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Review Article

Survival of Dental Implants in the Context of Oral Potentially Malignant Disorders: Evidence from a Systematic Review

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ABSTRACT

This review aims to evaluate the current evidence on dental implant survival in patients with oral potentially malignant disorders (OPMD) and to explore associated risk factors for peri-implant complications. A systematic literature search was performed in PubMed MEDLINE, Cochrane Library, and Web of Science in accordance with PRISMA guidelines, including publications from 2012 to 2023.
Studies on oral lichen planus (OLP) reported an overall implant survival rate of 99.3% (range: 50–100%) with a mean follow-up of 40.1 months. In contrast, a retrospective study examining leukoplakia and erythroplakia did not report implant survival rates but documented cases of oral squamous cell carcinoma (OSCC) near implants. A patient with proliferative verrucous leukoplakia (PVL) showed 100% implant survival, while those with systemic lupus erythematosus (SLE) had a survival rate of 97.67%. No evidence was found for other OPMD subtypes. Except for OLP, research on implant outcomes in patients with OPMD is limited or nonexistent. Existing data indicate that OLP does not negatively affect implant survival and is unlikely to increase the risk of peri-implant disease. Due to insufficient studies, no conclusions can be drawn for other OPMD types. Further large-scale, prospective investigations are needed, particularly for leukoplakia and erythroplakia, to clarify their impact on dental implant outcomes.

Keywords: Oral potentially malignant disorders, Dental implants, Implant survival, Peri-implant complications

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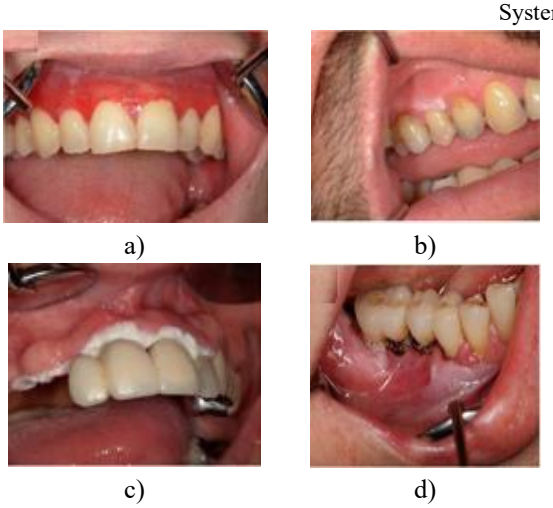
Introduction

Oral potentially malignant disorders (OPMD) comprise a broad and varied set of mucosal lesions marked by abnormal epithelial changes and a predisposition to transform into oral squamous cell carcinoma (OSCC) [1, 2]. This spectrum includes disorders such as oral lichen planus (OLP), leukoplakia, proliferative verrucous leukoplakia (PVL), erythroplakia (EP), erythroleukoplakia (ELP), oral submucous fibrosis (OSF), actinic keratosis (AK), palatal lesions from reverse smoking, systemic lupus erythematosus (SLE), and dyskeratosis congenita (DKC) [2] **(Figure 1)**. Each of these conditions varies in its clinical appearance, biological behavior, associated risk factors, and likelihood of malignant transformation. Globally, OPMD affects roughly 2% of the population, with nearly 8% of cases progressing to malignancy [3].

Epithelial dysplasia, according to the World Health Organization, describes structural and cellular alterations in the oral epithelium resulting from cumulative genetic mutations [2]. These alterations increase the probability of malignant transformation [4]. Although the process is thought to be driven by genetic factors, the exact mechanisms and sequence of changes remain largely unresolved.



a) b) c) d)

Figure 1. Clinical representation of OPMD entities: (a) oral lichen planus, (b) leukoplakia, (c) proliferative verrucous leukoplakia, (d) oral squamous cell carcinoma.

Mucosal disorders can weaken the attachment of epithelial tissue to implant surfaces [5, 6]. Consequently, it has been suggested that diseased peri-implant mucosa responds differently to bacterial challenges compared to healthy tissue, with a more rapid breakdown of the soft tissue seal around implants [7]. The purpose of a transmucosal attachment is to act as a barrier, preventing bacterial byproducts from reaching the underlying bone and thereby supporting successful osseointegration. For optimal function, a minimum peri-implant soft tissue thickness of 2 mm is recommended [8].

