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CLINICAL RESEARCH

Management of denture-related traumatic ulcers using ozone

Bader K. AlZarea, BDS, MSc

ABSTRACT

Statement of problem. Management of denture-related traumatic ulcers using ozone may improve tissue healing and reduce patient pain and discomfort.

Purpose. The purpose of this clinical investigation was to assess the efficacy of ozone in the treatment of denture-related traumatic ulcers.

Material and methods. Seventy-five participants (study group) with denture-related traumatic ulcers were evaluated in this blinded, controlled cohort observational investigation. A control group (n=75) of participants with denture-related traumatic ulcers who matched the study group in sex and age were also recruited. Ulcers were treated with ozone gas for 60 seconds in the study group and with air for 60 seconds in the control group. Pain levels were evaluated by means of a visual analog scale (VAS), and ulcer sizes were measured in each participant at experiment baseline and each day for 15 days. Ulcer duration was established by calculating the period it took to completely heal and disappear. Major outcome measurements were ulcer duration, ulcer size, and levels of pain.

Results. Ulcer size decreased from day 2 in the study group (after ozone application) ($P \leq .01$) and from day 4 in the controls ($P \leq .001$). Recorded pain levels decreased from the first day soon after ozone application in the study group ($P \leq .001$) and from day 3 in the controls ($P < .001$). Ulcer duration, ulcer size from day 3 to day 10, and reported pain levels from day 1 to day 10 decreased more in the study group ($P \leq .004$).

Conclusions. Exposure of denture-related traumatic ulcers to 60 seconds of ozone gas was associated with better ulcer healing and decreased pain levels, ulcer size, and ulcer duration. (J Prosthet Dent 2019;121:76-82)

Traumatic dental ulcers caused by denture-related problems are a common complaint among denture patients.[1-4] The ulcer shape fits the shape of the denture portion that induced the trauma. The most frequent location of ulcers is the vestibular sulci of the maxilla and mandible,[1] and ulcers are painful there.[1-6]

Management of denture ulcers includes discontinuing the use of the denture, denture correction, laser therapy, and oral and denture hygiene. Management also includes use of local drugs such as chlorhexidine mouth washes, topical hydrogels, hydrogel dressing patches, and sometimes topical cortisone.[5-7]

Ozone treatment has been used for many medical and dental purposes.[8-22] Its benefits come from its analgesic characteristics and abilities to encourage blood circulation and activate immune response, and its potent antimicrobial function.[8,9,12] Furthermore, it is a potent oxidant and a rich source of free radicals that have the capability to change or degrade materials.[8,9,12,17] Studies have established that ozone can reduce pain,[8-12,16-19] reduce tooth sensitivity,[10,11,17,19] and enhance regeneration and promote healing.[9-15,18]

Although ozone has been used in various human tissues and cells,[17-29] it does have side effects such as irritation to the respiratory tract mucosa and, consequently, asthma or allergy. Ozone supply systems should therefore provide a perfect seal and prevent leakage.[8-11,17-22,30,31]

Ozone has been prescribed for the management of different types of ulcers, including oral recurrent aphthous ulcers recurrent aphthous stomatitis,[18] gastrointestinal tract ulcers,[32,33] ulcers involving blood vessels,[34] and skin ulcers.[35-37] Nevertheless, the authors are unaware of investigations of the use of ozone in the management of denture-related traumatic ulcers.

Therefore, the purpose of this investigation was to evaluate levels of pain, ulcer duration, and ulcer size after exposure of denture-related traumatic ulcers to ozone for 60 seconds. The null hypothesis was that exposing

Dean, Associate Professor, and Consultant, College of Dentistry, Aljouf University, Sakaka, Saudi Arabia.

Clinical Implications

Use of ozone can improve tissue healing and decrease the pain and discomfort experienced by patients. Consequently, this treatment option should be considered in the management of denture-related traumatic ulcers.

denture-related traumatic ulcers to ozone for 60 seconds would not affect levels of pain, ulcer duration, or ulcer size.

MATERIAL AND METHODS

The sample size was calculated by using software (G*Power 3.1.9.2; Heinrich-Heine-University Dusseldorf) and use of data collected after a pilot study. The software repeated measurements design was applied for this purpose, where the size of the ulcer was the repeated measure and the treatment was the independent factor. The sample size was calculated to be 60 participants for each group, with an effect size of 20%, a significance level of 5%, and a statistic power of 80%. Extra numbers of participants were recruited to compensate for any drop-outs during the investigation.

