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Prevalence and Analysis of Contributing Factors for Proximal Contact Loss between Implant Supported Fixed Dental Prosthesis and Adjacent Teeth: A Systematic Review

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ABSTRACT: Proximal contact loss (PCL) between implant-supported prostheses and adjacent natural teeth is a common complication affecting function, stability, and periodontal health. This systematic review evaluated its prevalence and contributing factors. A PRISMA-based search of studies published from 2013 to 2023 identified 11 clinical studies with follow-ups ranging from 3 months to 21 years. Reported PCL prevalence ranged from 15% to 65%, occurring more frequently on mesial surfaces and in mandibular posterior regions. Key contributing factors included differential mobility, occlusal load, prosthesis design, and anatomy. PCL is multifactorial and warrants careful planning, monitoring, and standardized assessment in clinical practice.

KEYWORDS: Proximal contact loss, dental implants, implant-supported prosthesis, peri-implant health, occlusal loading, systematic review

I. INTRODUCTION.

A good, tight proximal contact is a mandatory requirement between an implant-supported prosthesis and the adjoining teeth. These contacts are essential not only for mastication and arch stability but also for preventing the loss of the interdental papilla by avoiding food lodgement between them.[1] Therefore, the tightness of proximal contact can be considered an essential clinical criterion for evaluating the quality of a restoration. Proximal contacts have been regarded as a physiological entity with a multifactorial origin, influenced by the type and location of the tooth, bite force, and even the time of day.[2] Interestingly, under normal physiological resting position, teeth do not make continuous contact; the average distance may range from 3–21 μm.[3] Natural teeth only come into contact during mastication and return to their non-contact state once mastication ceases. Despite proximal wear over time, tight contacts are maintained through the natural mesial migration of teeth.In contrast, dental implants, though widely used for replacing missing teeth, behave differently from natural dentition. Implants are effectively ankylosed replacements, lacking a periodontal ligament and exhibit minimal vertical mobility (<5 μm) under vertical occlusal load. This ankylosed behaviour contrasts with the adaptive movement of natural teeth and contributes to discrepancies in proximal relationships. Mesial drifting of adjacent teeth toward an osseointegrated implant is considered the primary mechanism of proximal contact loss (PCL), with factors such as age, occlusal dynamics, tooth vitality, and splinting further influencing its progression.[4,5]Evidence from clinical studies demonstrates that PCL is a common and progressive complication of implant-supported fixed prostheses. Reported prevalence rates vary widely, from 11% to over 80%, depending on follow-up duration, implant location, and patient-related factors.[6–20] Mesial surfaces are more frequently affected than distal contacts, and posterior regions show higher rates than anterior sites.[8,12,20] PCL has been associated with food impaction, infraocclusion, and compromised esthetics, occlusal stability, function and patient quality of life, although peri-implant tissue health often remains unaffected.[5,14] Therefore, PCL as a complication can lead to failure of the implant-supported prosthesis, leading to financial repercussions for the patient. However, the paucity of available studies and the lack of uniformity among them may prevent a consistent conclusion and identification of the risk factors. Specifically, there is a lack of information on what is an acceptable level of proximal contact tightness between implant prostheses and natural teeth, and there are no guidelines on when to intervene. Thus, it is important to critically and qualitatively evaluate the rate of PCL, contributing factors to PCL, and implications of PCL for the purpose of establishing some clinically relevant guidelines to manage PCL. Therefore, this qualitative systematic review aims to evaluate the prevalence of PCL, identify the risk factors that can influence the prevalence of PCL, and identify the implications of PCL.

II. METHODS

This systematic review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 protocol.[21] The systematic review is registered under the International Prospective Register of Systematic Reviews, bearing the registration number CRD420250441296.The following PICO question was formulated: “How prevalent is the proximal contact loss in implant-supported fixed dental prostheses in comparison to adjacent natural teeth?” The focused question was structured using the PICO acronym. Population (P) in this study were patients with implant-supported fixed dental prosthesis. Specifically, those experiencing proximal contact loss between the prostheses and adjacent teeth. Intervention (I) was the analysis of factors contributing to PCL. This may include examining various aspects such as material types, implant placement techniques, occlusal considerations, etc. Comparison (C) was the different types of implant-supported fixed dental prostheses or variations in treatment approaches. Comparative analyses may also explore the impact of contributing factors on proximal contact loss in different patient groups. And Outcome (O) was the prevalence of proximal contact loss between implant-supported fixed dental prostheses and adjacent teeth.The inclusion criteria consisted of clinical studies on humans, assessing potential factors which may influence the proximal contact loss between natural teeth adjacent to the implant-supported fixed dental prosthesis. Studies that included the prevalence of proximal contact loss on peri-implant and periodontal tissues in the interproximal areas and prevalence of interproximal contact loss were also included. Conversely, intervention studies, laboratory research, abstracts, case reports, protocols, personal opinions, letters and posters, and review of literature were excluded. Table 1 mentions the PICO criteria, inclusion and exclusion factors for this systematic review.

