THE ROLE OF LOW LEVEL LASER ON THE QUALITY OF NEW BONE FORMATION SECONDRY TO DISTRACTION OSTEOGENESIS OF MANDIBULAR BODY (Experimental Study)

A THESIS SUBMITTED TO THE NATIONAL INSTITUTE
FOR LASER ENHANCED SCIENCES
CAIRO UNIVERSITY

FOR FULFILLMENT OF THE REQUIERMENTS
FOR MASTER DEGREE IN MEDICAL
LASER APPLICATION IN DENTISTRY

By

MAHMOUD ABDEL-MONEIM MOSTAFA NASR
(B.D.S., MANSOURA UNIVERSITY).

NATIONAL INSTITUTE
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2009

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دوراللیزرمنخفض القدرة على كيفية تكوين العظام الجديدة في فترة التثبيت النهائية عقب إطاله العظام لجسم الفك السفلى (دراسة تجريبية)

رسالة مقدمة الى
المعهد القومي لعلوم الليزر - جامعه القاهرة
للحصول على
درجه الماجستير
في تطبيقا ت الليزر الطبيه في طب الأسنان

مقدمة من الطبيب
محمود عبد المنعم مصطفى نصر

المعهد القومي لعلوم الليزر
جامعه القاهره
2009

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To my parents

With

respect and love

Contents

Osteon:	Primitive osteon
Oc:	Osteonal canal
Foc:	Future osteonal canal
Fce:	Fibrocellular elements
iossS:	Intr-osseous space
Ob :	Osteoblast
OCL:	Osteoclast
Oy:	Osteocyte
Og:	Osteogenic cell / osteoprogenitor cell
OgCs:	osteoprogenitor cell
emptyL:	Empty lacuna
NVb:	Neurovascular bundle
Ls:	Lymphatics
NF:	Nerve fascicle
BTr:	Bony trabecula
Imoss:	Intramembranous ossification
FCs	Fat cells
Crbmx	Condensation of red or acidophilic matrix
WCfs	Woven collagenic fibers
OL:	Osteonal lining
Bv:	Blood vessel
bv:	Blood vessel
Beg	Bone edge
Mv	Marrow cavity
Cai	Canaliculi
Mc	Matrix condensation
Cf / Cfs	Collagen fibers
nbL:	New bone layer
nLOb:	New lacuna containing osteoblast
CL:	Cementing line
L:	Lacuna
afL:	Active fibrocellular layer
bL:	Bone layer
LL:	Lenticular lacuna
Ps:	Periosteum
Fs :	Fibroblasts
nBmx:	newly added matrix

Comparison between the Lased and the Non-Lased Distraction regenerates

	CRITERIA	*Non – Lased Groups*	*Lased Groups*
OSTEON	- **Degree of development:**	**ill-developed and less organized**	**More-developed and more or less organized**
	- **Shape of the osteon:**	**Elongated**	**Rounded & Oval**
	- **Size of Osteon:**	**Large**	**Small and uniform**
	- **Number of Osteon:**	**Few**	**Many**
	- **No. of Bony Lamellae:**	**3-5**	**3-5**
	- **No of lacunae:**	**Less numerous**	**Numerous**
	- **Shape of Lacunae:**	**Rounded**	**Oval & Elliptical**
	- **Size of Lacunae:**	**Large**	**Small**
	- **Empty Lacunae:**	**Few**	**Numerous**
	- **Capsule:**	**Clear, thin and mostly complete**	**Clear, thick but mostly incomplete**
	- **L with Osteocyte:**	**Few**	**Numerous**
	- **L with Osteoblast:**	**Abundant particularly at the periphery**	**Few particularly at the periphery**
	- **Presence of osteoclasts:**	**There are many foci of osteoclasia**	**Non or few**
	- **Osteonal canal:**	**Large**	**Small and large**
	- **Fibrocellulare elements (FCE) in the osteonal canal:**	**Clear , sometimes voluminous and filling mostly the inter-osseous spaces**	**Present but less abundant**
	- **Osteonal lining:**	**Clear**	**Less clear**
MATRIX	- **Staining affinity:**	**The red staining affinity tends to predominates in the matrix. However, pale stained matrix is seen in the deeper zone of bone section**	**Mostly pale or lightly basophilic and shows red staining affinity at the margin and the periphery of the developing bone**
	- **Pale matrix (Lbmx):**	**Not Predominates**	**predominating**
	- **Acidophilic matrix (rbmx):**	**Not Predominating**	**- At the border of the section** **- Around the lacunae** **- Around the inter-osseous spaces**
	- **Matrix condensation (mc):**	**Forming capsules around the Lacunae, Osteonal canals and the inter-osseous spaces**	
	- **Bone layers:**	**Less clear**	**Clear**
	- **Canaliculi:**	**Not clear**	**Clear and distinct**
	- **Woven collagenic fibers:**	**Present and are not organized and irregularly arranged giving the woven appearance in certain areas**	**Not clear as they became arranged into lamellae covered by bone matrix**
BONE CELLS	- **Occurrence of Osteoprogenitor cells:**	**Mostly near or on the surface**	**Rarely seen**
	- **Occurrence of Osteoblasts:**	**Near the bony surface or inside the osteonal canals**	**They appear dormant and lining the bony surface**

