



Oral Consequences of Systemic Lupus Erythematosus: an Update

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Abstract

Purpose of Review Systemic lupus erythematosus (SLE) is an autoimmune disease affecting multiple organs that has been associated with various oral manifestations. It affects mainly adult women, and its incidence is estimated to be 5.14 per 100,000 persons/year. Oral manifestations such as mucosal, periodontal, or carious lesions are common in SLE as well as temporomandibular joint disorders.

Recent Findings This systematic review aims to identify the oral manifestations of SLE and to evaluate the at-distance impact of SLE on oral health as well as to give clinical guidance for the oral care of SLE patients.

Summary SLE has a negative impact on general and oral health. The mechanisms underlying the development and progression of the disease are still not fully understood; however, genetic predispositions, environmental factors, or hormones might be involved in the onset of SLE. SLE treatment aims to control and limit the disease progression and expression by the adjunctive use of corticoids or immunosuppressive drugs that can impact oral health and management.

Keywords Autoimmune · Oral management · Orofacial manifestations · Systemic lupus erythematosus · Implant · Periodontitis

Introduction

Systemic lupus erythematosus (SLE) is a chronic autoimmune condition characterized by loss of immune tolerance against self-antigens, in particular nuclear self-antigens, leading to the production of various autoantibodies, immune complex formation and deposition that cause inflammation and tissue damage in multiple organs. The clinical manifestations can range from joint pain, skin lesions, fatigue to organ injuries including nephritis and serositis. North America has the highest estimated incidence worldwide, with 23.2 cases for 100,000 individuals, SLE primarily affecting African-Americans, Hispanics, and Asians. The global SLE incidence is estimated

to be 5.14 (1.4 to 15.13) per 100,000 person-years (1,2). SLE mostly affects adults and particularly women, with an incidence of 8.82 (2.4 to 25.99) per 100,000 person-years in the female population compared to an incidence of 1.53 (0.41 to 4.46) per 100,000 person-years in the male population with a peak onset between 20 and 30 years in women and 45 and 60 years in men (2,3).

SLE presentation is very heterogeneous. It can affect various organs and systems including the heart, lungs, and kidneys, as well as the hematologic and ocular systems, with a significant impact on the quality of life. SLE is characterized by a standardized mortality ratio (SMR) of 2–5 compared to the general population worldwide. Lupus nephritis and neuropsychiatric lupus are the main manifestations associated with increased mortality. Moreover, bacterial infection and cardiovascular complications remain important causes of death when SLE patients are compared to age and sex-matched counterparts (4).

Early stages of SLE are rather silent but the disease can be detected a long time before the first clinical signs. Indeed, antinuclear autoantibodies (ANA) can be found in the serum of SLE patients approximately 3 to 9 years before the first clinical signs of the disease and SLE

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diagnosis (5). During the initial phase, SLE mimics a viral syndrome characterized by fatigue, weight loss, low-grade fever, and sometimes by arthralgia or arthritis (1). Clinical features can be grouped into three patterns such as flare or crisis, chronically active disease, and quiescent form (4).

Diagnosis of SLE is based on clinical and immunological criteria which were compiled and proposed by the European League Against Rheumatism (ELAR) in collaboration with the American College of Rheumatology (ACR). This version updated the 1982 SLE classification and added 10 domains and 22 criteria (6). The domains included are clinical (cutaneous, constitutional, renal, arthritis, serositis, hematologic, neurologic) or

immunologic (antiphospholipid antibodies, complement proteins, highly specific antibodies), subdivided in weighted criteria (point system). In this update, in addition to a positive antinuclear antibody (ANA) test result, a total score of 10 is required to determine a diagnosis of SLE (Fig. 1).

Numerous studies pointed out that both genetic (several candidate genes have been described) and environmental (UV light exposure, viral infections, several drugs...) factors drive the development of SLE. However, the pathogenesis of the disease is very complex and still remains not fully understood (7). It is characterized by an autoimmune reaction in which the innate and adaptive immune systems direct

