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Research Article

Effect of Ozone on Wound Healing After Surgical Removal of Impacted Mandibular Third Molar

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Abstract

The current clinical study was conducted in an attempt to demonstrate the effect of ozone on the healing process after surgical removal of mandibular third molar. Twenty healthy patients subjected to removal of bilaterally impacted third molar nearly the same classification and surgical difficulty evaluated by Pederson and parant scale. Ozone generator device used to deliver ozone before and after the surgery only to left side (study group) and compared to the right side which not subjected to ozone (control group). The healing, pain, edema and bacterial count studied and analyzed clinically, microbiologically and radiographically. The results of this study revealed Significant increase in wound healing after surgery and bone density after 3 months in the side of ozone therapy, Significant decrease in pain severity and percentage of facial edema in the ozone group after surgery and significant antibacterial effect.

Keywords: *Ozone; Ozone Therapy; Ozone Generator Device; Impacted Mandibular Third Molar; Healing; Pederson Classification; Parant Classification; Third Molar Surgery*

Introduction

Surgical removal of impacted third molars in the lower jaw is one of the most common dento-alveolar procedures. The impacted third molars can be the cause of many symptoms, such as : local or general head neuralgias, acute inflammation of surrounding soft tissue (pericoronitis) and resorption of the root of the neighbor tooth [1]. Postoperative period of a wound is often accompanied with discomfort, pain, and swelling. Postoperative difficulties are mainly related in the healing of the surgical wound [2]. Ozone (O3) is a gas best known for its protective role in the earth's ecological harmony, that is present in small amounts in atmospheric air. Ozone molecules are composed of three oxygen atoms and present naturally in the upper layer of atmosphere in abundance as long as sun is shining. '" It protects living organisms by surrounding the earth at altitudes of 50,000 to 100,000 feet from the ultra-violet rays [3]. Among oxidant agents, it is the third strongest ($E° = +2.076$ V), after fluorine and persulphate [4]. Owing to the ability to eliminate 98% of the bacteria, viruses, and fungi at the place of usage, ozone therapy lowers the possibility of the emergence of postoperative infections and pain and speeds up wound healing [5].

Materials and Method

Twenty adult patients were selected their age ranged between 20 and 30 years old requiring surgical removal of bilaterally mandibular third molar with nearly the same classification and surgical difficulty. Preoperatively Lower night guard is fabricated to use it as tracing reference of bone density in postoperative X-rays and Facial measurement recorded by measuring the horizontal distance between the corner of mouth and tragus of ear, and vertical distance between canthus of eye and the angle of mandible. Pederson scale is used for preoperative evaluation of surgical difficulty and compared with parant scale which evaluate surgical difficulty postoperatively.

Ozone delivery achieved by using Ozone generator Device by corona discharge. Ozone therapy is applied preoperatively only in the left side by using # 3 probe "flat probe with output power at level 6 - 12 for 1 minute, then post operatively only in the left side by using # 4 probe "Conical probe" with output power at level 8 - 12 for 1 minute.

