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COMPARATIVE EVALUATION OF OZONE GAS AND OZONATED WATER AFTER ARTHROCENTESIS IN MANAGEMENT OF TEMPRO MANDIBULAR JOINT INTERNAL DERANGEMENT: A CLINICAL RANDOMIZED CONTROLLED STUDY

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ABSTRACT

Purpose: Tempro-mandibular joint pathology is a dilemma that concerns with temporo-mandibular disorders, tumors, infections, growth development anomalies, and traumatic lesions. TMDs require a multidisciplinary approach. Usually, first treatment options are noninvasive treatments, including occlusal splint (OS), photobiomodulation (PBM), manual therapy (MT), electrotherapy, acupuncture, oral exercises, and behavioral education therapies, as well as pharmacological therapy. Other treatment option was present when conservative (non-invasive) treatment of TMD was failed to obtain the suggested results as TMJ arthrocentesis. There are many different materials that can be injected after TMJ arthrocentesis including non-steroidal anti-inflammatory drugs (NSAIDs), opioid analgesics, corticosteroid, sodium hyaluronate (SH), platelet-rich plasma (PRP) and recently ozone.

Aim: The aim of this study was to compare and evaluate the effect of ozone gas and ozonated water after arthrocentesis in management of temporomandibular joint internal derangement.

Patients and methods: This was a clinical randomized controlled study conducted on 28 patients suffered TMJ internal derangement (anterior disc displacement with reduction). The patients were randomly divided into 2 groups, each group consists of 14 patients. Group A (Ozone group) received ozone gas injection after arthrocentesis with Ringer's solution. Group B (ozonated water group) received ozonized water arthrocentesis after arthrocentesis with Ringer's solution.

Results: When comparing the two groups, there were no statistically significant differences; between group A and group B regards changes in measuring pain on visual analogue scale (VAS) from pre-operative till post-operative at 12 months follow up periods (P value= 0.086). While, there were statistically significant differences; between group A and group B regards changes in maximum painless opening from pre-operative till post-operative at 12 months follow up periods (P value= 0.002)

Conclusion: The use of ozone gas injection following arthrocentesis for patients suffering from TMJ internal derangement pain is successful in improving TMJ function and help in reducing pain and assist in better mouth opening as it is simple, safe, effective procedure, minimally invasive and with low risk of infection.

KEYWORDS: TMJ, Ozone gas, Ozonized water, arthrocentesis.

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INTRODUCTION

Tempro-mandibular joint pathology is a dilemma that concerns with temporo-mandibular disorders, tumors, infections, growth development anomalies, and traumatic lesions. Studies of chronic pain and TMD suggest neurologic, endocrine and inflammatory pathways. Several alterations in pro- and anti-inflammatory cytokines have also been found in individuals with chronic painful TMD relative to TMD-controls, including elevated circulating levels of pro-inflammatory monocyte chemotactic protein (MCP-1), reduced levels of anti-inflammatory (omentin-1) and reduced transcription of anti-inflammatory transforming growth factor β1 (TGFβ1). [1-3]

TMDs require a multidisciplinary approach. Usually, first treatment options are noninvasive treatments, including occlusal splint (OS), photobiomodulation (PBM), manual therapy (MT), electrotherapy, acupuncture, oral exercises, and behavioral education therapies, as well as pharmacological therapy. [4-9] The primary goal of noninvasive therapies is pain relief, avoiding acute pain to become a chronic condition, which leads to changes of pain perception and delay of treatment responses. [6, 10-12]

Other treatment option was present when conservative (non-invasive) treatment of TMD was failed to obtain the suggested results as TMJ arthrocentesis. [13] Nowadays, TMJ arthrocentesis is not used only for acute disc displacement without reduction (Closed lock) but it is also used for the treatment of different TMD conditions such as; limited mouth opening caused by internal derangement or adherence/adhesion, disc displacement with or without reduction, chronic joint pain or TMJ arthralgia or arthritis and degenerative joint disease. [14-17] There are many different materials that can be injected after TMJ arthrocentesis including non-steroidal anti-inflammatory drugs (NSAIDs), opioid analgesics, corticosteroid [18-20], sodium hyaluronate (SH) [21, 22], platelet-rich plasma (PRP) and recently ozone. [23, 24]

Ozone has an analgesic, antimicrobial effects and an immune system stimulating action as it is one of the most powerful detoxication agent; due to these unique features, many authors used the ozone clinically in the oral cavity by the use of ozonized oil as a topical treatment for wound healing acceleration, the use of an ozone-oxygen gas mixture locally into the alveolus and intramuscularly into the inferior alveolar nerve area and finally the use of ozonized water in the arthrocentesis of the temporomandibular joint internal derangements. [25-29]