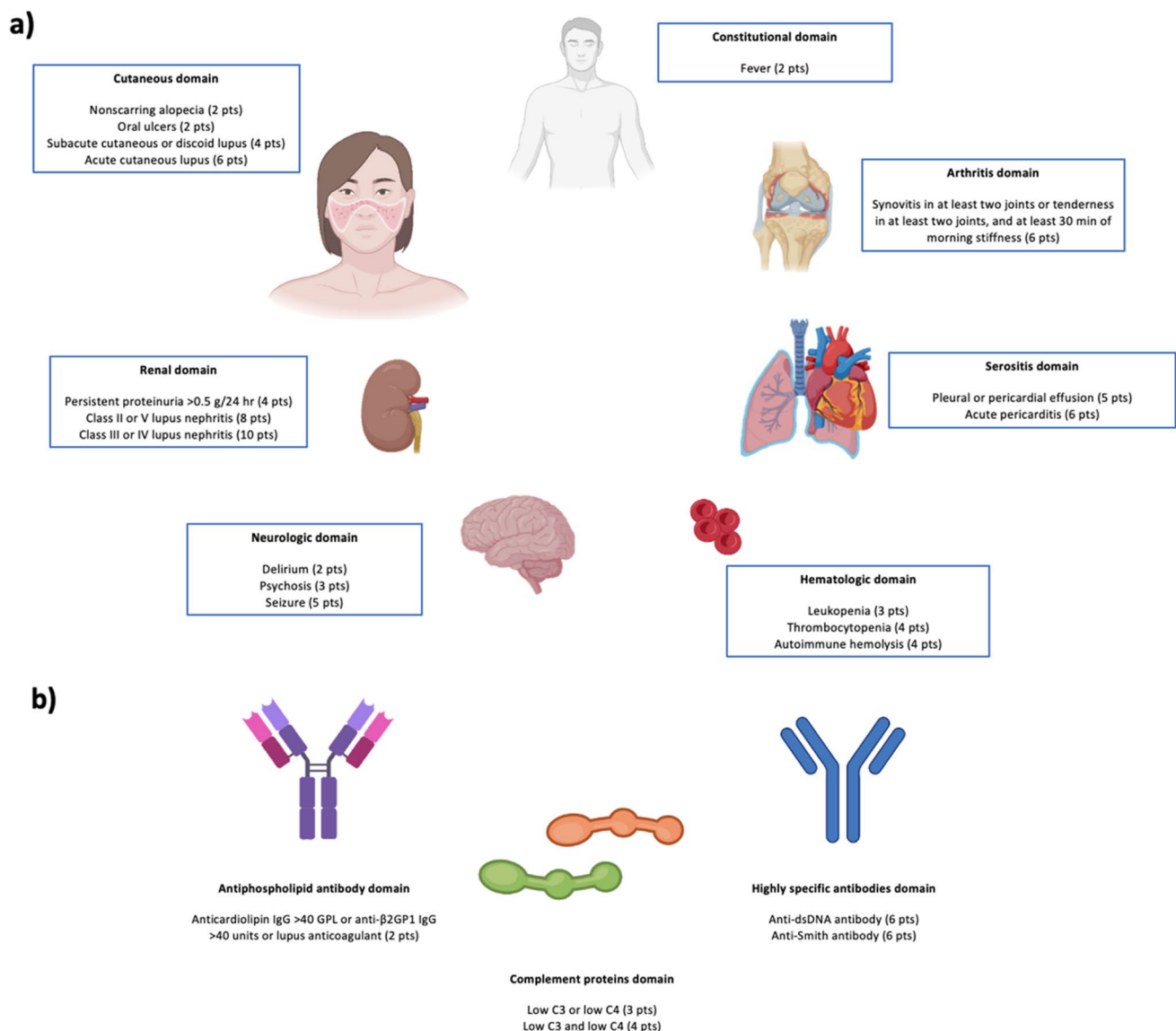


Fig. 1 Clinical (a) and immunologic (b) domains of EULAR/ACR classification criteria for systemic lupus erythematosus (according to Aringer et al., 2020) (6)

an inappropriate immune response against nuclear self-antigens. Several biological mechanisms are suggested to be involved. Nucleic acid-containing immune complexes as well as impaired clearance of apoptotic cells activate the innate immune response, leading to increased type I interferon (IFN) production. In addition, neutrophils are also involved notably through an excessive neutrophils extracellular traps (NETs) formation associated or not with a reduced clearance of NETs. Dysregulated adaptive immunity plays a crucial role in the pathogenesis of SLE. Self-reactive B cells produce a variety of autoantibodies and can activate autoreactive T cells and T-cells are characterized by several signaling alterations with abnormal cytokine secretion (7,8) (Fig. 2).

Different treatment strategies can be applied to ensure long-term survival, prevent organ damage, and improve patients' quality of life by controlling disease activity. SLE patients are typically treated with antimalarial (hydroxychloroquine), corticosteroids, and non-steroidal anti-inflammatory drugs, as well as immunosuppressive agents (cyclophosphamide, mycophenolate mofetil but also targeted therapies such as rituximab) (9). Despite these treatments and an early diagnosis of the disease, the mortality remains high (4) and the local and systemic involvement as well as the various treatment used to

control the disease activity may have a negative impact on oral health, periodontal and dental conditions. The aim of this review was to expose the SLE orofacial manifestations and adapted oral management.

