Review

Dental implants in patients with oral mucosal diseases – a systematic review

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SUMMARY To reveal dental implants survival rates in patients with oral mucosal diseases: oral lichen planus (OLP), Sjögren's syndrome (SjS), epidermolysis bullosa (EB) and systemic sclerosis (SSc). A systematic literature search using PubMed/Medline and Embase databases, utilising MeSH and search term combinations identified publications on clinical use implant-prosthetic rehabilitation in patients with OLP, SjS, EB, SSc reporting on study design, number, gender and age of patients, follow-up period exceeding 12 months, implant survival rate, published in English between 1980 and May 2015. After a mean observation period (mOP) of 53·9 months (standard deviation [SD] ±18·3), 191 implants in 57 patients with OLP showed a survival rate (SR) of 95·3% (SD ±21·2). For 17 patients with SjS (121 implants, mOP 48·6 ± 28·7 months), 28 patients with EB (165 implants, mOP 38·3 ± 16·9 months) and five patients with SSc (38 implants, mOP 38·3 ± 16·9 months), the respective SR was 91·7 ± 5·97% (SjS), 98·5 ± 2·7% (EB) and 97·4 ± 4·8% (SSc). Heterogeneity of data structure and quality of reporting outcomes did not allow for further comparative data analysis. For implant-prosthetic rehabilitation of patients suffering from OLP, SjS, EB and SSc, no evidence-based treatment guidelines are presently available. However, no strict contraindication for the placement of implants seems to be justified in patients with OLP, SjS, EB nor SSc. Implant survival rates are comparable to those of patients without oral mucosal diseases. Treatment guidelines as for dental implantation in patients with healthy oral mucosa should be followed.

KEYWORDS: dental implants, implant-supported prosthesis, oral lichen planus, Sjögren's syndrome, epidermolysis bullosa, systemic sclerosis

Introduction

Oral rehabilitation with dental implants supporting fixed or removable prostheses has been shown to be reliable with impressive 5-year success rates ranging between 90% and 100% for implant-supported prostheses or survival rates for implants exceeding 95% in patients without any oral or systemic complications (1, 2). While some systemic diseases and oral mucosal disorders commonly have been regarded as contraindications or risk factors for the placement of implants due to possible affections of oral tissues and increasing their susceptibility to other diseases (3), the benefits of such treatment in these patients sometimes seem to outweigh the risks (4, 5). In recent years, the spectrum of indications for dental implants has been widened, and thus, a number of patients with oral mucosal disorders have been selected for dental

implantology, mainly patients with OLP, SjS, EB and SSc (5, 6). These patients suffer from chronic inflammation followed by burning mouth, erosions and ulcerations of the oral mucosa (OLP), extreme dryness of the oral mucosa (stomatitis sicca) and chronic oral candidiasis (SjS), bulla formation and widespread epitheliolysis with severe pain (EB) and induration of the oral and perioral soft tissue structures with microstomia (SSc). Due to all these symptoms, the quality of life of these patients is often poor (7–9). The wearing of full or partial dentures for patients with OLP, SjS, EB and SSc is hardly possible due to the fragility of the oral mucosa. Pressure and micromovements by removable dentures cause irritation, ulcerations and pain. In contrast, implant-supported or fixed prosthetic devices minimise trauma to the oral mucosa thus improving speaking, chewing and swallowing followed by marked improvement of quality of life (4, 6). A short introduction to clinical features of OLP, SjS, EB and SSc for the reader follows below.

Oral lichen planus (OLP) is one of the most common chronic inflammatory autoimmune diseases that involve the oral mucosa with an incidence of 1–2% in various populations (10, 11). With regard to epidemiology, the most valid paper on the prevalence of oral lichen planus was carried out by Axell *et al.* in 1987 (12): Among 20 333 Swedish people over the age of 15 years, oral lichen planus was found in 1·9%, 1·6% among men and 2·2% among women. The highest prevalences were found in the age groups from 65 to 74 and from 55 to 64 years (13). Dental treatment of patients with OLP includes removal as well as avoidance of factors irritating the mucosa (14, 15). OLP usually manifests in age groups 40–70 years. Women are more often affected compared to men (about 70: 30%) (16). OLP may manifest as asymptomatic or symptomatic. Patients with OLP complain about burning sensations and occasionally pain. In 33% of patients, gingival manifestations are diagnosed. An erythematous gingival OLP may in some patients – particularly in women – be observed as the only manifestation of OLP. Symptomatic OLP is characterised by desquamation, bleeding, pain, erosions and ulcerations. An ill-fitting mucosa-borne denture may in such cases inhibit mucosal healing even during OLP-specific management and therapy. In contrast, implant-supported overdentures reduce contact with the oral mucosa, stabilise dentures and reduce

friction between the base of dentures and oral mucosa. In the past, dental implants in patients with OLP were considered to be contraindicated because of possible higher risk of peri-implant inflammation and thus early loss of implants (4).

