ORIGINAL RESEARCH PAPER

Surgery

"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".

KEY WORDS: Ozone, Irrigant, impacted third molars.

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ABSTRACT

Aims: The objective of this study was to evaluate the effect of ozonated water as an irrigant, on post-operative pain, trismus and swelling following the surgical removal of impacted mandibular third molar as compared with conventional saline.

Settings and Design: 90 Patients reporting to the Department of Oral and Maxillofacial Surgery, KLE V.K. Institute of Dental Sciences, Belgaum, from a period of September 2014 to September 2016, who consented to participate, were selected randomly (envelope method) for this prospective study.

Methods and Material: Ozonated water was used as irrigant in 45 surgical sites taken as study group and in other 45 sites normal saline was used as irrigant, taken as control. Medically compromised patients were not included in the study. Patients were alternatively grouped in 2 groups irrespective of age, sex, difficulty in impaction and their response to various drugs to eliminate bias. The follow up was on post-operative day 3 and day 7.

Statistical analysis used: Paired 't' test, Mann-Whitney U-test, Wilcoxon matched pair test.

Results: The results showed that pain ($p< 0.001$), trismus($p<0.001$) and swelling ($p1<0.001$, $p2<0.001$, $p3<0.001$) were far less in patients where ozonated water was used as compared to normal saline for day3 as well as for day7 they showed pain($p=0.002$), trismus($p=0.026$), swelling ($p1=0.001$, $p2<0.001$, $p3=0.001$).Thus we feel that ozonated water is a superior irrigant.

Introduction:

Third molar impaction surgery is a common dental procedure that requires a sound understanding of surgical principles. Often the removal of impacted lower third molar involves trauma to the soft and hard tissues due to retraction of a mucoperiosteal flap and the removal of bone, which is frequently followed by edema of varying degree, pain and at times trismus.

Overtime, standards have been established as benchmarks for treatment. Those standards are the same, such as timing for surgery, flap design, instrumentation, extent of bone removal, irrigant used, sectioning methods and suturing.

Over the year's different types of irrigant solutions like normal saline, ringers lactate, 1% povidine iodine, etc. have been used for the removal of impacted lower third molar to prevent irreversible bone necrosis caused by the heat generated.

Saline is the most commonly used irrigant not just in surgeries but even for cleaning of wounds. It has a good cleansing effect on the tissue and is isotonic. It has minimal toxicity on tissue and is used in third molar surgeries commonly to produce a cooling effect on the heat produced during bone cutting. Although it does not contribute directly to the healing process postoperatively, its cleansing action reduces the chances of postoperative infection.

Studies have shown Ozone has a positive influence on bone metabolism and reparative process of the bone and even decreases the microbial load at the site. It is noted that the influence of ozone leads to a higher expression of cytokines that are important for wound healing, especially TGF-β1, an important substance for regulation and coordination in the initial wound healing phase.

The impact of ozone on epithelial wound healing in oral cavity was observed by Filippi. It was found that ozone-water speeds up the angiogenesis, healing rate in the oral mucosa, even decreasing the bleeding in the surgical area thereby, influencing the post-operative healing, pain and subsequent swelling and trismus after surgical procedure. Ozone therapy has great potential in the treatment of various conditions encountered in dental practice.

In this study we assessed the effect of ozonated water as an irrigant in 3rd molar surgery and compared its outcomes with those of normal saline.

Aim of the study: To evaluate the effect of ozonated water on post-operative pain, trismus and swelling following the surgical removal of impacted mandibular third molar.

Objective of the study:

To assess the response to the use of ozonated water and normal saline as irrigant following the surgical removal of impacted mandibular third molar.

To compare the results of both techniques in post-operative period with regards to pain, swelling and trismus.