In the context of OPMD, it is assumed that the adhesion of epithelial cells to titanium implant surfaces may be compromised. The long-term success of dental implants relies heavily on the quantity and quality of surrounding soft tissues and bone. Alterations in soft tissue health can influence bone remodeling and overall implant performance. Marginal bone loss is commonly observed around dental implants [9], and the capacity of the epithelium to adhere and maintain a protective seal in this region is essential for implant survival. Effective dental implant therapy requires a robust interaction between the suprastructural portion of the implant and healthy oral mucosa to facilitate rapid epithelial cell attachment and minimize postoperative inflammation [10].

Initial research indicates that mechanical stress and other external forces may contribute to malignant transformation in the oral mucosa [11]. However, the long-term effects of dental implants in patients with OPMD on peri-implant soft tissue and bone remain poorly understood. Therefore, this systematic review was designed to evaluate dental implant survival in OPMD patients and identify potential risk factors for peri-implant disease.

Materials and Methods

Protocol and eligibility

The study protocol adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The research question was structured using the PICO framework: *"Do patients with oral potentially malignant disorders exhibit differences in implant survival compared to patients with healthy mucosa?"*

- *Population:* Patients diagnosed with OPMD.
- *Intervention:* Dental implant placement.
- *Comparison:* Patients with healthy oral mucosa.
- *Outcomes:*
  - *Primary:* Implant survival.
  - *Secondary:* Risk factors for peri-implant disease, including peri-implant mucositis, peri-implantitis, and bone loss.

Risk factors were defined according to each study and corroborated through clinical and radiographic assessment.

Inclusion criteria

- Clinically or histopathologically confirmed OPMD (including OLP, leukoplakia, PVL, erythroplakia, SLE, and OSF).
- Studies published in English or German.
- Clearly reported number of implants.
- Prospective designs: randomized or non-randomized controlled trials, cohort studies.
- Retrospective designs: controlled studies, case-control, single cohort, or case reports.

Exclusion criteria

- Studies not meeting all inclusion criteria or missing essential data.
- Studies without relevant implant survival or implant-related outcomes.
- Animal or in vitro studies.

Search strategy

A systematic search was conducted on 10 October 2023 across MEDLINE (via PubMed), Cochrane Central Register of Controlled Trials, and Web of Science (Clarivate Analytics). Searches combined MeSH terms and free-text keywords related to "dental implants" and "oral potentially malignant disorders." An example of the PubMed search strategy is shown in **Table 1**, with additional strategies available upon request from the authors.

Table 1. Search strategy on 10 October 2023.

#1	("dental implant*"[tiab] OR "dental prosthes*"[tiab] OR "oral implant*"[tiab] OR "dental implants"[Mesh] OR "dental implantation"[Mesh] OR "dental prosthesis, implant supported"[Mesh]).
#2	("Precancerous Conditions"[Mesh:NoExp] OR "oral potentially malignant disorder*"[tiab] OR OPMDS[tiab] OR OPMD[tiab] OR "preneoplastic condition*"[tiab] OR "precancerous condition*"[tiab] OR (leukoplakia[Mesh] OR leukoplaki*[tiab] OR leucoplaki*[tiab] OR "oral dysplasi*"[tiab] OR "oral keratos*"[tiab]) OR (erythroplasia[Mesh] OR erythroplasi*[tiab] OR erythroplaki*[tiab]) OR ("lichen planus, oral"[Mesh] OR "oral lichen planus"[tiab] OR OLP[tiab]) OR ("oral submucous fibrosis"[Mesh] OR "oral submucous fibros*"[tiab] OR OSF[tiab]) OR ("libman sacks diseas*"[tiab] OR "lupus erythematosus disseminatus"[tiab] OR "systemic lupus erythematosus"[tiab] OR SLE[tiab] OR "lupus erythematosus, systemic"[Mesh:NoExp]) OR ("actinic keratos*"[tiab] OR "keratosis, actinic"[Mesh] OR AK[tiab]) OR "reverse smok*"[tiab] OR ("dyskeratosis congenita*"[tiab] OR "zinsser cole engman syndrom*"[tiab] OR "Dyskeratosis Congenita"[Mesh])).
#3	#1 and #2.

To identify additional relevant studies, the reference lists of all included articles were manually screened. Duplicate records were removed using EndNote 20 (Clarivate Analytics, London, UK), following the Bramer Method [12].

Study selection

All studies meeting the inclusion criteria underwent a detailed evaluation, and full-text versions were obtained for review. The selection process, including the number of studies identified, excluded, and ultimately included, is summarized in the PRISMA flow diagram **(Figure 2)**.