Presently, no treatment guidelines or recommendations exist concerning implant therapy in patients with muco-cutaneous autoimmune diseases. Reports on oral rehabilitation in these groups of patients are rare and often consist of single case reports only.

Sjögren's syndrome (SjS) is a chronic systemic autoimmune disease affecting the exocrine glands, particularly the salivary and lacrimal glands resulting in hyposialia. Patients with Sjögren's syndrome (SjS) suffer from stomatitis sicca due to inflammatory changes of salivary glands. Clinical signs and symptoms include xerostomia, burning sensations, pain and difficulties to swallow (16). Patients with SjS hardly accept conventional full dentures because of poor retention, pain, sores and ulcerations (17). To avoid these complications, rehabilitation with dental implants might be considered an alternative.

In a systematic review on the epidemiology of primary SjS, the overall prevalence rate was 61 cases per 100 000 inhabitants (i.e. 0·061%) (18). The female/male ratio in prevalence data was 10·7, and the overall age of SjS patients was 56·2 years. However, the study also demonstrated that prevalence rates of SjS vary widely around the world (18). Patients suffering from SjS reveal significantly higher mean numbers of decayed, missing or filled teeth, a higher missing tooth score as well as higher plaque-index, gingival index and papillary bleeding index, but a significantly lower salivary pH, compared to non-SjS patients (19). Apart from that, a high proportion of denture-wearing patients suffering from xerostomia generally revealed increased mean-modified debris scores (20).

Epidermolysis bullosa (EB) is a rare, inherited, recessive disease of the skin and mucosal membranes, characterised by trauma-induced bullae, pseudosyndactyly of hands and feet and scar formation. Three variants are known: simplex, junctional and dystrophic types. Splitting occurs either intra-dermally/epidermolytic, epidermal–dermal/junctional or intra-lamina lucids, subdermal or sublamina densa. Involvement of oral- and gastrointestinal mucosa causes problems in swallowing and oesophageal stenosis with reduced food intake, loss of blood and proteins, anaemia and impaired growth. Oral lesions

include recurrent bulla formation, scar formation, microstomia, ankyloglossum, shallow vestibular sulci, severe periodontitis, resorption of alveolar bone, atrophy of maxilla and predisposition for OSCC (21, 22). Oral hygiene measures or dental treatment may result in severe bulla formation and ulcerations (21, 23). The most reliable figures on prevalence of EB are derived from the National Epidermolysis Bullosa Registry, which collected cross-sectional and longitudinal data on about 3300 patients in the United States from 1986 through 2002 (24). Over a 5-year period (1986 through 1990), the prevalence of EB was estimated to be approximately 8 per million live births. Data from the Australasian Epidermolysis Bullosa Registry provided a prevalence estimate of 1 case per 100 000 live births (25). Prevalence rates ranging from 1·5 to 3·2 cases per 100 000 have been estimated in the United Kingdom (26). Oral conditions include – among others – repeated blistering and scar tissue formation even following dental care or toothbrushing, limited opening of the mouth, elimination of buccal sulci, ankyloglossia, periodontal disease and alveolar bone resorption, all interfering with conventional restorative or prosthetic treatment (27–29). Due to rarity of EB, no information based on high evidence levels is available as to implant treatment of edentulous patients. However, some clinicians considered this as therapeutic alternative.

Systemic sclerosis (SSc) is an autoimmune multisystem rheumatic disorder that affects the connective tissue. SSc is characterised as an inflammatory, vascular, sclerotic disease of the skin involving organs such as lung, heart and gastrointestinal tract. Oro-facial clinical findings are mask-such as face, thin vermilion border, microstomia, radial perioral furrows, sclerosis of tongue-tie and induration of tongue (30, 31). Dental treatment in these patients is extremely difficult because of microstomia (32, 33). The prevalence estimate of SSc in the adult population is 1 up to 15 cases per 100 000 inhabitants (0·001–0·015%). Recent population studies suggest that SSc occurs more frequently in the United States than in continental Europe, the United Kingdom and in some areas in Asia. Evidence from multiple sources indicates that SSc does not occur randomly in the population; there are particular groups who are at greater risk. Sex- and race-specific prevalence estimates were significantly higher for women than for men, and for blacks than for whites but the factors that are responsible for this

are not apparent (34). Dental treatment options as well as use of any removable denture are limited by microstomia and rigidity of the tongue. Oral hygiene ability is sometimes limited by manual skill due to malformations (35).