Seventy-five consecutive study participants (40 women and 35 men, 55-65 years of age, mean ±SD age, 60.2 ±3.1 years) were investigated in this study. Participants were recruited from complete denture patients who had received new maxillary and mandibular complete dentures at the School of Dentistry, Aljouf University, KSA, between October 2015 and May 2017.

This research was conducted according to the ethical principles of the World Medical Association Declaration of Helsinki. This investigation was ethically approved by the Academic Research Committee, Aljouf University (reference number R23/1437). Study details were explained to each participant, and written informed consent was obtained from each participant before enrollment.

Participants were included in this investigation if they were between 55 and 65 years of age to control for age effects on the healing of ulcers. In addition, they were excluded if they were taking medication or had medical conditions including hematinic deficiencies, auto-inflammatory disorders, hormonal conditions, diabetes, Behçet disease, mental or psychological disorders, cardiovascular disease, renal disease, skin disease, gastrointestinal disease, or liver disease.[18,38] Furthermore, they were enrolled if they had denture-related ulcers in the facial vestibule and had received no other treatment for the ulcers. Also, participants who experienced these medical conditions and had obtained other treatment for the ulcers, smoked Narghile or cigarettes, or chewed tobacco were excluded from the investigation.

Detailed evaluation of participants' health status was achieved through thorough medical and dental histories, reporting health complaints, and recording personal data including occupation, sex, age, marital status, level of education, and address. A thorough clinical examination was conducted using an intraoral dental mirror (15/16 inch; Hanhnenkratt GmbH) on a dental unit with an extraoral light source. Clinical success of the dentures was assessed by specific clinical criteria, following previous recommendations, and included evaluation of esthetics, support, retention, occlusion, stability, speech, and health of supporting structures.[39,40]

Participants were seen 48 hours after insertion of the dentures. Ulcer size, ulcer duration, and pain caused by ulcers were the main study outcome measurements. Following the appraisal of participants' health status and the clinical examination, evaluation of pain levels caused by ulcers was obtained by using a visual analog scale (VAS) score from zero to 10 (where 0 signified no pain and 10 signified most severe pain due to ulcers). Participants were instructed to rate ulcer pain in comparison with the most severe pain they had ever experienced from their oral cavity. Then, the size of the ulcer was measured with digital calibers (Terensa, measuring precision of 0.01 mm). The actual mucosal defect was measured excluding the erythematous, intact surrounding mucosa.

Then, ozone gas was applied to the traumatic ulcers in the study group for 60 seconds. Ozone gas was produced by an ozone-generating machine (healOzone X4; Curozone) at 2350 ppm concentration and a flow rate of 615 mL/min.[17-22] The applied ozone concentration was verified by an ozone detection device, and the ozone flow rate was verified by using a flow meter before the start of the investigation.[17-22]

Ozone gas was delivered to the ulcers by using disposable silicone cups supplied by the manufacturer that ensured a total seal to prevent ozone leakage. Furthermore, the machine did not generate ozone if the seal of the silicone cup was not complete. These features made the machine safe for clinical use.[16-22,30,31]

After that, pain levels were evaluated, and ulcer sizes were measured, as described previously, on a daily basis for 15 days. Duration of ulcers was identified through calculation of how many days it took to completely heal. Participants were asked to discontinue using their dentures until the ulcers were completely healed and not to consume any local or systemic medications for management of ulcers during this investigation. A thorough clinical examination of each participant was conducted on a daily bases, and participants were excluded if they took any medication for the ulcers, used their dentures after starting the

investigation, or had any oral changes that might have interfered with pain evaluation or healing of ulcers such as having new trauma or oral pain other than the pain caused by the investigated traumatic ulcers. No study dropouts were recorded following the recruitment of participants. Dentures were adjusted accordingly before the participants started using them again following ulcer healing. Participants were then followed weekly for 1 month to make sure no further trauma was caused by the dentures.

Seventy-five control participants (40 women and 35 men, mean ±SD age, 60.3 ±3.2 years) were recruited from complete denture patients who received new maxillary and mandibular complete denture prostheses at the School of Dentistry, Aljouf University, KSA, between October 2015 and May 2017. The sex and ages of the controls matched those of the study group. Similar inclusion and exclusion criteria were applied to the controls. In addition, similar procedures were applied to assess health status, clinical examination, denture evaluation, pain evaluation, ulcer size measurement, and ulcer duration evaluation. For the control group, the healOzone machine applied only air (no ozone) for 60 seconds to the traumatic ulcer. The machine had a button on the back to stop flow of ozone and supply only air when it was turned on. Measurement of the ulcer size and the evaluation of pain levels among the controls were also carried out on a daily basis for 15 days by following the same procedures, as in the study group. Duration of the ulcers was also identified by calculating how many days they took to heal completely.