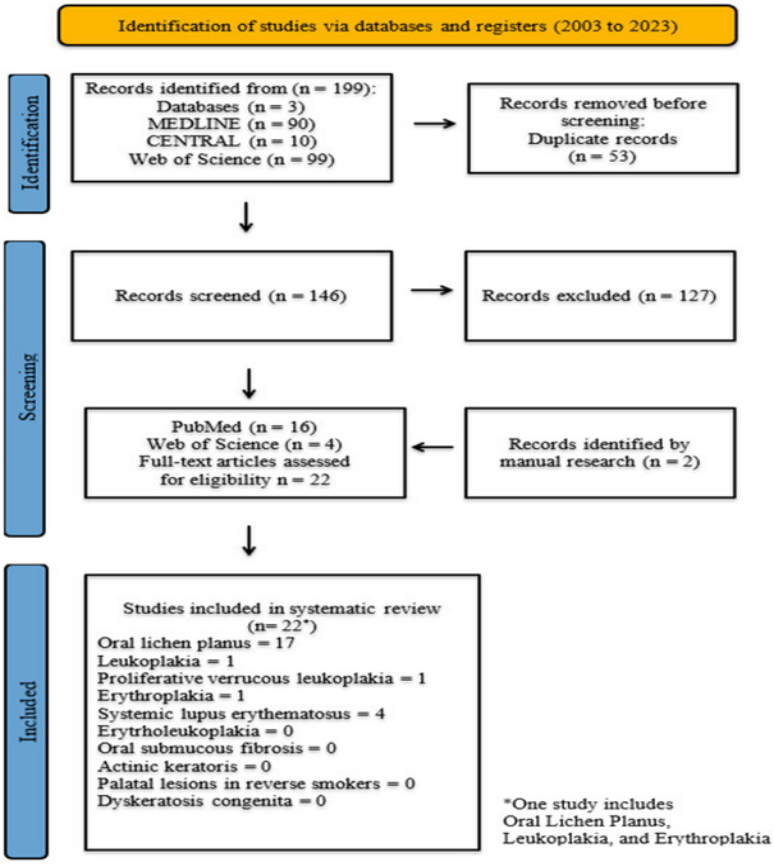


Figure 2. PRISMA flow diagram.

Data extraction and outcomes

For every study included in this review, data were systematically gathered on patient demographics, including age and sex, the total number of implants placed, the specific type of OPMD, whether the OPMD diagnosis was confirmed via biopsy, and clinical outcomes such as peri-implant mucositis, peri-implantitis, and bone loss. The duration of follow-up,

implant survival rates, any treatment of the OPMD before or after implant placement, and occurrences of malignant transformation were also recorded. Implant survival served as the primary outcome, while secondary outcomes focused on the frequency of peri-implant complications and the extent of bone loss. Bone loss was reported in varying ways: some studies provided numerical measurements in millimeters, while others described it qualitatively, such as noting crestal bone reduction. For studies with numerical data, bone loss was categorized as less than 3 mm or 3 mm and above [13].

Quality assessment

The reliability of the included studies was evaluated using the Joanna Briggs Institute critical appraisal tools, which cater to a range of study designs including case reports, case series, case-control, cross-sectional, and cohort studies [14]. The appraisal followed guidelines outlined by Goreth *et al*. [15]. Studies were rated as high quality when the majority (80–100%) of appraisal criteria were satisfied, moderate quality when 50–75% were met, and low quality when fewer than half of the criteria were addressed positively.

Results and Discussion

Study selection

From an initial pool of 199 articles, 22 studies fulfilled the eligibility criteria and were included in this review **(Figure 2)**. The majority of these were case reports [16–29], followed by six retrospective studies [30–35], one prospective study [36], and a single cross-sectional study [37]. Seventeen studies examined oral lichen planus (OLP) [16–22, 26, 27, 29, 30–34, 36, 37], while four focused on systemic lupus erythematosus (SLE) [24, 25, 28, 35]. One study each investigated leukoplakia [31], proliferative verrucous leukoplakia (PVL) [23], and erythroplakia [31]. Notably, the retrospective analysis by Moergel *et al*. [31] included patients with OLP, leukoplakia, and erythroplakia. No studies meeting the inclusion criteria were found for erythroleukoplakia (ELP), oral submucous fibrosis, actinic keratosis (AK), palatal lesions related to reverse smoking, or dyskeratosis congenita (DKC). Only three studies compared implant survival rates between patients with OLP and those with healthy oral mucosa.

Table 2. Summary of studies, number of patients and implants, PIM, PI, bone loss, follow-up, implant survival, implant success, and malignant transformation in all entities of OPMD.

