Bacterial colonization at implant – abutment interface: a systematic review

Tabrez Lakha[1], Mohit Kheur[2], Supriya Kheur[3], Ramandeep Sandhu[4]

[1,4]Postgraduate,
[2]Professor,
Department of Prosthodontics, M.A.Rangoonwala College of Dental Sciences and Research Centre, Pune, India.
[3]Professor and Head of Department, Department of Oral Pathology and Microbiology, D.Y.Patil Dental College, Pimpri, Pune, India

Address for Correspondence:
Dr. Tabrez Lakha
Postgraduate, Department of Prosthodontics, M. A. Rangoonwala College of Dental Sciences and Research Centre, Azam Campus, Hidayatullah Road, Pune 411011.
E-mail: tabrezlakha@gmail.com

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ABSTRACT

Background: Although implants have shown to have a high success rate, clinicians are also called upon to encounter numerous complications and failures. Among the numerous reasons of failures, peri-implantitis is reported to account for 10% of the failures. As the oral cavity provides a natural habitat for various micro-organism due to its non-shedding surface, there is some evidence that gram-negative anaerobic rods colonize around the implant leading to peri-implanitis. This colonization is dependent on various factors such as the micro-gap at the implant- abutment interface, the precision of fit, degree of micro-movement and applied torque.

Aim and Objective: The aim of this article is to provide an overview of current literature on bacterial colonization on the implant surface and the influence of different implant-abutment designs on bacterial colonization.

Material and Methods: An electronic search was conducted using the PubMed (Medline), PubMed central and Google scholar to identify articles published on bacterial colonization at the implant-abutment interface. The following search words were used: microbioleakage at implant-abutment interface, surface characteristics/roughness of implants, bacterial adhesion on dental implants, bacterial colonization at implant abutment surface. The articles included in the review comprises of in vitro studies, in vivo studies, review abstracts and review articles.

Results: The total number of articles for the key words" microbioleakage at implant-abutment interface" were 29 and for the key words" bacterial colonization at implant abutment interface" were 17. After considering the inclusive and exclusive criteria, case report, case series and review articles were excluded. 11 articles were considered eligible based on their relevance to the subject.

Conclusion: Although micro-gap formation inevitably occurs at the implant-abutment interface. The current literature highlights that the formation of this micro-gap is influenced by the type of implant-abutment design used. Though the results are insignificant, recent in vivo and in vitro studies have proved that external hexagon results in higher micro leakage compared to other connections used .Morse-taper connections shows the least amount of microbial leakage.

Key words: Implant-abutment interface, Microbial leakage, Bacterial colonization

INTRODUCTION

Implant failures can be divided into early and late failures.[1,2] Early failures are described as failures which have occurred before the abutment connection and are generally caused by inadequate Osseo integration. Studies have shown correlation between age, gender, insertion site, fixture length, smoking and success of an implant.[3-4] Late failures occur after occlusal loading of the implant and has been associated with plaque induced peri-implantitis.

Since two- stage implant system are frequently used they result in a micro-gap at the implant-abutment junction, this hollow space provides a favourable site for bacterial colonization and leads to inflammatory process at implant-abutment interface.[5-6] This infiltration of bacteria is a major contributory factor leading to perimplantitis.[1]

Peri-implantitis is a progressive disease of implant involving hard and soft tissues resulting in bone resorption, decreased osseointegration, pocket formation and purulence. Bone resorption may be induced by bio mechanical stress, bacteria, or a combination of both. However bacteria may be the primary factor, anaerobic bacteria have been observed growing in the micro-gap present at the implant-abutment interface and in the peri-implant sulcus.[7]The infiltration of the bacteria at implant abutment interface has been shown to depend on the type of implant-abutment connection and their sealing capacity.[8]

The frequently used abutments in different implant systems are internal hexagon, external hexagon, cylinder hex, conical, octagonal, spline cam, cam tube, pin/slot.[9] The hexagon design is oldest and was the most commonly used design, however it had

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shortcomings like screw loosening and compromised rotational and lateral stability.[9] Therefore to overcome the shortcomings different designs of abutments were developed, out of the designs mentioned conical abutments have gained popularity as it provides mechanically sound, stable self-locking interface.[10,11] Since it provides a friction lock, it minimizes the micro-gap present at implant-abutment interface. It has been suggested that conical connection reduces bacterial infiltration at implant abutment interface.[12]

MATERIAL AND METHODS

An electronic Search was conducted using the PubMed (Medline), PubMed central and Google scholar to identify articles published on bacterial colonization at the implant-abutment interface. The following search words were used: microbioleakage at implant-abutment interface, surface characteristics/ roughness of implants, bacterial adhesion on dental implants, bacterial adhesion on implant abutment surface. Literature covering both in vivo, in vitro studies and review articles were included.

RESULTS

The total number of articles for the key words" microbioleakage at implant-abutment interface" were 29 and for the key words "bacterial colonization at implant abutment interface" were 17.

After considering the inclusive and exclusive criteria case report, case series and review articles were excluded. 11 articles were considered eligible based on their relevance to the subject.

The articles were categorized with respect to the current literature on microbial leakage at implant-abutment interface, influence of torque values, roughness, and type of abutment connections which influences the microbial colonization at the interface.