None of the participants (study and control groups) knew whether they belonged to the study or the control group. Also, 1 investigator (B.A.) used the healOzone machine and was blinded to whether the machine was supplying ozone or only air.

Clinical assessments were performed by 1 investigator (B.A.). Intraexaminer reliability was calculated by assessing 10 duplicate clinical examinations by the same investigator, and kappa was found to be adequate (K=0.93). In addition, another investigator (M.K.AL-O.) assessed the same 10 examinations to calculate interexaminer reliability, and kappa was found to be adequate (K=0.89). This analysis ensured that the assessment methods were standardized with high inter- and intraexaminer agreements.

Statistical software (IBM SPSS Statistics, v19.0; IBM Corp) was used for data analysis. Relationships among participant demographic data and ulcer duration, ulcer size, and pain levels were assessed by using the Pearson correlation test. Within-group changes in ulcer size and pain levels throughout the study were assessed by using the paired samples *t* test. Ulcer duration, ulcer size, and pain levels of the groups were compared by using ANOVA test (α=.05 for all tests).

Table 1. Mean ±standard deviation, minimum, and maximum ulcer sizes among participants

	Ulcer Size (mm)		Minimum Ulcer Size (mm)		Maximum Ulcer Size (mm)	
Measurement Time	Study Group (n=75)	Control Group (n=75)	Study Group (n=75)	Control Group (n=75)	Study Group (n=75)	Control Group (n=75)
Study baseline	5.23 ±1.28	5.25 ±1.27	3.50	3.50	8.00	8.00
Day 1	5.23 ±1.28	5.25 ±1.27	3.50	3.50	8.00	8.00
Day 2	5.16 ±1.22	5.24 ±1.24	3.00	3.50	8.00	8.00
Day 3	4.69 ±0.99	5.23 ±1.23	3.00	3.50	7.00	8.00
Day 4	3.95 ±0.92	5.15 ±1.19	2.50	3.50	6.00	8.00
Day 5	3.10 ±0.86	4.51 ±1.15	2.00	3.00	4.50	7.00
Day 6	1.86 ±0.73	3.88 ±1.03	1.00	2.50	3.50	6.00
Day 7	0.97 ±0.44	2.86 ±1.03	0.50	1.00	2.50	5.00
Day 8	0.61 ±0.25	1.75 ±0.84	0.50	0.50	2.00	3.50
Day 9	0.24 ±0.30	0.87 ±0.47	0.00	0.00	1.50	2.50
Day 10	0.04 ±0.16	0.30 ±0.40	0.00	0.00	1.00	2.00
Day 11	0.01 ±0.08	0.07 ±0.22	0.00	0.00	0.50	1.50
Day 12	0.00 ±0.00	0.01 ±0.12	0.00	0.00	0.00	1.00
Day 13	0.00 ±0.00	0.01 ±0.06	0.00	0.00	0.00	0.50
Day 14	0.00 ±0.00	0.01 ±0.06	0.00	0.00	0.00	0.50
Day 15	0.00 ±0.00	0.00 ±0.00	0.00	0.00	0.00	0.00

RESULTS

A total of 150 participants, 75 with complete denture-related traumatic ulcers (n=75 study group) and 75 control group participants, were enrolled in the study. The duration of ulcers in the study group ranged from 8 to 11 days (mean ±SD, 8.5 ±0.7 days). Ulcers lasted for 8 to 14 days in the control group (mean ±SD, 9.7 ±0.9 days).

Table 1 shows the measurements of ulcer size on a daily basis for 15 days. The size of ulcers decreased in participants from both groups with time; however, a greater reduction in ulcer size was noticed in the study group treated with ozone gas ($P \leq .004$).

VAS scores for pain levels on a daily basis for 15 days are presented in Table 2. Pain levels decreased in participants from both groups with time; nonetheless, more decrease in pain levels was noticed in the study group treated with ozone ($P<.001$).

