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A Comparative Evaluation of the Efficacy of Local Active Oxygen Technology (Blue-M Gel®) in Wound Healing after Bilateral Surgical Disimpaction of Mandibular Third Molars - A Clinical Split Mouth Study"

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Abstract: ***Introduction: One of the most frequent oral surgical procedures performed by dental surgeons worldwide is the surgical extraction of impacted mandibular third molars. This procedure must be performed precisely to prevent any acute, delayed, or surgical complications. In order to promote better soft tissue healing and lessen postoperative complications like pain and swelling, the use of commercially available BLUE M® gel (high level oxygen releasing formula) has been recommended recently in surgical extraction wound sites. Aims and Objectives: To assess the feasibility and efficacy of Blue® m oral gel local Active oxygen technology in reducing postoperative complications such as pain and swelling after surgical extraction of impacted lower third molar. Materials and Methods: A prospective clinical split mouth study was conducted in a study sample involving 20 patients (40 impacted teeth split arch) with bilaterally impacted mandibular third molars. The surgical procedure was performed by a single surgeon bilaterally in the same appointment. Blue m oral gel was placed only into the post extraction socket (study site) with the help of gel applicator and after thorough irrigation both study site and control site sutured with 3 - 0 black silk. All the patients were assessed for post operative pain using 10 cm visual analogue scale (VAS) 4 hours post operatively and also on 2nd and 7th postoperative day. Post operative edema was assessed pre and postoperatively (2nd and 7th day) using physical method on a graduated measuring tape. The Post operative soft tissue healing response was noted using Landry Healing Index on 7th post operative day. Results: Out of 20 study subjects, 10 (50%) were males and 10 (50%) were females. The mean age for overall sample was 30.1 +/ - 5.7 years. The data was analysed by Statistical Package for Social Sciences (SPSS) to find statistical significance. P value less than 0.05 ($p<0.05$) considered statistically significant at 95% confidence interval. The results showed that there was statistically significant difference in relation to VAS scores taken at different time intervals on test side than control side. P value revealed that there was evidence of significant statistical difference with respect to LC - GO and TR - A measurements between case side (P value - 0.00014) and control side (P value - 0.0025) on 2nd post - operative day. Also, the post operative soft tissue healing response was very good with incorporation of active oxygen (blue® - m) gel within extraction sockets (study site) of impacted third molars. Conclusion: The present study concludes that incorporation of active oxygen (blue® - m) gel within extraction sockets of impacted mandibular third molars proved to be beneficial for patients, yielding a quicker postoperative recovery with fewer complications such as postoperative swelling and edema, pain, and trismus, better overall postoperative results in terms of faster soft tissue healing.***

Keywords: Pain, Swelling, Trismus, Third molar surgery, Blue® m oral gel, TR - A (Center of tragus to angle of mouth), LC - GO (Lateral canthus of eye to gonium)

1. Introduction

Surgical removal of impacted mandibular third molars is one of the most common oral surgical procedures done by dental surgeons around the globe. Despite of the various precautions taken, the postoperative period following surgical removal of third molar is frequently associated with complications such as pain, swelling, infection and temporary restriction of mouth opening [1]. Thus, many clinicians have emphasized the necessity for better discomfort control in patients who undergo third molar surgery and several types of medications have been proposed. Despite various advantages, the systemic

antibiotic therapy has various disadvantages with the evolution and maturing of resistant bacteria and administration of higher dosages so as to attain required concentration at the target sites [2] [3].

