The Effect of Rapid Distraction Rate on Bone Regenerate (An Experimental Study)

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Dedication

This work is dedicated to

My Dear parents
My brother and sisters

The light that leads my way

My true friends and colleagues for their encouragement and cooperation

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List of abbreviations

DO : Distraction osteogenesis

TMJ : Temporomandibular joint

CT : computed tomography

CBCT: Cone beam computed tomography

DEXA: (**DXA**) Dual-energy X-ray absorptiometry (Bone Densitometry)

cm : Centimeters

HU : Hounsfield unit

H&E : Hematoxylin and Eosin

SD : Standard deviation

Kv. : Kilo Volt.

mA. : Milliampere

mm : Millimeter

µm : Micrometer

Kg : Kilograms

Mg : Milligram

Ml : Milliliter

3D : Three dimensions

BMP : Bone morphogenetic protein

Introduction

Introduction

Bone reconstruction procedures in craniofacial region considered a complicated conditions, which usually require skeletal correction to overcome psychological, breathing and eating problems by reconstructing both soft and hard tissues. [1]

The conventional procedures like bone grafting and orthognathic surgeries are associated with various degrees of success. Significant complications were reported including: infection, dehiscence and graft resorption. [2,3]

Distraction Osteogenesis (DO) refers to a surgical technique designed to address defects and deficiencies in the skeleton. For over 40 years the orthopedic community has employed DO techniques to lengthen and reconstruct arms and legs. [4]

Distraction surgery was first reported to treat defects of the oral and facial region in 1992. [5] Since then, the surgical and technological advances made in the field of DO have provided oral and maxillofacial surgeons with a safe and predictable method to treat selected deformities of the oral and facial skeleton.

Since first clinical application of maxillofacial DO, [5] surgeons have not yet established a universally accepted rate of distraction. [6] Most studies on distraction rate suggested that one millimeter per day gives the most consistent osteogenesis with superior biomechanical properties of the bone regenerate. [7,8]

The craniofacial bones, however, have unique characteristics including an abundant blood supply and a rapid rate of bone healing as compared to long bones. Therefore, a rapid distraction rate might be considered of an added

value in the treatment of craniofacial deformities. [9] Distraction osteogenesis typically requires a long treatment period, which can lead to bone and soft tissue infection as well as considerable patient psychological and economical discomfort.

An important aim in DO is reducing time, so by using of a rapid distraction rate we could shorten the distraction period and therefore rapid DO may be a way of overcoming these problems in craniofacial deformities.

Review of Literature

Distraction Osteogenesis

Patients with craniofacial deformities usually require skeletal correction to overcome psychological, breathing and eating problems by reconstructing both soft and hard tissues. Autogenous bone grafting is one of traditional treatment methods. Although its several advantages such as biocompatibility, no disease transferring and retaining viable osteoblasts, the results are inconsistent because of problems as graft resorption, infection, donor site morbidity and limited quantities of harvested bone from donor site. [1]

Orthognathic surgery is another treatment method that was utilized to correct abnormalities of the jaw and face related to structure, growth, sleep apnea, temporomandibular joint (TMJ) disorders, malocclusion problems owing to skeletal disharmonies, or other orthodontic problems that cannot be easily treated with braces. But like any other surgery, there can be some complications such as bleeding, swelling, infection, nausea and vomiting. [10] There could also be some numbness in the face due to nerve damage. The numbness may be either temporary or unfortunately could be permanent. [11]

The procedure of Distraction Osteogenesis (DO) could overcome many of these problems. [12-14] In favor to avoid bone grafting and orthognathic surgery, distraction histogenesis furthermore allows the concurrent expansion of the soft tissue envelope. [15]

Distraction osteogenesis was developed in orthopedic surgery for long bone lengthening and has been applied for the correction of craniofacial defects. The historical developments, adaptations and applications of the technique are reviewed.

Distraction osteogenesis is the process of generating new bone in a space between osteotomized bone segments in reaction to the gradual traction that was created by distractor, which was fixed and adapted on the two osteotomized segments. [8] Uniquely, the formation of the new callus between the bone fragments continues throughout the stretching process. Distraction osteogenesis allows the formation of a large area of bone to correct a defect in syndromic patients. It also gives an alternative to conventional orthognathic and craniofacial surgery, where there is a risk of relapse as a result of lack of muscular accommodation to the new position. It was proposed that the slow, gradual traction during the process of DO allowed concurrent stimulation of growth in the surrounding soft tissues such as blood vessels, nerves, skin, mucosa, fascia, ligaments, cartilage, periosteum and muscle. [16-19] The response of the surrounding soft tissue to the distraction process is termed as distraction histogenesis. [15] Distraction osteogenesis and histogenesis both respond in parallel to gradual traction and this factor was important in the selection of this distraction concept.

History of Distraction Osteogenesis

Alessandro Codivilla, [20] was the first author described DO in 1905 as; he performed elongation of the femur up to 8 cm by fixing an external traction of 25-75kg in combination with plaster casting after an oblique osteotomy. Codivilla reported nerve problems and convulsions as final destination. Following from there, Putti in 1921, [21] designed a unilateral external fixation device to lengthen the femur and reduce trauma from the osteotomy by constant control of the traction process. Abbott in 1924, [22] conducted an application of bilateral external fixation and gained acceptance among surgeons, however this technique was not discredited over time