No significant relationships were detected among ulcer duration, ulcer size, and pain scores and participants' sex and age in either group ($P>.05$). Additionally, ulcer size decreased significantly from the second day after ozone application in the study group ($P \leq .01$) and from the fourth day in the control group ($P \leq .001$) (Table 3). Moreover, reported pain levels decreased significantly from the first day soon after ozone application in the study group ($P \leq .001$) and

Table 2. Mean ±standard deviation, minimum, and maximum VAS scores of pain levels among participants

Measurement Time	VAS Score for Pain		Minimum Pain VAS score		Maximum Pain VAS score	
	Study Group (n=75)	Control Group (n=75)	Study Group (n=75)	Control Group (n=75)	Study Group (n=75)	Control Group (n=75)
Study baseline	7.69 ±0.82	7.61 ±0.84	6	6	10	10
Day 1	5.68 ±0.99	7.61 ±0.84	3	6	8	10
Day 2	4.40 ±1.09	7.61 ±0.84	2	6	7	10
Day 3	3.30 ±1.23	6.93 ±0.83	1	5	6	9
Day 4	2.75 ±1.05	6.35 ±0.63	1	5	5	8
Day 5	2.15 ±0.88	5.31 ±0.64	1	4	4	7
Day 6	1.64 ±0.63	4.17 ±0.62	1	3	3	6
Day 7	1.04 ±0.56	2.87 ±0.64	0	1	2	4
Day 8	0.48 ±0.55	1.63 ±0.77	0	0	2	3
Day 9	0.04 ±0.20	0.72 ±0.71	0	0	1	2
Day 10	0.00 ±0.00	0.16 ±0.37	0	0	0	1
Days 11-15	0.00 ±0.00	0.00 ±0.00	0	0	0	0

VAS, visual analog scale.

Table 3. Paired samples *t* test results for within-group changes of ulcer size over time

Group	Ulcer Size Pair	Ulcer Size Mean (Baseline-Day)	Mean Ulcer Size Difference for Pairs	*T*	*df*	*P*
Study (n=75)	Baseline-Day 2	5.23-5.16	0.07	3.238	74	.002
Control (n=75)	Baseline-Day 2	5.25-5.24	0.01	1.000	74	.321
	Baseline-Day 3	5.25-5.23	0.03	1.424	74	.159
	Baseline-Day 4	5.25-5.15	0.10	3.512	74	.001

T, T statistics.

Table 4. Paired samples *t* test results for within-group changes in pain levels over time

Pain Level Pairs	Pain Level Means (Baseline-Day)	Pain Level Mean Difference for Pairs	*T*	*df*	*P*
Study group (n=75)					
Baseline-Day 1	7.69-5.68	2.01	20.227	74	<.001
Baseline-Day 2	7.69-4.40	3.29	32.919	74	<.001
Baseline-Day 3	7.69-3.30	4.40	37.115	74	<.001
Baseline-Day 4	7.69-2.75	4.95	48.478	74	<.001
Baseline-Day 5	7.69-2.15	5.55	63.320	74	<.001
Baseline-Day 6	7.69-1.64	6.05	73.362	74	<.001
Baseline-Day 7	7.69-1.04	6.65	81.501	74	<.001
Baseline-Day 8	7.69-0.48	7.21	100.508	74	<.001
Baseline-Day 9	7.69-0.04	7.65	85.007	74	<.001
Baseline-Day 10	7.69-0.00	7.69	81.098	74	<.001
Control group (n=75)					
Baseline-Day 1*	7.61-7.61	0.00	*	74	*
Baseline-Day 2*	7.61-7.61	0.00	*	74	*
Baseline-Day 3	7.61-6.93	0.68	12.540	74	<.001
Baseline-Day 4	7.61-6.35	1.27	17.040	74	<.001
Baseline-Day 5	7.61-5.31	2.31	25.922	74	<.001
Baseline-Day 6	7.61-4.17	3.44	39.320	74	<.001
Baseline-Day 7	7.61-2.87	4.75	62.330	74	<.001
Baseline-Day 8	7.61-1.63	5.99	73.335	74	<.001
Baseline-Day 9	7.61-0.72	6.89	86.623	74	<.001
Baseline-Day 10	7.61-0.16	7.51	94.415	74	<.001

**t* Test was not computed because mean differences in pain levels were zero.

from the third day in the control group ($P<.001$) (Table 4).

ANOVA demonstrated no significant variations ($P>.05$) between groups concerning participants' ages ($P=.715$), reported pain levels at the start of the study ($P=.555$), and ulcer size during day 1 ($P=.924$), day 2 ($P=.691$), and after day 10 of the investigation ($P>.05$) (Table 5).

