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Review Article

## Oxygen, Hyperbaric Oxygen and Ozone as Therapeutic Agents in Oral and Maxillofacial Surgery: literature Review

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### Abstract

Medical consideration in the surgical specialties such as Oral and Maxillofacial Surgery, in the form of prescribing medications for some diseases, preoperative preparation, post operative care and follow up, is an important and integrated part in management of surgical patients,

Oxygen as the drug plays key role in treatment of surgical patient, and contributes strongly in treatment of major trauma, shock, sepsis; perioperative and postoperative considerations and in patients with various other medical comorbidities.

in this review we discussed the oxygen therapy as well as hyperbaric Oxygen in addition to the Oxygen with the 3 atoms, namely Ozone, in oral and Maxillofacial Surgery speciality.

**Keywords:** O<sub>2</sub> supplement, adjunctive therapy, HBO, OZONE, osteonecrosis, Medication related necrosis

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### 1- O<sub>2</sub>

Oxygen therapy is the administration of oxygen at concentrations greater than that in ambient air (20.9%) with the intent of treating or preventing the symptoms and manifestations of hypoxia, which includes agitation, personality change, nausea, headache, tachycardia and cyanosis <sup>1</sup>

Administration of supplemental oxygen is an essential element of appropriate management of many conditions including, major trauma, shock, sepsis; perioperative and postoperative considerations as well as for patients with various other medical comorbidities <sup>2</sup>

#### 1-1 In general anaesthesia on daily base surgery

Oxygen supplement use For Maintenance of routine anesthesia, during the induction as Preoxygenation is well accepted practice <sup>3</sup> as well as in post operative recovery, most postoperative surgical patients routinely receive supplemental oxygen therapy to prevent hypoxemia, and furtherly prevent its deleterious effect s (arrhythmias, myocardial ischemia, and cognitive dysfunction), with its lately effect on the tissue oxygenation which will affect the tissue healing and the immune system ( Oxidative killing by neutrophils was impaired at low oxygen tensions often found in wounds) <sup>4</sup> to the degree that may precipitate infection <sup>5</sup> the goals of postoperative oxygen therapy should be to maintain normoxemia and avoid unnecessary oxygen administration

Causes which may precipitate postoperative hypoxemia are:

- Anaesthetic factors such as alveolar hypoventilation, ventilation/perfusion mismatching,

-decreased cardiac output,

-Shivering (increased oxygen consumption) <sup>6</sup> (induced by volatile agents or recovery from intra-operative hypothermia).

Also, 'diffusion hypoxia' may transiently contribute to early hypoxemia as a result of the very soluble nitrous oxide diffusing out of the circulation into the alveoli when aesthesia is terminated, reducing the concentration of oxygen in the alveolar gas. <sup>1</sup>

#### 1-2 FOR Trauma patient

Supplementary oxygen is widely used for trauma patient in both prehospital, initial phase of treatment, as well as hospital phase. <sup>7</sup>

Blood loss is one reason that can lead to hypoxia in trauma patient, due to the Low intravascular volume resulting in poor oxygen transportation, <sup>8</sup> which may necessitate administration of supplemented oxygen, and indeed supplementary oxygen will be simultaneously with the correction of the causative factors of hypoxaemia.

At a hospital level, the supplementary oxygen is needed at the time of operation for the correction and surgical treatment of the trauma. <sup>3</sup>

Both hypoxaemia and hyperoxaemia may be harmful, so using O<sub>2</sub> should be use cautiously

### 1-3 space infection, and/or septic patient

Air way obstruction represent a serious and dangerous manifestation in some space infection in the head and neck region such as parapharyngeal spaces, lateral pharyngeal spaces, and obviously Ludwig's angina, with the hypoxia as the final predicted result.<sup>1</sup>

By using the principle of treating the underline cause, the main concern should be directed to the correction of this obstruction, Oxygen is a treatment for hypoxaemia, not breathlessness. nevertheless, still the supplementary oxygen has got a role in the management of such cases<sup>1</sup>

On the other hand, there is an important role for supplementary Oxygen, if this infection progress to septic shock.

Sepsis is a common reason for ICU's admission<sup>9</sup> patients with sepsis receive supplemental oxygen to get the benefit that boost the body's ability to fight infection might be enhanced with liberal use of oxygen via enhanced oxidative killing of bacteria because neutrophil superoxide production increases in the presence of high oxygen tension<sup>3,4</sup>

## 2-Hyperbaric Oxygen;

HBO therapy is a therapy based on the inhalation of 100% pure oxygen intermittently in a completely closed pressure chamber, at pressures higher than 1 atmosphere, from ambient air, by mask or by endotracheal tube<sup>10</sup> it shares the effect of oxygen and effect of Pressure<sup>11</sup>

The pathophysiology of ORN is best illustrated by the "3 H" principle which describes the effect of radiation on tissue as presented by Marx<sup>12</sup>

Hyperbaric oxygen therapy (HBO) is an effective adjunctive therapy for chronic osteomyelitis and osteoradionecrosis and can also be used for the treatment of MRONJ<sup>13</sup> Although the mechanism of HBO effect on MRONJ is not fully clarified, this treatment modality has been proven to be successful in increasing as adjunctive therapy before or after the surgical treatment.<sup>14</sup>