Materials and Methods

Search Strategy

A literature search related to orofacial manifestations and dental management of SLE was performed according to PRISMA guidelines (10). Database search was realized in Google Scholar and PubMed/MEDLINE by the use of the following keywords: ("systemic lupus" OR "lupus" OR "rheumatic disease") AND ("oral" OR "caries" OR "mouth" OR "dental material" OR "orofacial" OR "dental prosthesis" OR "dental implant" OR "oral mucosa" OR "periodontal outcomes" OR "temporomandibular joint" OR "prosthodontics" OR "salivary gland" OR "xerostomia" OR "dental treatment" OR "dental therapeutics" OR "oral health" OR "periodontal disease"). Studies from 1978 to 2023 were searched. After the removal of the non-relevant articles by screening of the titles and abstracts, full-text articles were obtained and evaluated separately by independent reviewers (P.-Y.G.; R.W.).

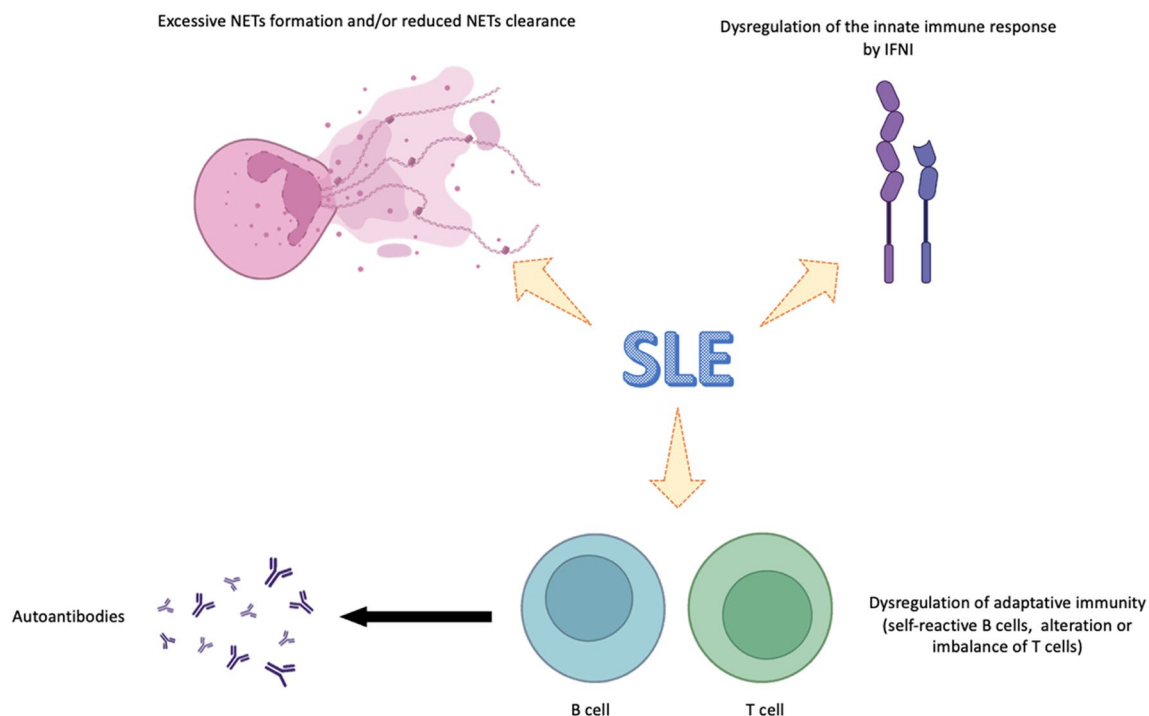


Fig. 2 Biological mechanisms involved in systemic lupus erythematosus

Eligibility Criteria

A study was considered eligible for inclusion if it met the following criteria: (1) article written in English, (2) studies reporting at least one orofacial manifestation, and (3) studies assessing oral, implant, or dental condition and treatment. Systematic reviews, meta-analysis, opinions, editorial letters, conferences, studies with inadequate or obviously mis-conducted methodology, not dealing with SLE, and dealing with SLE but in patients suffering from other systemic and/or syndromic diseases were excluded (Table 1). Different articles' characteristics were collected such as groups, sample size (number of SLE patients), dental, salivary gland, periodontal, implant or temporomandibular joint involvement, and treatment (Tables 2 and 3).

Results

The search strategy identified 135 articles. After removal of duplicates a total of 64 articles remained. After titles and abstracts evaluation, 26 articles were excluded and the number of eligible articles was 38. Then, 3 articles were not retrieved and 1 was excluded. Finally, 34 articles were included in this review (Fig. 3).

Mucosal Lesions in SLE

Thirteen studies evaluated the presence of mucosal lesions in SLE patients. The number of patients included in these studies ranged from 10 to 188 and only four of these studies evaluated the smoking status of the included patients (11–14). Eleven over thirteen studies found ulcerative lesions (12–22), and nine over thirteen found erythema or red macules (11–14,17–20,23). The lesions were in majority found at the palate (11,12,14–18,20,23), on the oral mucosa (12–15,17–20,22,23), sometimes on the lips (12–14,16,19,20,22), or even on the tongue (11,12,17). In the majority of studies, patients were treated with corticosteroids, antimalarial drugs, immunosuppressants, or other drugs used alone or in combination.