Subjects and Methods: The study was a prospective, in-vivo, clinical study with patients undergoing surgical removal of mandibular third molars. 90 Patients reporting to the Department of Oral and Maxillofacial Surgery, KLE V.K. Institute of Dental Sciences, Belgaum, who gave consent to participate,were selected for the study. Ozonated water was used as irrigant in 45 surgical sites taken as study groupand in other 45 sites normal saline was used as irrigant taken as control.

Materials:

Ozonated water
Saline water

Inclusion criteria:

- Patients between the Age group of 16 - 45 years.
- Patients requiring surgical removal of impacted third molars for either prophylactic or therapeutic reasons
- Patients with no contradictions to the drugs or anesthetic used in the surgical protocol.

Exclusion criteria:

- Medically compromised patients
- Patient unwilling to participate in study
- Patient allergic to any medications.

Methodology:

The study comprised 90 randomly selected patients (envelope method) with mandibular impacted third molar, diagnosed by established clinical and radiographic parameters and were alternatively grouped in 2 groups irrespective of age, sex, difficulty in impaction and their response to various drugs to eliminate bias. The position of impacted tooth was assessed using PEDERSON'S DIFFICULTY INDEX and tooth with a score of 5 or more were included in the study. All the patients were screened for inclusion and exclusion criteria. The patients of both groups were given same antibiotics and analgesics post-operatively:

Antibiotics- Amoxicillin 500mg
Analgesics- Diclofenac Sodium 50mg
The patients were grouped into:

Study Group-Sites where Ozonated water was used as an irrigant solution for surgical removal of mandibular 3rdmolar.

Control Group- Sites where conventional method i.e. normal saline was used as an irrigant for surgical removal of mandibular 3rdmolar.

Pre-operative Assessment

- Hb
- BT
- CT
- RBS
- OPG or IOPA

Surgical Protocol: Assigned patients underwent surgical procedure in the oral surgery unit by an experienced surgeon. Patients were alternatively grouped and in study group Ozonated water was used as irrigant whereas in control group normal saline was used as irrigant.Regional anaesthesia was applied by blocking the inferior alveolar nerve, lingual nerve, long buccal nerve with 2% lignocaine plus adrenaline, 1: 80,000.A full thickness incision was made to prepare a trapezoidal flap.Flap was raised and ostectomy and odontotomy performed using bur on straight hand piece under abundant irrigation with the respective irrigant. After completing the extraction, curettage of the socket was performed.The flap was repositioned and sutured with 3-0 silk sutures.All patients received post-extraction instructions. Patients of both groups received same antibiotics and analgesics.Patients were recalled on 3rd and 7thday for follow-up and evaluated for pain, trismus and swelling. Sutures were removed after 7days.

Ozone therapy: The Ozonated water was produced using an ozone generator (SY-G009L; OEM Collecting industrial co; Delhi) concentration of ozone in water 11-12 μg/ml. This was achieved by passing the ozone gas produced by the ozone generator through distilled water for 15 to 20minutes. Half a quart of ozonated water with required concentration of ozone was produced in a time span of 20 minutes.

Evaluation Criteria:

- Patients were provided with a STANDARD VISUAL ANALOG SCALE (VAS) data sheet with a score of 0-10. A score of 0-10 indicates no pain to extremely severe pain.
- Patients were asked to record and score on sheet, pain for next consecutive 7 days at the same time of the day.
- Trismus and swelling was checked on the follow up day, i.e. 3rdand 7th post-operative day.
- Trismus was checked by measuring the inter-incisal distance.
- Swelling was measured by means of validated landmarks and evaluating the difference between the preoperative and on follow up days (TRAGUS-CORNER OF THE MOUTH DISTANCE, TRAGUS- POGONION, LATERAL CANTHUS – ANGLE OF MANDIBLE)

This study was to evaluate:

1. Pain score
2. Swelling
3. Trismus

By the use of ozonated water in comparison with conventional normal saline as an irrigant solution.