A team of dental surgeons led by **Dr. Peter Blijdorp** in the Netherlands, developed a product based on active oxygen technology (blue® m oral gel), its composition, sodium perborate, the glucose oxidase enzyme derived from honey, xylitol and lactoferrin. Oxygen is an essential nutrient for cellular metabolism, especially energy production. The substance is involved in multiple processes including oxidative killing of bacteria, re - epithelialization, angiogenesis, and collagen synthesis [4]. In a clinical trial conducted in cardiology patients suffering from periodontal disease, inclusion in everyday hygienic oral care of blue® m toothpaste and mouthwash reduced the severity of inflammatory changes and improved the hygienic condition of the oral cavity [5]. A case study was done to evaluate the effects of blue® M mouthwash on oral surgical wounds which demonstrated that Topical Oral Oxygen Therapy (OOT) with blue® M mouthwash can be a substitute for chlorhexidine in postsurgical care [6]. Considering the benefits of slow oxygen release seems to induce wound healing and its beneficial effects in the few clinical studies related to periodontal diseases, the present study was done to compare and assess the effect of oxygen releasing oral gel for soft tissue wound healing after surgical extraction of impacted mandibular third molars [7]. The present study was published as a thesis submitted to the Kaloji Narayana University of Health Sciences, Hyderabad, Telangana by Dr. I. Venkata Krishna et al (2022) [32].

Aim

Evaluation of the efficacy of Blue® m oral gel local active oxygen technology in assessing:

1) Postoperative pain using visual analogue scale.
2) Postoperative edema.
3) Postoperative soft tissue healing response using Landry Healing Index.

2. Materials and Methods

The present study was a prospective clinical split mouth study with a sample size of 20 patients attending the Department of Oral and Maxillofacial Surgery, Panineeya Institute of Dental Sciences and Research Centre, who require surgical removal of impacted lower third molars under local anesthesia. We obtained institutional ethical clearance and informed consent from the subjects enrolled for the study. The following were the inclusion and exclusion criteria.

Inclusion criteria:

1) Healthy patients of age group 18 to 40 years.
2) Patients with bilaterally Impacted mandibular third molar with similar anatomical position, and similar surgical difficulty (Pell and Gregory classification was followed).

Exclusion criteria:

1) Medically compromised patients.
2) Associated pathology with mandibular third molars.
3) Patients with adverse oral habits like Heavy smoking and Tobacco chewing.

The procedure was performed by the same surgeon bilaterally in the same appointment and is done under Local anaesthesia (2% lignocaine hydrochloride in 1: 80, 000 dilution adrenaline). By giving similar incision and flap design (Wards incision), teeth were extracted on both sides with elevation or with minimal bone guttering under strict aseptic conditions. After removal of any sharp bony edges/ tooth particles and thorough curettage of the socket, proper irrigation with normal saline is done in both the sockets bilaterally. Blue m oral gel was placed only into the study socket with the help of gel applicator, after letting the gel to act for 2 mins, the area was rinsed with sterile saline. Primary wound closure done in both the sockets bilaterally using 3–0' Black silk. All the subjects were prescribed a five - day course of Antibiotics and Analgesics postoperatively.

Postoperative edema was assessed using physical method by measuring preoperative and postoperative distance between Center of tragus to angle of mouth (TR - A) and Lateral canthus of eye to gonium (LC - GO) measured on 2nd and 7th post operative day to quantify facial swelling. Patients were assessed for postoperative pain using Visual Analogue Scale, 4 hours post operatively, 2nd and 7th postoperative day. Post operative soft tissue healing response was noted using Landry Healing Index on 7th post operative day.

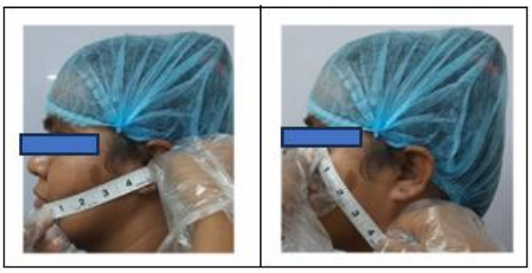

Figure 1: Physical method of measuring Lateral canthus of eye to gonium (LC - GO) and Center of tragus to angle of mouth (TR - A) in patients for the purpose of assessment of postoperative swelling.