Periodontal, Implant, and Temporomandibular Joint Disorders (TMD) in SLE

Sixteen studies evaluated periodontal, implant, and TMD in SLE patients. The number of patients included in these studies ranged from 5 to 75. Most of these studies evaluated the impact of SLE on periodontal parameters (18,24–33) and demonstrated a high correlation between SLE and periodontitis prevalence apart from Mutlu et al. who found a reduction of periodontal pocket depth (PPD) in patients

suffering from SLE (24). Indeed, despite the heterogeneity of the studies, a correlation was found between SLE duration and increased gingivitis incidence ($p=0.017$) (18), or between the increase of the occurrence of periodontitis and SLE (ranging from 40 to 68%) (25,27,30,31,33). Moreover, periodontitis was found to be less severe when patients were treated with low doses of prednisone (<10 mg/day) whereas the chronic use of immunosuppressants was found to be correlated with attachment loss >3 mm (33).

Temporomandibular joint disorder was less detected (12,18,34–37) but was also correlated with the diagnosis of SLE. TMD pain was observed in 27.3 to 58% (12,18,37) of SLE patients while mouth opening reduction occurred from 4.5 to 30% of the cases (12,18,37).

Only one study evaluated the effect of SLE on peri-implant parameters (31) and no impact of SLE was measured on implant survival and success rate at 5 years.

Tooth Decay and Salivary Flow Affection in SLE Patients

Thirteen studies evaluated tooth decay and salivary flow in SLE patients. The number of patients included in these studies ranged from 11 to 214. Seven studies over thirteen found signs of xerostomia or hyposalivation (11,14,21,30,38–43) in SLE patients. Xerostomia was found to be very prevalent when associated with SLE, ranging from 17 to 100% according to different studies (11,21,38,40,43). Hyposalivation was also frequently found in SLE patients (7.29 to 13.05%).

Four studies over thirteen evaluated the impact of SLE on tooth decay (18,27,30,42) and one the tooth loss due to tooth decay (26) with a DMFT ranging from 4 to 13.65% (18,30,42). Nevertheless, it was demonstrated that SLE has a negative impact on the oral hygiene level (18,30).

Discussion

Systemic lupus erythematosus is an autoimmune disease that can present itself with several patterns of clinical manifestations. This disease remains difficult to diagnose and treat due to the high heterogeneity of the clinical signs and phases of activity (alternation of flares and quiescence). It can affect various organs including the oral cavity. Indeed, oral lesions are a common manifestation of the disease appearing as ulcerative lesions, on the palate, tongue, lips, or oral mucosa (44). Oral ulcers (in particular palatal ulcers) are one of the 17 clinical criteria (2019 EULAR/ACR classification) for the diagnosis of SLE (6).

Periodontal disease in SLE is also largely documented. In our review, eleven studies demonstrated an increased prevalence of periodontitis in SLE patients. A systematic review and meta-analysis focusing on such

