procedure in dental practice. Numerous factors affect the overall outcome of these subjects, such as pain, the extent of trismus, incidence of dry socket or alveolar osteitis, and infection. The use of various irrigation solutions has significantly affected the clinical outcome following these surgeries.

The use of ozonated water as an irrigant for surgical procedures has proved to be boon in dentistry. There is a well-documented result of ozone therapy in the field of restorative dentistry, but insufficient evidence regarding the effects of ozonated water and its comparative efficacy with other irrigant solutions in oral surgical procedures is present. More clinical studies with standardized trials are necessary to ensure greater knowledge about the use of ozonated water in oral surgical procedures.^[28,29]

Conclusion

The present study on comparing three irrigating solutions, ozonated water, normal saline, and povidone-iodine, following the extraction of mandibular third molar demonstrated good outcome for ozonated water. Statistically significant effects were seen for alveolar osteitis and pain incidence for ozonated water. Thus, this study provided good evidence that ozonated water

is the best irrigating solution following and intraoperative third molar surgeries.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

References

- Juodzbalys G, Dangela P. Mandibular third molar impaction: Review of literature and a proposal of a classification. *J Oral Maxillofac Res* 2013;4:1-12.
- Khiavi RK, Pomallahverdi M, Pourallahverdi A, Khiani SG, Oskonei SG, Mokhtari H. Pain control following impacted third molar surgery with bupivacaine irrigation of tooth socket: A prospective study. *J Dent Res Dent Clin Dent Prosp* 2010;4:105-10.
- Jadhao VA, Rao A, Hande P, Mahajan M, Raktade PP, Gedam R, *et al.* The efficiency of three irrigating solutions after surgical removal of impacted mandibular third molars. *J Contemp Dent Pract* 2018;19:1147-81.
- Castagnola R, Lajolo C, Minciaccchi I, Getella G, Foti R, Marigo L, *et al.* Efficacy of three different irrigation techniques in the removal of smear layer and organisms debris from root canal microscopic study. *Giornale Italiano di Endodonzia* 2014. doi: 10.1016/gien. 2014.09.001.
- Sabe-Alarab M, Al-Essa H, Jaber F, Saleh H. Role of povidone-iodine (PV-I) in surgical extraction of impacted lower third molars.: Hemostyptic and anti-edema? *Int J Appl Dent Sci* 2019;5:306-9.
- Sayadizadeh M, Shojaeipour R, Aminizadeh M, Horri A, Estabragh SR, Aminizadeh M, *et al.* Comparing a combination of saline and chlorhexidine with saline as root canal irrigation solutions in pulpectomy of the primary molars in 6-9-year-old children: A double-blind clinical trial. *JDMT* 2019;8:174-82.
- Gloria JCR, Douglas-de-Oliveira W, e Silva LDA, Falci SGM, dos Santos CRR. Influence of ozonized water on pain, edema and trismus during impacted third molar surgery: A randomized, triple blind clinical trial. *BMC Oral Health* 2020;20:47-50.
- Gharminia H, Hoppenreys JJM, Xi J, Fennis JP, Maal JJ, Berge SJ, Meyer GJ. Postoperative socket irrigation with drinking tap water reduces the risk of inflammatory complications following surgical removal of third molar: A multicenter randomized trial. *Clin Oral Invest* 2017;21:71-83.
- Goldberg MH, Nemarich AN, Marco WP. Complications after mandibular third molar surgery: A statistical analysis of 500 consecutive procedures in private practice. *JADA*