Follow up: Clinical follow up of 1 week post operatively

Results: The distribution of male and female in the two groups was 23 (51.11%) in both groups and 22(48.89%) in both groups. The sex distribution in both groups was same to eliminate any variation in results due to different gender.(table 1)

PAIN: This variable was measured using the Visual Analog Scale(VAS). The pre-operative reading was taken as baseline. The pain was measured on post-operative day 3 and on post-operative day 7. The difference between the readings on post-operative day 3 and baseline readings was considered as the pain score for post-operative day 3 for both groups. Similarly, the difference between the readings on post-operative day 7 and the baseline readings was considered the score for post-operative day 7 for both groups. The comparison between the scores showed that they were lesser for ozone group indicating that patients irrigated with ozonated water experienced lesser post-operative pain. The p value for post-operative day3 was <0.001 and that for post-operative day 7 was 0.002 indicating the difference to be statistically significant. (table 4).

TRISMUS: This variable was measured by measuring the interincisal distance. The pre-operative measurement was taken as baseline. The measurements were also taken on post-operative day 3 and on post-operative day 7. The difference between the measurements on post-operative day 3 and baseline measurements was considered as the trismus score for post-operative day 3 for both groups. Similarly, the difference between the measurements on post-operative day 7 and the baseline measurements were considered the score for post-operative day 7 for both groups. The comparison between the scores showed that they were greater for ozone group indicating that patients irrigated with ozonated water experienced lesser post-operative trismus. The p value for post-operative day3 was <0.001 and that for post-operative day 7 was 0.026 indicating the difference to be statistically significant. (table 5).

SWELLING: The swelling being a three-dimensional variable was measured by taking into account the following reference points: -
Swelling A- distance from angle of mandible to corner of eye.
Swelling B- distance from corner of mouth to Tragus.
Swelling C- chin from Pogonion to Tragus.

SWELLING A: This variable was measured by measuring the distance from the angle of mandible to the corner of eye. The pre-operative measurement was taken as baseline. The measurements were also taken on post-operative day 3 and on post-operative day 7. The difference between the measurements on post-operative day 3 and baseline measurements was considered as the swelling score in this region for post-operative day 3 for both groups. Similarly, the difference between the measurements on post-operative day 7 and the baseline measurements were considered the swelling score in this region for post-operative day 7 for both groups. The comparison between the scores showed that they were lesser for ozone group indicating that patients irrigated with ozonated water experienced reduced post-operative swelling in the region from the angle of mouth to corner of eye. The p value for post-operative day3 was <0.001 and that for post-operative day 7 was 0.001 indicating the difference to be statistically significant. (table 6).

SWELLING B: This variable was measured by measuring the distance from the corner of mouth to the tragus. The pre-operative measurement was taken as baseline. The measurements were also taken on post-operative day 3 and on post-operative day 7. The difference between the measurements on post-operative day 3 and baseline measurements was considered as the swelling score in this region for post-operative day 3 for both groups. Similarly, the difference between the measurements on post-operative day 7 and the baseline measurements were considered the swelling score in this region for post-operative day 7 for both groups. The comparison between the scores showed that they were lesser for ozone group indicating that patients irrigated with ozonated water experienced reduced post-operative swelling in the region from the corner of mouth to the tragus. The p value for post-operative day3 was <0.001 and that for post-operative day 7 was <0.001 indicating the difference to be statistically significant. (table7).

SWELLING C: This variable was measured by measuring the distance from the Pogonion to the tragus. The pre-operative measurement was taken as baseline. The measurements were also taken on post-operative day 3 and on post-operative day 7. The difference between the measurements on post-operative day 3 and baseline measurements was considered as the swelling score in this region for post-operative day 3 for both groups. Similarly, the difference between the measurements on post-operative day 7 and the baseline measurements were considered the swelling score in this region for post-operative day 7 for both groups. The comparison between the scores showed that they were lesser for ozone group indicating that patients irrigated with ozonated water experienced reduced post-operative swelling in the region from the Pogonion to the tragus. The p value for post-operative day3 was <0.001 and that for post-operative day 7 was 0.001 indicating the difference to be statistically significant. (table 8)

DISCUSSION:

Ozone also known as triatomic oxygen and trioxygen is a naturally occurring compound consisting of three oxygen atoms [6]. It is a naturally found gas in the upper atmosphere which filters potentially damaging ultraviolet light from reaching the Earth's surface [6]. Its molecular weight is 47,98g/mol [5]. Ozone is thermodynamically highly unstable compound, dependent on system conditions like temperature, pressure and it decomposes to pure oxygen with a short half-life [5].