OPMD	Oral Lichen Planus	Leukoplakia	Proliferative Verrucous Leukoplakia	Erytrhoplakia	Systemic Lupus Erythematosus
Studies	17	1	1	1	4
Patients	153	12	1	2	8
Implants	365	Nm	Nm	Nm	43
PIM	55/164	Nm	Nm	Nm	Nm
PI	23/119	1/12	Nm	Nm	Nm
Bone loss <3 mm	163/178	Nm	Nm	Nm	12/43
Bone loss ≥3 mm	15/178	Nm	Nm	Nm	x
Mean follow-up (months)	40.1	65.25	60	72.5	34
Implant survival	99.33% (298/300)	Nm	100%	Nm	97.67%
Implant success	96.42% (56/56)	Nm	Nm	Nm	Nm
Malignant Transformation	9	12	Nm	2	0

PIM: peri-implant mucositis; PI: peri-implantitis; Nm: not metioned.

Oral lichen planus

A total of seventeen studies examining dental implants in patients with oral lichen planus (OLP) were included in this review, consisting of ten case reports [16–22, 26, 27, 29], five retrospective studies [30–34], one prospective study [36], and one cross-sectional study [37]. Collectively, these studies described 365 implants in 153 patients, aged between 44 and 83 years. Among the patients, 84 were female (54.9%), 27 male (17.65%), and 42 (27.45%) had unreported sex. Implant survival data were available for 300 implants, showing a survival rate of 99.3% (ranging from 50% to 100%) over a mean follow-up of 40.1 months, with only two implant losses reported.

Bone loss around implants was evaluated in nine studies, either qualitatively [18, 29, 37] or quantitatively [17, 22, 27, 33, 34, 36]. Quantitative assessments, conducted primarily through radiographic imaging and in one study combined with clinical examination [36], were available for 178 implants. Of these, 163 implants exhibited less than 3 mm of bone loss, while 15 implants had bone loss of 3 mm or more. Peri-implantitis (PI) was observed in 23 of 119 implants across four studies [26, 27, 36, 37], occurring at various follow-up intervals, including one implant at 24 months, three at 12 months, five at 56.5 months, and fourteen at 42 months. Peri-implant mucositis (PIM) was reported in 55 of 164 implants [17, 32, 36, 37], with occurrences documented at 36, 42, and 56.5 months depending on the study. Reporting of PI and PIM was generally binary, though one study applied Roos-Jansåker criteria, defining PIM as bleeding on probing with probing depth ≥4 mm and no bone loss, and PI as bleeding or pus with bone loss exceeding three implant threads [36, 38]. Another study categorized PIM as either absent or present based on clinical signs such as redness, tissue irregularity, or altered morphology, with calibration for consistency [37].

Perioperative management of OLP was described in nine studies, employing interventions such as glucocorticoids of varying formulations and dosages [20, 22, 29, 30, 32–34, 36, 37], retinoids [30], antibiotics, or chlorhexidine mouthwash [22]. In one notable study, 55 implants were placed in 23 patients with active OLP, resulting in a low survival rate of 23.6%. After adjunctive treatment with low-level laser therapy across ten sessions and gradual escalation of oral corticosteroid dosage to 20 mg/day, 42 implants were placed with no losses over a 36-month follow-up [32].

Several studies reported excellent implant survival rates. Three studies documented 100% survival over follow-ups of 24, 36, and 72 months [16, 17, 30]. Anitua *et al*. observed a 98.48% survival rate in 66 short implants among 23 patients with erosive OLP, with a single implant loss after a mean follow-up of 68 months [33]. Additional case reports and series also reported no implant failures [22, 29]. Three studies directly compared implant outcomes in OLP patients versus healthy controls [34, 36, 37]. Survival rates were high in both groups, ranging from 96.77% to 100%, with no statistically significant differences in marginal bone loss or peri-implant disease. One study highlighted that OLP patients managed with low-dose corticosteroids demonstrated comparable bone stability to healthy controls over four years, whereas patients without controlled therapy exhibited greater marginal bone loss [34].

Regarding malignant transformation, six studies reported the development of oral squamous cell carcinoma (OSCC) in nine patients (5.88%) following implant placement [18, 19, 20, 21, 26, 31]. These findings primarily reflected the inherent risk of malignancy associated with OLP in the presence of implants.

Methodological quality assessment

All included OLP studies were appraised using the Joanna Briggs Institute critical appraisal tools, with instruments chosen according to study design. Case reports were evaluated in ten studies **(Table 3)**, three case series **(Table 4)**, two case-control studies **(Table 5)**, one cross-sectional study **(Table 6)**, and one cohort study **(Table 7)**. Overall, four studies (23%) were rated as high quality [20, 22, 27, 36], eleven (65%) as moderate quality [17–19, 21, 26, 29–32, 34, 37], and two (12%) as low quality [16, 33].

