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Review Article

Causes, risk factors and complications of dental implant failure

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ABSTRACT

Osseointegration, which refers to the direct attachment of dental implants (DIs) to the neighboring host bone, is a great predictor of the therapeutic efficacy of DIs. The factors that determine whether DIs are successful have been evolving over time. Presently, these factors comprise the lack of mobility at the beginning of the prosthetic stage. DIs have a high chance of success; however, they occasionally fail. The failure of properly implanted DIs has been attributed to inappropriate patient identification; inadequate dental hygiene associated with microbial plaque buildup. The three most significant factors that lead to early implant failure appear to be a paucity of basic stability, surgical injury, and infection. Due to disruption of the basic bone recovery process, initial symptoms of infection may portend a far more serious outcome than if similar issues arise later. It appears that peri-implantitis and occlusal overloading are the main causes of late failure. Among the predisposing variables for implant problems and failure include poor prosthesis fabrication and subpar implant design.

Keywords: Dental implants, Osseointegration, Early failure, Late failure, Peri-implantitis

INTRODUCTION

Endosseous dental implants (DI) are now the standard of care for replacing missing teeth due to advancements in DI research and technology over the past 20 years. A DI supported prosthesis serves as the primary course of therapy for long-term recovery. The factors that determine whether DI are successful have been evolving over time. Presently, these factors comprise the lack of mobility at the beginning of the prosthetic stage, the lack of persistent radiolucency around the DI, the lack of suppurating peri-implantitis (PI), and patient reports of subjective discomfort.[1,2]

METHODS

This study is based on a comprehensive literature search conducted on 21 December 2022, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the

previously listed papers as a starting point. We looked for valuable information in papers that discussed the information about causes, risk factors and complications of dental implant failure. There were no restrictions on date, language, participant age, or type of publication.

DISCUSSION

The failure of properly implanted DIs has been attributed to inappropriate patient identification, inadequate dental hygiene associated with microbial plaque buildup, faulty prosthesis repair, debris accumulation, and bone preparation in the absence of coolants.[3]

Early failures

Early problems happen within some weeks and months after DI are inserted into the bone. They disrupt the process of healing or modify how it heals.[2,4,5]

Implant selection

From an etiologic perspective, inappropriate implants, like short DIs, result in their failure because of an undesirable crown root ratio.[2,6] In a 1993 investigation by Bahat on planning management and placing implants in the posterior maxilla, 732 DIs were positioned there by partially edentate patients. The failure rate for 7 mm DIs was 9.5%, compared to 3.8% for all other sizes.[7] Akin to this, relatively small DIs are much less likely to tolerate loads that could cause the DI components to shatter. The failure rate for all 5 mm DIs was 2-3%, and the failure rate for all double DIs was 1-2%, according to research by Bahat and Handelsman that examined the medical outcomes of placing different combination of DIs at one location posteriorly.[8] Owing to the conical screw structure, the superstructure has a tendency to come loose in the oral cavity.[6] The retention of the DI in the bone is aided by DI characteristics including surface roughness and contaminants, which are crucial to DI success.[2] The kind of bone that accepts a DI is also important to the effectiveness of the DI as DI qualities.

Bone type

In the anterior mandible, dense compact bone and porous compact bone are more advantageous because they keep the DI firmly in the socket. In comparison, the posterior maxilla's porous and trabecular bone reduces the retention of the DI in the bone.[9] According to Jaffin and Berman's (1991) five-year investigation, porous trabecular bone accounted for up to 35% of all DI failures because of its thin cortex. The likelihood of failure rises when the DI is positioned in immature bone grafted areas.