In 1840, Shonbein named the substance, which gave odor ozone, from the Greek word "ozein"- to smell. Ozone has a long history of research and clinical applications [6]. Ozone therapy was accepted as an alternative medicine in the USA from 1880 and has been used for over 130 years in twenty countries throughout the world [7]. During World War I, ozone gas was used for treating gaseous post-traumatic gangrene, infected wounds, mustard gas burns and fistulas in German soldiers [6].

E.A. Fisch was the first dentist to use ozone in his practice in the 1930s. He used ozonated water during dental surgeries to aid in disinfection and wound healing. Today ozone therapy is used extensively in Europe in both dentistry and medicine. [7]

Ozone therapy can be defined as a versatile bio-oxidative therapy in which oxygen/ozone is administered via gas or dissolved in water or oil base to obtain therapeutic benefits. [7] Ozone therapy is proving to be a new therapeutic modality with great benefits for patients. The potent antimicrobial power of ozone, along with its capacity to stimulate the circulatory system and modulate the immune response, makes it a good therapeutic agent.

Previous studies have shown significant improvement in the use of therapeutic ozone on post-operative pain trismus and swelling as compared to normal saline [2].

In a placebo-controlled, randomized double blind study, the healing process of three identical wounds of the oral mucosa in 30 patients which were examined planimetrically, immunohistochemically and micromorphologically, one third of the wounds were irrigated without pressure every day using ozonized water (concentration 11-12 µg ozone/ml water), the next third using water, and the last third remained without any treatment. The application of ozonized water clearly showed an acceleration of wound healing within the first 48 hours, resulting in earlier epithelial wound closure after 7 days [1].

Wound hypoxia is necessary for leukocyte adherence, neovascularization, collagen formation, and bone formation; however, chronic wound hypoxia blunts polymorphonuclear and antibacterial activity, cellular energy metabolism, collagen synthesis, and neovascularization.

The role of oxygen in wound healing is many-fold as discussed by Craig L Broussard in his review of literature on hyperbaric oxygen and wound healing. He said that disruption of microcirculation is the first event causing to wound hypoxia which remains in chronic wounds. Cellular energy metabolism is dependent on oxygen, specifically the production of adenosine triphosphate (ATP). Even though cellular energy metabolism can exist in an anaerobic state, hypoxia leads to acidosis. Anaerobic metabolism requires more utilization of glucose to provide the same level of energy as ATP resulting in inadequate ATP to maintain cellular function in the wound. Platelets exposed to fibrin release cytokines that serve as chemotactants, recruiting fibroblasts and macrophages to the site of injury. Oxygen consumption is increased as leukocytes migrate to the wounded area, adding to the already hypoxic state of the wound. An oxygen environment of 40 mmHg is needed to sustain fibroblast activity that leads to collagen deposition in a healing wound. Collagen synthesis is dependent on proline and lysine, which hydroxylate oxygen to produce collagen. The ability of macrophages to phagocytize bacteria is greatly reduced in hypoxic tissue because hypoxic tissue decreases the oxidative killing of bacteria by the macrophages. Macrophages also produce cytokines that promote angiogenesis, specifically vascular endothelial growth factor. Epithelial growth factor is also oxygen dependent with decreased epithelialization in a hypoxic environment. Oxygen in wound healing, as well as the effects of hyperbaric oxygenation promote wound healing. Also the use of hyperbaric oxygenation is a viable adjunct to faster healing. [3].

