



PROGRAM AND PROCEEDING BOOK

The 3rd ASEAN Plus and Tokushima Joint International Conference

Theme:

“Strategic Achievement of Oral Sciences and Promotion of Quality of Life and Professional Education for Oral Hygienists by Using Information and Communication Technology”

Organized by:

Faculty of Dentistry
Hasanuddin University
Makassar, Indonesia



Faculty of Dentistry
The University of Tokushima
Tokushima, Japan



Venue: **Imperial Aryaduta Hotel, Makassar, Indonesia**
Date : **December 4th - 5th, 2014**

Publisher
Faculty of Dentistry
Hasanuddin University
Makassar, Indonesia



Eiji Tanaka
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Program and Proceeding Book

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on "Strategic Achievement of Oral Sciences and Promotion of Quality
of Life and Professional Education for Oral Hygienists by Using
Information and Communication Technology"**

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Organized by

**Collaboration,
Faculty of Dentistry The University of Tokushima
Faculty of Dentistry Hasanuddin University**

Executive Editors : Eiji Tanaka, Mansjur Nasir

Editor : Ardo Sabir

Administrator : Abdul Majid Saputra

Design & Layout : Pitter L. Bosh



Preface



Dear Colleagues,

It is with great pleasure that I welcome you to the 3rd Asian Plus and Tokushima Joint International Conference, Makassar, Indonesia on December 4 and 5, 2014.

The past 1st and 2nd conferences were successfully completed with 200 participants at Bali in 2010 and with 800 participants at Yogyakarta in 2012, respectively, and highlighted with cutting-edge scientific research on dentistry as well as the international exchange of young researchers and clinicians. The mission of this conference is to try to improve the level of basic and clinical sciences on dentistry, education for dentists and oral hygienists,

and furthermore, people's oral health. To ensure the success of this mission, we decided to have this year's theme as "Strategic Achievement of Oral Sciences and Promotion of Quality of Life and Professional Education for Oral Hygienists by using Information and Communication Technology". ICT has especially become a potent tool for promoting and enhancing international communication skills and knowledge. I would also like to see discussions about effective applications of ICT for fostering human resources. This conference promises to be yet another memorable meeting with special lectures, science and clinical exhibits from our esteemed colleagues around South-east Asia and Japan.

Once again, I hope this conference will be a forerunner of the many more personal and interdepartmental exchanges between Tokushima University and universities in South-east Asia. I wish you all a very successful and highly enjoyable meeting.

Finally, I would like to thank Dr. Mansjur Nasir and his faculties at Hasanuddin University for the preparations and arrangements of this conference.

With best wishes,

Tetsuo Ichikawa, DDS, PhD
Dean, Faculty of Dentistry
Professor, Oral & Maxillofacial Prosthodontics
Tokushima University

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Faculty of Dentistry Hasanuddin University
Makassar, South Sulawesi, Indonesia

Jl. Perintis Kemerdekaan KM.10 Makassar 90245
Telp : +62 411 586012, +62 411 587444 Fax. 584641



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Schedule of Conference



December 4th, Thursday, Allamanda Ballroom

9:00^{am} - 9:15^{am} Opening Remark by Dean Prof. Tetsuo Ichikawa

9:15^{am} - 10:55^{am} Session 1 "Biomaterials & Tissue Engineering"

**Chairpersons: Prof. Takafumi Noma (The University of Tokushima)
& Dr. Susilowati (Hasanuddin University)**

9.15 - 9.35 Keynote speaker 1

"Extremely Low Frequency Pulsed Magnetic Fields Accelerate Osteoblast Differentiation"

Megumi Watanabe

(Dept. Prosthodontics, Tokushima Univ. Grad. Sch)

9.35 - 9.55 Keynote speaker 2 *

"The Effect Of Oxygen Hyperbaric Therapy On Activity Of Collagenase 2 In Hyperglycemic Gingiva Rats"

Dian Mulawarmanti

(Dept. Oral Biology, Hang Tuah University)

9.55 - 10.55 General speakers (Presentation 10 min + discussion 5 min)

9.55 - 10.10 "Ctip2 Regulation Of Tooth Development Via Sp6 Gene Expression"

Arya Adiningrat

(Dept. Molecular Biology, Tokushima Univ. Grad. Sch.)