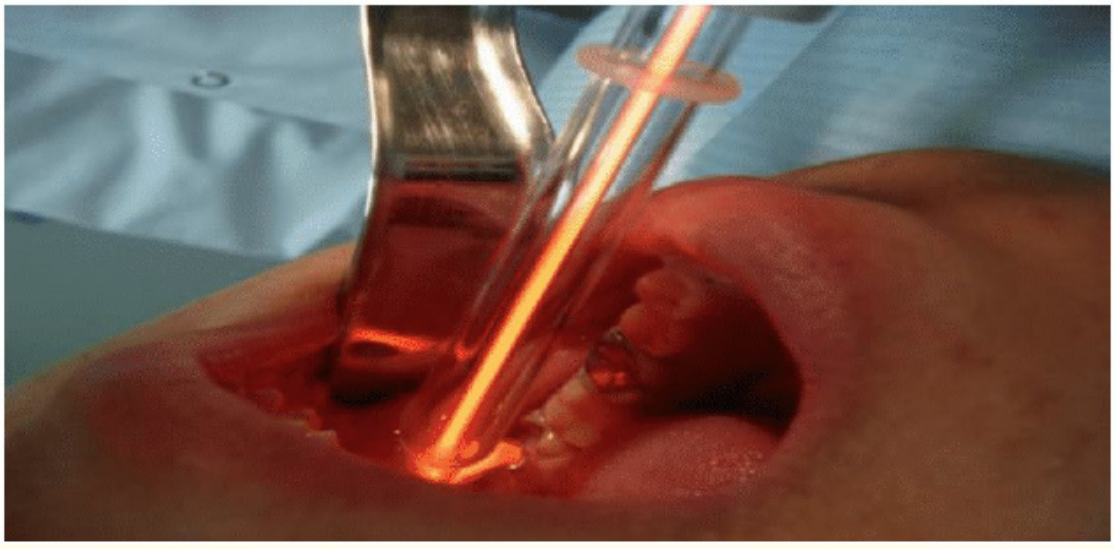

Figure 1: *Clinical photograph showing presurgical exposure to ozone.*

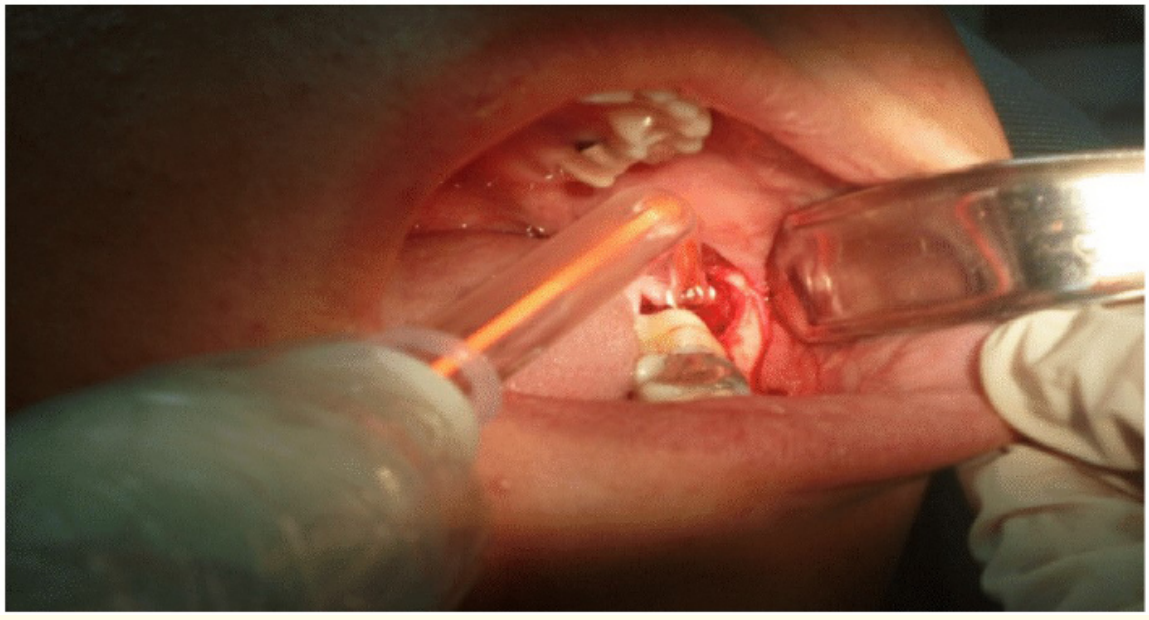

Figure 2: *Clinical photograph of postoperative exposure to ozone.*

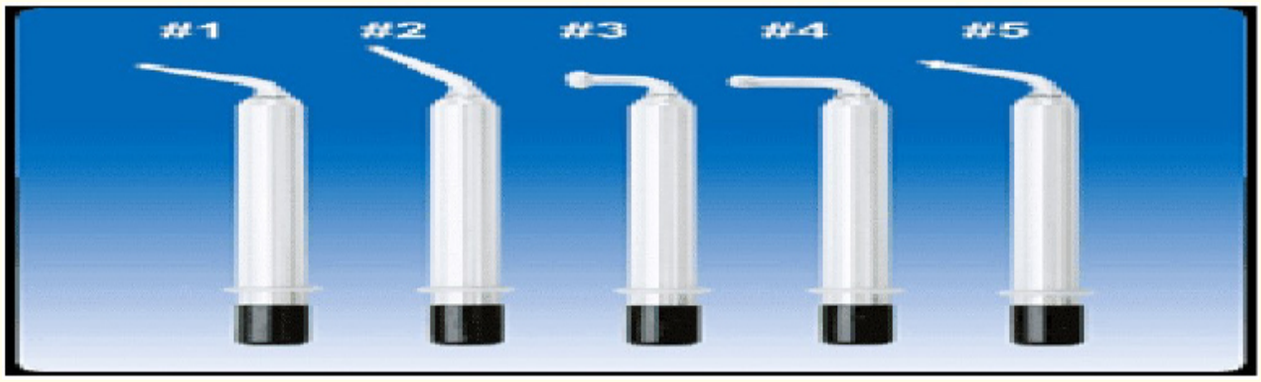

Figure 3: *Different tips of ozone generator device.*
#1: 10° pointed probe: Gingivitis therapy
#2: 50° pointed probe: Gingivitis therapy
#3: Flat probe: Skin and mucous membrane therapy
#4: Conical probe: Alveolar therapy after tooth extraction
#5: 10° pointed probe with conical plastic: Root canal therapy

Postoperative assessment

Microbial assessment: The specimens pre-ozone and post-ozone exposure are delivered to the microbiology lab within 1 hour which incubated for one day in blood agar diluted to 1:10000 which is non-selective highly nutritive and indicator medium for subculture and counting which composed of nutrient broth oxide with 5% sterile blood.