Bysan A et al. suggested that application of ozone gas for a period of 10 to 20 seconds results in

99% of the microorganisms being destroyed [5]. Ozonated water is very much effective in killing gram positive, gram negative oral microorganisms. Ozone significantly reduces the oral microbial load. Significant reduction in bacterial count in the sites irrigated with ozonized water has been reported along with antiseptic properties of ozonated water [4]. Ozone gas has a high oxidation potential and is effective against bacteria, viruses, fungi, and protozoa. It is highly valued for various effects, such as antimicrobial, analgesic and immune-stimulating on biological systems. These mechanisms of action are supported with a lot of case reports and scientific studies which allow using it in different fields of medicine [5]. Application of ozone for a period of 10 seconds was also capable of reducing the number of Streptococcus mutans and Streptococcus sobrinus in vitro. [6]

The antimicrobial effect of ozone is studied the most. The main reason for cell death is the local damage of cytoplasmic membrane due to ozonolysis of dual bonds, and also ozone-induced modification of intracellular contents (oxidation of proteins, loss of organel functions) because of secondary oxidants effects. This action is non-specific and selective to microbial cells; it does not damage human body cells because of their major antioxidative ability. Ozone is very efficient in antibiotics resistant strains. Its antimicrobial activity increases in a liquid environment of acidic pH. In viral infections the mechanism of ozone action lies in the intolerance of infected cells to peroxides and change of activity of reverse transcriptase, which takes part in synthesis of viral proteins. [6]

In a clinical survey Stübinger et al. described the local effectiveness of ozone on infected intraoral wounds following high-dose radiotherapy. Ozone has a therapeutic effect that facilitates wound healing and improves the supply of blood. [5]

Guerra et al.17 compared the use of ozonated oil in an experimental group to a control group in which Alvogil and antibiotic therapy was used in the treatment of alveolitis. Patients treated with Oleozon healed more quickly without the need for systemic medication when compared to the control group. This finding suggests ozonated oil might be effective in the treatment of alveolitis [5].

Irrigation of a surgical site with ozonated water speeds healing and helps remineralize the bone. Thus, ozonated water would be helpful for extractions, cavitational surgery and implant surgery. [5]

The comparison with saline, shows that the enhancement of healing is due to the ozone-oxygen mixture and not due to the effect of irrigation or saline alone. The microbiological properties should be noted, these being clearly more accentuated in solution than in a dry ozone-air mixture. The wound receives more oxygen when ozonised water is applied. The modification of wound healing under application of oxygen is well known [1].

Studies have shown Ozone has a positive influence on bone metabolism and reparative process of the bone and even decreases the microbial load at the site. It is noted that the influence of ozone leads to a higher expression of cytokines that are important for wound healing, especially TGF- 1, an important substance for regulation and coordination in the initial wound healing phase [5].

Ozone causes the synthesis of biologically active substances such as interleukins, leukotrienes and prostaglandins. Ozone influences cellular and humoral immune system; it stimulates proliferation of immunocompetent cells and synthesis of immunoglobulins. It also activates function of macrophages and increases sensitivity

of micro-organisms to phagocytosis. Ozone brings about the rise of pO2 in tissues and improves transportation of oxygen in blood, which results in change of cellular metabolism – activation of aerobic processes (glycolysis, Krebs cycle, B-oxidation of fatty acids) and use of energetic resources. It also prevents formation of erythrocytes aggregates and increases their contact surface for oxygen transportation. Ozone causes secretion of vasodilators such as NO, which are responsible for dilatation of arterioles and venules. It also activates mechanisms of protein synthesis, increase number of ribosomes and mitochondria in cells. These changes on the cellular level explain elevation of functional activity and regeneration potential of tissues and organs. [6]

It was found that ozone-water speeds up the angiogenesis, healing rate in the oral mucosa, even decreasing the bleeding in the surgical area thereby, influencing the post-operative healing, pain and subsequent swelling and trismus after surgical procedure. Ozonised water has found its place in the disinfection of dental units; it may be kept free or practically free of germs over a long period [1].

