



Use of Hyperbaric Oxygen Therapy for Reducing Postoperative Swelling: A Randomized Controlled Trial

Dou Huang; Kaide Li; Xiaohui Zheng; Lei Liu*

State Key Laboratory of Oral Diseases & National Clinical Research Center for Oral Diseases & Department of Oral and Maxillofacial Surgery, West China Hospital of Stomatology, Sichuan University, Chengdu, China.

*Corresponding Author(s): Lei Liu

Professor, State Key Laboratory of Oral Diseases & National Clinical Research Center for Oral Diseases & Department of Oral and Maxillofacial Surgery, West China Hospital of Stomatology, Sichuan University, Chengdu, China.

Tel: +86-28-85501456, Fax: +86-28-85582167;

Email: drliulei@163.com

Abstract

Objective: To evaluate the effect and risks of hyperbaric oxygen therapy on postoperative swelling.

Methods: A prospective randomized, non-blinded, controlled clinical trial included 60 patients with single jaw cysts, who were randomly divided into two groups. Patients were treated with conventional surgical treatment in both groups. Only the experimental group received 10-day hyperbaric oxygen therapy. The primary predictor variable was hyperbaric oxygen therapy. The postoperative swelling, age, sex and other postoperative complications were statistically analyzed.

Results: Overall, 60 patients completed the study. The total number of patients included 34 men and 26 women, with a mean age of 42.33 years (range 18.8 - 70.2 years). A comparison of swelling over time is presented in Figure 1. There was no statistical difference between the experimental and control groups at day 1 after the surgery ($P > 0.05$). The degree of swelling in the experimental group was significantly lower than in the control and blank groups from 2 to 7 days after surgery ($P < 0.05$).

Conclusion: Hyperbaric oxygen therapy was effective to reduce the postoperative swelling, and should be considered for clinical application.

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Introduction

Postoperative swelling is an inevitable process after almost every surgery, which compress the around vessels and nerves, affecting healing and causing pain and discomfort [1]. In maxillofacial region, the loose tissue and rich blood vessels make the swelling more severe compared with other parts of the patient's body [2]. In addition, the maxillofacial region is the exposed area, which is closely related to the appearance. Therefore, the swelling would directly affect the facial appearance, increasing the psychological burden and anxiety of patients, so as to reduce the satisfaction of patients and prolongs the early recovery time after operation [3-5]. At present, glucocorticoids

and cryotherapy are commonly used to reduce postoperative swelling [6,7]. Glucocorticoid drugs are widely used in clinic, but there still are undesirable side effects, such as adrenal insufficiency, increased infection risk, hyperglycaemia, high blood pressure, osteoporosis, and development of diabetes mellitus [8,9]. Among the cryotherapy methods, ice packs are widely used, but they have the potential for frostbite and have limited effects [10,11]. Therefore a safe and effective method to reduce

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the postoperative swelling is still needed.

Hyperbaric oxygen therapy (HBOT) includes the inhalation of 100% oxygen at super-atmospheric pressure in order to enhance the amount of oxygen dissolved in the body tissues, which has been widely used in many diseases, such as osteomyelitis, compromised skin graft and flap, anaerobic and mixed bacterial infections [12]. There are many studies that showed that HBOT could play important roles in signaling pathways for promoting neovascularization, matrix formation, and decreasing inflammation [13,14]. Therefore, we propose that HBOT could help to reduce the postoperative swelling.

Jaw cyst is a very common disease in the oral and maxillofacial area and the enucleation is the most common procedure for jaw cysts [15]. There is damage to the bone and soft tissue during the surgery, so the postoperative swelling is often serious. Hence, we chose the patients with jaw cyst as the research objects [16].

This study was designed to evaluate the clinical effect of HBOT for the management of the postoperative swelling. We hypothesized that HBOT could reduce the postoperative swelling.

Aim: The specific aim of the study was to compare the degree of postoperative swelling in two groups.

Materials & methods

Study design and patient samples

To address the research purpose, the authors designed and conducted a prospective, randomized, non-blinded, controlled clinical trial that got ethical approval from the institutional research board of our institute (review document: WCHSIRB-CT-2020-229), and conformed to the Declaration of Helsinki.

The study sample was composed of all patients who diagnosed with a single jaw cyst by two clinically experienced doctors and gave consent for the surgical treatment between September 2016 and June 2019 in our institution. The patients whose longest cystic diameter was greater than 2 cm on Computerized Tomography (CT) images were enrolled in the study. The patients were excluded from this study if they refused surgical treatment; they could not complete at least 6-month follow-up; they had contraindications of hyperbaric oxygen therapy.

This study included 60 patients, who were randomly divided into two groups according to a random numbers table, including the experimental group and control group, with 30 in each group. Enucleations were performed and the bone substitute was used to fill in all patients, and the 10-day HBOT was applied in the experimental group.

Equipment and software

The patients received HBOT in a multiplace hyperbaric chamber (HAUX, Germany). The bone substitute filled in the bone defects was β -tricalcium phosphate (DePuy Synthes, Switzerland). The Guided Tissue Regeneration (GTR) membrane was bovine acellular dermal matrix (Zhenghai, China). Statistical analyses were performed through SPSS 23.0 (IBM Corp, USA).