Table 1 Mucosal lesion in SLE

Studies	Included patients	Patient description	Findings	Localization and lesion description	Treatment
Urman et al., 1978	SLE: <i>n</i> = 182	NR	Oral ulcer (26%)	Hard palate Gingiva Buccal mucosa	Corticosteroid therapy Antimalarial drug Salicylate
Burge et al., 1989	SLE: <i>n</i> = 53 CCL: <i>n</i> = 68	NR	Oral ulcer (36%) Cheilitis (6%) Oral plaque (3%)	Hard palate Vermillion border Soft palate Lower lip	Chloroquine Prednisolone Hydroxychloroquine Azathioprine
Jorizzo et al., 1992	SLE: <i>n</i> = 10	NR	Oral ulcer (70%) Erythema (60%) Discoid lesion (30%)	Palate Buccal mucosa Gingiva Tongue	Prednisone Plaquenil Atabrine Cyclophosphamide Methotrexate
Jensen et al., 1999	SLE: <i>n</i> = 20	35% smoker 0.65 non-smokers	Minor mucosal lesion (84%) Telangiectasia (55%) Median rhomboid glossitis (10%) Erythema (25%) Epithelial hyperplasia (5%)	Palate Tongue 35% smoker 0.65 non-smokers	Prednisolone Antimalarial Azathioprine Methotrexate
Fernandes et al., 2007	JSLE: <i>n</i> = 48 Controls: <i>n</i> = 48	Juvenile	Erythema/discoid lesions (41.6%) Oral ulcer (6.25%)	Hard palate Oral mucosa	Chloroquine Hydroxychloroquine Immunosuppressants
Lourenço et al., 2007	SLE: <i>n</i> = 13 CLE: <i>n</i> = 33		Erythemo-ulcerative plaque (46%) White plaque types (54%) Valid for SLE group	Buccal mucosa Lower lip Upper lip	NR
López-Labady et al., 2007	SLE: <i>n</i> = 38 CLE: <i>n</i> = 52		Oral ulcer (5.5%) Red macula (4.4%) Red plaque (6.6%) White plaque (1.1%)	Hard palate Buccal mucosa Upper lip Lower lip	Immunosuppressants
Xu et al., 2010	SS/SLE: <i>n</i> = 41 SLE: <i>n</i> = 214		Oral ulcer: 14.6% (SS/SLE) 12.1% (SLE)	NR	Corticosteroid therapy
Aliko et al., 2010	SLE: <i>n</i> = 22 RA: <i>n</i> = 88 SSC: <i>n</i> = 14	SLE: 9.1% smoker RA: 14.8% smoker SSC: 7.1% smoker	Red lesions (35.5%) White lesions (7.3%) Red white lesions (6.5%) Nodular lesions (5.6%) Ulcerative lesions (8.9%) Vesicullo-bullous (0.8%) Pigmented lesions (3.2%) Other (4%)	Palate Labial/buccal mucosa Tongue Alveolar mucosa/gingiva Sulci Vermillion border/lips Commissures Floor the mouth	Oral steroids NSAIDs Methylprednisolone Methotrexate
Khatibi et al., 2012	SLE: <i>n</i> = 188	27.2% smokers 72.8% non-smokers	Oral ulcer (28.1%) Erythema (white speckles/striae) (13.8%) Erythema (9.5%) White plaque (2.6%)	Buccal mucosa Lower lip Upper lip	Corticosteroid therapy Azathioprine Hydroxychloroquine Cyclophosphamide
Bahloul et al., 2017	SLE: <i>n</i> = 30 RA: <i>n</i> = 4 D: <i>n</i> = 5 LA: <i>n</i> = 1 S: <i>n</i> = 1		Oral ulcer (25%) Hyperpigmentation (13.3%)	Lip Gum Mucosa	Prednisone Antiaggregant Oral anticoagulants Hydroxychloroquine

Table 1 (continued)

Studies	Included patients	Patient description	Findings	Localization and lesion description	Treatment
Menzies et al., 2018	SLE: <i>n</i> = 11 CCL: <i>n</i> = 11 DLE: <i>n</i> = 20	45% smokers 14% ex-smokers 29% non-smokers 12% unknown	Oral ulcers (23%) Erosions (23%) Erythema (19%) White plaque (19%) Others (16%)	Hard palate (38%) Labial mucosa Buccal mucosa Gingiva Alveolar ridge	Oral prednisolone Steroid inhaler Antibiotic
Del Barrio-Díaz et al., 2019	SLE: <i>n</i> = 58 CLE: <i>n</i> = 92 Control: <i>n</i> = 151		White streaks (59%) Brown macules (63%) Red macules (60%) Telangiectasia (100%)	Palate Gingiva Jugal mucosa	NR

patients was recently published and showed that these two inflammatory diseases could have a bidirectional association. Indeed, in this study, SLE patients are found to be more prone to develop periodontitis. The SLEDAI index (SLE disease activity index), an index related to SLE activity, was also found to be correlated with periodontitis diagnosis (45). To support the bidirectional association, it has been found that periodontal treatment improved the response to immunosuppressive therapy in SLE patients (29). Several biological links are proposed to explain the relationship between periodontitis and SLE. Genetic links have been found, particularly the polymorphism of Fcγ receptor which was associated with periodontitis-SLE connection (27,46). Other etiologies have been suggested such as the systemic immune dysregulation of subgingival microbiota caused by SLE, SLE-induced imbalance between pro- and anti-inflammatory cytokines, or B-cells hyperactivity (47).

TMD are frequently associated with SLE, and it has been shown that TMD was correlated with an increased number of immunosuppressive drugs intake, which indirectly reflects the disease activity (18). The systemic use of corticosteroids in SLE patients was demonstrated to potentially have an effect on condylar flattening due to erosion (48). Indeed, the disease activity and the use of corticosteroids were found to be linked to the loss of joint cartilage and bone (49).

Contrary to the association between periodontitis and SLE, the incidence of peri-implantitis in SLE patients has not been widely explored. Indeed, a previous review demonstrated that the implant survival rates in SLE patients were equivalent to those observed in healthy individuals (50). Only few data are available on this particular topic. Thus, further studies are needed to show a causal association between SLE and implant condition.

Hyposalivation was also found to be associated with SLE. It can be caused by SLE itself or due to a secondary Sjögren's syndrome (SS) which is another systemic autoimmune

condition affecting exocrine glands such as salivary and lacrimal glands, leading to xerostomia and xerophthalmia (51). SS can occur alone (primary SS) or can be found in association with other systemic autoimmune diseases (secondary SS), in particular SLE (15 to 36% of the cases) (52). Xerostomia is a well-known factor that can lead to the onset and progression of carious lesions due to the loss of remineralizing and buffering action of the saliva (53,54), which naturally leads to a higher risk of tooth loss due to severe carious lesion.