Comparison between the One and Two Months Non-Lased Groups

	CRITERIA	***One Month Non Lased Groups***	***Two Months NonLased Groups***
OSTEON	- Degree of development:	ill-developed	less organized
	- Shape of the osteon:	Elongated	Rounded or elongated
	- Size of Osteon:	Large	Large
	- Number of Osteon:	Few	Many
	- No. of Bony Lamellae:	3-5	3-5
	- No of lacunae:	Less numerous	Numerous
	- Shape of Lacunae:	Rounded	Rounded, oval or elongated
	- Size of Lacunae:	Large	Large
	- Empty Lacunae:	Few	scanty
	- Capsule:	Clear, thin and mostly complete	Clear
	- L with Osteocyte:	Few	Numerous
	- L with Osteoblast:	Numerous particularly at the periphery	At the periphery
	- Presence of osteoclasts:	There are many foci of osteoclasia	Non or few
	- Osteonal canal:	Large	Clear & large
	- Fibrocellulare elements (FCE) in the osteonal canal:	Clear , sometimes voluminous and filling mostly the inter-osseous spaces	distinct
	- Osteonal lining:	Clear	Clear
MATRIX	- Staining affinity:	Mostly pale or lightly basophilic and shows red staining affinity at the periphery of the developing bone	The red staining affinity tends to predominates in the matrix. However, pale stained patches are seen in most sections
	- Pale matrix (Lbmx):	Predominates towards the interior	clear
	- Acidophilic matrix (rbmx):	- At the border of the section - Around the lacunae - Around the inter-osseous spaces	
	- Matrix condensation (mc):	Forming capsules around the Lacunae, Osteonal canals and the inter-osseous spaces	
	- Bone layers:	Not clear	Not clear
	- Canaliculi:	Not clear	Not clear
	- Woven collagenic fibers:	Present and give the woven appearance in certain areas in some sections	Not clear
BONE CELLS	- Occurrence of Osteoprogenitor cells:	Mostly near or on the surface	Near the bone surface
	- Occurrence of Osteoblasts:	Near the bony surface or inside the osteonal canals	Near the bone surface

Comparison between the One Month and Two Months -Lased Groups

	CRITERIA	***One Month Lased Groups***	***Two Months Lased Groups***
OSTEON	- Degree of development:	less organized	more or less organized
	- Shape of the osteon:	circular	Rounded or elongated
	- Size of Osteon:	Large	Large
	- Number of Osteon:	Many	Many
	- No. of Bony Lamellae:	3-5	3-5
	- No of lacunae:	Less numerous	Numerous
	- Shape of Lacunae:	Rounded or Oval	Irregularly rounded
	- Size of Lacunae:	Moderate	Large
	- Empty Lacunae:	Few	clear
	- Capsule:	Mostly complete	Mostly incomplete and condensed
	- L with Osteocyte:	Few	Fairly Numerous
	- L with Osteoblast:	Abundant particularly at the periphery	Few particularly at the periphery
	- Presence of osteoclasts:	Non or few	Non or few
	- Osteonal canal:	Clear, Large &elongated	Clear & large
	- Fibrocellulare elements (FCE) in the osteonal canal:	sometimes voluminous and filling mostly the inter-osseous spaces	illdistinct
	- Osteonal lining:	Present	Not clear
MATRIX	- Staining affinity:	Mostly pale or lightly basophilic and shows red staining affinity at the periphery of the developing bone	
	- Pale matrix (Lbmx):	Not clear	Clear
	- Acidophilic matrix (rbmx):	- At the border of the section - Around the lacunae - Around the inter-osseous spaces	
	- Matrix condensation (mc):	Forming capsules around the Lacunae, Osteonal canals and the inter-osseous spaces	
	- Bone layers:	Not clear	Clear in many sections
	- Canaliculi:	Not clear	Distinct in many sections
	- Woven collagenic fibers:	Present in certain areas in some sections	Not clear
BONE CELLS	- Occurrence of Osteoprogenitor cells:	Mostly near the surface	
	- Occurrence of Osteoblasts:	Near the bony surface or inside the osteonal canals	