10.10 - 10.25 "Combined Effects Therapy Of Recombinant Parathyroid Hormone (PTH 1-34) And Low-Intensity Pulsed Ultrasound On Osteoporotic Bone Fracture Healing In Rats"

Karima Qurnia Mansjur

(Dept. Orthodontics, Tokushima Univ. Grad. Sch.)

10.25 - 10.40 "Basic Research And Clinical Application Of Propolis In Conservative Dentistry And Endodontic Treatment"

Ardo Sabir

(Dept. Conservative Dentistry, Hasanuddin University)



10.40 - 10.55 "Analysis Of Gene Mutation Of Topoisomerase II (Gyrase A) *Porphyromonas gingivalis* Which Is Resistant To Ciprofloxacin"
Irene Edith Rieuwpassa
(Dept. Oral Biology, Hasanuddin University)

10:55^{am} - 3:35^{pm} Session 2 "Mastication And Swallowing"
Chairpersons: Prof. Yoshizo Matsuka (The University of Tokushima) & Prof. Mansjur Nasir (Hasanuddin University)

10.55 - 11.15 Keynote speaker 1
"Oral Health Improvement Of School Age Children And Elderly In Indonesia Related To Quality Of Life"
Armasastra Bahar
(Dept. Dental Public Health, Univ. of Indonesia)

11.15 - 11.35 Keynote speaker 2
"Clinical Significance Of The Main Occluding In Prosthodontic Treatment"
Takaharu Goto
(Dept. Prosthodontics, Tokushima Univ. Grad. Sch)

Special lecture:

Invited Speakers from Asian Countries and World

11.35 - 12.35 "Development Of Novel LZ-8 Protein-Containing Porous Composite Sponge Scaffold For Biomedical Applications: Biocompatibility Evaluation And An Animal Study In Rabbit"
Keng-Liang Ou
(Taipei Medical University, Taiwan)

12.35^{pm} - 1.35^{pm} Lunch

1.35 - 2.35 "Afflictions Of The Lips"
Hashim Yaacob
(Quest International University Perak, Malaysia)

- 2.35 - 3.35** **General speakers (Presentation 10 min + discussion 5 min)**
- 2.35 - 2.50** “Masseter Muscle Activity During Awake/Sleep State With All Day
EMG Recording”
Katsuhiko Omoto
(Dept. Prosthodontics, Tokushima Univ. Grad. Sch)
- 2.50 - 3.05** “Leptin Role In The Process Of Orthodontic Tooth Movement”
Eka Erwansyah
(Dept. Orthodontics, Hasanuddin University)
- 3.05 - 3.20** “A Study Of Bolton Analysis, Arch Form And Tooth Inclination In
Orthodontic Treatment”
Edy Heriyanto Habar
(Dept. Orthodontics, Hasanuddin University)
- 3.20 - 3.35** “Plaque Accumulation And Matrix Metalloproteinase 8 In Gingival
Crevicular Fluid After Insertion Porcelain Fused To Metal Jacket
Crown”
Ike Damayanti Habar
(Dept. Prosthodontics, Hasanuddin University)
- 3.35pm - 3.50pm** **Coffee Break**
- 3.50pm - 5.50pm** **Poster presentations and Discussion**
- 7.00pm - 10.00pm** **Banquet Dinner (Welcome party)**

Session 1.2

The Effect Of Oxygen Hyperbaric Therapy On Activity Of Collagenase 2 In Hyperglycemic Gingiva Rats

Dian Mulawarmanti¹, Kristanti Parisihni¹, Widyastuti²

¹ Laboratory of Oral Biology, ² Laboratory of Periodontic Faculty of Dentistry, Hang Tuah University, Surabaya, Indonesia.