SLE patients are at risk for carious and periodontal disease as well as TMJ disorders, which can become challenging for dental practitioners. Moreover, SLE patients are often treated with various drugs that can have an impact on oral health and can have various adverse effects (55). Given the fact that oral manifestations, especially ulcers on the hard palate, are commonly found in SLE, dentists have a key role in SLE patient diagnosis and management who require a multidisciplinary treatment approach to prevent disease evolution and reduce disease morbidity. Hence, patients treated with immunosuppressants or corticosteroids are more at risk of infection, and antibiotic prophylaxis may be recommended concomitantly to invasive treatments including periodontal and surgical treatments. Regular screening and adapted oral care should be performed on these patients. Reduced salivary secretion will be associated with an increased risk of carious lesions, periodontitis, or fungal infection due to a qualitative change in oral microbiota (56). This impairment should be considered as it can complicate oral treatment and prosthetic rehabilitation. According to the results of our study, implant placement seems to remain a good alternative for tooth replacement, even if we need to carefully evaluate the risk–benefit balance of this kind of rehabilitation, particularly if the patients are under immunosuppressive treatments. Moreover, the number of studies available on implant rehabilitation in SLE patients remains low and further studies are needed.

Table 2 Periodontal, implant, and temporomandibular affection in SLE

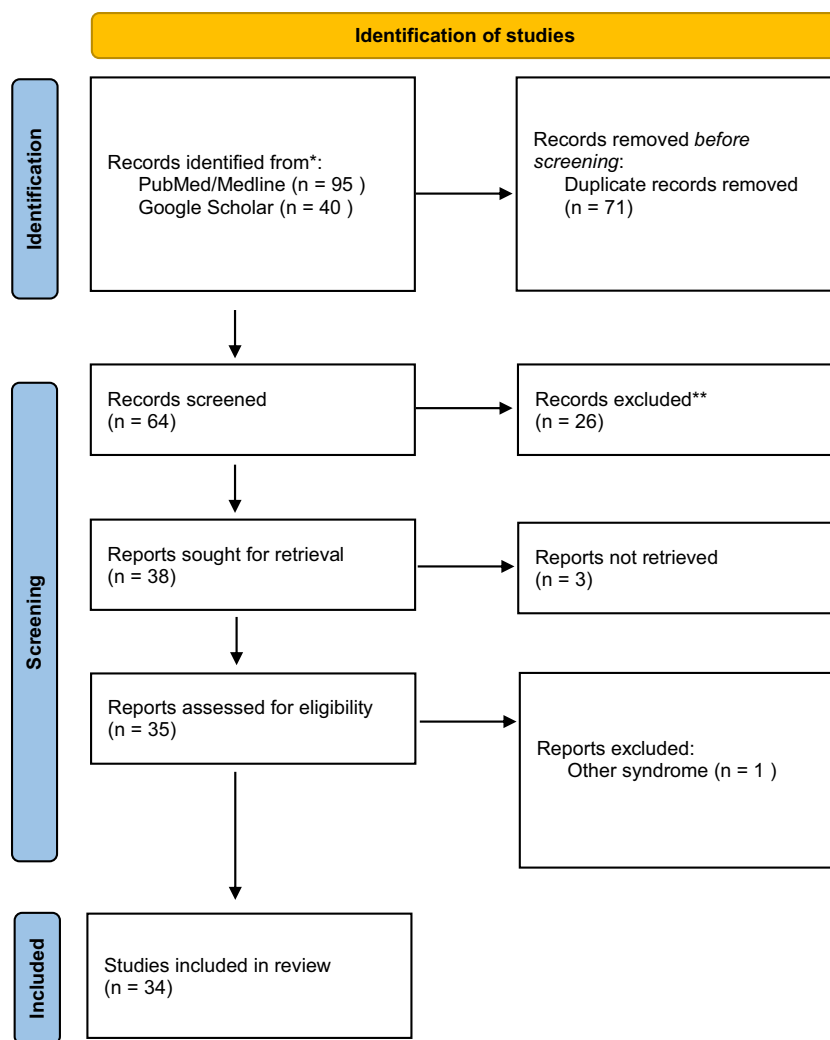
Studies	Patient included	Periodontal situation	Implant situation	Temporomandibular situation	Findings	Treatment
Jonsson et al., 1983	SLE: <i>n</i> = 37 C: <i>n</i> = 37	–	–	Severe dysfunction: 14% TMD signs: 41%	–	–
Mutlu et al., 1993	SLE: <i>n</i> = 53 C: <i>n</i> = 48	PI: 0.57 ± 0.12 GI: 0.4 ± 0.08 PD: 1.28 ± 0.07	–	–	Lower periodontal probing depth found in SLE patients	Corticosteroid NSAIDS Immunosuppressants Antimalarial
Novo et al., 1999	SLE: <i>n</i> = 30 RA: <i>n</i> = 30 C: <i>n</i> = 20	Periodontitis: 60% (SLE)	–	–	Increased risk of periodontitis in SLE patients	–
Meyer et al., 2000	SLE: <i>n</i> = 46	Gingival inflammation Periodontal lesions	–	–	High rate of periodontal lesions due to immunodysregulation	Immunosuppressants
Fernandes et al., 2007	JSLE: <i>n</i> = 48 C: <i>n</i> = 48	PI: 61.5 BGI: 26.0	–	Impaired TMJ function (23%) TMJ pain (58%) ns Pain on mandibular movement (2%) ns Mobility reduction (8%)	Higher incidence of gingivitis and temporomandibular joint dysfunction	Chloroquine Hydroxychloroquine Immunosuppressants
Kobayashi et al., 2007	SLE + P: <i>n</i> = 46 SLE: <i>n</i> = 25 P: <i>n</i> = 58 C: <i>n</i> = 44	PD (mm): SLE + P: 2.3–0.1, SLE: 1.8–0.1 CAL (mm): SLE + P: 2.7–0.1, SLE: 2.1–0.1 BL: SLE + P: 16.4–1.4%, SLE: 10.0–1.1%	–	–	Increased risk prevalence of periodontitis (64.8%) in SLE patients	Corticosteroid Bisphosphonate therapy
Figueredo et al., 2008	JSLE: <i>n</i> = 16 C: <i>n</i> = 14	PI: 33 (± 19) mm GBI: 33.2 (± 16) mm PD: 17 (± 16) mm AL: 0.2 (± 0.6) mm	–	–	JSLE patients have presented a probing depth of greater or equal to 3 mm	Immunomodulatory drugs
Aliko et al., 2010	SLE: <i>n</i> = 22 RA: <i>n</i> = 88	–	–	TMJ sounds: 36.4% Pain: 27.3% Reduced mouth opening: 4.5%	TMJ symptoms were reported in SLE patients commonly, and pain was the most frequent	Oral steroids NSAIDS Antirheumatic drugs Methotrexate Hydroxychloroquine
Aceves-Avila et al., 2013	SLE: <i>n</i> = 25 RA: <i>n</i> = 92 AS: <i>n</i> = 33 OA: <i>n</i> = 21	–	–	TMD: 20%	TMD has been presented in the first year of the disease more frequently than in later	NR