Many authors reported the use of ozone gas injection for the treatment of knee rheumatoid arthritis and these studies proved the safety and the effectiveness of the used of ozone gas injection. [30] After injection of ozone gas into the knee joint, ozone had the ability to decrease the inflammation and enhanced the knee function. [31, 32] Ozone gas prevent the release of proteolytic enzymes or pro-inflammatory cytokines and stimulate the proliferation of fibroblasts and chondrocytes with increased synthesis of the matrix and articular cartilage. [33] In addition to its anti-inflammatory action, the ozone gas exerts its therapeutic effects by accelerating glucose usage in the cellular metabolism, improving protein metabolism, converting unsaturated fatty acids into hydrosoluble compounds and increasing erythrocyte activity. So, it is suggested that the use of intra-articular injection of ozone gas may be an effective way to relieve disease-associated chronic pain. [34]

The aim of this study was to compare and evaluate the effect of ozone gas and ozonated water after arthrocentesis in management of temporomandibular joint internal derangement.

PATIENTS AND METHODS

Study Design

This was a clinical randomized controlled study conducted on 28 patients suffered TMJ internal derangement (anterior disc displacement with reduction). The patients were randomly divided into

2 groups, each group consists of 14 patients. Group A (Ozone group) received ozone gas injection after arthrocentesis with Ringer's solution. Group B (ozonated water group) received ozonized water arthrocentesis after arthrocentesis with Ringer's solution. The study was conducted in the Faculty of Dentistry, Cairo University, department of oral and maxillofacial surgery. Details of the procedure has been explained simply to each patient, then they were asked to sign a written consent before starting the treatment. Approval of were obtained before starting the study.

ELIGIBILITY CRITERIA

The patients were selected as:

A. Including criteria:

- Age from 18- 45 years old.
- Anterior disc displacement with reduction.
- Sounds during condylar movement (popping, clicking, etc.).
- Impaired joint movements with pain and masticatory muscle tenderness.
- Males and females will be included.

B. Excluding criteria:

- Local infection at the needle pass of insertion.
- Systemic inflammatory joint disease.
- Patients with only muscle pain.
- Anterior disc displacement without reduction.
- Allergic reaction to ozone medication.
- Coagulopathy blood disorders.

Randomization

This study was a randomized clinical controlled trial. Patients were randomly assigned into two equal groups: group (A) and group (B) according to the website (http//www.random.org.eg). Each group consisted of 14 patients.

Preoperative evaluation:

Adequate preoperative assessment of the patients included detailed dental and medical history was obtained to determine the degree of joint pain, TMJ dysfunction, history of joint treatment; and finally, a clinical examination of the temporo-mandibular regions and masticatory muscles was done. Data for each patient were collected in his or her own questionnaire and examination chart.

Also, measuring the maximum painless mouth opening and pain on visual analogue scale (VAS) were performed for each patient. The procedure was performed under local anesthesia given to the auriculotemporal nerve with complete aseptic condition.

Methodology

The pre-auricular area of the affected side was prepared with betadine solution and the area was isolated with sterile drapes. The external auditory meatus was blocked with Vaseline gauze to prevent the entry of lavage fluid into the external auditory meatus. The points of needle insertion on the skin were determined as follows: a line was draw from the middle of the tragus to the outer canthus of the eye. The posterior entry point was present along the canthotragal line, 10 mm from the tragus line and 2 mm below, the anterior entry point was present 20 from the tragus line and 10 mm below. An 18-gauge needle and 10 ml syringe were inserted into the predetermined points and Ringer's solution (RINGER'S INJECTION, El Nasr Pharmaceutical Chemicals Co. -Abu Zaabal-Egypt.) was injected in the upper joint compartment for TMJ arthrocentesis **(Figure 1).** Approximately 100–200 ml of Ringer's solution was used. During the TMJ lavage, the mandible was moved in different directions to facilitate lysis of adhesions. **For Group A (Ozone gas group)**, once arthrocentesis with Ringer's solution was completed, the anterior needle was removed and the superior compartment of the affected joint was injected through the posterior needle by (2 ml) ozone gas (ozone gas concentration 10μg/ ml) [35] **(Figure 2).** Finally, the posterior

needle was removed and pressure dressing was placed in site of injection. **For Group B (Ozonated water group)**, once arthrocentesis with Ringer's solution was done. The procedure was completed by ozonized water arthrocentesis. Ozonized water was prepared using a glass bottle of 100 ml. capacity filed with injectable distilled water (distilled water for injection produced by EPICO, Egypt). It was bubbled with 70 µg/ml. ozone for 30 minutes at room temperature of 17-25 °C **(Figure 3).** Finally, anterior and posterior needles were removed and pressure dressing was placed in site of injection.