Figure 2: Pre - operative, 2nd and 7th day post operative extraoral images of the patient

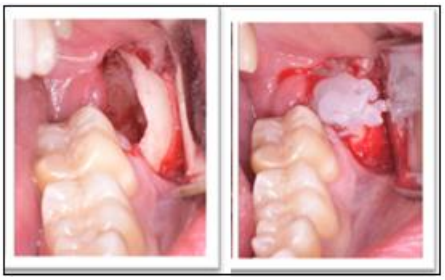

Figure 3: Intra operative images of case site

Figure 4: Blue m gel and applicator

Figure 5: 7th Postoperative day - assessment of soft tissue healing on case site and control site

3. Observations and Results

Paired simple "t" test, chi - square test, and one - way analysis of variance were applied for testing the statistical significance, using Statistical Package for Social Services (SPSS), version 20, for windows software. P value less than 0.05 ($p<0.05$) considered statistically significant at 95% confidence interval.

Out of 20 study subjects, 10 (50%) were males and 10 (50%) were females. The mean age for overall sample was 30.1 +/ - 5.7 years. P value revealed that there was evidence of significant statistical difference with respect to LC - GO and TR - A measurements between case side (P value - 0.00014) and control side (P value - 0.0025) on 2nd post - operative day. One - way ANOVA test output shows that there was statistically significant difference in relation to VAS score on case site and control site at different time intervals (p= 0.0001).

Out of 20 control sides, 14 (70%) showed good healing, whereas 6 (30%) showed very good healing. Out of 20 case sides, 7 (30%) showed very good healing and 13 (40%) excellent healing. Chi - square output showed that there was significant association between the treatment groups (chi square value= <0.001).

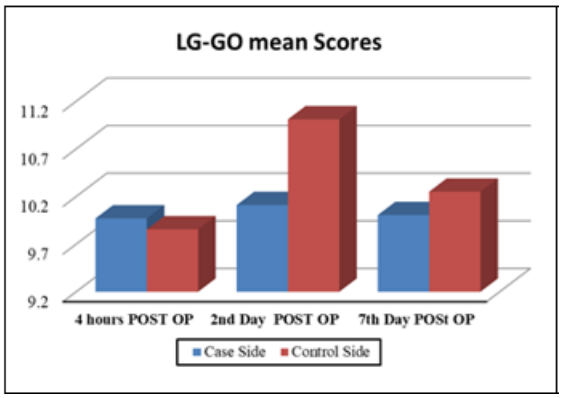

Figure 6: Mean values of swelling parameter Lateral canthus of eye to Gonium (LC - GO) in cases & controls at different time events

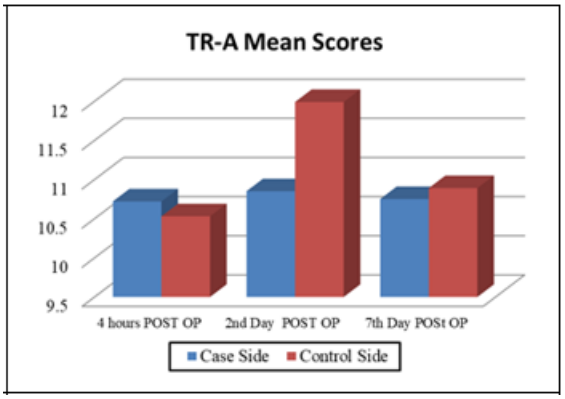

Figure 7: Mean values of swelling parameter Center of tragus to Angle of Mouth (TR - A) in cases & controls at different time events

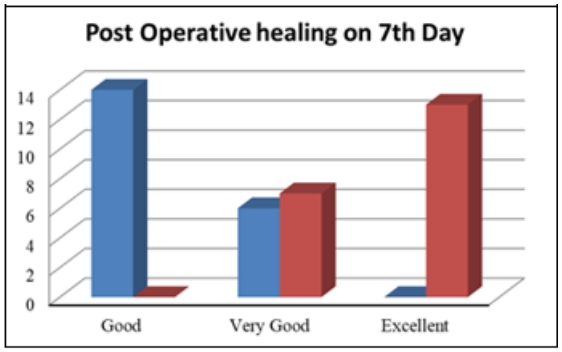

Figure 8: Distribution of patients (cases & controls) according postoperative healing on day 7