Table 2 (continued)

Studies	Patient included	Periodontal situation	Implant situation	Temporomandibular situation	Findings	Treatment
Fabbri et al., 2014	SLE: <i>n</i> = 49	BGI: $40.8 \pm 31.0\%$ PD: 1.7 ± 1.8 mm PAL: 2.5 ± 1.9 mm		–	Periodontitis is an important factor in the maintenance of the inflammatory response that occurs in SLE	Corticosteroid Cyclophosphamide
Corrêa et al., 2018	SLE: <i>n</i> = 75 C: <i>n</i> = 78	Periodontitis: 68%			SLE has a negative impact on the oral health-related quality of life of patients with SLE	NR
Mozzati et al., 2021	SLE: <i>n</i> = 5	Periodontitis: 40%	12 implants placed: 100% of success at 5 years		Drugs treatment slows down the healing. SLE seems not to have a detrimental effect on implant survival and success rate at 5 years in contrary to smoking	NSAIDs and glucocorticoids
Pessoa et al., 2019	SLE: <i>n</i> = 60 (29 inactive/31 active)	58% of active SLE and 69% of inactive SLE had chronic localized periodontitis			Periodontitis severity correlated with the length of the disease. No real impact on the oral microbiota	NR
Rodrigues Pires et al., 2021	SLE: <i>n</i> = 25	SLE: 68% periodontitis stage III			Periodontitis seems to be less aggressive in patient receiving low doses of prednisone (< 10 mg/day). Immunosuppressants favorize attachment loss	Prednisone
Sirin et al., 2021	Rheumatic disease: <i>n</i> = 65	–	–	Correlation between RD and TM arthritis	Degeneration of the articulation	NSAIDs
Ahmed et al., 2023	SLE: <i>n</i> = 10			TMJ sound: 40% TMJ pain: 35% Mouth opening reduction: 30%	Significant correlation between SLEDAI and TMJ sound/mouth opening reduction	