e-mail: dian.mulawarmanti@hangtuah.ac.id

Objectives: Collagenase-2 is an important for tissue modeling, and active collagenase-2 in gingiva is associated with the degradation of periodontal tissues in progressive periodontitis whereas the latent enzyme is predominant in gingivitis. Hyperbaric Oxygen Therapy (HBOT) is involved administration 100% oxygen under pressure. It has been used as an adjuvant therapy to improve wound healing. The aim of the research is to investigated effects HBOT 2,4 ATA on activation of collagenase-2 in hyperglycemic gingival rats

Materials and Methods: A total of 45 male Wistar rats were equally divided in healthy controls (group 1), hyperglycemic (group 2), hyperglycemic+HBOT (group 3), hyperglycemic ligature-induced (group 4), and hyperglycemic ligature-induced +HBOT (group 5). Experimental hyperglycemic was induced by once daily intraperitoneal administration of streptozotocin is diluted in buffer citrate, at a dose of 30 mg/kg of BW for 4 days. ligature-induced periodontitis was created by tying silk ligatures on the necks of mandibular incise until 30 days, treatment HBO 2,4 ATA 3x30 minutes for 10 days and the animals were decapitated. The measurement collagenase 2 in gingival tissue after 50 days with ELISA method.

Results : It was found gingival collagenase-2 activity at hyperglycemic decreased significantly $p=0.000$ (1.59378 ± 0.447) after 10 sessions HBOT than without HBOT (10.395 ± 0.6817) and gingival MMP-8 levels hyperglycemic ligature-induced (2.0911 ± 0.2798) decreased significantly $p=0.000$ than without HBOT (11.4271 ± 0.2055).

Conclusion: HBOT can reduces collagenase 2 in hyperglycemia gingiva.

Key words: collagenase-2, hyperbaric oxygen, hyperglycemia, periodontitis.

References : Sorsa T, Tervahartiala, Leppilahti J, Hernandez M, Gamonal J, Tuomainen AM, Lauhio A, Pussinen PJ, Mäntylä P. 2011. Collagenase-2 (MMP-8) as a point-of-care biomarker in periodontitis and cardiovascular diseases. Therapeutic response to non-antimicrobial properties of tetracyclines. *Pharmacological Research*. 63:108-113. Zhang Q and Gould, L. J. 2013. Hyperbaric Oxygen Reduces Matrix Metalloproteinases in Ischemic Wounds through a Redox-Dependent Mechanism . *Journal of Investigative Dermatology* 134, 237-246.



THE EFFECT OF OXYGEN HYPERBARIC THERAPY ON COLLAGENASE-2 OF HYPERGLYCEMIC GINGIVA RATS

Dian Mulawarmanti

Laboratory Oral Biology
Faculty of Dentistry, Hang Tuah University
Surabaya, Indonesia



The 3rd ASEAN Plus and Tokushima
Joint International Conference

Dr. Lika Damayanti

Abstract

Background : Collagenase-2 / Matrix Metalloproteinase-8 (MMP-8) is an important mediator of tissue destruction in inflammatory diseases. The active MMP-8 in gingiva is associated with the degradation of periodontal tissues in progressive periodontitis whereas the latent enzyme is predominant in gingivitis. Hyperbaric Oxygen Therapy (HBOT) is involved administration 100% oxygen under pressure. It has been used as an adjuvant therapy to improve wound healing.

Purpose : To investigate the effect of HBOT 2,4 ATA on activation of collagenase-2 in hyperglycemic gingival rats

Methods : A total of 45 male Wistar rats were equally divided in healthy controls (group 1), hyperglycemic (group 2), hyperglycemic+HBOT(group 3), hyperglycemic ligature-induced (group 4), and hyperglycemic ligature-induced +HBOT (group 5). Experimental hyperglycemic was induced by using once daily intraperitoneal administration of streptozotocin that is diluted in buffer citrate, at a dose of 30 mg/kg of BW for 4 days. Ligature-induced periodontitis was created by tying silk ligatures on the necks of mandibular incisors until 30 days, treatment HBO 2,4 ATA 3x30 minutes for 10 days and the animals were decapitated. The measurement collagenase-2 in gingival tissue after 50 days was examined using ELISA method.