Clinical assessment: Each patient returned for postoperative assessment after 1, 7, 14, 28 days and after 3 months. Clinical assessment of the healing process was done point for time of wound closure as rapid(within one week), normal (within two weeks), slow (within 3 weeks).

Also the following data of other postoperative complications were collected:

Pain: Wong baker faces pain scale and the visual analogue pain scale is used to compare pain after the surgery in both sides. The pain scale is an easy method for pain evaluation by the patient on days: one, seven and fourteen postoperatively indicating the degree of pain the patient experienced using simple digits and simple faces expressions.

Edema: Horizontal and vertical facial measurements were taken, the first measurement was taken just before surgery and two measurement post operatively after one and 7 days. Facial measurements were calculated from these data as follows:

$$\text{Facial measurement} = \frac{\text{horizontal measurement} + \text{vertical measurement}}{2}$$

The percentage of the facial edema was calculated according to the following formula:

$$\text{Percentage of facial edema} = \frac{\text{Postoper - Preoper. Measurements}}{\text{Preoper. Measurement}} \times 100$$

Radiographic assessment: Indirect digital panoramic radiographs were used to evaluate the bone density of the socket previously occupied by the impaction recording the progress of the healing process. It is taken immediately postoperatively (where there is no bone laid yet in the alveolus), and after 12 weeks.

All panoramic radiographs were taken using the same machine and the imaging technique is standardized according to the manufacturer's instruction specifications.

All films were processed automatically under the same conditions, so that standardization is obtained also during film processing.

Results

Healing: Ozone group showed statistically significantly higher prevalence of rapid healing than control group.

Group	Ozone		Control		P-value
Healing	n	%	N	%	
Slow	0	0	4	20	NC
Normal	6	30	12	60	0.845
Rapid	14	70	4	20	0.036*

Figure 2: *The frequencies (n), distributions and results of McNemar's test for the comparison between healing in the two groups.*
**: Significant at P ≤ 0.05, Not computed because there are no cases in Ozone group*

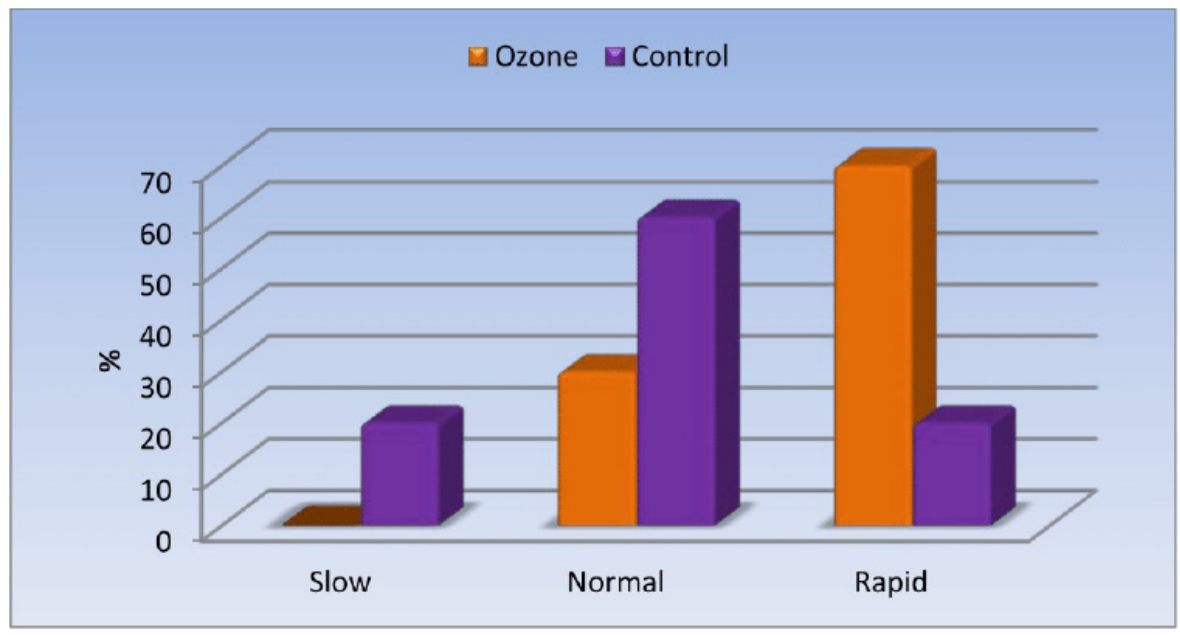

Figure 4: *Prevalence of healing in the two groups.*

Visual Analogue Scale for pain (VAS score): After 1 day, Ozone group showed statistically significantly lower mean VAS than Control group.

