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COMPLICATION AND FAILURE OF TITANIUM IMPLANTS - AN EVIDENCE BASED REVIEW

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ABSTRACT

Despite continual innovation in implant systems and various interceptive medical approaches, dental implant failure has been connected with risks and consequences. The success rate of dental implants as a treatment option for missing teeth has increased over time. Dental implants are designed to be compatible with a variety of bone types. Endosseous implants are not successful for a handful of reasons. This review article discusses all the possibilities for the unsuccessful implant placement and their related factors. A greater understanding of the variables causing implant failure may improve and guide in the clinical decision-making and may advance the practise of implant dentistry.

Keywords: Dental implant, titanium, titanium implant, implant failure, innovation

INTRODUCTION

Dental implants are inert, alloplastic materials that are placed in the upper jaw and and lower jaw to replace damaged orofacial components caused by trauma, neoplasia, or congenital abnormalities. Endosseous dental implants are the most frequent type, consisting of a discrete, single implant unit (often screw- or cylinder-shaped) inserted within a drilled area within dentoalveolar .Dental implants are commonly made of commercially pure titanium or titanium alloy.Titanium is one of the most extensively used materials for implant placement due to its excellent mechanical strength, biocompatibility, and extensive history of usage. It has been in the field for years, demonstrating its longevity and continuous use (1). Today's titanium dental implants have a good success rate, and the industry has advanced by huge leaps since the first dental implant was implanted.Today's titanium dental implants have a good success rate, and the industry has advanced by huge leaps since the first dental implant was implanted. P.-I. Branemark discovered osseointegration in 1969 when he noticed that a piece of titanium embedded in rabbit bone became securely lodged and hard to remove (2). After one year of surveillance, no inflammation was found in the peri-implant bone; and meanwhile, soft tissue had developed an attachment to the metal and bone had created a connection to the titanium (3).The Branemark system of dental implants was introduced in 1971. An estimated one million endosseous dental implants are placed per year worldwide and different manufacturers produce 220 implant brands (4,5). Dental implants are typically placed under local anaesthetic in general dental practice. However, there are no regulatory controls over the operating environment. Despite this, and the contaminated oral surgical sector in which they are implanted, success rates have been reported to be as high as 90-95 percent (6,7).Titanium dental implants and the infections linked with their failure are discussed in this research.Our team has extensive knowledge and research experience that has translated into high quality publications(8–26).

OSSEOINTEGRATION

The process of osseointegration begins after endosseous implant fixtures are surgically implanted into bone. Osseointegration is considered ‘a direct, structural and functional connection between organized vital bone and the surface of a titanium implant, capable of bearing the functional load’(27).This is possible as the titanium surface oxide layer (mainly titanium dioxide) is biocompatible, reactive and spontaneously forms calcium-phosphate apatite (28). Furthermore, the titanium oxide surface of implants achieves a union with the superficial gingivae restricting the ingress of oral microorganisms. Consequently, the implant/soft tissue interface is similar to the union between tooth and gingiva (29,30).

TITANIUM BASED DENTAL IMPLANTS

The development of titanium alloys has led to the increased use of dental implants to replace missing teeth in patients(2,31).Periodontal disease is the most common cause of tooth loss in adults (31).Modern titanium-based dental implants have a high success rate with less failures .Titanium alloys are utilized for making dental implants because of their good mechanical characteristics, low density (4.5 g/cm3), and strong bone-contact biocompatibility.The main alloy pure titanium (3). This metal is classified into four categories based on its purity and processing oxygen content (32). These grades differ in corrosion resistance, ductility, and strength, with grade 4 cp-Ti having the greatest oxygen concentration (about 0.4 percent) and the best overall mechanical strength (32).