Table 3. Critical appraisal results of case reports

Assessment of Studies Using the Joanna Briggs Institute Critical Appraisal Tools for Case Reports									
Study	**Were Patient's Demographic Characteristics Clearly Described?**	**Was the Patient's History Clearly Described and Presented as a Timeline?**	**Was the Current Clinical Condition of the Patient on Presentation Clearly Described?**	**Were Diagnostic Tests or Assessment Methods and the Results Clearly Described?**	**Was the Intervention(s) or Treatment Procedure(s) Clearly Described?**	**Was the Post-Intervention Clinical Condition Clearly Described?**	**Were Adverse Events (Harms) or Unanticipated Events Identified and Described?**	**Does the Case Report Provide Takeaway Lessons?**	**Assessment of Methodological Quality**
Esposito *et al*. (2003) [29]	Yes	Yes	No	Yes	No	No	No	Yes	Moderate quality

Öczakir *et al*. (2005) [16]	Yes	No	No	No	No	No	No	Yes	Low quality
Reichart (2006) [17]	Yes	Yes	Yes	No	Yes	No	No	Yes	Moderate quality
Czerninski *et al*. (2006) [18]	Yes	Yes	No	Yes	No	No	No	Yes	Moderate quality
Gallego *et al*. (2008) [19]	Yes	Yes	No	Yes	No	No	No	Yes	Moderate quality
Marini *et al*. (2013) [20]	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	High quality
Raiser *et al*. (2016) [21]	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Moderate quality
Fu *et al*. (2019) [22]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Noguchi *et al*. (2019) [26]	Yes	Yes	Yes	Yes	No	No	No	Yes	Moderate quality
Martin-Cabezas *et al*. (2021) [27]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality

Table 4. Critical appraisal results of case series.

Assessment of Studies Using the Joanna Briggs Institute Critical Appraisal Tools for Case Series											
Study	**Were There Clear Criteria for Inclusion in the Case Series?**	**Was the Condition Measured in a Standard, Reliable Way for All Par Ticipants Included in the Case Series?**	**Were Valid Methods Used for Identificaton of the Condition for All Participants Included in the Case Series?**	**Did the Case Series Have Consecutive Inclusion of Participants?**	**Did the Case Series Have Complete Inclusion of Participants?**	**Was There Clear Reporting of the Demographic of the Participantsin the Study?**	**Was There Clear Reporting of Clinical Information of the Participants?**	**Were the Outcomes or Follow up Results of Cases Clearly Reported?**	**Was There Clear Reporting of the Presenting Site(s)/ Clinic(s) Demographic Information?**	**Was Statistical Analysis Appro-Priate?**	**Assessment of Metho-Dological Quality**
Moergel *et al*. (2014) [31]	No	Yes	Yes	Yes	Unclear	Yes	Yes	Not applicable	Not applicable	Yes	Moderate quality
Aboushelib *et al*. (2017) [32]	No	Yes	Yes	No	Unclear	Yes	No	Yes	Not applicable	Yes	Moderate quality
Anitua *et al* (2018) [33]	Yes	No	Yes	No	Unclear	No	No	Yes	Not applicable	Yes	Low quality

Table 5. Critical appraisal results of case control studies.

Assessment of Studies Using the Joanna Briggs Institute Critical Appraisal Tools for Case Control Studies										
Study	**Were the Groups Comparable Other Than the Presence of Disease in Cases or the Absence of Disease in Controls?**	**Were Cases and Controls Matched Appropriately?**	**Were the Same Criteria Used for Identification of Cases and Controls?**	**Was ExposureMeasured in a Standard, Valid and Reliable way?**	**Was Exposure Measured in the Same Way for Cases and Controls?**	**Were ConfoundingFactors Identified?**	**Were Strategies to Deal with Confounding Factors Stated?**	**Were Outcomes Assessed in Standard, Valid and Reliable Way for Cases and Controls?**	**Was the Exposure Period of Interest Long Enough to be Meaningful?**	**Was Appropiate Statistical Analysis Used?**	**Assessment of Metho-Dological Quality**
Hernandez *et al*. (2012) [36]	Yes	Yes	Yes	Yes	Yes	No	Not applicable	Yes	Yes	Yes	High quality

Czerninski *et al*. (2013) [30]	Yes	Yes	Yes	Yes	Yes	No	Not applicable	Yes	No	Yes	Moderate quality

Table 6. Critical appraisal results of cross-sectional study.