SEARCH STRATEGY: A comprehensive electronic search was conducted in the PubMed (National Library of Medicine), Google Scholar, Scopus, Cochrane Library and EBSCO host databases. A manual literature search was conducted by reviewing grey literature from the hospital library. The literature search was supplemented by manual searching of the list of references of the included studies. Two independent reviewers performed the searches and screened the retrieved articles. The literature search was carried out using a combination of keywords and MeSH terms. The following search terms were applied: “interproximal contact loss,” “proximal contact loss,” and “prosthesis and implants.” The search was further refined by restricting results to studies on adult human populations (≥19 years), published in English, within the past decade.

The complete PubMed search string was as follows:
(“proximal”[All Fields] OR “proximalisation”[All Fields] OR “proximalise”[All Fields] OR “proximalise [All Fields] OR “proximalises” [All Fields] OR “proximalising”[All Fields] OR “proximally”[All Fields] OR “proximals”[All Fields])
AND (“contact”[All Fields] OR “contactable”[All Fields] OR “contacted”[All Fields] OR “contacting”[All Fields] OR “contacts”[All Fields])
AND (“loss”[All Fields])
AND(“implant”[All Fields] OR “implantability[MeSH Terms] OR “implantable”[All Fields] OR “implantables”[All Fields] OR “implanted”[All Fields] OR “implantation”[All Fields] OR “implantitis”[All Fields])
AND(“prosthese”[All Fields] OR “prostheses and implants”[MeSH Terms] OR “prostheses”[All Fields])

TABLE 1. PICO question and eligibility criteria.

Focused Question (PICO)	How prevalent is the proximal contact loss in implant-supported fixed dental prostheses in comparison to adjacent natural teeth, and the factors that contribute to it?
Population	Patients with implant-supported fixed dental prostheses. Specifically, those experiencing proximal contact loss between the prostheses and adjacent teeth
Intervention or exposition	Analysis of factors contributing to proximal contact loss. This may include examining various aspects such as material types, implant placement techniques,

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	occlusal considerations, etc.
Comparison or control	Comparisons can involve different types of implant-supported fixed dental prostheses or variations in treatment approaches. Comparative analyses may also explore the impact of contributing factors on proximal contact loss in different patient groups
Outcome measure(s)	Prevalence of proximal contact loss between implant-supported fixed dental prostheses and adjacent teeth. Identification and analysis of contributing factors and assessment of the effectiveness of various interventions or techniques in preventing or minimizing proximal contact loss.
Types of studies included	1) clinical studies conducted in human participants. 2) investigations assessing potential factors influencing PCL between natural teeth and implant-supported fixed dental prostheses; and 3) studies reporting the prevalence of PCL and/or its effect on peri-implant and periodontal tissues in the interproximal region.
Studies excluded	a) studies not directly related to PCL. b) interventional studies, laboratory-based investigations, case reports, abstracts, protocols, letters, and narrative reviews c) publications not available in full text; and d) non-English language studies.

STUDY SELECTION: For article selection, two researchers independently selected potentially eligible articles by title and abstract. Articles that met the PICO and inclusion criteria were included in the review for the final analysis. Only peer-reviewed articles published in English within the past 10 years were considered. A detailed PRISMA diagram explaining the selection process can be found in Fig

III. RESULTS

These results serve as evidence-based for understanding clinical variations and implications. A total of 648 studies were retrieved through the electronic search of databases. 12 additional studies were identified through sources like hand search and grey literature. Therefore, the total number of studies screened was 660. After removing duplicates, a total of 484 studies remained. Studies were then screened by title and abstract to ensure they met the eligibility criteria, leading to 11 studies published between 2015 and 2020 that were included in this systematic review that studied the proximal contact loss (PCL) between implant-supported fixed dental prosthesis and adjacent natural teeth. Among the 11 studies included, 8 were retrospective cohort studies, 2 were prospective cohorts, and one was a cross-sectional study; follow-ups ranged from 3 months to 21 years. Table 2 summarizes characteristics of the studies included, such as sample size, type of study, age range of the participants, prevalence of PCL and periodontal conditions of the participants.