SUCCESS AND FAILURES

Adell revealed the rate of success of 895 implant placement over a 5- to 9-year period of observation (5). 81% of maxillary implants and 91% of mandibular implants were found to be stable. Even though there is a high success rate, implant fixture failure is possible and is described as "the insufficiency of the host tissue to maintain osseointegration" (6). According to one study, just under 2% of implants failed to deliver osseointegration after insertion (33). A meta-analysis found that the rate of failure for Branemark dental implants (excluding bone grafts) were 7.7% after 5 years (6). Surprisingly, failure rates in edentulous patients were nearly double those in partially dentate individuals (7.6% versus 3.8%). Furthermore, failure in the edentulous maxilla was around 3 times greater than in the edentulous mandible.Peri-implantitis is defined as "an inflammatory process affecting the tissues around an

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osseointegrated implant in function, resulting in bone loss" (34).Clinical and radiographic signs of a failed dental implant are recognised, and the diagnosis is done in the same manner as periodontitis (16). Clinical parameters such as peri-implant gingival attachment loss, bleeding on probing, plaque indices, and mobility are measured, radiograph and microbiological sampling are also important measures. Peri Implantitis has been documented in 5-8% of instances involving specific implant systems (35).

CLASSIFICATION OF FAILURES

Several clinical and radiographic factors can be used to determine whether an implant has failed. A failing implant shows increasing loss of supporting bone as well as attachment to nearby tissues, but it is clinically stable, whereas a failing implant will have mobility clinically (36). When an implant is considered to be failed, it is suggested that it should be removed, but a failing implant may be saved if it is diagnosed and treated effectively to overcome the etiological component (37,38). Implant failures can also be classified as either early or late. Initial failures can occur before osseointegration and prosthetic rehabilitation, while late failures occur after (39). Factors influencing dental implant failure can be roughly characterized as implant, patient and surgical technique/environment-related. Late failures often affect a small majority of individuals, and the reason is unknown (33). Late failures are categorized as either late early or late delayed based on whether they arise during and after the first year of loading. Modifications in loading circumstances in respect to bone quality/volume and peri-implantitis are likely causes of late-delayed failures (40). The possibility of bacteria causing infection is determined by virulence and host variables (41). While the above mentioned criteria are related to implant failure in terms of bone anchorage, the infectious phase is sometimes restricted to the soft tissues over the healing implant site, which results n peri-implant mucositis (38). An implant damaged by soft-tissue issues has a better prognosis than one damaged by bone loss (42). Infection that begins in the soft tissues has the ability to spread deeper into the bone and disrupt the osseointegration process. Residual suture material, poorly seated cover screws, protruding implants, and trauma from partially alleviated dentures or occlusal trauma from opposing teeth are some of the most common causes of soft tissue infection during the healing phase (36).

DRAWBACKS OF TITANIUM MATERIAL

Titanium implants have very high toxicity thus it causes wear and corrosion especially in an environment like oral cavity. The released particle can come from the titanium coating layer or from the titanium implant. The accumulation of titanium ions and particles can occur systematically as well as in the surrounding tissues, which can lead to toxic reactions in other tissues including yellow nail syndrome (43). It has been proposed that implantation failures in dental titanium implants may be induced by inflammatory reactions in surrounding tissues caused by titanium alloy corrosion or an allergic reaction to titanium and titanium alloys.Another drawback is attributed to allergic reactions to titanium such as erythema, urticaria, eczema, swelling, pain, necrosis, and bone loss due to titanium dental implants (44).

ESTHETICS

Titanium implants can also compromise the esthetics. For instance the metal color of the titanium will be seen especially if the patient has a very thin biotype of the gingiva. Once the gingiva slowly recedes the margins of the gingiva is evident (45).

CONCLUSION

Dental implants are becoming a more frequent form of prosthetic device inserted in individuals. Data on dental implant failure and complications should be collected and analyzed in a structured manner. Modern generation implant material like zirconia, polyether ether ketone (PEEK) , Poly ether ketone ketone (PEKK) can be a great alternative as these are esthetic tooth coloured implant material.

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