Assessment of Studies Using the Joanna Briggs Institute Critical Appraisal Tools for Analytical Cross Sectional Study										
Study	**Were the Criteria for Inclusion in the Sample Clearly Defined?**	**Were the Study Subjects and the Setting Described in Detail?**	**Was the Exposure Measured in a Valid an Reliable Way?**	**Were Objective, Standard Criteria Used for Measurement of the Condition?**	**Were Confounding Factors Identified?**	**Were Strategies to Deal with Confounding Factors Stated?**	**Were the Outcomes Measured in a Valid and Reliable Way?**	**Was Appropriate Statistical Analysis Used?**	**Assessment of Methodological Quality**
Lopez-Jornet *et al*. (2014) [37]	Yes	Yes	Yes	No	Unclear	Unclear	Yes	Yes	Moderate quality

Table 7. Critical appraisal results of cohort study.

Assessment of Studies Using the Joanna Briggs Institute Critical Appraisal Tools for Cohort Studies												
Study	**Were the Two Groups Similar and Recruitedfrom the Same Opulation?**	**Were the Exposure Measured Similarly to Assign People to Both Exposed and Unexposed Groups?**	**Was the Exposure Measured in a Valid and Reliable Way?**	**Were Confounding Factors Identified?**	**Were Strategies to Deal with Confoun-ding Factors Stated?**	**Were the Groups/Participants Free of the Outcome at the Start of the Study (or at the Moment of Exposure)?**	**Were the Outcomes Measured in a Valid and Reliable Way?**	**Was the Follow up Time Reported and Sufficient to Be Long Enough or Outcomes to Occur?**	**Was Follow up Complete, and if Not, Were the Reasons to Loss to Follow up Described and Explored?**	**Were Strategies to Address Incomplete Follow up Utilized?**	**Was Appropriate Statistical Analysis Used?**	**Assessment of Metho-dological Quality**
Khamis *et al*. (2019) [34]	No	Yes	No	No	No	No	Yes	Yes	Yes	No	Yes	Moderate quality

Leukoplakia

Only one study [31] reported data on leukoplakia, alongside OLP and erythroplakia. This investigation included twelve patients, evenly divided between females and males, aged 42 to 88 years, who developed oral squamous cell carcinoma (OSCC) in proximity to dental implants. The interval from implant placement to OSCC diagnosis ranged from 29 to 120 months. The study did not provide specific information on the number of implants, implant survival rates, or follow-up durations. Nonetheless, it highlighted cases of OSCC occurring adjacent to dental implants in patients with leukoplakia.

Proliferative verrucous leukoplakia

A single case report [23] described a 63-year-old woman with histologically confirmed proliferative verrucous leukoplakia. She underwent dental rehabilitation with implants following multiple interventions, including cryosurgery, laser therapy, diathermic ablation, and excision of dysplastic epithelium and areas of malignant transformation. Implant placement was successful, and the patient was followed for 60 months. However, the report did not specify the number of implants, bone loss, or exact survival rates.

Erythroplakia

Although five publications addressing erythroplakia were identified, none met the inclusion criteria. In the study by Moergel *et al*. [31], two patients (a 70-year-

old female and a 73-year-old male) with histopathologically confirmed erythroplakia received dental implants. OSCC developed near the implants at 48 and 97 months post-placement, respectively, but no further details on implant survival or bone loss were reported.

Systemic lupus erythematosus

Four studies, including three case reports [24, 25, 28] and one retrospective study [35], investigated dental implants in patients with systemic lupus erythematosus (SLE). In total, eight patients (five female, three male, aged 28–66 years) received forty-three implants. Follow-up periods ranged from 18 to 58 months, with an overall implant survival rate of 97.67% (42/43 implants). One patient received intravenous immunoglobulin therapy every four weeks [28], while another study assessed the use of calcium-ion-modified implant surfaces in combination with platelet concentrates for rehabilitation [35]. Among the implants evaluated, 12 of 43 (27.9%) exhibited bone loss of 3 mm or less, with no additional data reported [35].

Oral submucous fibrosis

No eligible studies examining dental implant outcomes in patients with oral submucous fibrosis were identified.

The primary objective of this systematic review was to evaluate dental implant survival in patients with oral potentially malignant disorders (OPMD) and to identify potential risk factors for peri-implant complications, including peri-implant mucositis, peri-implantitis, and peri-implant bone loss. In addition, the potential for malignant transformation in these patients represents a clinically significant consideration. Although malignant transformation was not pre-specified as a secondary outcome, its inclusion was essential to comprehensively assess the risks associated with OPMD, enhancing the clinical relevance of our findings.