Table 2: Characteristics of included studies

Authors	Year	Study Design	Sample Size	Contact Areas	Age (years)	Analysis type/Intervention	%. of PCL	Mesial%/ Distal %	Max %/ Mand %	Ant %/ Post %	Marginal Bone Loss	Follow-up time
Saber et al[23]	2020	Retrospective Study	83	183	40-70	Dental Floss 70 microns	32.8	42.1/ 14.5	34.1/31.5	45 / 31.3	0.73-0.78 mm	3m-5y
Liang et al[16]	2020	Retrospective Study	317	850	54.22	Dental Floss	19	27/ 5				3m-18.2y

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Authors	Year	Study Design	Sample Size	Contact Areas	Age (years)	Analysis type/Intervention	%. of PCL	Mesial%/ Distal %	Max %/ Mand %	Ant %/ Post %	Marginal Bone Loss	Follow-up time
Bompolaki et al[14]	2022	Retrospective Study	83	118	19-85	Shim stock foil 12 microns			33/ 50			4m-10.6 y
Yen JY et al[17]	2020	Retrospective Study	147	296	25-85	Radiographic analysis	15	6.61				
French et al[24]	2019	Retrospective Study	4325			Dental Floss	17		15/ 20	14/ 18	0.44-0.81 mm	4m-21.6 y
Shi et al[25]	2019	Prospective Clinical Study	74	144	43.6	Dental Floss	24.3	23/ 25.7	9.1/ 37.2	24.3		1y
Pang et al[22]	2017	Prospective Clinical Study	150	299	58.36	Metal shim strip 50 microns	59.9	66.2l 36.9	66.4/ 55.4			2y -7 y
Cochrane et al[12]	2016	Retrospective Study	2060	4591	19-50	Radiographic analysis	40.0				0.06-0.44 mm	133m
Varthis et al[8]	2016	Retrospective Study	128	174	19-91	Dental Floss 70 microns	52.8	78.8/ 21.8	57.9/ 49	47.8 / 53.6		3m-1y
Byun et al[5]	2015	Cross-sectional Study	94	191	56	Dental Floss	34	38/ 24	30.8/ 37	41.9 / 30.2		3m-13y
Wong et al[7]	2015	Retrospective Study	45	66	27-74	Tofflemire matrix strip 38 microns	65	65				6m-12y

The prevalence rates, as extracted from the review of diverse studies, exhibited variability, emphasizing the need for a nuanced approach to comprehending the interplay of contributing factors. The primary outcome measured was PCL, and interventions to measure PCL ranged from predominant use of dental floss (70 microns), radiographic analysis[12,17], metal shim strip (50 microns) [22] and Tofflemire matrix strip (38 microns)[7]. PCL in patients was reported as the percentage of prevalence as per the sample size in each study and ranged from 15 to 65% among the selected studies.PCL were reported both mesially and distally, with substantial inter-study variability: Mesial PCL ranged from 6.61% to 78.8% while Distal PCL ranged from 5% to 36.9%. Therefore, PCL is higher mesially than distally, except for one study. Comparison of arch and region distribution showed that maxillary contact loss percentages ranged from 9.1% to 66.4%, while mandibular contact loss percentages ranged from 24% to 55.4%. Anterior region contact was documented between 14% and 47.8%, whereas posterior region values ranged from 18% to 53.6%. Five studies provided data on marginal bone loss, which ranged from 0.06 mm to 0.81 mm, depending on the duration of follow-up and assessment method. Follow-up durations were variable, spanning from as short as three months to as long as 21.6 years,

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highlighting both short- and long-term observations.

IV. DISCUSSION

This systematic review assessed the prevalence and influencing factors contributing to PCL between the implant-supported fixed dental prosthesis and adjacent natural teeth and revealed a notable prevalence ranging from 15 to 65% among the selected studies.[7,15] Therefore, the null hypothesis that proximal contact integrity is maintained between implant-supported fixed dental prosthesis and adjacent natural teeth was proven to be false, and studies showed a significant variation in PCL in relation to the location of the implant (mesial vs. distal; maxillary vs. mandibular; anterior vs. posterior).