Although the prevalences of OLP, SjS, EB and SSc seem to be low, symptoms' onset of these diseases mostly – except patients with EB – reveal in adult patients over 50 years of age, often in need for prosthetic treatment. On the other hand, conventional prosthetic treatment options and improvement of patients' oral conditions following therapy might be limited due to direct or indirect effects of the underlying disease.

The purpose of this review was to reveal periods of dental implants survival as well as survival rates in patients with oral mucosal diseases such as oral lichen planus (OLP), Sjögren's syndrome (SjS), epidermolysis bullosa (EB) and systemic sclerosis (SSc), to reveal the present state of research and to identify the need for further research if necessary.

Material and methods

A systematic literature search was performed using electronic databases (Medline/PubMed; Embase). Search strategy focused on combinations of MeSH terms and a variety of search term combinations and included English language articles on case reports, case series, clinical studies and review articles describing the outcome of dental implant treatment in patients with oral mucosal diseases (OLP, SjS, EB, SSc) according to PICO format. The population comprised patients suffering from OLP, SjS, EB or SSc, undergoing implant-prosthetic treatment (intervention). Reported implant survival rates were considered as outcomes. Publications were included, if a structured abstract was available, and if the study design, number of patients, gender and age, clinical variant of OLP, SjS, EB and SSc, implant number, follow-up period exceeding 12 months and dental implant survival rate were indicated. An initial search for publications on survival rates of osseointegrated implants (search term combinations: (osseointegrated[All Fields] AND implant[All Fields]) AND ("survival"[All Fields] OR "survival"[MeSH Terms]) AND (("1975/01/01"[PDAT]:   "1990/12/31"[PDAT])   AND   "humans"[MeSH Terms]) without consideration of any supposed risk factors revealed a few publications,

which appeared in 1980 and following years (36–39). Therefore, search interval reached from 1980 to May 2015.

Search term combinations concerning OLP were ("dental implants"[MeSH Terms] OR ("dental"[All Fields] AND "implants"[All Fields]) OR "dental implants"[All Fields] OR ("dental"[All Fields] AND "implant"[All Fields]) OR "dental implant"[All Fields]) AND ("lichen planus, oral"[MeSH Terms] OR ("lichen"[All Fields] AND "planus"[All Fields] AND "oral"[All Fields]) OR "oral lichen planus"[All Fields] OR ("oral"[All Fields] AND "lichen"[All Fields] AND "planus"[All Fields])).

For SjS, the following search term combinations were used: ("dental implants"[MeSH Terms] OR ("dental"[All Fields] AND "implants"[All Fields]) OR "dental implants"[All Fields] OR ("dental"[All Fields] AND "implant"[All Fields]) OR "dental implant"[All Fields]) AND sjogren[All Fields]) and ("dental implants"[MeSH Terms] OR ("dental"[All Fields] AND "implants"[All Fields]) OR "dental implants"[All Fields] OR ("dental"[All Fields] AND "implant"[All Fields]) OR "dental implant"[All Fields]) AND ("sjogren's syndrome"[MeSH Terms] OR ("sjogren's"[All Fields] AND "syndrome"[All Fields]) OR "sjogren's syndrome"[All Fields] OR ("sjogren"[All Fields] AND "syndrome"[All Fields]) OR "sjogren syndrome"[All Fields]).

Search term combinations for EB were ("dental implants"[MeSH Terms] OR ("dental"[All Fields] AND "implants"[All Fields]) OR "dental implants"[All Fields] OR ("dental"[All Fields] AND "implant"[All Fields]) OR "dental implant"[All Fields]) AND ("epidermolysis bullosa"[MeSH Terms] OR ("epidermolysis"[All Fields] AND "bullosa"[All Fields]) OR "epidermolysis bullosa"[All Fields]).

For SSc, the search term combinations were ("dental implants"[MeSH Terms] OR ("dental"[All Fields] AND "implants"[All Fields]) OR "dental implants"[All Fields] OR ("dental"[All Fields] AND "implant"[All Fields]) OR "dental implant"[All Fields]) AND ("scleroderma, systemic"[MeSH Terms] OR ("scleroderma"[All Fields] AND "systemic"[All Fields]) OR "systemic scleroderma"[All Fields] OR "scleroderma"[All Fields] OR "scleroderma, localised"[MeSH Terms] OR ("scleroderma"[All Fields] AND "localised"[All Fields]) OR "localised scleroderma"[All Fields]) as well as ("dental implants"[MeSH Terms] OR ("dental"[All Fields] AND "implants"[All Fields]) OR "dental implants"[All Fields] OR ("dental"[All Fields] AND "implant"[All Fields]) OR "dental implant"[All Fields]) AND ("sclerosis"[MeSH Terms] OR "sclerosis"[All Fields]).