Previous reviews, such as those conducted by Torrejon-Moya *et al*. [39] and Chrcanovic *et al*. [40], have explored implant placement in the context of mucosal disorders, but these largely focused on single conditions like oral lichen planus and general implant survival. A recent systematic review by Li *et al*. [41] similarly examined the relationship between OLP and peri-implant diseases but did not address peri-implant bone loss. In contrast, the present review represents the first attempt to systematically analyze specific peri-implant risk factors in patients with OPMD, including the incidence of peri-implant mucositis, peri-implantitis, and bone loss. Our analysis also highlights the insufficient long-term data regarding the progression of these complications and the effects of their management, underscoring important directions for future research.

Oral lichen planus

Oral lichen planus is a chronic autoimmune inflammatory disorder of uncertain etiology, characterized by cycles of remission and exacerbation. Clinically, it presents as white reticular lesions, which may be accompanied by atrophic, erosive, ulcerative, or plaque-like areas, often with bilateral symmetry [2]. In this review, data from 365 implants placed in 153 patients with OLP were analyzed. Reported implant survival rates in healthy populations generally range from 95% to 98% over 5 to 10 years [42, 43], which aligns closely with the 99.3% survival observed in OLP patients in this review, although individual outcomes may vary depending on disease severity, therapeutic interventions, and patient response. Erosive OLP, in particular, is associated with pain and resistance to treatment, making implant management challenging. While no standardized treatment exists, therapeutic strategies including systemic corticosteroids, retinoids, and targeted anti-IL-17/IL-23 agents have demonstrated efficacy [44].

Despite heterogeneity across studies in symptomatic management of OLP [20, 22, 29, 30, 32–34, 36, 37], evidence suggests that implant placement during the active phase of erosive OLP can lead to complications and implant failure. For instance, Aboushelib reported implant loss when placement occurred during active disease [32], and Anitua *et al*. documented failure of one implant due to peri-implant inflammation in a patient with erosive OLP, noting a corresponding reduction in peri-implant bone stability [33]. These findings collectively indicate that delaying implant placement until disease control is achieved may reduce the risk of complications and improve implant survival.

Peri-implant bone loss is a key marker of potential long-term complications, including an elevated risk of peri-implantitis and eventual loss of osseointegration [45]. Although some studies report thresholds for peri-implantitis risk as low as 0.5 to 1 mm of bone loss [46], clinical practice typically defines peri-implantitis as bone loss equal to or greater than 3 mm [13]. Due to inconsistencies in the literature, this review categorized bone loss into two groups—less than 3 mm and 3 mm or greater—to facilitate comparison and distinguish between early and advanced peri-implant bone changes.

Oral lichen planus

In our review, peri-implant bone loss of 3 mm or greater was reported in four studies, affecting a total of 15 implants [17, 22, 27, 36]. Peri-implantitis (PI) was observed in 23 of 119 implants [26, 27, 36, 37], while peri-implant mucositis (PIM) occurred in 55 of 164 implants [17, 32, 36, 37]. Hernandez *et al*. noted that PIM prevalence was higher in the control group (58%) than in OLP patients (44.6%), a finding potentially attributable to superior oral hygiene practices in the OLP cohort [36]. Overall, the evidence suggests that factors such as bone loss, PIM, and PI do not substantially compromise long-term implant survival in patients with OLP. Reported rates of PIM and PI among OLP patients (17.86% and 25%, respectively) are similar to those observed in the general population (18% and 16%) [37].

Despite these findings, significant heterogeneity exists regarding the oral sites affected by OLP, and it remains uncertain whether OLP directly influences peri-implant tissues. Only two studies explicitly reported OLP lesions adjacent to implants [17, 26], while another study required complete healing at the implant site as a condition for inclusion [36]. Isolated clinical images in several studies suggested active OLP manifestations near peri-implant tissues [21, 29, 30, 32, 37].

Malignant transformation was documented in nine patients with dental implants [18, 19, 20, 21, 26, 31]. Moergel *et al*. suggested that OLP may increase the risk of oral squamous cell carcinoma (OSCC), particularly in areas exposed to chronic irritation, such as around implants [31]. However, no definitive causal link between implants and malignant transformation has been established. Case reports by Noguchi *et al*. and Martin-Cabezas *et al*. describe epithelial hyperplasia and peri-implant changes that can resemble PIM [26, 27]. It has been proposed that implant placement may contribute to OSCC development by disrupting periodontal tissues and the periodontal ligament [47].

