RESEARCH PAPER

Association of Histopathological Findings and Clinical Causes for Failure of Dental Implant

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ABSTRACT

Background:
Dental implant failure is a complicated clinical condition. Examining failed implants histopathologically may reveal crucial details about the tissue alterations that underlie implant failure.

Aim:
To examine the clinical causes and histological aspects of dental implant failure and to discover clinical and histopathological factors independently related with biologically mediated implant failure.

Materials and Methods:

One hundred individuals with dental implant failure were assessed in this study. Peri-implantitis, lack of osseointegration, mechanical overload, and implant fracture were identified as the clinical reasons of implant failure. Inflammatory infiltrates, fibrous connective tissue development, bone resorption, necrotic tissue, and lack of osseointegration were evaluated by histopathological investigation.

Results:
Patients between the ages of 46 and 60 made up the biggest percentage (44.0%), followed by those over 60 (36.0%). Males formed the bulk of the study population (57.0%). The study involved 100 patients in total. Peri-implantitis was the most frequently recognised reason, accounting for 30.0% of implant failures, followed by poor osseointegration (30.0%). Overall, the study population's dental implant failure was primarily caused by biological reasons, including peri-implantitis and insufficient osseointegration. In 66.0% of failed implants, there was evidence of decreased or nonexistent osseointegration, followed by bone resorption (64.0%). Reduced osseointegration showed the highest link ($r = 0.65$, $p < 0.001$), followed by bone resorption ($r = 0.54$, $p < 0.001$).

Conclusion:
Impaired osseointegration and peri-implantitis were the main causes of dental implant failure. Clinical severity was closely correlated with histopathological evidence of inflammation, bone resorption, and decreased

osseointegration. The significance of periodontal and risk-factor assessment in implant therapy is highlighted by the fact that smoking and a history of periodontal disease were also important clinical predictors of biologically mediated failure.

Keywords: clinical causes, dental implant, failure, histopathological findings

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Introduction

Dental implants, which provide dependable prosthetic support and functional rehabilitation, have gained widespread acceptance as a replacement for lost teeth [1]. Although treatment predictability has improved due to advancements in implant design, surgical procedures, surface features, and maintenance protocols, implant failure is still a clinically significant consequence [2]. A number of biological and mechanical reasons, including as poor osseointegration, peri-implant infection, mechanical stress, implant fracture, and prosthetic problems, can lead to implant failure [3].

Dent dental dental dental dental dental dental dental dental dental dental dental dental dental dental cells. Pathological alterations in the peri-implant tissues and increasing loss of supporting bone are the hallmarks of peri-implantitis, a significant inflammatory complication [5]. On the other hand, insufficient bone-to-implant contact and the formation of fibrous connective tissue at the implant interface may be contributing factors to osseointegration failure [6].

An analysis of the histopathology can reveal important details about the biological mechanisms behind implant failure. The tissue response surrounding failed implants may be demonstrated by characteristics including necrotic tissue, bone resorption, foreign-body giant cells, fibrous connective tissue development, and inflammatory cell infiltration [7]. The degree of osseointegration and the biological alterations linked to its failure can also be understood through histological evaluation of the implant–bone contact [8].

It may be easier to interpret failed implants and gain a better understanding of the mechanisms underlying failure if the relationship between the clinical causes of implant failure and their histological features is understood. Clinicians may be able to identify patients who need closer monitoring and suitable preventive measures by identifying clinical and histopathological variables linked to biologically induced implant failure. In order to assess the clinical causes and histopathological features of dental implant failure, investigate the connection between tissue-level findings and clinical failure patterns, and determine clinical and histopathological predictors of biologically mediated implant failure, the current study was conducted.

Materials and method

One hundred patients with dental implant failure were enrolled in the current investigation, which was carried out at a tertiary care facility. Smoking status, diabetes mellitus, history of periodontal disease, and implant location were among the pertinent clinical features that were recorded.

The clinical causes of implant failure were categorised into seven groups: Peri-implantitis , Lack of osseointegration , Mechanical overload , Implant fracture , Prosthetic complications , Infection/abscess and Other causes. Peri-implantitis is the most common clinical clinical clinical clinical clinical clinical clinical clinical category.

Histopathological examination study was carried out. The examined findings included chronic inflammatory infiltrate, lymphoplasmacytic infiltration, neutrophilic infiltration, fibrous connective tissue surrounding the implant, foreign-body giant cells, necrotic tissue, bone resorption, and decreased or absent osseointegration.

Evaluation of the Clinical-Histopathological Association

The association between specific histological findings and the clinical reason of implant failure was assessed. Reduced or absent osseointegration, fibrous connective tissue development, bone resorption, and chronic inflammatory infiltration were all given special consideration.

In contrast to instances categorised clinically as lacking osseointegration, which showed higher frequencies of fibrous connective tissue development and reduced/absent osseointegration, peri-implantitis was primarily characterised by inflammatory alterations and bone resorption. Clinical findings were statistically statistically statistically statistically statistically statistically statistically statistically significantly dramatically statistically significant.

The association between histological features and the clinical severity of implant failure was assessed using Spearman's rank correlation coefficient (r). All of the examined histopathological parameters showed significant positive relationships. The strongest link was found with reduced osseointegration ($r = 0.61$, $p < 0.001$), followed by chronic inflammatory infiltration ($r = 0.52$, $p < 0.001$) and bone resorption ($r = 0.58$, $p < 0.001$).

We computed adjusted odds ratios (OR) and their 95% confidence intervals (CI). There were statistically significant correlations between physiologically induced implant failure and reduced osseointegration, bone resorption, chronic inflammatory infiltrate, history of periodontal disease, and smoking. There was no statistically significant independent correlation seen with diabetes mellitus.