- 1985;111:277-80.
10. Brunello G, De Biagi M, Gepaldi G, Rodrigues FI, Sivoilella S. An observational cohort study on delayed-onset infections after mandibular third molar extractions. *Int J Dent* 2017. doi: 10.1133/2017/1435348.
 11. Osborn TP, Frederikson G Jr, Small JA, Torgerson JS. A prospective study of complications related to mandibular third molar surgery. *J Oral Maxillofac Surg* 1985;43:767-9.
 12. Patil PH, Gulve MN, Kolhe SJ, Samuel RM, Aher GB. Efficacy of new irrigating solution on smear layer removal in the apical third of root canal: A scanning electron microscopic study. *J Conserv Dent* 2018;21:190-3.
 13. Kashyap N, Upadhyay M, Sharma J, das SJ, Katlam T. Irrigating solutions in Pediatric Dentistry: A big deal In little teeth. *EC Dent Sci* 2017;C8.7:1620-6.
 14. Kanitkar R, Balihallimath L. Comparison of effect of ozonated water with normal saline as an irrigant on post-operative pain, swelling and trismus following the surgical extraction of impacted mandibular third molar. *Paripex-Ind J Res* 2017;6:105-12.
 15. Cherian NM, George AJ, Panackal AS, Sman RR, Issac AV. Postoperative evaluation after surgical removal of mandibular third molar, with or without local administration of injection dexamethasone 8 mg: A comparative study. *Int J Prev Clin Dent Res* 2019;6:35-8.
 16. Cho H, Lynham AJ, Hsu E. Post-operative interventions to reduce inflammatory complications after third molar surgery: Review of current evidence. *Austr Dent J* 2017;62:412-9.
 17. Lone PK, Jamwal R, Lone BA. Comparison of two different irrigating solutions; 3% hydrogen peroxide and 0.12% chlorhexidine in pericoronitis of partially erupted mandibular third molars. *Int J Contemp Med Res* 2016;3:3353-6.
 18. Quadric A, Quadri S, Khan T. Comparative study of post-operative complications in third molar surgery with or without sutures: A prospective study. *Int J Scient Study* 2010;4:168-72.
 19. Suh Y, Patel S, Re K, Gandhi J, Joshi G, Smith NL, Khan SA. Clinical utility of ozone therapy in ental and oral medicine. *Med Gas Res* 2019;9:163-7.
 20. Rathod D, Mulay S. Evaluation of efficacy of Nd: YAG laser, ozonated water, and ultrasonic irrigation with 3% sodium hypochlorite for disinfection of root canal: An *in vivo* study. *Endodontology* 2018;30:135-9.
 21. Srinivasan SR, Amaechi BT. Ozone: A paradigm shift in dental therapy. *J Global Oral Health* 2019;2:68-77.
 22. Ahmedi J, Ahmedi E, Hamiti V. Efficiency of gaseous ozone in reducing the development of dry socket following surgical third molar extraction. *Eur J Dent* 2016;10:381-5.
 23. Khan AR, Abid J. Management of dry socket using ozone gel versus Alvogyl- prospective clinical trial. *Int Dent J student's Res* 2015;3:29-33.
 24. Shah U, Haren P, Hiren P, Byal B, Dewan H. Efficacy of chlorhexidine versus betadine as an irrigating agent during removal of bilateral impacted lower third molars. *Pak Oral Dent J* 2014;34:264-8.
 25. Anisuzzaman MM, Bhuiyan MSR, Ahmed GI, Abdullah MK, Kafi AH, Khan S. The efficacy of normal saline versus distilled water as irrigating solution in surgical removal of mandibular third molar tooth. *Bangladesh Dent Coll J* 2013;4:1-5.
 26. Tolstunov L. Influence of immediate post-extraction socket irrigation on development of alveolar osteitis after mandibular third molar removal: A prospective split-mouth study, preliminary report. *Br Dent J* 2012;213:597-602.
 27. Chaudhary M, Singh M, Singh S, Singh SP, Kaur G. Primary and secondary closure technique following removal of impacted mandibular third molars: A comparative study. *Nat J Maxillofac Surg* 2012;3:10-5.
 28. Suh Y, Patel S, Kaitlyn R, Gandhi J, Joshi G, Smith NL, *et al.* Clinical utility of ozone therapy in dental and oral medicine. *Med Gas Res* 2019;9:163-7.
 29. Malik T, Kaura S, Kakria P. Dental ozone: A boon for dentistry. *Indian J Dent Sci* 2020;12:49-52.