Taking into account the limitations of the included studies and potential biases, the findings support the recommendation that implant therapy can be offered to patients with OLP, provided that implants are not placed during acute or symptomatic phases, especially in erosive OLP. Maintaining meticulous oral hygiene and adhering to guideline-based mucosal monitoring are essential for minimizing inflammatory complications and facilitating early detection of malignant transformation.

Leukoplakia

Leukoplakia is defined by the World Health Organization as a predominantly white plaque of uncertain risk that cannot be attributed to other known disorders that carry no increased cancer risk [48]. The condition has a global prevalence of approximately 4.1% [49]. Nonhomogeneous leukoplakia carries a higher likelihood of malignant transformation compared to the homogeneous form, particularly in lesions exhibiting varying degrees of epithelial dysplasia [9].

Moergel *et al*. [31], who reported the largest series of cases with malignancy adjacent to implants, identified peri-implant mucositis as the predominant clinical feature in 12 leukoplakia cases. Although the overall incidence of tumors near implants remains low, it is unclear whether interactions between dental implants and surrounding tissues significantly influence carcinogenesis. Chronic mechanical irritation has been proposed as a potential contributing factor in oral cancer development [50], and recent meta-analyses have supported the association between repeated mucosal trauma and oral squamous cell carcinoma [51]. To date, there are no studies assessing implant survival, complications, or malignant transformation specifically in patients with leukoplakia undergoing dental rehabilitation.

Proliferative verrucous leukoplakia

Proliferative verrucous leukoplakia (PVL) is recognized as a progressive, persistent, and irreversible variant of oral leukoplakia with a markedly elevated risk of malignant transformation, with cumulative rates reported at 49.5% [3]. Currently, there is a lack of evidence regarding the survival of dental implants or potential complications, including malignant transformation, in the vicinity of PVL lesions. Given the high oncogenic potential of PVL, successful management relies on early diagnosis, surgical excision, and adherence to long-term, guideline-based follow-up protocols.

Erythroplakia

Erythroplakia presents as a red, often irregular mucosal lesion that cannot be classified as any other known oral disorder [2]. Among oral potentially malignant disorders, it carries one of the highest risks of malignant transformation, second only to proliferative verrucous leukoplakia, with a reported rate of 33.1% [3]. Only a single retrospective study was identified that included two patients with erythroplakia, both of whom developed oral squamous cell carcinoma in proximity to dental implants and had a prior history of oral malignancy [31]. Because data on implant outcomes in erythroplakia patients are extremely

limited, no definitive recommendations regarding implant success or peri-implant complications can be made. Consequently, early recognition, prompt surgical management, and adherence to structured long-term follow-up remain essential in managing patients with erythroplakia.

Systemic lupus erythematosus

Systemic lupus erythematosus (SLE) is a chronic autoimmune condition that may occur in systemic, drug-induced, or discoid forms [2]. Oral involvement is reported in approximately one-fifth of patients, often resembling lesions observed in oral lichen planus [2]. This review identified three case reports [24, 25, 28] and one retrospective study [35] including eight SLE patients who received dental implants. In SLE, oral ulcers and reduced salivary flow frequently complicate the use of conventional mucosal prostheses [52, 53], and ill-fitting devices can exacerbate mucosal trauma and ulceration [54]. For these patients, implant-supported restorations offer a valuable alternative, improving function and comfort. As with other OPMDs, careful and regular follow-up is critical to monitor implant sites and mitigate the risk of complications.

Conclusion

Dental implants demonstrate high survival rates in patients with oral lichen planus, with approximately 99.3% of implants remaining functional, which is comparable to rates observed in the general population. Peri-implant bone loss exceeding 3 mm is associated with an increased risk of peri-implantitis and should be monitored closely. Implants should not be placed during active or symptomatic phases of OLP; placement should be deferred until the condition is well-controlled. The health of the peri-implant mucosa is a major determinant of long-term success, emphasizing the need for preventive strategies both before and after treatment.

Malignant potential in patients with OPMDs remains a major consideration, necessitating vigilant follow-up and early intervention. The heterogeneous nature of OPMDs, including diverse lesion types, locations, and clinical behaviors, presents challenges for implant therapy and reinforces the need for individualized treatment approaches. Beyond oral lichen planus, clinical evidence for implant therapy in other OPMDs is limited, precluding definitive guidance. Future research should focus on prospective, controlled studies with standardized definitions for peri-implant complications, comprehensive follow-up, and stratification by lesion type to provide more reliable evidence for clinical practice.

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