Results :It was found that gingival collagenase-2 in hyperglycemic condition decreased significantly $p=0,000$ ($1,59378\pm0,447$) after 10 sessions HBOT than without HBOT ($10,395\pm0,6817$) and gingival collagenase-2 levels hyperglycemic ligature-induced ($2,0911\pm0,2798$) decreased significantly $p=0,000$ than without HBOT ($11,4271\pm0,2055$).

Conclusions : HBOT can reduce collagenase-2 in hyperglycemia gingiva

Keywords : collagenase-2, hyperglycemia, hyperbaric oxygen



INTRODUCTION

Epidemiological data indicate that hyperglycemia is a major risk factor to periodontal tissue disease. The main complications of hyperglycemia affect organs and tissues rich in capillary vessels and are secondary to the development of angiopathy. Similar changes in small vessels can be found in the oral tissues (Popławska-Kita A, 2013). Gingivitis is a periodontal disease that may progress to periodontitis. There is relationship between the degree of hyperglycemia with severity of periodontitis. The mechanism of the relationship between them is still incomplete to be known, but it involves aspects of the immune system, the activity of neutrophils and cytokines. (Marchetti E, et al, 2012). The prevalence of periodontitis with diabetes each year in Indonesia and in the world is increasing (Preshaw, 2012). Susceptibility of periodontitis increased three-fold in patients with diabetes. Similarly, patients with periodontitis increasing prevalence of diabetes (Stanko P et al, 2014, Preshaw et al, 2012).

Chronic hyperglycemia is associated with the development of numerous long-term diabetic complications, some directly affecting oral health, such as delayed wound healing and periodontitis. These conditions, in part, are due to the heightened immuno-inflammatory response reported in diabetics, driven primarily by the development of *Advanced Glycation End-Products* (AGEs). Advanced Glycation End Products (AGEs), which is an irreversible reaction nonenzymatic and its affect the formation of collagen crosslinking resulting in damage to the blood vessels and the disintegration of the basement membrane of the gingival tissue. AGEs form a complex with the receptor of AGEs (RAGE), which resulted in the formation of reactive oxygen species, which induce a variety of signaling pathways in the pathogenesis of diabetes that affect gene transcription factors (Straka M. 2011). AGEs in diabetes patients increased inflammation via up-regulation of TNF α and IL-1 β in monocytes and macrophages. The connective tissues of diabetic humans and experimental animals exhibit abnormalities in collagen metabolism including an increased production of collagenolytic enzymes by gingival explants in tissue culture.

Treatment at hyperglycemia /diabetes tends to focus on treating the surface ulcer and commonly ends in nothing more than added expense without successful healing. The factors involved in the development of a chronic wound remain unclear; however, the most common cause, according to Mathieu et al. is thought to be related to the detrimental effects of prolonged wound hypoxia (oxygen deficiency) (Chen TL, 2002). It has been suggested that while oxidant species, produced by neutrophils and macrophages within the wound, may serve as messengers to promote healing, overproduction may in fact overwhelm the immune system and delay healing (Tousoulis, D, 2013) Chronic wounds can be arrested in any one of the stages of wound healing, but disruption commonly occurs in the inflammatory or proliferative phases. Braiman-Wiksman argued that within the proliferative phase, reepithelialization is



crucial for successful healing. Hypoxia appears to inhibit the wound healing process by blocking fibroblast proliferation, collagen production and capillary angiogenesis and to increase the risk of infection (Hujoel, PP and Miller MS. 2011, Stanko and Holla Li. 2014)

Collagenase-2 (Neutrophyl collagenase / Matrix Metalloproteinase-8 / MMP-8) is an Zn²⁺dependent endopeptidase, which are crucial to damage components of the extracellular matrix, basement membrane, migration of cells in physiological and pathological conditions. During normal tissue remodeling and development, MMPs mediate important functions and their expression and activity is low. But during the destructive pathological conditions like infection, gingivitis, periodontitis, increased MMP activity has been reported in several tissues. MMPs are a family of structurally related but genetically distinct enzymes that degrade extracellular matrix and basement membrane (BM) components (Sorsa, 2011, Desarda H, Gaikwad S. 2013)