Study variables

The primary predictor variable was HBOT. The primary outcome variable was degree of postoperative swelling. Other variables were age, sex, and other postoperative complications.

Surgical technology

After administering general anesthesia, all patients were operated on by one experienced surgeon. After the cysts were taken out whole, the β -tricalcium phosphate was put into the bone defects, and the GTR membrane was placed and fixed to cover the lateral wall of the bone defect in all patients. Finally, the wound was sutured.

Following the surgery, the patients in the experimental group received HBOT for 10 days, while the patients in the control group did not receive HBOT. The HBOT therapeutic regimen was a 90-minute treatment of breathing 100% oxygen once a day for 10 days in a multiplace hyperbaric chamber pressurized to 2.0 atmosphere absolute.

All patients received the routine nursing cares for 7–10 days before the sutures were removed.

Data collection and measurement

The postoperative swelling was observed, graded and recorded from day 1 to day 7 after the surgery, according to the clinical features, which included local soft tissue enlargement, skin surface tension, the clarity of skin texture and brightness, etc.

Statistical analysis

Two doctors who were not on the surgical team undertook the statistical analysis. The analysis of variance and the Fisher exact test was used for statistical analyses. The weighted Kappa statistics were calculated to evaluation the consistency between the two investigators. All statistical analyses were calculated using SPSS 23.0 for Windows. A P value less than 0.05 was considered statistically different.

Table 1: The baseline characteristics and postoperative complications.

Study Variables	Experimental Group	Control Group	P Value
Sample size(n)	30	30	A
Age years (mean \pm SD)	44.5 \pm 25.7	40.16 \pm 20.8	0.64
Sex, n			
Men	16	19	0.60
Women	14	11	
Relevant nerve injury, n (%)	0 (0)	0 (0)	1
pathological fracture n (%)	0 (0)	0 (0)	1
Soft tissue depression n (%)	0 (0)	3 (10.7)	.000
Sites, n(%)			
Left maxilla	9 (31.1)	6 (21.4)	0.704
Right maxilla	7 (24.1)	4 (14.3)	
Left mandible	6 (20.7)	8 (28.6)	
Right mandible	7 (24.1)	10 (35.7)	

Note: Chi-squared test (Fisher exact probability method) and analysis of variance were used for analysis.

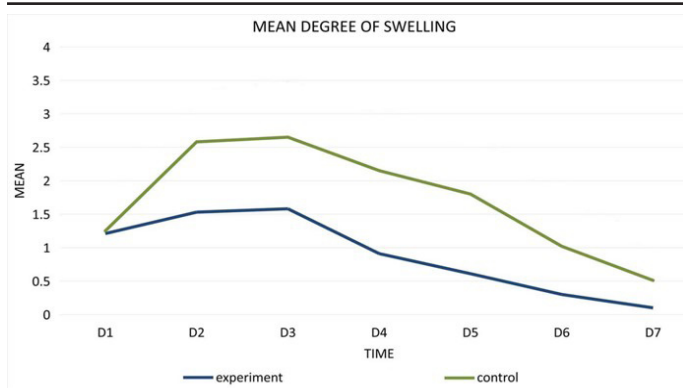


Figure 1: The swelling from day 1 to day 7 in the two groups.

Results

Overall, 60 patients completed the study. The total number of patients included 34 men and 26 women, with a mean age of 42.33 years (range 18.8 - 70.2 years). The operations and routine nursing cares were well performed in all patients. HBOT was conducted successfully in the experimental group. Base-line characteristics of enrolled participants who completed the study were displayed in Table 1.

A comparison of swelling over time is presented in Figure 1. There was no statistical difference between the experimental and control groups at day 1 after the surgery ($P > 0.05$). The degree of swelling in the experimental group was significantly lower than in the control and blank groups from day 2 to day 7 after the surgery ($P < 0.05$, $\kappa = 0.791 - 0.822$). These results indicated that the degree of swelling in the experimental group was significantly lower than the control group.

Discussion

The postoperative swelling is still an annoying problem. At present, the shortcomings of the existing methods to reduce postoperative swelling lead to the search for new methods, and HBOT has been suggested as a promising solution [9-11]. Therefore, we conducted a randomized controlled clinical trial to assess the effects of HBOT to reduce the swelling after enucleations of the jaw cysts.

In the present study, the results showed that the degree of postoperative swelling in the experimental group was significantly reduced compared with the control group. Possible mechanisms of action could be that that HBOT can promote the production of a variety of cytokines, which reduce capillary permeability and leakage. Furthermore, HBOT may cause blood vessels to contract to reduce tissue swelling [17,18].

Limitations

Limitations of this study include the small samples, results from only a single center and etc. As a result, selection bias and confounding bias could exist. The result of this study showed that HBOT could reduce the postoperative swelling; however, a larger scale, multicenter clinical study is needed to confirm the practical value of HBOT after the surgeries.