All patients were given postoperative instructions as follow: the patient must be kept on soft diet for 2 weeks and the patient instructed to perform physical exercise to maintain the obtained jaw opening after treatment by gradual opening of the jaw starting from third day postoperatively and maintain the physical exercises for at least one month postoperatively by increasing the mouth opening 0.5 cm daily until the mouth opening reach the normal opening range. postoperative medication was described to the patients as follow: Anti-inflammatory and analgesic was prescribed for five days (Ibuprofen 600 mg capsules 2 times per day for one week) (Brufen, Abbott co., Egypt). Antibiotic (amoxicillin & clavulanic acid 1 gm 2 times per day for a one week) (Augmentin, GSK co., Egypt) and muscle relaxant (Orphenadrine citrate, aspirin and caffeine Multilayer tablets 2 time per day for 2 weeks) (Norgesic, Epico co., Egypt).

Fig. (1): Photograph showing the entry points for TMJ arthrocentesis and the ouflow and inflow needles in place.

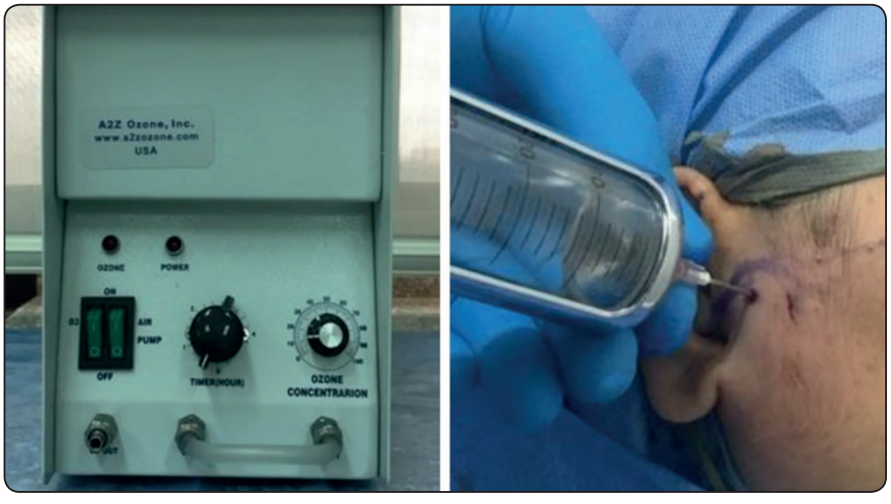

Fig. (2): Photograph showing ozone gas generator and the injection of ozone gas through the posterior needle after removal of the anterior needle.

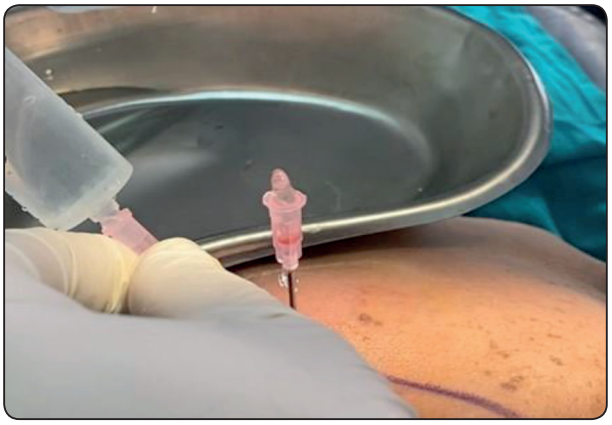

Fig. (3): Photograph showing arthrocentesis with ozonized water.

Patients were followed up at regular intervals (one week, 1,3,6, and 12 months after the procedure) to assessed the pain intensity using the visual analogue scale (VAS) to define the degree of pain on a scale from 0 to 10 where 0 = no pain and 10 = worst pain and to assessed the jaw range of motion function in millimeters in terms of maximum incisal opening (MIO) by measuring the distance between the upper centrals incisors and the lower centrals incisors in millimeters after the patient opened his mouth as wide as he/she can without feeling pain. All data was collected and analyzed using Statistical package for Social Science (SPSS 24 for windows; SPSS Inc, Chicago, IL).