### 2-1- Osteoradionecrosis (ORN)

is a dreaded complication of the use of radiation therapy in the treatment of head and neck cancer<sup>15</sup> The incidence of osteonecrosis in oncology patients treated with high doses of radiation (1% to 15%).<sup>16</sup> The mandible is most commonly affected<sup>17</sup>

Hyperbaric Oxygen therapy (HBOT) for treatment of radiation-damaged tissues was introduced in the early 1970.<sup>18,19</sup>

There is a role of HBO in both treatment and prophylaxis of osteonecrosis(ORN)<sup>20</sup>

Although still considered controversial by some, hyperbaric oxygen (HBO) therapy used as an adjunctive treatment for ORN has been associated with improved success rates<sup>21,22,23</sup>

There is wide consensus on the use of prophylactic HBO in prophylaxis of mandibular osteonecrosis, still there is a lack of knowledge about the indications for HBOT in ORN and, whether the stage of ORN also plays a role in the efficacy of HBOT<sup>24</sup>

### 2-2 In Medication related necrosis

Medication-related osteonecrosis of the jaw (MRONJ), new nomenclature replacing bisphosphonate-related osteonecrosis of the jaw [BRONJ]) is one of the major complications after tooth ex- traction in patients using bisphosphonates (BPs)<sup>25</sup>. Microscopically, MRONJ as a condition that causes depletion of osteoclast activity and function, which is affect the bone

turnover and wound healing<sup>26</sup>. Since osteoclast activity and functions are regulated by reactive oxygen-sensitive signaling molecules, theoretically, this gives justification to HBO to be use adjunctive therapy.<sup>26</sup>

HBO is not yet widely considered an efficient treatment for MRONJ as there are a lack of Randomized Control Trials (RCT) on its action.<sup>27</sup>

## 3-Ozone

Ozone (O<sub>3</sub>), a gas discovered in the mid-nineteenth century is a molecule consisting of three atoms of oxygen in a dynamically unstable structure<sup>28</sup>. It is an atmospheric gas (O<sub>3</sub>) founded in the Earth's stratosphere with excellent medicinal properties, and minimally invasive therapy, including antimicrobial activity, immunostimulant and antioxidative<sup>29</sup>

Medical O<sub>3</sub> 's effectiveness has been well-documented, with minimal side effects. in treating the infection, by its ability to Inactivate bacteria, viruses, fungi, yeast and protozoa:

It was suggested that the effects of ozone are cumulative, so the repeated therapies are recommended<sup>30</sup>

There is 3forms for the Ozone in the medical field: gaseous, water (ozonated water), and oil "Commercially available ozone gel/oil (depending on the medical condition for which it is intended to be used<sup>31</sup>

Ozone can accelerate Post extraction socket healing and more over can act as analgesic and as antibiotic with its antibacterial activity.<sup>31</sup>

### 3-2- In osteonecrosis

There is a wide variation in recommendations and guidelines in international literature for the treatment of osteoradionecrosis. The benefits of using ozone as stimulation of local revascularization through the enhancement of angiogenesis and fibroblasts, there is promising result in treatment of osteoradio necrosis<sup>32</sup> as well as the prophylaxis<sup>33</sup>

### 3-3- In medication related necrosis

Ozone therapy was introduced in the list of approaches to treat MRONJ in 2012<sup>29</sup>

The O<sub>2</sub> /O<sub>3</sub> therapy with and without the debridement with piezoelectric surgery represents a promising approach to improve the treatment of BRONJ and therefore the life quality of the patient<sup>34</sup>

It acts as Coadjunct therapy with promising result<sup>29</sup>

### 3-4 In Temporomandibular joint disorder

TMDs are commonly treated in a conservative fashion, accordingly emerging of ozone minimally invasive with its all properties as analgesic and antibacterial is let it more than welcoming for the treatment of TMJD,

It was found that Ozone gas injection for treatment of internal derangement of the TMJ has a better outcome in comparing with other therapy nonsteroidal anti-inflammatory drugs and muscle relaxants<sup>35</sup>

On the other hand, there is effectiveness of bio-oxidative ozone therapy in the TMD of muscular origin<sup>36</sup>

The O<sub>2</sub> /O<sub>3</sub> therapy has a low biological and economic impact thus representing a valuable therapeutic approach that could be considered/implemented as the mainstream therapy for the

## Conclusion

Medical aspect in treatment of patients is being hand in hand with the surgical part in oral and Maxillofacial surgery, before surgery the patient needs to be medicated as part of preparation for the surgery and then for optimal result, the wound healing is an important factor for satisfying surgical result.

Oxygen as a drug play important role before, during and after any surgical procedure.

Both Hyperbaric oxygen and Ozone have been used as adjunctive therapies before or after, the surgical treatment of osteoradionecrosis and Medication related necrosis.

hyperbaric oxygen and Ozone (oxygen with 3 atoms) constitute application of the modern science at the medical field assisting in healing in many cases.

## Author Contributions

The author confirms being the sole contributor of this work and has approved it for publication

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