Ozone therapy presents a potential for an atraumatic, biologically-based treatment for conditions encountered in dental practice. The therapy has been more beneficial than present conventional therapeutic modalities that follow a minimally invasive and conservative application to dental treatment. Further research is needed to standardize indications and treatment procedures of ozone therapy. [5]

Acknowledgement-
We would, like to acknowledge the support of the Department of Oral and maxillofacial surgery at K.L.E.'s Vishwanath Katti Institute Of Dental Sciences, Belagavi while conducting the study and for providing with full co-operation in patient management during the period of the study from September 2014 to September 2016.

Table 1: Distribution of male and females in two groups (I, II)

Sex	Group I	%	Group II	%	Total
Male	23	51.11	23	51.11	46
Female	22	48.89	22	48.89	44
Total	45	100	45	100	90

Table 2: Distribution of male and females in two groups (I, II)

Sex	Group I		Group II		Total	
	Mean	SD	Mean	SD	Mean	SD
Male	28.23	7.57	28.43	7.46	28.33	7.43
Female	27.95	7.48	27.95	7.48	27.95	7.39
Total	28.09	7.44	28.20	7.39	28.15	7.37

Table 3: Normality of all variables at baseline by Kolmogorov-Smirnov Test

Variables	Group I		Group II	
	Z-value	p-value	Z-value	p-value
VAS	.178	.001	.175	.001
Trismus	.300	.000	.281	.000
Swelling 1	.400	.000	.338	.000
Swelling 2	.305	.000	.251	.000
Swelling 3	.332	.000	.293	.000

*p>0.05 indicates follows normal distribution.

Table 4: Comparison of two groups (I, II) with respect to VAS scores at baseline, day 3 and day 7 by Mann-Whitney U test

Groups	Baseline		Day 3		Day 7		Changes from					
							BL-Day 3		BL-Day 7		Day 3-Day 7	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Group I	1.67	1.35	1.98	0.84	0.69	0.60	-0.31	1.36	0.98	1.27	1.29	073
Group II	1.73	1.20	5.11	1.54	1.62	0.83	-3.38	1.70	0.11	1.39	3.49	1.52
% of change in Group I							-15.98% #, <0.001*		55.78% #, <0.001*		65.37% #, 0.700	
% of change in Group II							-218.03 % #, <0.001*		2.76% #, <0.001*		66.73% # <0.001*	
Z -value	-0.332		-7.816		-5.273		-6.952		-3.031		-6.91	
P -value	0.74		<0.001*		<0.001*		<0.001*		0.002*		<0.001*	

*p<0.05, # applied Wilcoxon matched pairs test

Table 5: Comparison of two groups (I, II) with respect to Trismus scores at baseline, day 3 and day 7 by Mann-Whitney U test

Groups	Baseline		Day 3		Day 7		Changes from					
							BL-Day 3		BL-Day 7		Day 3-Day 7	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Group I	3.9	0.45	3.6	0.42	3.96	0.30	0.30	0.46	-0.06	0.43	-0.36	0.41
Group II	3.87	0.46	2.79	0.64	3.71	0.35	1.08	0.71	0.156	0.50	-0.92	0.65
% of change in Group I							6.97% #, <0.001*		-2.54% #, <0.001*		-11.04% #, 0.002*	
% of change in Group II							27.15% #, <0.001*		2.92% #, <0.001*		-42.52% #, <0.001*	
Z -value	-0.511		-5.872		-3.643		-5.354		-2.221		-4.465	
P -value	0.609		<0.001*		<0.001*		<0.001*		0.026*		<0.001*	

*p<0.05, # applied Wilcoxon matched pairs test

Table 6: Comparison of two groups (I, II) with respect to swelling A scores at baseline, day 3 and day 7 by Mann Whitney U test

