SHORT COMMUNICTION

FATIGUE FAILURE IN DENTAL IMPLANTS

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ABSTRACT
In clinical conditions, dental implants are frequently utilised to replace natural teeth. Implant failure is a major issue for dentists and patients, despite substantial breakthroughs in materials, methods, and implant design. Periimplantitis and a lack of osseointegration are two of the most common causes of implant failure. Implant failure can also be caused by occlusal overloading, the patient's medical condition, smoking, and implant features. The goal of this brief study is to address the aetiology of implant failures by emphasising the many classifications proposed by different authors and proposing a new one.

KEYWORDS
Dental Implants, Failures of implants, Fatigue failure.

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Introduction

Implant failure is defined as total failure of the implant to fulfill its purpose (functional,esthetic or phonetic) because of mechanical or biological reasons. Implant failure is characterized by progressive bone loss, signs of inflammation and mobility of the implant.

Classification of implant failures

Classification of oral implant failures based on the osseointegration concept.[1]

1. **Biological failure**
   - Primary (before loading): failure to establish osseointegration.
   - Secondary (after loading): failure to maintain the achieved osseointegration.
2. **Mechanical failure**
   - Fracture of implants, connecting screws, bridge frameworks, coating etc.
3. **Iatrogenic failure**
   - Nerve damages, wrong alignment of implants, etc.
4. **Failure due to Inadequate patient adaptation**

Signs of Implant Failure		
Group	**Clinical condition**	**Management**
Success (Optimal health)	• No pain during function • No mobility • < 2 mm radiographic bone loss • No exudate	• Regular follow-up
Satisfactory survival	• No pain during function • No mobility • 2- 4 mm radiographic bone loss • No exudate	• Reduce stress on implant • More follow-up • Local drug therapy • Yearly radiographs
Compromised Survival	• Sight sensitivity during function • No mobility • > 4 mm radiographic bone loss (less than half of implant body) • Probing depth > 7 mm • May have exudate history	• Reduce stress on implant • More follow-up • Drug therapy • Surgical re-entry • Yearly radiographs
Failure (Clinical or absolute failure)	• Mobility • > 4 mm radiographic bone loss (less than half of implant body) • Probing depth > 7 mm • May have exudate history	• Remove implant [2]

- Phonetical, esthetical, psychological problems, etc.

Signs of implant failure

- Connecting screw loosening
- Connecting screw fracture
- Gingival inflammation
- Purulent exudate
- Pain
- Fracture of prosthetic component
- Radiographic evidence of bone loss and inflammation

Types of stress related implant failure[3]

-Fatigue failure in dental implants:

Fatigue is the initiation and propagation of cracks in a material due to cyclic loads over a period of time.

Stages of fatigue failure:

a.Crack initiation stage
b.Crack growth stage
c.Ultimate failure stage

Four factors influence's fatigue failure in implant dentistry:

a.Biomaterial
b.Macro geometry
c.Force magnitude
d.Number of cycles. [4]

Biomaterial

The choice of material used can also affect the biomechanical performance of implant abutment screws. These minute screws should have excellent ductility so that they can elon- gate and produce a retentive force when tightened. Screw loosening is one of the most common complications associated with implants. There are various factors that can affect screw loosening. These include the type of material used, the forces acting on the implant and design of the implant. Pure titanium is prone to fracture. Flence, alloys of titanium or noble metals are generally used as an abutment material. With recent advances in zirconia, more aesthetic abutments are being manufactured. Current evidence suggests that abutments made of metals and alloys have fewer complications.[5]

Macro Geometry

The shape of the implants and the design of the macroscopic features can affect the mechanism of load transfer between the implant and bone.[6]Smooth-sided, cylindrical implants provide ease in surgical placement. However, they produce larger shear forces on the bone. Smooth-sided, tapered implant allows for compressive load to be delivered to the bone-to-implant interface, depending upon the degree of taper. The larger the taper, the greater the component of compressive load delivered to the interface. Unfortunately, greater the taper of an implant, lesser the overall surface area of the implant body. Hence, the amount of taper cannot be greater than 30 degrees as this will compromise the length of the implant.[7]It should be remembered that too much compressive forces are also detrimental to the surrounding bone. The implant should be designed such that the forces will stimulate and not resorb bone. Threaded implants with circular cross-sections provide for ease of surgical placement, better functional surface area (for force distribution) and can prevent micro-movement during healing.[8]

Force Magnitude

Various forces acting on the natural tooth causing micro movements of the tooth is greatly influenced by the periodontal attachments of the tooth. Cuspal inclination and location of the cusp in relation to the ridge alters the acting forces. As implants are devoid of periodontal ligaments there are no micro movements associated with Osseointegrated implants. Forces acting on the implant differ from those acting on natural teeth. Changing tooth position and cuspal orientation limits the forces acting on the implant. The type of force acting and the consequences of poor fit are related to each other. Prosthesis combining natural teeth with an osseointegrated prosthesis requires new design principles and detailed understanding of failure mechanisms.[9]

Number of Cycles

Para functional forces on teeth or implants are characterized by repeated or sustained occlusion.The most common cause of implant failure after successful surgical fixation or early loss of rigid fixation during the first year of implant loading is the result of parafunction. Such complications occur with greater frequency in the maxilla, because of a decrease in bone density and an increase in the moment of force.[10]

Counteracting Fatigue failure

1.Clinical scenario of short span edentulous spaces: When facing implant failure, one should always consider the number of teeth necessary for adequate function or what dentition assures oral function?[11] In certain cases the treated area can remain edentulous and this should be considered as a treatment option. An important indicator of oral health status is the number of teeth present.[12] In 1992, the World Health Organization (WHO) stated that throughout life, the retention of a functional, esthetic, natural dentition of 20 teeth, without requiring prostheses, should be the treatment goal for oral health.

2.Managing the implant prosthesis: Prosthesis should have low occlusal height,narrow occlusal table such that the cuspal orientation is in line with the residual ridge and for counteracting lever forces A-P length should be managed according to the case.

Conclusion

The magnitude of loads on dental implants can be reduced by consideration of arch position, higher loads in the posterior compared with anterior mandible and maxilla, elimination of moment loads, and increase in surface area available to resist an applied load. Fatigue failure is reduced by reducing the number of loading cycles. Thus aggressive strategies to eliminate parafunctional habits and reduce occlusal contacts serve to protect against fatigue failure.

Authors Contribution

Adil Bhimbal: Manuscript editing, Literature search, data collection
Maaz Vohra: Data Analysis, manuscript drafting

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