SHORT COMMUNICATION

LOADS IN DENTAL IMPLANTS

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ABSTRACT
Dental implants undergo occlusal loads when placed in occlusion; such loads may vary dramatically in magnitude, frequency, and duration depending on the patient's parafunctional habits. A force was described by Sir Isaac Newton in 1687 in what is now referred to as Newton's laws of motion**.** In his second law, Newton stated that the acceleration of a body is inversely proportional to its mass and directly proportional to the force that caused the acceleration. This law is expressed as F = ma. A force applied to a dental implant is directed clinically along loading axes that exist in implant dentistry: mesiodistal, faciolingual, and occlusal apical**.** Forces may be described as compressive, tensile, or shear. The implant body design transmits the occlusal load to the bone. Threaded or finned dental implants impart a combination of all three force types at the interface under the action of a single occlusal load. Cylinder implants in particular are at highest risk for harmful shear loads at the implant-to- tissue interface under an occlusal load directed along the long axis of the implant body. Hence, cylinder implants require a coating to manage the shear stress. A load applied to a dental implant may induce deformation of the implant and surrounding tissues. Biological tissues may be able to interpret deformation or a manifestation thereof and respond with the initiation of remodelling activity**.** The greater the magnitude of stress applied to a dental implant system, the greater the difference in strain between the implant material and bone. In such cases, the implant is less likely to stay attached to the bone, and the probability of fibrous tissue ingrowth into the interfacial region to accommodate the range of difference becomes greater. Moment of force or torque is the rotational equivalent of linear force. Torque can act on the tooth/dental implant in three different planes i.e Mesio-distal plane, Facio-lingual plane, occluso-apical plane these are called moment arms. These moment arms can also be clinically correlated as occlusal height, cantilever length, and occlusal width.

KEYWORDS
Dental Implants, Forces,Movements, Load Delivery, Impact Loads.

How To Cite This Article: MaazV.,Shalini A. LoadsIn Dental Implants– A Review. Int J Prostho Rehabil 2020; 1: 1:28-30

Received: 22-03-20; Accepted: 28-04-20; Web Published: 13-06-2020

Introduction

Dental implants undergo occlusal loads when placed in occlusion; such loads may vary dramatically in magnitude, frequency, and duration depending on the patient's parafunctional habits.
-Muscle forces from the tongue and surrounding muscle generate low but frequent horizontal loads on implant abutments. These loads are of higher magnitude with parafunctional movements[1].

Mass, force and weight

The property of Mass describes the degree of gravitational attraction the matter of the body experiences.
A force was described by Sir Isaac Newton in 1687 in what is now referred to as Newton's laws of motion[2]. In his second law, Newton stated that the acceleration of a body is inversely proportional to its mass and directly propor- tional to the force that caused the acceleration. This law is expressed as F = ma.
-Weight is the gravitational force acting on an object at a specified location.

Forces

-Forces are described by magnitude, duration, direction, type, and magnification factors. Forces acting on dental implants are vector quantities
-Maximum bite force exhibited by a human is affected by age, sex, degree of edentulism, bite location,and parafunction[3][4].
-A force applied to a dental implant is directed clinically along loading axes that exist in implant dentistry: mesiodistal, faciolingual, and occlusal apical[5].
-Forces may be described as compressive, tensile, or shear[6].

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-Compressive forces attempt to push masses toward each other
-Tensile forces pull objects apart.
-Shear forces on implants cause sliding. Compressive forces maintain the integrity of a bone-to-implant interface, whereas tensile and shear forces tend to distract or disrupt such an inter- face. Shear forces are the most destructive type of force acting on implants and bone compared with other loads.
-Cortical bone sustain compressive load stronger than the shear load[7].
-The implant body design transmits the occlusal load to the bone. Threaded or finned dental implants impart a combination of all three force types at the interface under the action of a single occlusal load.
-Cylinder implants in particular are at highest risk for harmful shear loads at the implant-to- tissue interface under an occlusal load directed along the long axis of the implant body.Hence, cylinder implants require a coating to manage the shear stress.

Stress

-The manner in which a force is distributed over a surface is referred to as mechanical stress.
-The magnitude of stress depends on two variables: force

magnitude and cross-sectional area over which the force is dissipated. The force magnitude rarely can be controlled completely by a dentist. The magnitude of the force may be decreased by reducing these significant magnifiers of force: cantilever length, offset loads, and crown height.
-The functional surface area over which the force is distributed, however, is controlled completely through careful treatment planning.