Groups	Baseline		Day 3		Day 7		Changes from					
							BL-Day 3		BL-Day 7		Day 3-Day 7	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Group I	10.37	0.59	11.13	0.92	10.43	0.56	-0.77	0.77	-0.07	-0.58	0.70	0.84
Group II	10.47	0.66	13.11	1.47	11.09	0.79	-2.64	1.52	-0.62	0.98	2.02	1.37
% of change in Group I							-6.51% #, <0.001*		-0.80% #, <0.001*		5.84% #, <0.001*	
% of change in Group II							-19.20% #, <0.001*		-6.30% #, <0.001*		14.58% #, <0.001*	
Z-value	-0.848		-6.070		-4.005		-5.930		-3.182		-5.052	
P-value	0.397		<0.001*		<0.001*		<0.001*		0.001*		<0.001	

*p<0.05, # applied Wilcoxon matched pairs test

Table7: Comparison of two groups (I, II) with respect to swelling B scores at baseline, day 3 and day 7 by Mann Whitney U test

Groups	Baseline		Day 3		Day 7		Changes from					
							BL-Day 3		BL-Day 7		Day 3-Day 7	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Group I	10.56	0.75	11.49	0.84	10.47	0.61	-0.93	0.79	0.09	0.56	1.02	0.85
Group II	10.84	0.98	13.19	1.03	11.38	0.78	-2.34	1.37	-0.53	1.04	1.81	1.17
% of change in Group I							-9.07% #, <0.001*		0.66% #, <0.001*		8.55% #, <0.001*	
% of change in Group II							-22.46% #, <0.001*		-5.50% #, <0.001*		13.30% #, <0.001*	
Z-value	-1/371		-6.510		-5.229		-5.145		-3.814		-3.329	
P-value	0.170		<0.001*		<0.001*		<0.001*		<0.001*		0.001*	

*p<0.05, # applied Wilcoxon matched pairs test

Table 8: Comparison of two groups (I, II) with respect to swelling C scores at baseline, day 3 and day 7 by Mann-Whitney U test

Groups	Baseline		Day 3		Day 7		Changes from					
							BL-Day 3		BL-Day 7		Day 3-Day 7	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Group I	12.27	0.86	13.38	1.07	12.38	0.72	-1.11	0.91	-0.11	0.48	1.0	0.80
Group II	12.56	1.10	16.67	1.49	13.20	0.79	-4.11	1.70	-0.64	1.09	3.47	1.44
% of change in Group I							-9.24% #, <0.001*		-1.04% #, <0.001*		7.17% #, <0.001*	
% of change in Group II							-33.52% #, <0.001*		-5.68% #, <0.001*		20.33% #, <0.001*	
Z-value	-1.20		-7.67		-4.50		-7.25		-3.38		-7.32	
P-value	0.23		<0.001*		<0.001*		<0.001*		0.001*		<0.001*	

*p<0.05, # applied Wilcoxon matched pairs test.

Figure 1: Comparison of two groups (I, II) with respect to VAS scores at baseline, day 3 and day 7

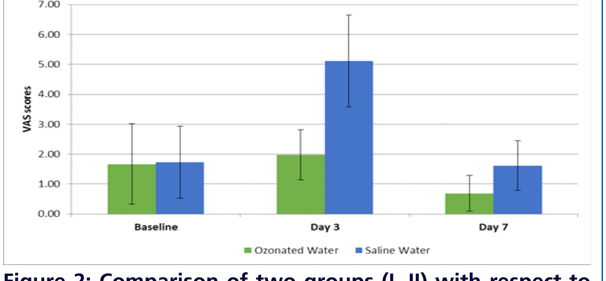


Figure 2: Comparison of two groups (I, II) with respect to Trismus scores at baseline, day 3 and day 7