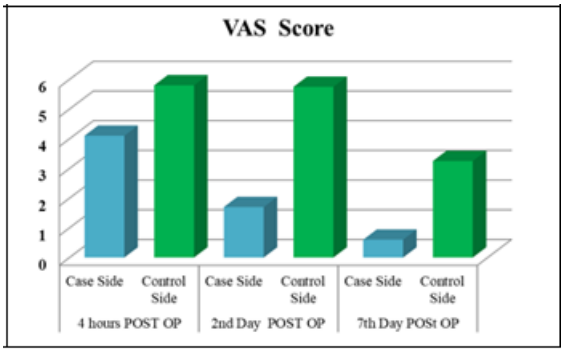

Figure 9: Distribution of pain (VAS) at different time events in Cases and Controls

Table 1: Comparison of Lateral canthus of eye to Gonium (LC - GO) Measurements between Cases and Controls Day 2 Post Operative

Group Statistics							
Group	N	Mean	Standard Deviation	Est. Error Mean	Mean Difference	P Value	Significance
Cases	20	10.11	0.57	0.13	-0.9	0.00014	Significant
Controls	20	11.01	0.77	0.17			

Table 2: Comparison of Center of tragus to Angle of Mouth (TR - A) Measurements between cases and Controls Day 2 Post Operative

Group	N	Mean	Standard Deviation	Est. Error Mean	Mean Difference	P Value	Significance
Cases	20	10.845	1.05	0.23	-1.145	0.0025	Significant
Controls	20	11.99	1.18	0.26			

Table 3: Comparison of Healing Index Scores between the two groups on 7th Post Operative Day.

Chi Square Test							
			Healing			Total	Chi Square
			Good	Very Good	Excellent		
Group	Controls	Count	14	6	0	20	<0.001
		% with in Healing	70.00%	30.00%	0%	100.0%	
	Cases	Count	0	7	13	20	
		% with in Healing	0%	35.00%	65.00%	100.0%	
Total		Count	14	13	13	40	
		% with in Healing	35.00%	32.5%	32.5%	100.0%	

4. Discussion

The main results of our study are local application of Blue - m® oral gel during third molar surgery resulted in significant reduction in swelling, pain and reduced incidence of postoperative complications when compared with controls. Postoperative pain, edema, and dry socket are consequences of tissue injury and microbial infection during third molar surgery.

Many Strategies have been used to inhibit postoperative swelling following removal of impacted lower third molar. These include different surgical closure techniques with or without incorporation of drains, use of drugs such as analgesics, corticosteroids and antibiotics. Other reported modalities include physical therapeutic methods such as cold compresses, cryotherapy and laser application.

The Bluem® oral gel is a specially recently developed formula by implantologists, oral surgeons and dentists for specific targeted problems in the mouth. Blue ®m active oxygen technology accelerates wound healing, implant integration and bone regeneration in a safe, effective, and non - invasive approach. Wound healing requires a variety of cells to increase their metabolic activity, resulting in a high oxygen demand [13]. Oxygen at the wound site has been shown to promote wound healing by stimulating several processes, including neovascularization [14], Collagen production [15, 16, 17] epithelialization [13], phagocytosis (engulfing of microorganisms, cells, or debris by macrophages or neutrophils), neutrophil - mediated oxidative microbial killing [12] and degradation of necrotic wound tissue [18]. Lack of sufficient oxygen (hypoxia) has been associated with pain in the wound area, with the prevalence of hypoxia being more pronounced in patients who are smokers and diabetics. These populations demonstrate slower wound healing and increased risk of wound healing complications compared to healthy patients [19, 20, 21].

