Evaluation of the effect of Calcitonin on osseointegration of dental implant.

Thesis

Submitted to the faculty of Oral and Dental Medicine

(Cairo University)

For partial fulfillment of the requirements

of the master degree in Oral and Maxillofacial surgery

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B.D.S

Faculty of Oral and Dental Medicine
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2009

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DEDICATION

To my mother and father who gave me love, care and support.

ACKNOWLEDGMENT

Words can't express my deep appreciation to Doctor **Mohammad El Sayed Dehis,** Professor of Oral & Maxillofacial surgery, Faculty of Oral & Dental Medicine, Cairo University and Doctor **Effat Ahmed Abbas**, Professor of Oral Pathology, National Research Center, Cairo.

I would like to express my sincere thanks to Doctor **Abeer Mohamed Kamal**, Researcher in Oral Surgery department in National Research Center for her continous help to accomplish my work and Doctor **Rokaiah Soliman,** Professor of Anthropology in National Research Center for her help and the facilities offered in Dual Energy Xay Absorpiometry DEXA.

My deep appreciation goes to all doctors and staff members of the National Research Center, all doctors and staff members of Oral & Maxillofacial Department, Faculty of Oral and Dental Medicine ,Cairo University and to my co operativepatients.

Last but not least, I would like to thank my dear husband who was there for me in each step, without his support, this work would not be accomplished in such a way

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LIST OF ABBREVIATIONS

Co Cr: Cobalt Chromium

TPS: Titanium Plasma Sprayed

Zr O_2: Zirconium Dioxide

SAM: Self Assembled Monolayer

BP: Bihosphonates

BMP: Bone Morphogenic Proteins

TGF: Transforming Growth Factor

PRP: Platelet Rich Plasma

PDGF: Platelet Derived Growth Factor

GTR: Guided Tissue Regeneration

NBM: Natural Bone Mineral

SC: Salmon Calcitonin

CGRP: Calcitonin Gene Rlated Peptide

PK: Protein Kinase

PTH: Para Thyroid Hormone

IU: International Unit

IM: Intramuscular

IV: Intravenous

BMD: Bone Mineral Density

BMC: Bone Mineral Content

SV: Siveret

Ca: Calcium

HAS: Hip Structural Analysis

MRI: Magnetic Resonance Image

CBCT: Cone Beam Computed Tomography

qCT: Quantitative C.T.

3D: Three Dimentional

HU: Hounsfield Unit

DEXA: Dual Energy Xray Absrptiometry

PT: Prothrombin time.

PTT: Partial Thrmboblastin Time.

SGOT: Serum Glutamine Oxalic Transaminase

SGPT: Serum Glutamine Pyruvic Transaminase

CBC: Complete Blood Count

CT: Computed tomography.

SD: Standard Deviation.

SE: Standard Error

CV: Coefficient of Variation

Introduction

Osseointegration is the basic aim of placing implants in edentulous areas. It is defined as permanent incorporation of a non biological component to carry unlimited functional load in endoprosthetic and exoprosthetic replacement in structure and function. It results in permanent attachment of Titanium to human bone. In order to achieve proper osseointegration certain criteria were reported such as proper diagnosis, treatment plan and follow up. It is so important to select the suitable cases for implant placement. Patients are preferred to be systemically free or at least well controlled. i.e. (not suffering from epilepsy or oral carcinomas or blood or bone diseases). Extreme ages are not preferred as very old or very young, below 18 years. Smoking should be prohibited as it interferes with healing. [1, 2]

Two ways have been reported as major tools for success of osteointegration. The clinical as well as radiographic assessment. Clinical methods are obtained by using periodontal probing to measure depth of pockets and bleeding index. Radiographic aids (Panoramic view and C.T. scan) are essential preoperatively for diagnosis, detecton of vital structures and determination of bone height and width as well as post surgical to measure degree of bone formation and density. Proper technique is mandatory as using successive drills and high torque, coolant to avoid heat generation and bone necrosis besides proper angulation. Delayed loading is prefered than immediate loading.[3,4]

Calcitonin is a major hormone secreted by thyroid gland responsible for bone formation and decrease of blood calcium level.

It has been proved that the synthetic Salmon Calcitonin enhance bone growth in depth as well as in width that is why they used it as a treatment for bone diseases and fractures. Salmon Calcitonin is a mixture of amino acids plus a modifying agent. It was reported that the effect of calcitonin on bone healing around titanium implants. It was concluded that there is a growth in endosteal bone in width and height. [5,6]

Dual energy x ray absorptiometry (DEXA) measures bone mineral density (amount of minerals) to assess the bone quality in a volumetric value (pre and post operatively) around implants. It is a non invasive, non painful safe and quick tool in the form of low dose of radiation. It is a two dimentional image, which lacks details and can not differentiate between cortical and cancellous bone. C.T. scan is an another accurate method to measure bone mineral density around implants (pre and post operatively), according to studies by Edwin Mc. Glumphy et al.[7] besides measuring precisely bone width and height of alveolar ridge. It can detect approximation of vital structures. It can also detect any pathological lesions present or any bone abnormality. It can differentiate between cortical and cancellous bone as it is done in slices. The main disadvantages of C.T. scan that it exposes the patient to a high radiation dose equivalent to (1-2 mSV) besides being of a high cost .