Surgical criteria

A crucial requirement for a healthy DI is surgical precision. This is dependent on the DI's axial positioning, the distance between adjacent DIs, and how well it first stabilizes in the bone. DI s positioned in the buccal region endanger the buccal cortical plate. Comparable to how implants that are lingually positioned obstruct speech.[10] A smaller gap between two DIs damages the interdental bone, which results in bone loss.[11] In contrast, if the gap is greater than is necessary, more cantilevers are added, increasing the pressure on the supporting DIs and increasing the likelihood that they will collapse.[10] Highest pressures were found to be focused at the farthest bone/implant contact, which was on the loaded side of the terminal DI, according to Sertgoz et al's report. Raising the cantilever length raised the stress value at the bone DI interface.[12] Excessive inward and outward motion reduces bone density by over-preparing the bone location. The integrity of the bone is reduced when dense bone drills are used on low density bone.[4] Necrosis is caused by overheating it (47° for longer than a minute).[6] Problems of osseointegration brought on by high heating of bone resulted in the loss of 5.8% of DI.[13] Watering reduces the likelihood of bone deterioration.[6]

Surgical conditions

It is crucial to preserve sterility throughout the surgical operation. Saliva, perioral skin, unkempt tools, soiled protective gear, operating room air, or patient-expired air all tamper with the surgical intervention, contaminating the DI site and resulting in infection.

Prosthetic considerations

For a DI to be viable, prosthetic rehabilitative and occlusal modifications must be factored in. Despite the surgeon and prosthodontist's collaboration, Fumihiko Watanabe et al revealed in 2002 that an DI was positioned incorrectly. This failure highlighted the need to thoroughly explain the prosthodontic component of the therapy to every team member prior to performing any surgical procedures.[14] Force distribution improves the effectiveness of the DI. Breaking of a prosthesis component results from greater force on one DI.[2,4] Therefore, it is best to avoid placing too much pressure on a single DI. DI misfit causes elements to be under constant tension, which increases the risk of screw breakage or release.[2,4] In 2003, Simon came to the following conclusion: the failure frequency of implants was 4.6%, with issues of abutments screw loosening (7%).[15] Heavy DI loading, particularly on cantilever abutments, and poor design raise the risk of collapse.[4] The odds of failure increase with cantilever span.[4,11]

Late failures

In the same way that some circumstances contribute to initial failures, another group of factors contribute to late failures. The pathological mechanisms in formerly osseointegrated DIs are the cause of these failures. These are primarily connected to the patient's health. They fall within the category of host factors.

Host factors

Diabetics have slower wound recovery, which affects the osseointegration mechanism.[1,6,9] Diabetes that is not under control causes DI failure. Diabetics had a reduced success rate of just 85% according to Fiorellini et al, however Olson et al discovered that the length of diabetes had an impact on DI success, with more failures occurring in individuals who had it for a longer time.[9,16,17] Osteoporotic and arthritic diseases negatively impact bone density. Porous bone results from this. Such bone cannot support DIs successfully.[1,9] According to a 2004 study by Keller et al, bone diseases like osteoporosis have an impact on the osseointegration properties of implants.[18] Metabolic syndrome, which includes obesity, causes a rise in peri-implant inflammations, which consequently influence the prognosis for DIs.[1] Growing older is a significant risk factor, according to research on DIs and relative risk variables.[9] Individuals between the ages of 60 and 70 had a greater chance of DI failure than those under the age of 40.[19]

Tissue abuse and parafunctional behavior

DI success is negatively impacted by tissue abuse practices, parafunctional behaviors, and psychiatric illnesses.[2] Smoking is linked to noticeably more severe degrees of bone loss. It decreases bone density, which prevents osseointegration and raises the failure rate.[1,9] Bain and Moy noted that a considerably higher proportion of DI failures happened in smokers (11.3%) than in non-smokers (4.8%), and Lambert et al reported that patients who smoked had more failures.[9] The occlusal stress on DIs is increased by parafunctional behaviors like bruxism. It causes DI fracture, which results in failures.[6] 41 patients who got 127 immediately loaded DIs were assessed by Glauser et al. Their findings demonstrated that DIs lost more often in patients with parafunctional behaviors (bruxers) than in people without parafunction (41% versus 12%).[20] Surgeries are hampered by cognitive problems, intellectual disabilities, and a shortage of assistance. Mental disorders have a negative impact on DI success.[2]