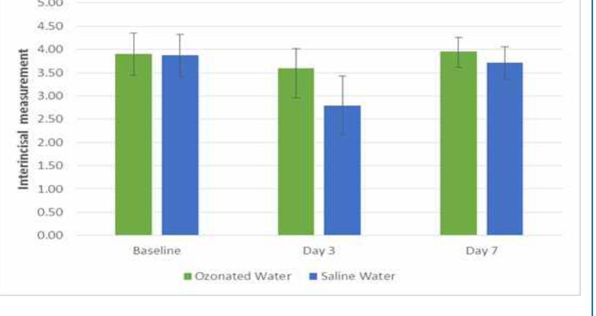


Figure 3: Comparison of two groups (I, II) with respect to swelling A scores at baseline, day 3 and day 7

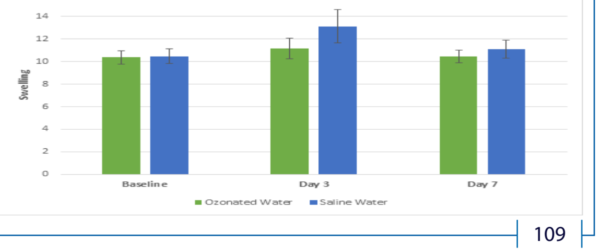


Figure 4: Comparison of two groups (I, II) with respect to swelling B scores at baseline, day 3 and day 7

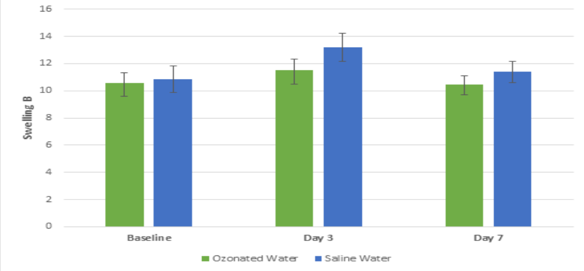
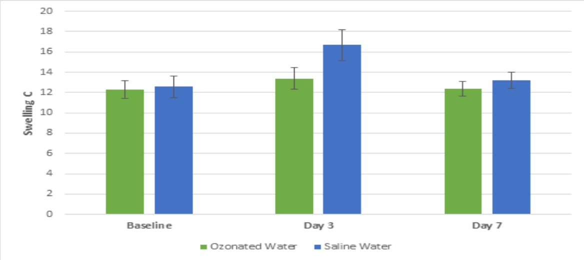


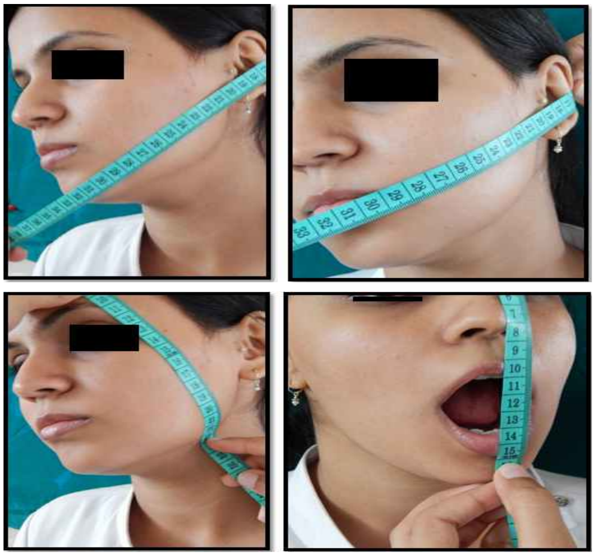
Figure 5: Comparison of two groups (I, II) with respect to swelling C scores at baseline, day 3 and day 7



PROFILE PICTURES OF PATIENT IN GROUP OZONE

PRE-OPERATIVE:

POST-OPERATIVE DAY 3:



POST-OPERATIVE DAY7:

PROFILE PICTURES OF PATIENT IN SALINE GROUP

PRE-OPERATIVE:

POST-OPERATIVE DAY3:

POST-OPERATIVE DAY7:

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