In contrast, ulcer duration ($P<.001$), ulcer size from day 3 to day 10 ($P\leq.004$), and reported pain levels from day 1 to day 10 ($P<.001$) decreased significantly more in the study group treated with ozone (Table 5). In addition, participants' sex distribution was not different between groups (chi-square, 0.667; $P=.414$).

DISCUSSION

Results of this investigation revealed that exposing denture-related traumatic ulcers to 60 seconds of ozone gas was associated with faster healing of the lesions and decreased levels of pain. Consequently, the null hypothesis of this research was rejected.

The healOzone appliance was chosen because it had been used in earlier clinical investigations.[16-22,30,31] It has been found safe, as its mechanism for supplying ozone must be perfectly sealed before the device is able to generate and deliver ozone.[16-22,30,31]

The direct application of ozone to the oral mucosa was not accompanied with noticeable harmful effects on the tissues. This is consistent with earlier investigations that demonstrated that ozone had less harmful effects on human gingival fibroblasts and oral epithelium than hydrogen peroxide, sodium hypochlorite, or chlorhexidine.[23] Moreover, osteoblastic cell adhesion and proliferation was not influenced by ozone application.[24] No harmful effects of the direct application of ozone on human oral mucosa, periodontal tissues, gingiva, bone, peri-implant tissues, or teeth have been reported.[16-28]

In the current investigation, reported pain levels decreased significantly after the application of ozone to denture-related traumatic ulcers. This is consistent with previous research that reported decreased pain levels after application of ozone on hard and soft oral tissues for management of jaw osteonecrosis, extraction of third molars, treatment of recurrent aphthous ulcers, and bleaching of teeth.[17-19,25-27] In addition, ozone has been documented to have analgesic properties.[8,9,12]

The duration and size of denture-related traumatic ulcers decreased after ozone application. This might

Table 5. ANOVA was computed to show differences between groups (n=150)

Variable		Sum of Squares	*df*	Mean Square	F	*P*
Age	Between groups	1.307	1	1.307	0.134	.715
	Within groups	1439.867	148	9.729		
	Total	1441.173	149			
Ulcer size at baseline	Between groups	0.015	1	0.015	0.009	.924
	Within groups	241.853	148	1.634		
	Total	241.868	149			
Pain at baseline	Between groups	0.240	1	0.240	0.349	.555
	Within groups	101.733	148	0.687		
	Total	101.973	149			
Ulcer duration	Between groups	49.307	1	49.307	80.203	<.001
	Within groups	90.987	148	0.615		
	Total	140.293	149			
Ulcer size						
Day 1	Between groups	0.015	1	0.015	0.009	.924
	Within groups	241.853	148	1.634		
	Total	241.868	149			
Day 2	Between groups	0.240	1	0.240	0.159	.691
	Within groups	223.260	148	1.509		
	Total	223.500	149			
Day 3	Between groups	10.935	1	10.935	8.770	.004
	Within groups	184.533	148	1.247		
	Total	195.468	149			
Day 4	Between groups	54.602	1	54.602	48.601	<.001
	Within groups	166.273	148	1.123		
	Total	220.875	149			
Day 5	Between groups	74.202	1	74.202	71.896	<.001
	Within groups	152.747	148	1.032		
	Total	226.948	149			
Day 6	Between groups	153.015	1	153.015	193.227	<.001
	Within groups	117.200	148	0.792		
	Total	270.215	149			
Day 7	Between groups	133.482	1	133.482	211.906	<.001
	Within groups	93.227	148	0.630		
	Total	226.708	149			
Day 8	Between groups	48.735	1	48.735	125.804	<.001
	Within groups	57.333	148	0.387		
	Total	106.068	149			
Day 9	Between groups	15.042	1	15.042	95.845	<.001
	Within groups	23.227	148	0.157		
	Total	38.268	149			
Day 10	Between groups	2.535	1	2.535	27.030	<.001
	Within groups	13.880	148	0.094		
	Total	16.415	149			
Day 11	Between groups	0.107	1	0.107	3.801	.053
	Within groups	4.153	148	0.028		
	Total	4.260	149			
Day 12	Between groups	0.007	1	0.007	1.000	.319
	Within groups	0.987	148	0.007		
	Total	0.993	149			
Day 13	Between groups	0.002	1	0.002	1.000	.319
	Within groups	0.247	148	0.002		
	Total	0.248	149			
Day 14	Between groups	0.002	1	0.002	1.000	.319
	Within groups	0.247	148	0.002		
	Total	0.248	149			
Pain						
Day 1	Between groups	140.167	1	140.167	167.152	<.001
	Within groups	124.107	148	0.839		
	Total	264.273	149			
Day 2	Between groups	387.207	1	387.207	409.957	<.001
	Within groups	139.787	148	0.945		
	Total	526.993	149			
Day 3	Between groups	496.860	1	496.860	453.325	<.001
	Within groups	162.213	148	1.096		
	Total	659.073	149			
Day 4	Between groups	486.000	1	486.000	646.990	<.001
	Within groups	111.173	148	0.751		
	Total	597.173	149			
Day 5	Between groups	374.460	1	374.460	634.581	<.001
	Within groups	87.333	148	0.590		
	Total	461.793	149			
Day 6	Between groups	240.667	1	240.667	613.833	<.001
	Within groups	58.027	148	0.392		
	Total	298.693	149			
Day 7	Between groups	125.127	1	125.127	345.843	<.001
	Within groups	53.547	148	0.362		
	Total	178.673	149			
Day 8	Between Groups	49.307	1	49.307	110.122	<.001
	Within Groups	66.267	148	0.448		
	Total	115.573	149			
Day 9	Between Groups	17.340	1	17.340	64.158	<.001
	Within Groups	40.000	148	0.270		
	Total	57.340	149			
Day 10	Between Groups	0.960	1	0.960	14.095	<.001
	Within Groups	10.080	148	0.068		
	Total	11.040	149			