Functional cross-sectional area is that surface that participates in load bearing and stress dissipation. This area may be optimized by
(1) increasing the number of implants for a given edentulous site and
(2) selecting an implant geometry.
-Peak stresses are in a particular orientation (or geometric configuration) in which all shear stress components are zero.
-A load applied to a dental implant may induce deformation of the implant and surrounding tissues. Biological tissues may be able to interpret deformation or a manifestation thereof and respond with the initiation of remodelling activity[8].

Stress strain relationship[9]

-Relationship is needed between the applied force (and stress) that is imposed on the implant and surrounding tissues and the subsequent deformation (and strain) experienced throughout the system.
-The closer the modulus of elasticity of the implant resembles that of the contiguous biological tissues, the less the likelihood of relative motion at the tissue-to-implant interface.
-The macrogeometry of the implant has a strong influence on the nature of the force transfer at the tissue-to-implant interface.
-The greater the magnitude of stress applied to a dental implant system, the greater the difference in strain between the implant material and bone. In such cases, the implant is less likely to stay attached to the bone, and the probability of fibrous tissue ingrowth into the interfacial region to accommodate the range of difference becomes greater.
-Decreasing stress in softer bone is more important for two primary reasons:
(1) to reduce the resultant tissue strains resulting from the elasticity difference
(2) because softer bone exhibits a lower ultimate strength.

Impact loads

When two bodies collide in a small interval of time,large reaction forces develop. Such a collision is described as impact. In dental implant systems subjected to occlusal implant loads, deformation may occur in the prosthodontic restoration, in the implant itself, and in the contiguous interfacial tissues. The nature of the rela- tive stiffness of these components in the overall implant system largely controls the response of the system to impact load. The higher the impact load, the greater the risk of implant and bridge failure and bone fracture[7].

Movements in dental structures[8]

1.Forces due to Functional movements
Functional movements include chewing, speech, swallowing and yawning.Forces acting during chewing could be compressive,tensile or shear in nature.

2.Forces due to Para Functional movements
Para-functional movements include movements during clenching, bruxism and other habitual movements. These movements should be recorded and studied in order to fabricate an appropriate prosthesis that functions in harmony with these movements.

3.Forces due to Perioral movements
Bone is plastic in nature and is responsive to various muscular forces exerted on it.The band of musculature extending from anterior to posterior are orbicularis Oris,Buccinator and Superior Constrictor of Pharynx. All this muscles applies inward forces on the bone and to counteract this forces tongue applies outward forces and thus this forces get neutralised.This is called as Buccinator mechanism [8].

Load delivery on dental implants[9]

-Moment of force or torque is the rotational equivalent of linear force. Torque can act on the tooth/dental implant in three different planes i.eMesio-distal plane,Facio-lingual plane,occluso-apical plane these are called moment arms.
-These moment arms can also be clinically correlated as occlusal height, cantilever length, and occlusal width.

a.Occlusal height-
-Occlusal height is a moment arm for force components acting along the faciolingual axis: working or balancing occlusal contacts, tongue thrusts, or in passive loading by cheek and oral musculature.

b.Cantilever length-
-Cantilever length refers to the length of prosthetic space to be rehabilitated using an implant abutment. Here the implant acts as cantilever abutment.
-Distance away from the implant is referred to as Offset distance and this offset distance produces rotational forces. Basically acting as a Class 1 lever mechanism.
-Vertical axis force components generally produce large moments. Force applied directly over the implant does not induce a moment load or torque because no rotational forces are applied through an offset distance.
-When a line is drawn from the distal of each posterior implant,the distance to the center of the most anterior implant is called the anteroposterior distance (A-P spread). More the A-P spread between the center of the most anterior implants and the most distal aspect of the posterior implants, the smaller the resultant loads on the implant system from lever forces because of the stabilizing effect of the anteroposterior distance. Clinical experiences suggest that the distal cantilever should not extend 2.5 times the A-P spread under ideal conditions.

Authors contribution:

Shalini A.: Manuscript editing, Literature search, data collection
Maaz Vohra: Data Analysis, manuscript editing

Acknowledgement:

The authors would thank all the participants for their valuable support and thank the dental institutions for the support

Conflict of interest: All the authors declare no conflict of interest

Source of funding: None

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