RESULTS

The current study was conducted on 28 patients (3 males and 25 females) ranging from 18- 45 years old. All patients suffered from TMJ internal derangement (anterior disc displacement with reduction) with severe pain and history of unsuccessful medical treatment. Patients in this study were classified into two groups to receive arthrocentesis with Ringer's solution followed by ozone gas injection (group A) and arthrocentesis with Ringer's solution followed by ozonized water arthrocentesis (group B).

1. The Visual Analog Scale (VAS)

A. Group A (Ozone Gas group)

The average Visual Analog Scale (VAS) in group A (Ozone Gas group) recorded an average (SE) of 91.43±2.06 preoperatively, however, postoperatively The Visual Analog Scale (VAS) significantly decreased ($p<0.001$) to an average of 18.57±7.02, 7.14±2.66, 4.29±1.37, 7.14±3.39, and 12.14±5.76 after 1, 3, 6, 9, and 12 months respectively. The VAS decreased significantly (<0.001) from 91.43±2.06 preoperative to 9.86±4.04 postoperatively (Table 1).

TABLE (1): The Visual Analog Scale (VAS) of group A (Ozone Gas group)

Group A (Ozone Gas group)				
The Visual Analog Scale (VAS)				
Pre- operative		Mean	SD	SE
		91.43	7.70	2.06
Post-operative	1 m	18.57	26.27	7.02
	3 m	7.14	9.94	2.66
	6 m	4.29	5.14	1.37
	9 m	7.14	12.67	3.39
	12 m	12.14	21.55	5.76
	Total	9.86	15.11	4.04

Significant at p<0.05, <0.01, <0.001; NS, non-significant at p>0.05.

B. Group B (Ozonized water group)

The average Visual Analog Scale (VAS) in group B (Ozonized water group) recorded an average (SE) of 90.00±2.10 preoperatively, however, postoperatively VAS decreased significantly ($p<0.001$) to an average of 5.71±2.02, 10.71±2.67, 15.71±3.59, 26.43±3.72, and 37.86±4.71 after 1, 3, 6, 9, and 12

months respectively. The VAS decreased significantly (<0.001) from 90.00±2.10 preoperative to 19.29±3.34 postoperatively (Table 2).

TABLE (2): The Visual Analog Scale (VAS) of group B (Ozonized water group)

Group B (Ozonized water group)				
The Visual Analog Scale (VAS)				
Pre- operative		Mean	SD	SE
		90.00	7.84	2.10
Post-operative	1 m	5.71	7.56	2.02
	3 m	10.71	9.97	2.67
	6 m	15.71	13.42	3.59
	9 m	26.43	13.93	3.72
	12 m	37.86	17.62	4.71
	Total	19.29	12.50	3.34

Significant at p<0.05, <0.01, <0.001; NS, non-significant at p>0.05.

C) Comparison between the Visual Analog Scale (VAS) of groups A and B

The average Visual Analog Scale (VAS) in groups A and B were decreased significantly from an average of 91.43±2.06, and 90.0±2.10 preoperatively to a level of 9.86±4.04 and 19.29±3.34 postoperatively respectively. Group A treated with ozone gas showed lowest significant difference regards changes in VAS from pre-operative till postoperative against group B treated with ozonized water. Moreover, there were no statistically significant differences; between group A and group B regards changes in VAS from pre-operative till postoperative at 12 months follow up periods (P value= 0.086) (Table 3).

TABLE (3): Comparative effect of ozone gas and ozonized water on the Visual Analog Scale (VAS) both pre-operative and postoperative.

VAS		Mean	SE	t-value	P value	Sig.
Pre till 12 months	Group A	9.86	4.04	-1.49	0.086	NS
	Group B	19.29	3.34			

Significant at p<0.05, <0.01, <0.001; NS, non-significant at p>0.05.

2. The maximum incisal opening MIO

A) Group A (Ozone Gas group)

The average Maximum Incisal Opening (MIO) in group A (Ozone Gas group) recorded an average (SE) of 21.0±1.76 preoperatively, however, postoperatively MIO increased significantly (p<0.001) to an average of 38.43±1.12, 39.79±1.16, 39.36±1.32, 37.64±1.70, and 36.36±2.13 after 1, 3, 6, 9, and 12 months respectively. The MIO increased significantly (<0.001) from 17.86 preoperative to 32.11 postoperatively (Table 4).