Changes in bone density are likely to contribute to implant fixation failure. Bone densitometry provides useful information with regard to bone architecture around implants, and various techniques have been employed to measure the degree of bone density change around implants with varying degrees of accuracy. These techniques include radiographic absorptiometry, dual energy X-ray absorptiometry (DEXA), and quantitative computed tomography (qCT). [7,8,9].

Review of Literature

Osseointegration is defined as a direct and stable anchorage of an implant by the formation of bony tissue without growth of fibrous tissue at the bone-implant interface. To achieve long-term success, rigid fixation of the implants within the host bone site is required. This biological concept of osseointegration was first introduced by Branemark et al. in the 1960s.[10]A defining feature of osseointegration is that osteoblasts and mineralized matrix contacts the implant surface even when loads are applied. Several factors, such as implant geometry, preparation technique, and quality and quantity of local bone influence primary stability, and primary implant stability is one of the main factors influencing implant survival rates. It is a prerequisite to establish mechanical rest, which seems to be essential for undisturbed healing and osseointegration. A common perception is that several weeks must be given to achieve implant osseointegration. [10]

Material of Implant:

Commercially pure Titanium and its alloys are the materials most often used in implant manufacturing because of their excellent biocompatibility, favourable mechanical properties and well-documented beneficial results.When exposed to air Titanium immediately develops a stable oxide layer which forms the basis of its exceptional biocompatibility. The properties of the oxide layer, i.e. its chemical purity and surface cleanliness, are of great importance for the biological outcome of the osseoitegration of titanium implants. A typical implant consists of a titanium screw, with a roughened surface.

This surface is treated either by plasma spraying, etching or sandblasting to increase the integration potential of the implant.

Surface properties of the implanted biomaterial is an important factor for succes, because the first interactions between the material and the biological environment occur at the surface upon implantation. The first processes that can impact the long time stability of an implant (protein adsorption, cell-surface interaction, tissue development, etc.) are affected by the physical, chemical and biochemical properties of the implant surface.

Thus, there is an increasing interest to improve the cell-material interactions of biomaterials by tailoring their surface properties. Titanium and its alloys have a successful history as dental implants ,so they have been chosen because of their good mechanical properties. The native thin surface titanium oxide film gives the metal a general inertness and biocompatibility, allowing it to readily heal into bone. [11,12]

Pure Titanium, Titanium alloy, and cobalt chromium (Co-Cr) are metals currently approved by the Food and Drug Administration for use in biomedical implants. Titanium and its alloys are attractive because of their low density, low modulus of elasticity, excellent corrosion resistance, and biocompatibility. Pure Titanium is the most biocompatible metal. Titanium alloy is more commonly used when osseointegration is desired. This is because the alloy is nearly as biocompatible as pure Titanium, but has higher strength than pure Titanium. For this reason Cobalt Chromium CoCr with improved wear-resistance over that of Titanium alloys, is commonly used when

high abrasion resistance is needed, despite the reduced biocompatibility compared to Titanium and its alloys. [13]

Conventional ion implantation, plasma source nitrogen ion implantation, conventional nitriding, conventional plasma nitriding, and intensified plasma ion nitriding as Titanium nitride films have been reported inorder to overcome the low wear performance of Titanium and its alloys in abrasive wearing conditions.[14,15]

Titanium nitride is a ceramic material often used as a coating to improve wear resistance and to provide aesthetic appeal due to its characteristic gold color. However, as a discrete coating on metals, an abrupt metal/ nitride interface may lead to film delamination due to mismatch of mechanical properties across the interface. With plasma nitriding, it is possible to create a gradual transition in bonding and therefore minimize the mechanical instabilities associated with a sharp interface and associated mechanical property mismatch. [16,17]

Surface treatment-modifications:

The quality of the implant surface is one major factor that influences wound healing at the implantation site and subsequently affects osseointegration. In recent years, much effort has been exerted to improve implant anchorage in bone tissue by modifying the surface characteristics of titanium implants.Various studies have demonstrated that the success of integration of implants into bone tissue correlates positively with a special surface roughness of the implant surface . Another advantage of a roughened titanium surfaces is a shorter healing period and the option of utilizing shorter implants, still with a good long-term prognosis because of the better bone anchorage, therefore various surface modifications of titanium implants have been