To highlight the important aspects and to give a clear overview of the literature, the articles have been described in various headings.

ABUTMENT DESIGNS

Implant-abutment connections can be categorized into internal and external connection. The distinctive feature which separates the two is the presence and absence of geometric feature extending on the coronal surface of the implant.

This can be categorized as a slip-fit joint where a space exist between the implant – abutment interface or a frictional fit where there is minimal space at the interface. This geometry can be of following types octagonal, hexagonal, cone screw, cone hex, cylinder hex, sline cam, cam tube and pin / slot.[9]

There has been various in vivo and in vitro studies which have evaluated the micro-gap present at the interface of the different designs and the microbial leakage at the interface.

IMPLANT-ABUTMENT INTERFACE-THE MICROBIAL LINK

Two piece implant system consists of the endosteal part (implant) which is placed during the first surgical phase and the mucosal part (abutment) which is attached after osseointegration. Screwing the abutment to the implant results in gap between the two components. It has been reported that this micro-gap measures around 40-60μm, due to this gap there is micro-movement during function which in turn enhances microbial leakage.[13] Presence of gap near the alveolar crest is also responsible for 1mm of bone loss during the first year of functional loading.[14]

The colonization of the bacteria at the implant-abutment interface depends on factors like the precision at the implant-abutment interface of different implant system and their marginal fit, the closing torque values also alters the sealing ability of the abutments.[15]

To demonstrate the microbial leakage at implant-abutment interface an in vitro study was carried out on implant-abutment assemblies using blood serum media inoculated with micro-organism. The serum was incubated in anaerobic condition for 7 days with the implants partially and completely immersed in it. The micro-organisms from the implants were collected and incubated in blood agar plates in anaerobic conditions. The result of this study showed presence of micro-organisms in both the assemblies indicating bacterial leakage.[16]

Bacterial leakage have also been observed after functional loading of implants, it has been shown that chewing reduces component stability which favours bacterial colonization at the micro-gap. When the implants are subjected to functional loads there is exchange of fluids between internal and external environment which increases the bacterial infiltration at the peri-implant area.

Therefore implant-abutment interface plays a vital role in bacterial colonization, different connections have been compared to evaluate their stability under loading conditions.

Comparison between internal and external abutment connections of different implants systems have demonstrated that internal connections provide better marginal fit at the interface, thus minimizing the microbial leakage.

In vivo and in vitro studies have demonstrated that among various connections used, Morse taper connections achieved higher seal as it has frictional lock system and thus reduced the bacterial infiltration at the implant-abutment interface. Also conical abutments showed superiority in terms of torque maintenance and abutment stability which in turn minimized the bacterial colonization.[17] Though external hexagon are one of the oldest and commonly used abutment connections, they are considered to be

ineffiecient in preventing microbial leakage at the implant-abutment interface.

An in vivo study was done on bacterial colonization at the peri-implant sulcus and inside the implant connection after 5 years of functional loading, significant difference between connection type and total bacterial counts was noted. Connections types compared in the study were external hexagon, internal hexagon with external collar and conical. Bacteria belonging to the red and orange complex were evaluated, these included Aggregatibacter actinomy-cetemcomitans (Aa), Porphyromonas gingivalis (Pg), Tannerella forsythensis (Tf), Treponema denticola(Td), Prevotella intermedia (Pi), Peptostreptococcus micros (Pm), Fusobacterium nucleatum (Fn), Campylobacter rectus (Cr), Eikenella corrodens (Ec), and Candida albicans (Ca). Significant results were observed as the conical connection showed least amount of red complex bacteria as compared to external hexagon, and internal hexagon with external collar.[17]

An in vitro study was also performed to evaluate the bacterial leakage at the implant-abutment interface and the sealing efficiency of implants when they were subjected to in different torque values. The torque values used was 20N.cm and 30N.cm. Higher contamination was observed with implants in which 20N.cm torque was applied.[15]

DISCUSSION

Microbial penetration through the micro-gap invariably exists at the implant-abutment interface. This gap has shown to be a potential source of microbial infiltration and peri-implantitis leading to implant failure, as it offers a welcoming environment for the bacteria to colonize.

Though conical connections have shown a better sealing ability, micro-gap invariably exists at the interface, therefore it can be stated that no connection has completely eliminated the micro-gap formation or has led to a sterile environment inside the implant connection.

Type of connection used is one of the important factor influencing bacterial adhesion, however other factors should also be given prime importance when implants are used. Factors such as surface roughness of implants, the amount of torque used, the variability or the changing oral micro flora has to be considered. As it been shown that rapid biofilm formation occurs at the implant surface which is difficult to clean. There is a need to optimize the implant-abutment connections in order to achieve better outcomes.

CONCLUSION

After analysing the current literature, it could be concluded that bacterial colonization depends on multiple factors and certain modifications should be always undertaken to minimize the factors which promote bacterial infiltration at the implant-abutment interface. Current implant systems cannot safely prevent microbial leakage and bacterial colonization of the inner part of the implant. There is a need for modifications to seal the implant-abutment contact area.

Use of conical implants can be promoted as it has better sealing abilities compared to other systems. Manufacturers and clinicians must be aware of the problem of microbial leakage, since it is likely that microbial colonization of the marginal gap and the inner part of the implant can result in soft tissue inflammation leading to implant failure.

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