Blue ®m oral gel is using a mechanism to deliver active oxygen (H2O2) in a controlled manner directly to the treatment site. In contact with saline, Sodium perborate is converted into sodium borate and H2O2. In low concentrations of 0.003% - 0.015%, hydrogen peroxide has a disinfectant action [18], and occurs together with antibacterial ROS (reactive oxygen species) during the respiratory burst of neutrophils in normal wound fluid [22, 23] and has a chemotactic effect on leucocytes [24]. The concentrations of hydrogen peroxide in the blue ®m products used are not comparable to the high concentrations (1.5 – 3%) of hydrogen peroxide used in medicine as a disinfectant. It is known that the production of free radicals then causes damage to the wound [12, 22]. Research has shown that the continuous presence of a low concentration of hydrogen peroxide kills pathogenic bacteria much more effectively than a one - off high concentration [25]and that fibroblasts are not damaged by this [26].

The sodium perborate active ingredient in Blue ®m oral gel when applied to injured tissues accelerates tissue re - modelling [27]. In - addition helps in plaque control along with other ingredients like honey and xylitol [28]. The other ingredient lactoferrin potently stimulates the proliferation and differentiation of primary osteoblasts, thus acting as a bone growth accelerator [29]. More over lactoferrin acts as antibacterial, - antiviral, antifungal, anti - inflammatory, and anticarcinogenic properties.

Acute postoperative pain following third molar surgery is predominantly a consequence of inflammation caused by tissue injury [30]. Its course depends on the degree of surgical trauma suffered, the need for bone tissue removal, and the extension of periosteum displacement [31].

The present study showed a statistically significant decrease in mean pain score (VAS) on the test side than the control side on 2nd and 7th post operative day. This difference may be attributed to the fact that, release of more active oxygen of

Blue - m oral gel normalize and controls detrimental bacteria at the test side extracted socket wounds.

The results showed that there is significant decrease in post - operative swelling was observed with respect to lateral canthus to gonium measurements (LC - GO) measurements and center of tragus to corner of mouth (TR - A) measurements on 2nd post - operative day. The results were in accordance with the study conducted by **Tatiana Miranda et al** to evaluate the effects of blue® - m mouthwash on oral surgical wound, in which the results have shown that the number of inflammation pixels was lower on the test side, indicating improved healing [6].

In the present study, the post - operative soft tissue wound healing response was improved with topical application of Blue® M gel because it provides adequate wound tissue oxygenation. As oxygen is intricately involved in numerous biological processes including cell proliferation, angiogenesis, and protein synthesis, it helps in the restoration of the tissue function and integrity (9). Major advantages of Topical Oxygen Therapy appear to be its independence of the wound microcirculation, its lower cost compared with systemic oxygen therapy, the lower risk of oxygen toxicity, and its relative simplicity of application and portability.

This study clearly indicated that the Blue® - m oral gel does affect the post - operative consequences following surgical removal of impacted mandibular third molars. In this series of cases, we opted to prescribe for patients the topical application of blue® - m oral gel that has a slow release of oxygen, with the hypothesis that, on the side that the product was applied, the patient would feel less pain and have a lesser inflammatory process. The present study was published as a thesis submitted to the Kaloji Narayana University of Health Sciences, Hyderabad, Telangana by Dr. I. Venkata Krishna et al (2022) [32].

Inflammatory complications after third molar surgery remain an important factor in the quality of life of patients at the early postoperative period [10]. Oral surgeons should be aware of the different modalities of alleviation of these complications to make postoperative recovery more comfortable for patients.

5. Conclusion

This study shows that incorporation of active oxygen (Blue® - m) gel within extraction sockets of impacted third molars proved to be beneficial for patients, yielding a quicker postoperative recovery with fewer complications such as postoperative swelling and edema, pain, and trismus, better overall postoperative results in terms of faster soft tissue healing. Also, it is critically important to recognize that O2 cannot act in isolation as the other fundamental factors in wound care are fluid management, temperature management, pain control, the use of appropriate sterile techniques, and administration of prophylactic antibiotics are required to successfully execute wound healing. Thus, local active oxygen therapy through Blue - M oral gel is generally recommended as an adjunct to other forms of wound care.

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