Conclusion

In conclusion, the results showed that the use of HBOT played a role to reduce the postoperative swelling. Therefore, HBOT should be considered for application in clinical work. Moreover, more high quality experiments are needed to explore the effect of HBOT on the swelling after other operations.

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References

1. Te Slaa A, Dolmans DE, Ho GH, Mulder PG, van der Waal JC, et al. Prospective randomized controlled trial to analyze the effects of intermittent pneumatic compression on edema following autologous femoropopliteal bypass surgery. *World J Surg.* 2011; 35: 446-454.
2. Singh V, Garg A, Bhagol A, Savarna S, Agarwal SK. Photobiomodulation Alleviates Postoperative Discomfort After Mandibular Third Molar Surgery. *J Oral Maxillofac Surg.* 2019; 77: 2412-2421.
3. Silva LD, Reis EN, Faverani LP, Farnezi Bassi AP. The efficacy of etodolac and ibuprofen, regarding gender, on pain, edema and trismus after impacted lower third molar surgery: A randomized prospective clinical split-mouth study. *Med Oral Patol Oral Cir Bucal.* 2020; 9: 24082.
4. Sari E, Simsek G. Comparison of the Effects of Total Nasal Block and Central Facial Block on Acute Postoperative Pain, Edema, and Ecchymosis After Septorhinoplasty. *Aesthetic Plast Surg.* 2015; 39: 877-880.
5. Ilhan AE, Cengiz B, Caypinar Eser B. Double-Blind Comparison of Ultrasonic and Conventional Osteotomy in Terms of Early Postoperative Edema and Ecchymosis. *Aesthet Surg J.* 2016; 36: 390-401.
6. Iannitti T, Rottigni V, Palmieri B. Corticosteroid transdermal delivery to target swelling, edema and inflammation following facial rejuvenation procedures. *Drug Des Devel Ther.* 2013; 7: 1035-1041.
7. Alfuth M, Strietzel M, Vogler T, Rosenbaum D, Liem D. Cold versus cold compression therapy after shoulder arthroscopy: a prospective randomized clinical trial. *Knee Surg Sports Traumatol Arthrosc.* 2016; 24: 2209-2215.
8. Polderman JA, Farhang-Razi V, Van Dieren S, Kranke P, DeVries JH, et al. Adverse side effects of dexamethasone in surgical patients. *Cochrane Database Syst Rev.* 2018; 11: CD011940.
9. Lima CAA, Favarini VT, Torres AM, da Silva RA, Sato FRL. Oral dexamethasone decreases postoperative pain, swelling, and trismus more than diclofenac following third molar removal: A randomized controlled clinical trial. *Oral Maxillofac Surg.* 2017; 21: 321-326.
10. Park YH, Song JH, Kim TJ, Kang SH, Chang AS, et al. Comparison of the use of evaporative coolants and ice packs for the management of preoperative edema and pain in ankle fractures: A prospective randomized controlled trial. *Arch Orthop Trauma Surg.* 2019; 139: 1399-1405.
11. Yan LJ, Zhang FR, Ma CS, Zheng Y, Chen JT, et al. Arteriovenous Graft for Hemodialysis: Effect of Cryotherapy on Postoperative Pain and Edema. *Pain Manag Nurs.* 2019; 20: 170-173.
12. Mathieu D, Marroni A, Kot J. Tenth European Consensus Conference on Hyperbaric Medicine: recommendations for accepted and non-accepted clinical indications and practice of hyperbaric oxygen treatment. *Diving Hyperb Med.* 2017; 47: 24-32.
13. Lam G, Fontaine R, Ross FL, Chiu ES. Hyperbaric Oxygen Therapy: Exploring the Clinical Evidence. *Adv Skin Wound Care.* 2017; 30:181-190.
14. Weitgasser L, Ihra G, Schäfer B, Markstaller K, Radtke C. Update

-
- on hyperbaric oxygen therapy in burn treatment. *Wien Klin Wochenschr.* 2019.
15. Ettl T, Gosau M, Sader R, Reichert TE. Jaw cysts - filling or no filling after enucleation?. A review. *J Craniomaxillofac Surg.* 2012; 40: 485-493.
 16. Pappalardo S, Guarnieri R. Randomized clinical study comparing piezosurgery and conventional rotatory surgery in mandibular cyst enucleation. *J Craniomaxillofac Surg.* 2014; 42: e80-5.
 17. Bosco G, Vezzani G, Mrakic Sposta S, Rizzato A, Enten G, et al. Hyperbaric oxygen therapy ameliorates osteonecrosis in patients by modulating inflammation and oxidative stress. *J Enzyme Inhib Med Chem.* 2018; 33: 1501-1505.
 18. Nasole E, Nicoletti C, Yang ZJ, Girelli A, Rubini A, et al. Effects of alpha lipoic acid and its R+ enantiomer supplemented to hyperbaric oxygen therapy on interleukin-6, TNF- α and EGF production in chronic leg wound healing. *J Enzyme Inhib Med Chem.* 2014; 29: 297-302.