Facial edema %: After 1 day as well as 7 days, Ozone group showed statistically significantly lower mean facial edema % than Control group.

Bone density: Immediately post-operative, there was no statistically significant difference between the two groups. After 3 months, Ozone group showed statistically significantly higher mean bone density than Control group.

Bacterial counts (CFU): In Ozone group, there was a statistically significant decrease in mean CFU post-Ozone.

Discussion

In this study we found that there was increase in wound healing clinically on the ozone group (left side) more than control side(right side), this may be attributed to the ozone related effects: stimulation of blood flow and activation of osteoblasts and osteosynthesis, decrease in osteoclastic activity and anti-inflammatory action. All of which are factors that stimulate healing of wounds. This agreed with filippi results who concluded that ozonized water can accelerate the healing rate of the oral mucosa [6]. After the statistical analysis of data of the present study revealed that after 1, 7 days, there was significant decrease in cases with moderate and severe pain and increases in cases with no pain in side of the ozone therapy than the other side, perhaps this may be attributed to the anti-inflammatory effect of the ozone by activation of the enzymatic antioxidants, activation of superoxide dismutase (SOD), removal of the superoxide radicals which are responsible for generation of reactive oxygen species (ROS) and lipid oxidation products (LOPs) responsible for: a) Possible inactivation and inhibition of the release of proteolytic enzymes and proinflammatory cytokines, b) An increased release of interleukin one (IL-I) soluble receptor or of other soluble receptors and antagonists able to neutralize proinflammatory cytokines such as IL-1, IL-8, IL-12, IL-15 and tumor necrosis factors (TNFs), c) Conversely the release of immunosuppressive cytokines, such as TGF-B1 and IL-10 may inhibit inflammation, d) Release of bradykinin and synthesis of inflammatory prostaglandins (PCs) is probably inhibited, with reabsorption of edema and pain relief. These results seems to agree with Akiyo M. who reported decrease in pain and acceleration of healing after the use of ozonated water to the surgical site of impaction removal for a minimum of 5 days after the surgery [1]. We revealed in this study that the side of ozone therapy through all the periods showed significantly lower mean percentage of facial edema than the other side, it attributed this due to ozone reacts with biomolecules (antioxidants, PUFA, Proteins), generates ROS and LOPs responsible for; a) Release of Bradykinin and synthesis of inflammatory Prostaglandins may be inhibited with reabsorption of edema and pain relief. b) The release of immunosuppressive cytokines such as TGF-β1 and IL-10 may inhibit inflammation. c) An increased release of Interleukin 1 soluble receptor or of other soluble receptors and antagonists able to neutralize proinflammatory cytokines such as Interleukin- 1, 8, 12, 15 and TNF. d) Possible inactivation and inhibition of the release of proteolytic enzymes and pro-inflammatory cytokines. We also found that there is decrease in dry socket and alveolar osteitis with no need for systemic antibiotics, this supported by D'mello, who concluded that ozone therapy applied through topical application has a good curative effect on infection caused by bacteria and partial effect on viruses [7]. He concluded that ozone therapy stimulates production of immunoglobulins in the blood, increase resistance of body to microbes, improves oxygen transportation mechanism of the blood. These properties of ozone are similar to those of antibiotics, without adverse effect or resistance development against ozone [8]. Also Yissel Maurin G. use oleozon in treatment and prevention of dental alveolitis [9]. As for the radiographic assessment, digora software system were used to evaluate the bone density of the socket previously occupied by the impaction recording the progress of the healing process. It is taken immediately postoperatively and after 12 weeks. The results showed there was no significant difference between mean bone density in the ozone and control postoperatively as no bone formed yet, but after 12 weeks there was a significant higher mean percentage of bone density in the side of ozone therapy. Bocci V. in his book How ozone acts and how it exerts therapeutic effects, explained this due to the wound receives more oxygen when ozonized water is applied leading to shortening of initial healing time, accelerating migration of epithelial cells, activation of fibroblasts, which are important for collagen synthesis and at last 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, as TGF-β1 has marked influence on cell proliferation, chemotaxis (monocytes and fibroblasts), angiogenesis, synthesis of extracellular matrix and collagen [10].

Conclusion

From the current study, it could be concluded that:

- Significant increase in wound healing in the ozone group (left side) than control group (right side).
- Significant decrease in pain severity in the ozone group.
- Significant decrease in percentage of facial edema in the ozone group.
- Significant increase in bone density in the side of ozone therapy after 3 months.
- Ozone has a significant antibacterial effect like antibiotics without any adverse effect of therapeutic doses and microbial resistance.
- In this study Pederson scale fails to predict the preoperative surgical difficulty in comparison to modified parant scale for postoperative evaluation.

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