There are two forms, pro-collagenase-2 / pro-MMP-8 / zymogen in an inactive and active. Secretion in the form of latent / inactive and becomes active when the inflamed tissues, excretion induced by inflammatory mediators such as IL-1 β produced by neutrophils or induced fibroblast cells (Sorsa, 2011, Hardy DC, 2012). Increased activity of collagenase-2 in gingival tissue associated with the presence of gingival inflammation and progression to chronic periodontitis were strongly influenced by systemic conditions such as diabetes (Desarda H and Gaikwad S. 2013). In active periodontitis gingival tissue degradation occurs due to increased activity of the enzyme MMP-8 by inflammatory cells (monocytes, macrophages, lymphocytes, polimorphonuklear) and fibroblasts, epithelial and endothelial. Diabetes increases gingival collagenase activity. (Grover,HS and Luthra S. 2013).

Non healing wounds are a major health problem worldwide. Managing difficult wounds often involves prolonged hospitalizations, numerous surgical interventions, and medical wound management, all of which frequently lead to exuberant costs, morbidity, and even mortality. A thorough understanding of basic wound healing, diagnosis, and principles of hyperbaric oxygen as an adjuvant therapy can facilitate healing a problem wound. Oxygen is essential for intracellular aerobic metabolism. Ischemia/tissue hypoxia (oxygen levels below 30 mmHg) impairs significantly normal metabolic activity and wound healing. Anaerobic metabolism provides insufficient energy for the hypoxic wound. Oxygen is necessary for fibroblast proliferation, collagen synthesis, exportation of collagen from the fibroblast cell membrane and neo-epithelialization (Svalestad, E, 2013).

Hyperbaric oxygen (HBO) therapy is a therapy in patients with the administration of 100% pure oxygen by inhalation in air pressure more than 1 Atmosphere Absolute (ATA) which is inserted in a chamber / high pressure air chamber (Thackham, JA, 2008, Svalestad 2013). This therapy results in tissue oxygen levels that are 10 times higher than the usual levels. Under normal conditions 98% of oxygen is bound to hemoglobin and carried in the bloodstream, while the remaining 2% is



dissolved in the plasma. Breathing 100% oxygen under hyperbaric conditions elevates the arterial pO₂ from approximately 100 mmHg (at 1 ATA sea level) to around 1500 mmHg at 2 ATA and up to 2000 mmHg at 3 ATA . The latter is sufficient to supply the tissue with all the metabolic requirements even in the absence of hemoglobin (Thom S.R. 2009, Kotsovos A. 2012). The dissolved plasma oxygen passes even through partially occluded capillaries, where the passage of red blood cells is limited. The dissolved oxygen content remains at its elevated levels for 2 to 4 hours after HBOT has been terminated, which induces the synthesis of endothelial cell nitric oxide synthase.(Kulikovsky M, 2009)

HBO therapy has been widely used for wound healing in diabetic foot gangrene, burns, ischemia, and as adjuvant therapy in various diseases. The process of wound healing and inflammation has been shown to lower the role of inflammatory cytokines IL-1 β and TNF- α , reduction of edema, increase the anti-inflammatory cytokine IL-10, the formation of VEGF, TGF- β , lowering PGE-2 (increasing the antioxidant superoxide dismutase, heme oxygenase , suppress NADPH and apoptosis (Zhang, 2008, Thackham, JA, 2008, Thom S.R. 2009, Kotsovos A. 2012 Svalestad 2013). The aim of this research is to investigate the effect of HBOT 2,4 ATA on activation of collagenase-2 in hyperglycemic gingival rats.

Method

A total of 45 Wistar rats (*Rattus norvegicus*) were divided into 5 groups: normal glucose control group (K1), hyperglycemia (K2), hyperglycemia + HBOT (P1), hyperglycemia + induction ligature (P2), and a ligature induced hyperglycemia + + HBOT (P3). Condition of hyperglycemia was done by inducing streptozotocin with a dose of 30 mg / kg dissolved in 0.05 citrate buffer, pH 5.5 intraperitoneally for 4 days to obtain a blood glucose level > 300 mg / dl. The provision aims to aggravate the condition periodontitis ligature by binding to the first incisive teeth of the lower jaw with a ligature for 30 days. In the end of the treatment the animals were sacrificed, then given with 2.4 ATA HBO therapy 3x30 minutes for 10 times within 10 days in a row. MMP-8 gingival tissue was measured by using ELISA method.