Radiation

Patients with malignancies of the maxilla and mandible receive radiotherapy. It results in osteoradionecrosis, which reduces bone volume and prevents osseointegration.[1,9] The reported success rate is only around 70%, there are few long-term investigations, although Jacobsson et al found that radiation-induced DI loss increased over time.[21]

Personnel responsible (early failures)

Placing an DI requires a surgical intervention that is jointly performed by specialists from oral surgery, prosthodontics, and periodontics.[5] Periodontists and oral surgeons evaluate the extraction of natural teeth, the amount and quality of the bone, the person's periodontal wellness, and the patient's general wellbeing. The prosthetic, occlusal layout, and DI design are handled by prosthodontists. The effectiveness of the DI is decreased by any inconsistency in any of these procedures. DI failure is caused by inaccuracy in DI design, which raises the occlusal loading on the DIs. Consequently, the laboratory technician also has a crucial function.[6]

Personnel responsible (late failures)

The patient is responsible for maintaining the DI in the oral cavity after it has been safely placed. Poor postoperative maintenance and negligence in sustaining oral hygiene cause peri-implantitis, an infection at the DI location.[22] Compared to individuals with proper dental hygiene, edentate individuals with bad dental hygiene showed more resorbed bone around fixtures.[23] This demonstrates that the outcome of the DI depends not only on surgical accuracy but also on those involved in its process and care.[5]

Failure mode

Early and late breakdowns have different modes of failure occurrence. Early failures are triggered by a dearth of osseointegration, but late failures are brought on by the patient's functional and psychological characteristics.[2] Direct connection between the DI surface and bone is known as osseointegration.[24-26] Absence of osseointegration results in DI loosening in the bone, which lowers DI success rates. Due to fibrous connection of tissues rather than osseointegration, failure rates are significant.[5] Failure of DIs is caused by their mobility from a dearth of osseointegration.[25] Osseointegration is hindered by DI site infections, low bone density, and poor DI design.[24,27]

DI success is impacted by poor aesthetics, psychological issues such emotional volatility, emotional issues, dementia, and a lack of assistance.[5] Oral infections can potentially result in DI failure. These primarily include early-stage peri-implantitis that occurs during or right after DI placement. Retrograde infection is the main culprit in the latter phases. These infections can generally be classified as having biological basis.[4]

Single DI supported crowns, and bridges supported by several DIs may experience a number of mechanical, biologic, or technical issues. One of the key elements that negatively affects failures is poor patient choice.[28]

Mechanical complications

Biomechanic overloading frequently leads to mechanical difficulties.[29] Poor DI position/angulation (angulation of cusps, DI inclination, horizontal and. apical offset of the DI, inadequate posterior support (i.e., missing posterior dentition), suboptimal availability of bone, or the existence of extreme pressures from parafunctional behaviors, i.e., bruxism, are all variables that contribute to biomechanic overloading.[30]

Screw loosening

DI components that have been overloaded frequently become loose or break.[31] According to Goodacre et al, screw loosening or breakage affected prosthetic screws more frequently than abutment screws.[32] More screw loosening has been observed in single-crown DI restorations as opposed to multiple DIs with multiple restored units, and lower molar DI treatments are more susceptible to screw loosening than upper ones.

Screw/implant fracture

Biomechanical overloading and peri-implant vertical bone resorption are the two primary reasons of DI breakage.[33] When vertical bone resorption is so extensive as to coincide with the screw's apical cap, the danger of DI fracture double.[34] The manufacture and design defects of the DI itself are another cause of DI fractures.[35] A hazard for DI fracture is undetected and recurring loose screw, which denotes a redesign of the device.[36] The fracturing that occurs when the hexagonal head of the screw separates from the primary structure of the screw is the most prevalent.[37]

Cement failure

Another effect of biomechanic overload is cement failure, which often has an impact on prosthetic attachment and can be managed with a recementation technique.[31] Decementation is now less common as a result of advances in materials research, notably for luting substances.[38] To prevent such occurrences, though, strict management planning and therapeutic guidelines must be observed.