Comparison between the One Month Non Lased and One Month Lased Groups

	CRITERIA	***One Month Non Lased Groups***	***One Month Lased Groups***
OSTEON	- Degree of development:	ill-developed	less organized
	- Shape of the osteon:	Elongated	circular
	- Size of Osteon:	Large	Large
	- Number of Osteon:	Few	Many
	- No. of Bony Lamellae:	3-5	3-5
	- No of lacunae:	Less numerous	Less numerous
	- Shape of Lacunae:	Rounded	Rounded or Oval
	- Size of Lacunae:	Large	Moderate
	- Empty Lacunae:	Few	Few
	- Capsule:	Clear, thin and mostly complete	Mostly complete
	- L with Osteocyte:	Few	Few
	- L with Osteoblast:	Numerous particularly at the periphery	Abundant particularly at the periphery
	- Presence of osteoclasts:	There are many foci of osteoclasia	Non or few
	- Osteonal canal:	Large	Clear, Large &elongated
	- Fibrocellulare elements (FCE) in the osteonal canal:	Clear , sometimes voluminous and filling mostly the inter-osseous spaces	sometimes voluminous and filling mostly the inter-osseous spaces
	- Osteonal lining:	Clear	Present
MATRIX	- Staining affinity:	Mostly pale or lightly basophilic and shows red staining affinity at the periphery of the developing bone	
	- Pale matrix (Lbmx):	Not clear	Clear
	- Acidophilic matrix (rbmx):	- At the border of the section - Around the lacunae - Around the inter-osseous spaces	
	- Matrix condensation (mc):	Forming capsules around the Lacunae, Osteonal canals and the inter-osseous spaces	
	- Bone layers:	Not clear	Not clear
	- Canaliculi:	Not clear	Not clear
	- Woven collagenic fibers:	Present and give the woven appearance in certain areas in some sections	Present in certain areas in some sections
BONE CELLS	- Occurrence of Osteoprogenitor cells:	Mostly near the surface	
	- Occurrence of Osteoblasts:	Near the bony surface or inside the osteonal canals	Near the bony surface or inside the osteonal canals

Comparison between the Two Months Non Lased and Two Months Lased Groups

	CRITERIA	***Two Months NonLased Groups***	***Two Months Lased Groups***
OSTEON	- Degree of development:	less organized	more or less organized
	- Shape of the osteon:	Rounded or elongated	Rounded or elongated
	- Size of Osteon:	Large	Large
	- Number of Osteon:	Many	Many
	- No. of Bony Lamellae:	3-5	3-5
	- No of lacunae:	Numerous	Numerous
	- Shape of Lacunae:	Rounded, oval or elongated	Irregularly rounded
	- Size of Lacunae:	Large	Large
	- Empty Lacunae:	scanty	clear
	- Capsule:	Clear	Mostly incomplete and condensed
	- L with Osteocyte:	Numerous	Fairly Numerous
	- L with Osteoblast:	At the periphery	Few particularly at the periphery
	- Presence of osteoclasts:	Non or few	Non or few
	- Osteonal canal:	Clear & large	Clear & large
	- Fibrocellulare elements (FCE) in the osteonal canal:	distinct	illdistinct
	- Osteonal lining:	Clear	Not clear
MATRIX	- Staining affinity:	Mostly pale or lightly basophilic and shows red staining affinity at the periphery of the developing bone	
	- Pale matrix (Lbmx):	Clear	Clear
	- Acidophilic matrix (rbmx):	- At the border of the section - Around the lacunae - Around the inter-osseous spaces	
	- Matrix condensation (mc):	Forming capsules around the Lacunae, Osteonal canals and the inter-osseous spaces	
	- Bone layers:	Not clear	Clear in many sections
	- Canaliculi:	Not clear	Distinct in many sections
	- Woven collagenic fibers:	Not clear	Not clear
BONE CELLS	- Occurrence of Osteoprogenitor cells:	Mostly near the surface	
	- Occurrence of Osteoblasts:	Near the bony surface or inside the osteonal canals	

Introduction

The introduction of rational idea of **Distraction Osteogenesis (DO)** into the field of long bones lengthening came in 1905 from ***Alessandro Codivilla*** . He aroused general interest in the issue of lengthening and initiated a logical approach to this problem**.** [1] **Distraction Osteogenesis** is the biologic process of new bone formation between the surfaces of bone segments that are gradually separated by incremental traction.[2] The traction generates tension on the skeletal and surrounding soft tissue structures, which stimulates new bone formation parallel to the vector of distraction.[3]

Distraction Osteogenesis is also called **callus distraction**,[4] **callotasis**[4] or **osteodistraction,**[5] A corticotomy is used to fracture the bone into two segments, and to move them gradually apart during the distraction phase, allowing new bone to form in the gap**.**[6,7]

Early techniques of distraction osteogenesis had a high number of **complications** [8, 9] such as device failure, premature fusion of the segments undergoing distraction. These problems necessitate a repeat surgical procedure to reosteotomize the bone segments**.**

The breakthrough came with a technique introduced by ***Gavril Ilizarov.*** Ilizarov developed a procedure based on the biology of the bone and on the ability of the surrounding soft-tissues to regenerate under tension .[9] He divided the treatment into five sequentional periods, each of equal