Result

Statistical analysis using the Kruskal-Wallis test Chi Square values obtained = 46 890 p = 0.000 (p <0.05) and performed Wilcoxon-Mann Whitney analysis (Table).



The mean and standard deviations MMP-8 Table gingival tissue

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Group	\bar{x}	SD	Min	Max	Kruskal-Wallis
normal /1	.99167 ^a	.079721	.850	1.129	Chi Square = 46.890 p = 0.000
Ligature/ 2	10.39511 ^b	.681740	9.509	11.436	
Ligature HBO/P1 +	11.42711 ^d	.205509	11.182	11.752	
STZ + HBO/P2	1.59378 ^c	.447559	.485	2.011	
STZ + ligature + HBO/P3	2.09111 ^e	.279843	1.678	2.573	

Description: The same superscript showed no significant difference between groups

The results of the examination of the gingival tissue MMP-8 showed that administration of 2.4 ATA HBO therapy may reduce levels of MMP-8 well in hyperglycemia group (between-group K1 and P2) and ligature-induced hyperglycemia group (between the P1 and P3) at $p < 0.05$. Decreased levels of MMP-8 in the group treated with HBO hyperglycemia (P2) is still higher than the normal group (K0) were significantly $P < 0.05$. In the normal group showed higher levels of MMP-8 lower than hyperglycemia group. Giving ligature / group P1 resulted in increased levels of MMP-8 compared to STZ-induced group / K1. In conditions of hyperglycemia increased levels of MMP-8 highly significant $p < 0.05$ compared to the normal group.

Discussion

Chronic hyperglycemia induces a variety of cells (PMN, macrophages, lymphocytes, fibroblasts, etc.) to secrete cytokines and inflammatory mediators IL-1 β and TNF- α , PGE2, compounds indirectly increase the activity of MMP-8. It is associated with the COX2 and subsequent reactive oxygen pathogenesis of periodontitis (Hardy DC, 2012).

Ligature induced occurs resulting mechanical stress as a stimulus to the formation of inflammatory processes that accelerate the onset periodontitis. In inflammatory conditions there is an increase in the transcription factor NF-kB and HIF-1 α , resulting in increased expression of inflammatory genes are like the inducible nitric oxide (iNOS) mRNA gene transcription or increased MMP-8. Nitric Oxide due to increased iNOS activity and reactive oxygen compounds that increase due to hyperglycemia can lead to the formation of peroxynitrite radicals are destructive to the gingival tissues. This will be activate MMP-8 (Desarda H, Gaikwad S. 2013, Stanko and Holla Li, 2014).



HBO therapy 2.4 ATA decreases the levels of MMP-8 significantly in the group hyperglycemia with ligature administration compared with the group without HBO therapy significantly at $p < 0.05$. HBO therapy is expected to reduce the inflammatory process by reducing gingival bleeding, pocket depth and attachment loss between the teeth and gingiva, so the periodontal tissue damage can be reduced. HBO therapy is thought to: 1) increase of oxygen affects the hydroxylation reaction prolin; 2) effect on the regulation at the level of transcription, 3) HBO increase glutathione levels in the blood, and 4) induces the expression of a number of enzymes in the heme oxygenase network including known to have cytoprotective effects (Kudchodcar, 2000).