Majority of the studies noted that PCL was more prevalent on the mesial side (27% to 78%) rather than the distal side (5% to 40%). As expected, this can be attributed to the mesial migration of the natural teeth next to the implant-supported fixed dental prosthesis. However, in one retrospective study, the distal (25.7%) PCL over one year was more than the mesial (23%) PCL, though this difference was not statistically significant ($P > 0.05$).[25]

Similarly, the prevalence of PCL was seen more in the anterior region than the posterior region, ranging from 41%-45% in the anterior and 30%-32% in the posterior region.[5,23] They concluded that the anterior complement of forces acting on the implant is responsible for the migration of teeth mesially, but implants being ankylosed in the bone cause open contacts.[5,25] However, in other studies[8,24,25], PCL was also found to be higher in the posterior region, ranging from 18% to 53.6% than in the anterior region which ranged from 14% to 47.8%. Their philosophy stated that the temporomandibular joint (TMJ) functions as a class 3 lever, and the posterior teeth, being positioned closer to the fulcrum, experience a higher force acting directly upon them.[8,12,25] Thus, the force created causes drifting of teeth, leading to open contacts between the implant and adjacent natural tooth. Therefore, PCL is prevalent in both the anterior and posterior regions of the jaws.

Another factor observed to affect PCL was the nature of the maxilla and mandible bones. PCL was more commonly seen in the mandible than in the maxilla.[5,14,24,25] Due to the buttressing nature of the mandibular bone, more forces act upon the posterior teeth, which are dissipated through the periodontal ligament (PDL).[12,14,24] Implants are osseointegrated in the bone lacking PDL, and hence are considered ankylosed within the bone. This imbalance in attachment within the bone creates interdental spaces, causing PCL between the implant and adjacent natural tooth[14]. However, the studies done by Saber et al, Pang et al and Varthis et al we observed more prevalence of PCL in the maxilla (34% to 66.4%) than the mandible (31% to 55.4%) as the maxillary bone is relatively less dense than the mandible owing to the presence of sinuses, it is relatively easier for the migration of teeth due to the anterior complement of forces acting on the teeth leading to PCL between the implant and adjacent fixed dental prosthesis.[8,25,26]

The factors influencing PCL can be divided into five categories - anatomical factors, restoration-related factors, occlusal factors, surgical techniques and patient-related factors.

Anatomical characteristics of the dentition and surrounding structures play a fundamental role in the development of proximal contact loss (PCL). Variations in interdental space, root angulation, and craniofacial growth can influence the ability to establish and maintain stable contacts adjacent to implant-supported prostheses.[5] Physiological tooth migration is largely driven by the anterior component of force, a mesial force vector generated during mandibular closure and transmitted through interproximal contacts.[23,27] Unlike natural teeth, which can adaptively migrate, dental implants behave as ankylosed units and do not compensate for occlusal or craniofacial changes, thereby predisposing adjacent contacts to open over time.[28,29] These findings underscore the importance of detailed preoperative assessment of tooth angulation, occlusal relationships, and growth potential to optimize implant positioning and minimize anatomical contributors to PCL.

The design and material characteristics of implant-supported fixed dental prostheses significantly affect proximal contact stability. Variations in framework materials, veneering ceramics, emergence profiles, and contour designs have been linked to differences in stress distribution and the maintenance of interproximal integrity.[8] Techniques such as splinting adjacent crowns or designing broader contact surfaces have been shown to reduce interproximal contact loss in photo elastic models.[30] Improperly contoured restorations, divergent roots, and open gingival embrasures may further promote food impaction and accelerate contact deterioration.[13] Careful selection of restorative materials, precision in fabrication, and adherence to evidence-based prosthetic design principles are therefore critical to reducing restoration-related risks for PCL.

Occlusal loading patterns exert a direct influence on the longevity of proximal contacts in implant-supported fixed dental prostheses. Imbalanced or unadjusted occlusal schemes may produce concentrated mechanical stress, which, over time, can compromise interproximal stability.[16] Given that occlusion is dynamic and subject to change, minor discrepancies may amplify contact wear or shift stress vectors in ways that predispose to PCL. Clinical management strategies such as occlusal equilibration and regular occlusal adjustments are essential in mitigating these risks. Establishing occlusal harmony not only preserves proximal contacts but also reduces the potential for overloading adjacent natural teeth, highlighting the integral role of occlusal management in long-term implant success.