Statistical evaluation

Appropriate descriptive and inferential statistical techniques were used to analyse the data. Categorical data, including age group, gender, smoking status, diabetes mellitus, history of periodontal disease, implant placement, clinical reason of implant failure, and histological findings, were expressed as frequencies and percentages. Histopathological results could coexist in the same failed implant specimen and were regarded as categorical variables.

The connection between clinical causes of dental implant failure and histological results was examined using the Chi-square test of independence. Fisher's exact test was deemed suitable when anticipated cell frequencies were low. Within each category of clinical failure, the results were presented as percentage.

Result

Table 1: Clinical Characteristics

Category	Characteristic	percentage
Age	Age 30–45 years	20
	Age 46–60 years	44
	Age >60 years	36
Gender	Male	57
	Female	43
Clinical Characteristics	smoking	28
	Diabetes mellitus	31
	periodontal disease	38
	Mandibular implant	52
	Maxillary implant	48

The clinical and demographic details of the 100 patients with dental implant failure are shown in Table 1. The biggest proportion of patients belonged to the 46–60-year age group (44.0%), followed by those aged >60 years (36.0%) and 30–45 years (20.0%). The study population was made up of 43.0% females and 57.0% males.

Table 2: Allocation of Implant Failure and Clinical Causes

Clinical cause	percentage
Peri-implantitis	30 (30%)
Lack of osseointegration	28 (28 %)
Mechanical overload	22 (25%)
Implant fracture	9 (9 %)
Prosthetic complications	6 (6%)
Infection/abscess	5 (5%)
Total	100

Table 2 illustrate the distribution of clinical causes of dental implant failure among the 100 patients included in the study. Inadequate osseointegration (30.0%) and mechanical overload (22.0%) were the next most common causes of implant failures, after peri-implantitis (30.0%). Nine failures were due to implant fractures, whereas six percent were caused by prosthesis problems. Five percent of the cases had an abscess or infection. Overall, the study population's dental implant failure was primarily caused by biological reasons, including peri-implantitis and insufficient osseointegration.

Table 3: Histopathological result connected with Implant Failure

Histopathological finding	percentage
Chronic inflammatory infiltrate	53
Fibrous connective tissue surrounding implant	49
Bone resorption	64
Reduced/absent osseointegration	66
Necrotic tissue	42

In 66.0% of failed implants, there was evidence of decreased or nonexistent osseointegration, followed by bone resorption (64.0%). Chronic inflammatory cell infiltration was the most common observation, occurring in 53.0% of patients. There was 49% fibrous connective tissue and 42% necrotic tissue surrounding the implant.

Table 4: Correlation Between Histopathological Features and Clinical Severity of Implant Failure

Histopathological parameter	Correlation coefficient (r)	p

Chronic inflammatory infiltrate	0.48	<0.001
Bone resorption	0.54	
Fibrous tissue formation	0.39	
Reduced osseointegration	0.65	

The Spearman's correlation analysis, shown in Table 4, showed statistically significant positive correlations between the clinical severity of dental implant failure and all evaluated histological features. The strongest correlation was found to be the strongest correlation ($r = 0.65$, $p < 0.001$), followed by bone resorption ($r = 0.54$, $p < 0.001$) and chronic inflammatory infiltrate ($r = 0.48$, $p < 0.001$), while fibrous tissue formation showed a significant positive correlation of moderate strength ($r = 0.39$, $p < 0.001$). Overall, the results show that increased histological deterioration—specifically, loss of osseointegration, bone resorption, and chronic inflammatory changes—is linked to increasing clinical severity of implant failure.

Discussion

Examining the clinical factors that are factors that are studied, biologically mediated, biologically mediated, clinically mediated, tissue-related, biologically mediated, biologically mediated. The data indicated that implant failure was multifaceted, with peri-implantitis, absence of osseointegration and mechanical overload comprising the most frequent clinical reasons. Histopathological analysis also revealed that among failed implants, bone resorption, decreased or absent osseointegration, and chronic inflammatory infiltration were more prevalent. These results highlight the significance of biological and mechanical parameters in influencing the prognosis of implants. The histopathology results shed more light on the biological processes that underlie implant failure.

Wang et al. (1996) stressed that rather than a single causative factor, implant failure may be caused by a mix of local and systemic risk factors.[9] Clinical studies have also shown a connection between peri-implant illness and implant failure. (2015) Daubert et al. [10] Smoking may adversely affect the biological milieu surrounding dental implants through effects on vascularity, tissue repair, immunological response, and bone metabolism. These systemic and behavioural traits may affect the probability of implant failure, according to Chen et al. (2013), who conducted a meta-analysis looking at smoking, radiation, diabetes, and osteoporosis as potential risk factors.[11]

LIMITATIONS

A number of restrictions should be taken into consideration when interpreting the results. First, the study contained a relatively tiny sample of 100 patients, which may constrain the generalisability of the results to larger and more diverse implant populations. Second, the analysis's observational design makes it more difficult to prove a link between the risk factors found and implant failure. Despite the use of multivariable analysis, residual confounding from other surgical, implant-related, patient-related, and maintenance factors cannot be ruled out.

Conclusion

Peri-implantitis and a lack of osseointegration were the main clinical causes of dental implant failure, which showed a complex pattern. In terms of histopathology, increased clinical severity was closely linked to impaired osseointegration, bone resorption, and chronic inflammation. The best independent predictor of physiologically mediated failure was reduced osseointegration; smoking and a history of periodontal disease were also important predictors. The significance of the long long long long long long long long health of the long prognancy of the period.

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