The three phases of wound healing are inflammation, repair, and maturation, all of which superimpose to effectively repair a wound. The inflammation phase involves vascular and cellular responses. Arterioles constrict, and then dilate. Fibrin congregates, platelets aggregate, and the coagulation cascade is initiated. Neutrophils and macrophages invade the wound, removing tissue debris and bacteria. Macrophages attract the fibroblast to the injured site, stimulating fibroblast proliferation and angiogenesis. Resolution of the inflammation phase initiates the repair phase, in which collagen synthesis from fibroblast proliferation occurs. During maturation, collagenase is present, promoting breakdown and repair of existing collagen cross-links, and thus contributing to the wound strength. (Kulikovsky M, 2009,

Problem wounds are those that fail to heal in response to standard medical and surgical therapy. These wounds are frequently found in patients who have multiple local and systemic factors inhibiting tissue healing. Advanced age, nutritional deficits, vascular insufficiency, diabetes, infection, tobacco use, hypoxia, and immunosuppression are among some of the important risk factors that interfere with wound healing. Among these, hypoxia and infection adversely affect wound healing most frequently. The consequence of many of these risk factors results in low oxygen tensions, which adversely effect neutrophil, macrophage, and fibroblast functions. (Zamboni, 2003). The neutrophil, macrophage, and fibroblast require oxygen to function during inflammation and repair phases. Both, oxygen-dependent and oxygen-independent systems are required in order for neutrophils and macrophages to kill microorganisms. Proteolytic activity of MMP-8 can be through: 1) the regulation of the transcription process, 2) the transcription of enzymes in the zymogen form, 3) interaction with MMP inhibitors which Tissue Matrix inhibitory proteins (TIMPs).

Oxygen radicals derived from molecular oxygen are important in bacterial killing. Leukocytes contain an enzyme—NADPH-linked oxygenase that is activated, resulting in oxidants. After activation, an oxidative burst allows molecular oxygen to be reduced to superoxide radicals, thus killing bacteria by oxidizing cell membranes. The superoxide radicals are reduced to oxygen and peroxide by superoxide dismutase. Myeloperoxidase combines with peroxide and chloride or iodide to form hypochlorite or hypiodite. Intracellularly, excess peroxide is reduced to oxygen by a catalase. If iron



is present, the reaction occurs extracellularly producing OH^\cdot , a harmful oxygen radical. This oxygen radical kills bacteria effectively, but also harms surrounding cells. If cells are hypoxic, the oxygen-dependent pathway is severely incapacitated, leading to increasing rates of infection.

Collagen synthesis from fibroblasts also requires oxygen. Fibroblasts follow the macrophages into the wound environment. Nonhelical procollagen is created by protein synthesis involving proline, lysine, and glycine. Oxygen is an important cofactor required during hydroxylation of proline and lysine during formation of procollagen. Next, propeptides are cleaved off of procollagen to form tropocollagen via lysyl oxidase. Glycosaminoglycans provide a matrix for cross-linking and aggregation of collagen molecules to form collagen mature fibers. Mature collagen synthesis requires prolyl-hydroxylase and lysyl-hydroxylase, which are enzymes dependent on oxygen for function. Energy metabolism of the cell is first priority, occurring through oxidative phosphorylation, which then allows enzymes to use molecular oxygen. If the tissue is hypoxic, procollagen hydroxylation suffers and mature collagen cannot be formed.

The problem wound environment is hypoxic, acidotic, and contains high levels of lactate. This environment forms a concentration gradient, largely responsible for the inward movement of wound healing cells. Hypoxia is the result of the initial vascular damage, coagulation, and vasoconstriction. The management of problem wounds should always include correction of perfusion and oxygenation deficiencies, debridement, infection control, aggressive wound care, and surgical closure. In problem wounds, adjunctive care may also be necessary. When a deficiency in oxygenation of the wound is found, in the face of non-reconstructable vascular disease, HBO as an adjunctive therapy should be considered. A transcutaneous oxygen tension greater than 50 mm Hg indicates that the wound should heal spontaneously. Values between 30 and 50 mm Hg are marginal, and values below 30 mm Hg indicate that the wound will not heal without adjunctive therapy. HBO therapy will accelerate tissue repair in hypoxic wounds in which oxygen tension can be elevated to therapeutic levels. When compared with conventionally treated wounds, HBO patients had an accelerated rate of healing.

Conclusion HBO therapy 2.4 ATA for 3x30 minutes with a 5 minute break to breathe can decrease the activation of MMP-8 in gingival tissue with hyperglycemia.

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