Technical complications

In comparison to DI supported removable prostheses, DI supported FPDs experience technical problems more frequently.[39]

Breakdown of the framework

Strains are invariably generated in every part of the framework when there is a hard link between the osseous DI and the fixed resultant framework. The higher functional load results in additional pressures that have an impact on the construction of the prosthesis. Therefore, the difficulty for a prosthodontist is to provide an acceptable implant without endangering the longevity of the intervention.[40] In order for the DI to effectively osseointegrate with the surrounding bone in the long run, passive fit of the frame has been recommended as a prerequisite.[41]

According to reports, the risk of framework fracturing is increased in partially edentate patients since the DI abutment interface and abutment retention screw are subject to greater lateral bending stresses, tilting, and lengthening than they would be in a jawbone that is fully devoid of teeth.[42]

Fracture of veneering porcelain

The most popular forms of restorations are metal ceramic ones.[43] As time has gone on, patients' expectations for aesthetics have increased, which has led physicians to concentrate on all-ceramic treatments.[44] The future of zirconia restorations seems bright, and it is also being employed to create DI abutments for cement-retained restorations or direct veneering for screw-retained prosthetics.[44] Another frequent issue with single DI restorations is the veneering ceramic fracturing.[38]

Peri-implantitis

Bacterial pathogens, pathogenic plaque development, gradual decrease in bone, and sensory disturbances are a few examples of biologic failures.[45,46] Early biologic failures and delayed DI failures are two subcategories of biologic problems, where the initial failures are caused by improper aseptic technique placement of the surgical implant and the delayed complications are generally peri-implantitis and infectious diseases caused by microbial plaque.[10,46,47] An inflammatory condition known as peri-implantitis impacts the structures next to an osseointegrated DI. Along with hemorrhage, suppuration, greater probing depth, and movement, it leads to the destruction of the supporting bone. Peri-implantitis is primarily caused with pathogenic bacteria.[5,9,22,27] Gram negative anaerobic microbes such *Porphyromonas gingivalis*, *Prevotella intermedia*, and *Actinobacillus* constitute the microflora at failed DI sites.[3,22,27]

The peri-implant illness that develops after a DI has effectively osseointegrated is a result of an imbalance between the host immune response and rising microbial load.[48] Periodontal bacteria were found surrounding failed DIs. The peri-implant illness often progresses and shows clinical manifestations after five years.[9] If the biologic barrier is penetrated, it could lead in microbial contamination and swift deterioration of the tissues around the DI.[45,46] In a healthy ecosystem around the DI, the structures serve a crucial function in limiting the dissemination of pathogens.[49] The peri-implant disease is linked to unevenly distributed occlusal stress, that might cause the framework to detach, the surrounding sites to get infected, and ultimately result in the inflammatory reaction.[50]

Unmanaged diabetes, osteoporosis, smoking, long-term corticosteroid use, unchecked periodontal disease, radiation therapy, and chemotherapy are examples of aggravating systemic disorders.[48] To avoid DI treatment failure, peri-implant disease therapy options have been investigated and put to use.[51] For periodontal infection and peri-implantitis, they comprise nonsurgical mechanical cleansing, localized antibiotic administration, and surgical

debridement with bone grafting. If there has been more than 60% bone destruction with peri-implantitis and there is indication of movement, DI removal is necessary.[52]

CONCLUSION

DI failure is a complex phenomenon. The final failure of the DI is caused by a number of factors. To cure the existing situation, every practitioner has to determine the underlying cause. The cause of failure will be identified with the aid of appropriate data gathering, patient input, and precise diagnostic instruments. A timely intervention is always achievable with routine checks. The determination of potential causative variables affects the care plan for problems and failing DIs. The etiologic factor should be eradicated, and therapy must be started as soon as feasible when a diagnosis has been made and potential etiologic variables have been discovered.

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