In terms of the surgical factors, implant placement, both in terms of position, angulation and soft tissue trauma, tends to affect the proximity of the implant-supported FPD to adjacent teeth. Careful consideration of surgical protocols and implant positioning is necessary to ensure optimal emergence profiles and preservation of proximal contacts. Additionally, soft tissue management, including proper flap design and suturing techniques, can influence the soft tissue health and esthetic and functional outcomes of implant-supported FPDs.[14] Clinicians should strive to maintain an appropriate distance between implants and adjacent teeth to facilitate proper contact establishment and prevent contact loss.

Cochran et al[12]studied the relationship between crestal bone levels (CBL) and soft tissue inflammation scores. They were evaluated using a modified Mombelli Bleeding Index that included suppuration using controlled probing force. Radiographic CBL was low with a mean of <0.2 mm over a 1–3 year period and remained low <0.5 mm over a 5-10 year period for both tissue level and bone level designs. Similar findings are seen with micro rough implants of either monotype transgingival design, as well as the more recent platform switching design. The trend was seen for increased bone remodeling in the first year and towards more stable bone levels over time. It has been shown that in the absence of other clinical symptoms. BOP around implants may be a weak indicator of ongoing or future loss of crestal bone.[12]

Lastly, patient factors such as oral hygiene practices, including effective interdental cleaning and regular professional maintenance, play a vital role in preventing plaque accumulation and subsequent inflammation that can compromise the contact stability. Parafunctional habits, such as bruxism, clenching, or other non-physiological forces, lead to increased mechanical stress on implant-supported fixed dental prosthesis, potentially resulting in PCL.[16] Patient education and awareness of these factors are crucial for promoting long-term implant success. Jeong et al conducted a study where 215 embrasures of 150 fixed dental prosthesis in 100 patients were included. Clinical assessments of the periodontal/peri-implant tissue conditions, radiographic assessments of embrasure dimensions and overall patient satisfaction were used as variables for food impaction and periodontal/peri-implant mucosa conditions adjacent to the implant-supported fixed dental prosthesis. Food impaction was reported in 44.7% of embrasures. Overall patient satisfaction was negatively influenced by food impaction in the proximal embrasures ($p=0.012$).[31]

This literature review also had many limitations, such as heterogeneity in study designs, methodologies, and measurement criteria, which posed challenges in synthesizing the evidence and further affected the ability to conduct a meta-analysis on the systematic review. Furthermore, the available literature lacked standardized definitions of contact loss and varied in follow-up durations, making direct comparisons difficult. Future research efforts should aim to establish consistent measurement methods for assessing contact loss, consider longer follow-up periods to understand the long-term behaviour of implant-supported fixed dental prosthesis better and explore the potential impact of emerging technologies, such as digital dentistry and computer-aided design, on contact stability.

The temporal dimension adds another layer of intricacy, emphasizing the importance of long-term follow-up and maintenance protocols. As the studies reviewed encompassed varying durations of observation, it becomes evident that the evolution of proximal contact loss is a dynamic process requiring sustained vigilance. The insights garnered from this review can inform clinical decision-making, aiding practitioners in optimizing the success of implant-supported fixed dental prostheses.

Moreover, the review identifies gaps in the current literature, pointing towards the need for standardized reporting and further research endeavors. Future studies should strive for methodological consistency to facilitate more robust comparisons and conclusive insights. In essence, this systematic review contributes significantly to the evolving landscape of implant dentistry, offering a synthesized understanding of proximal contact loss and laying the groundwork for future advancements in both research and clinical practice.

In conclusion, this systematic review presents a comprehensive overview of the prevalence and influential factors contributing to proximal contact loss between implant-supported fixed dental prosthesis and adjacent teeth. Anatomical considerations, restoration-related factors, occlusal factors, surgical techniques, and patient-related factors collectively contribute to this complex phenomenon. Recognizing and addressing these factors during treatment planning, surgical procedures, and prosthetic design is paramount to achieving and maintaining stable proximal contacts. This understanding is vital for clinicians to enhance the long-term success and durability of implant-supported fixed dental prostheses, ultimately benefiting patient outcomes and satisfaction in implant dentistry.

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