Table 3 Tooth decay and salivary flow affection in SLE patients

Studies	Included patients	Saliva	Tooth decay and tooth loss due to decay	Findings	Treatment
Skopouli et al., 1991	SLE: <i>n</i> = 72	Xerostomia: 17% Perivascular lymphocytic infiltration: 24%	NR	NR	Concomitant Sjögren's syndrome may have effect in salivary gland in SLE
Ben-Aryeh et al., 1993	SLE: <i>n</i> = 22 C: <i>n</i> = 27	Flow: 0.25 ± 0.15 mL/min IgA: 10.45 ± 7.10 mg/100 mL IgM: 0.36 ± 0.39 mg/100 mL IgG: 1.68 ± 1.64 mg/100 mL	–	Significantly high level of IgA and IgM were detected in patient with SLE	Prednisone NSAIDS Cytotoxic drugs Antihypertensive drugs
Jensen et al., 1999	SLE: <i>n</i> = 20 C: <i>n</i> = 20	Xerostomia: 85% Dry mouth: 45% Flow: 0.24 (0.02–1.18) mL/min	–	High rate of xerostomia and sicca symptom were shown in patient with SLE	Prednisone Antimalarials Azathioprine Methotrexate
Meyer et al., 2000	SLE: <i>n</i> = 46	–	High rate loss (NR)	High rate of oral lesions due to immunodysregulation	Immunosuppressants
Fernandes et al., 2007	JSLE: <i>n</i> = 48 C: <i>n</i> = 48	–	DMFTI: 4.0 (0–14.0) (ns)	Higher incidence of inadequate oral hygiene	Chloroquine Hydroxychloroquine Immunosuppressants
Kobayashi et al., 2007	SLE + P: <i>n</i> = 46 SLE: <i>n</i> = 25 P: <i>n</i> = 58 C: <i>n</i> = 44	–	2.5–0.4 (ns) SLE: 1.3–0.4 tooth loss: SLE + P: (ns)	Increased risk prevalence of periodontitis (64.8%) in SLE patients	Corticosteroid Bisphosphonate therapy
Fernandes et al., 2010	SLE: <i>n</i> = 12 SS: <i>n</i> = 16	Xerostomia: SLE: 100% IgG deposit: 58% (SLE) Mild/moderate sialadenitis	–	Risk of xerostomia and mild/moderate sialadenitis have been detected in patients with SLE	NR
Xu et al., 2010	SS/SLE: <i>n</i> = 41 SLE: <i>n</i> = 214	Xerostomia	–	SLE has a distinctive serological and clinical features with SS	Corticosteroid Glucocorticoid Immunosuppressants
Leite et al., 2015	SLE: <i>n</i> = 48	Hyposalivation: 7.29%	–	Hyposalivation in SLE is associated with disease activity and age	Antihypertensive Anticonvulsant diuretic
Loyola Rodriguez et al., 2016	SLE: <i>n</i> = 60	Flow: 0.6 mL/min pH: 4.6	Frequency: 85% DMFT: 12.6 ± 5.7 IDCI: 9.8 ± 5.9	Increased risk of caries and high count of cariogenic bacteria have been detected in patients	NR
Menzies et al., 2018	SLE: <i>n</i> = 11 CCL: <i>n</i> = 11 DLE: <i>n</i> = 20	Dry mouth: 16%	–	In SLE, associated diseases such as Sjögren's syndrome may influence saliva	Oral prednisolone Steroid inhaler Antibiotic
Bologna et al., 2018	SLE: <i>n</i> = 13 DLE: <i>n</i> = 7 SCLE: <i>n</i> = 3	Xerostomia: 100% (SLE) Flow: 0.29 mL/min Hyposalivation: 13.05%	–	Different kinds of alteration from SS were shown in minor labial salivary gland in SLE	NR
Corrêa et al., 2018	SLE: <i>n</i> = 75 C: <i>n</i> = 78	Flow ≤ 0.3 mL/min (12%)	DMFTI: 13.65 (6.48%)	SLE has a negative impact on the oral health-related quality of life of patients with SLE	NR

Fig. 3 Flow diagram of literature search and inclusion

Limitations

The limitations of this systematic review are mainly due to the heterogeneity of the studies and of the population studied. Most of the studies did not always mention the disease activity, or if SLE was associated with other diseases, in particular Sjögren's syndrome. Moreover, the number of studies based on the impact of SLE on implant conditions is still scarce.

Conclusion

SLE is an autoimmune disease associated with a large spectrum of clinical manifestations, including oral involvement such as mucosal and periodontal lesions, as well as TMJ

disorders or xerostomia leading to the increase of carious lesions and tooth loss. Due to the localization of the lesions, dentists are in the first line for the detection and diagnosis of SLE and should address the patient to a specialist in order to initiate multidisciplinary care and avoid therapeutic wandering.

Data Availability Data are available from authors upon reasonable request.

Declarations

Conflict of Interest The authors declare no competing interests.

Human and Animal Rights and Informed Consent This article contains no studies with human or animal subjects performed by any of the authors.

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Papers of particular interest, published recently, have been highlighted as:

- Of importance
- Of major importance

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