have been because ozone is a strong oxidant and can modify the inflammatory process and enhance immune reaction and blood circulation.[8,9,12] Ozone oxidizes toxins, which leads to their faster excretion; ozone also influences cellular and humoral immune responses, promotes the generation of immunoglobulins and immunocompetent cells, enhances phagocytosis by macrophages, and stimulates the production of interleukins, leukotrienes, tumor necrotizing factor (TNF-α), and prostaglandins that stop the process of inflammation and promote tissue healing.[29] Also, ozone stimulates cellular ribosomes, mitochondria, and protein synthesis. It also improves the ability of blood to carry oxygen, which boosts the cellular metabolism of inflamed tissues and improves energy use by triggering aerobic metabolism (glycolysis, Krebs cycle, and β-oxidation of fatty acids). Therefore, it enhances cell

regeneration and activity and improves tissue healing.[29] These mechanisms of ozone function hasten ulcer healing and explain the reported decrease in ulcer size and duration in this investigation.

Decreased ulcer size and duration is consistent with findings in earlier investigations that demonstrated ozone-improved healing of skin, veins, stomach, and recurrent aphthous ulcers.[18,32-37] Nevertheless, the outcomes of this investigation differ from the outcomes of earlier investigations that reported no effects of ozone on the duration of healing of soft and bony tissues after the surgical extraction of third molars.[25-27] The reasons behind this difference could be variations in sample size and experiment design, including testing other tissues (soft and bony tissues vs ulcerated mucosa), use of different ozone-supplying devices, and application of small doses of ozone for limited durations at reduced flow rates with lower concentrations.

Ozone can be used to treat denture-related traumatic ulcers because it can decrease levels of pain, decrease ulcer size, enhance ulcer healing, and decrease treatment time. This may reflect on a patient's quality of life, perceptions, and compliance with ulcer treatment.[18,38] In addition, the application of ozone is convenient and quick and easily controlled by ozone-generating machines. Also, ozone delivery appliances allow sufficient control of ozone delivery site, application time, flow rate, and concentration.[17-22]

A limitation of the current experiment was that pain levels were subjectively evaluated by the participants using the VAS score. This is an intrinsic shortcoming of subjective and self-evaluation of symptoms. Nevertheless, participants received a detailed explanation of the VAS score and were assured of the anonymity and security of the information they supplied. They were also asked to rate ulcer pain while considering the most severe pain they had ever experienced in their oral cavity as a reference base.

Future research is recommended to reveal the effects of various ozone concentrations and application protocols to ulcers among various populations. Also, further research is recommended to compare the effects of ozone with other remedies used to treat denture-related traumatic ulcers.

CONCLUSIONS

Within the limitations of this clinical investigation, the following conclusion was drawn:

1. Exposure of denture-related traumatic ulcers to 60 seconds of ozone gas was associated with better ulcer healing and decreased levels of pain levels, decreased ulcer size, and decreased duration of ulcers.

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Corresponding author:
Dr Bader K. AlZarea
School of Dentistry
Aljouf University
Sakaka
SAUDI ARABIA
Email: baderalzarea@hotmail.com

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