TABLE (4): The Maximum Incisal Opening (MIO) of group A (Ozone Gas group)

Group A (Ozone Gas group)				
The Maximum Incisal Opening (MIO)				
Pre- operative		Mean	SD	SE
		21.50	6.57	1.76
Post-operative	1 m	38.43	4.18	1.12
	3 m	39.79	4.35	1.16
	6 m	39.36	4.94	1.32
	9 m	37.64	6.37	1.70
	12 m	36.36	7.97	2.13
	Total	38.31	5.56	1.49

Significant at p<0.05, <0.01, <0.001; NS, non-significant at p>0.05.

B. Group B (Ozonized water group)

The average Maximum Incisal Opening (MIO) in group B (Ozonized water group) recorded an average (SE) of 18.00±1.28 preoperatively, however, postoperatively MIO increased significantly ($p<0.001$) to an average of 35.36±1.16, 35.29±1.17, 33.79±1.12, 31.36±1.09, and 29.14±1.22 after 1, 3, 6, 9, and 12 months respectively. The MIO increased significantly (<0.001) from 18.00±1.28 preoperative to 32.99±1.15 postoperatively (Table 5).

TABLE (5): The Maximum Incisal Opening (MIO) of group B (Ozonized water group)

Group B (Ozonized water group)				
The Maximum Incisal Opening (MIO)				
Pre- operative		Mean	SD	SE
		18.00	4.79	1.28
Post-operative	1 m	35.36	4.34	1.16
	3 m	35.29	4.39	1.17
	6 m	33.79	4.17	1.12
	9 m	31.36	4.09	1.09
	12 m	29.14	4.55	1.22
	Total	32.99	4.31	1.15

Significant at p<0.05, <0.01, <0.001; NS, non-significant at p>0.05.

C) Comparison between The Maximum Incisal Opening (MIO) of groups A and B

The average Maximal Incisal Opening (MIO) in groups A and B were increased significantly from an average of 21.50±1.76, and 18.0±1.28 preoperatively to a level of 38.31±1.49 and 32.99±1.15 postoperatively respectively. There were statistically significant differences; between group A and group B regards changes in maximum painless opening from pre-operative till post-operative at 12 months follow up periods (P value= 0.002) (Table 6).

TABLE (6): Comparative effect of ozone gas and ozonized water on The Maximum Incisal Opening (MIO) both pre-operative and postoperative.

MIO		Mean	SE	t-Value	P value	Sig.
Pre till 12 months	Group A	38.31	1.49	3.93	0.002	S
	Group B	32.99	1.15			

Significant at p<0.05, <0.01, <0.001; NS, non-significant at p>0.05.

DISCUSSION

Management of patients with TMD is one of the biggest challenges faced by oral and maxillofacial surgeons. people with pain have a multifactorial problem with physical and psychosocial symptoms. [36] It has been reported that 80 % of patients with signs and symptoms of TMJ disorders have some form of ID of the TMJ, [37] and up to 25% of the entire world population has internal derangement of the TMJ. Internal derangement can be diagnosed with considerable accuracy through dental and clinical history, clinical examination and magnetic resonance imaging (MRI) may be useful. [38]

The result of present study showed that ozone therapy has positive effects in terms of decreasing pain and enhanced TMJ function which is in agreement with A Hammuda et al. [28] study and with SW Arafat et al. [29] study who utilized ozonized water injection in TMJ arthrocentesis and proved the effectiveness of ozonized water as a clinical applicable form of ozone in ozone therapy for the temporomandibular joint disorders. All patients included in those study showed significant improvement for the first six months in the visual analog scale (VAS) and maximal incisal opening (MIO).

The present study shown long term and significant efficacy of ozone group (group A) in the

form of intra-articular ozone gas injection following arthrocentesis that last for 85% of the cases in (group A) in contrast with 57% improvement persisted in (group B) up to one year. The results of (group A) is in agreement with different studies which used ozone gas injection for the treatment of knee rheumatoid arthritis. They reported that the biological action therapy of ozone gas for knee joint rheumatoid arthritis including the inhibition of the release of proteolytic enzymes or pro-inflammatory cytokines and stimulate fibroblasts and chondrocytes proliferation and stimulated the synthesis of the matrix and articular cartilage. These results can explain the long term and significant outcome of group A. [30-33] On the contrary with the other intra-articular injectable materials, the reason for the favorable long-term effects in the ozone may be also explained by the study of SK Mishra et al [39] which reported that ozone gas promotes better vascularization in bones and cartilage, and accelerating anabolism and recovery in osteoarticular diseases.

So, it is obvious that the use of ozone gas injection following arthrocentesis for patients suffering from TMJ internal derangement pain is successful in improving TMJ function and help in reducing pain and assist in better mouth opening as it is simple, safe, effective procedure, minimally invasive and with low risk of infection.

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