Two reviewers (P.A.R. and F.P.S.) independently evaluated the abstracts considering formal inclusion criteria. Following screening, the abstracts reaching full consent between the reviewers, publications were further selected for inclusion due to content matching the search purposes.

Calculations of weighed mean values and standard deviations were performed utilising SPSS 19.0 software* .

Results

Oral lichen planus

The literature search yielded 20 publications considering OLP, of which nine met the inclusion criteria (see Table 1). Most studies (5, 40–44) were single case reports or case series. Three controlled studies – one prospective (45) the others retrospective (46, 47) – were found.

A total of 57 patients were reported in nine studies (44 women and 13 men of a weighed mean age of 60·8 years; standard deviation [SD] ±7·0). Thirty-eight patients were diagnosed with the erosive variant of OLP, 17 showed reticular type; for two patients, no specification of OLP was given.

In only three publications, duration of OLP (weighed mean 13·2 years; SD ±5·0) and clinical signs and symptoms were mentioned (41–43).

In Table 2, implant systems and type of dentures utilised, implant survival rates and duration of follow-up period are shown. In nine studies, results obtained of a total of 191 implants have been reported in patients with OLP. In only five of nine studies, implant types were stated. Two implants had a smooth 'machined' surface, 11 implants had a micro-rough surface and 57 implants had a micro-rough and anodically oxidised surface. A total of 121 implants were not further characterised. The mean period of observation was 53·9 months (SD ±18·3), and the weighed mean implant survival rate was 95·3% (SD ±21·2).

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Table 1. Demographic and clinical data of patients with OLP (n. a. not announced)

Authors	Study design	Number of patients with OLP and dental implants	Gender	Age (years)	OLP variant	OLP duration (years)
Esposito *et al.* (40)	Case report	1	Female	69	Erosive	n. a.
Esposito *et al.* (41)	Case report	2	Female	72/78	Erosive	16
Öczakir *et al.* (5)	Case report	1	Female	74	n. a.	n. a.
Reichart (42)	Case report	3	Female	63/68/79	1 erosive 2 reticular	10/12/20
Czerninski *et al.* (43)	Case report	1	Female	52	n. a.	8
Gallego *et al.* (44)	Case report	1	Female	81	Reticular	n. a.
Hernandez *et al.* (45)	Prospective controlled	18	14 female 4 male	53·5 (mean)	Erosive	n. a.
Czerninski *et al.* (46)	Retrospective controlled	14	11 female 3 male	59·5 (mean)	11 erosive 3 reticular	n. a.
López-Jornet *et al.* (47)	Retrospective controlled	16	OLP 10 female 6 male	64·5	5 erosive 11 reticular	n. a.
Total	6 case reports 1 prospective, 2 retrospective controlled studies	57	44 female 13 male	60·8 SD ±7·0	38 erosive 17 reticular 2 n. a.	13·2 SD ±5·0

Sjögren's Syndrome

The literature search revealed 15 publications, of which six (5, 17, 48–51) met the inclusion criteria, reporting on patients with SjS and dental implants with a follow-up of more than 18 months (mean 48·6 months; SD ±28·7), revealing a weighed mean implant survival rate of 91·7% (SD ±5·97). In Table 3, clinical data are summarised. Of 80 implants with a machined surface, inserted in 11 patients, the weighed percentage implant survival was 87·5% (SD ±0·71) within a weighed mean observational period of 38·2 months (SD ±14·1), whereas for 35 implants with a micro-rough surface, inserted in seven patients, no implant loss was reported within a weighed mean observational period of 53·1 months (SD ±13·8).

Epidermolysis bullosa

The literature search revealed 13 publications, of which ten (52–61) were clinical case series or reports of individual patients with EB and dental implants. In 28 patients with 165 implants, implant survival rates ranging between 87·5 and 100% (mean observation period 38·3 months; SD ±16·9, range 15–108 months; weighed mean implant survival rate 98·5%; SD ±2·7) (52–61) were published. Table 4 shows clinical details.

Systemic sclerosis

Literature search revealed 17 publications, of which five were eligible for further review, comprising 38 implants inserted in five patients suffering from SSc (5, 50, 62–64). Following a mean observational period of 38·3 months; SD ±13·4, a weighed mean implant survival rate of 97·4%; SD ±4·8, was calculated. Demographic and clinical details are listed in Table 5.

Discussion

Oral lichen planus

Of all oral mucosal disorders reviewed, most cases have been report in patients with OLP. In 2012, the first controlled prospective study was published including 18 patients with OLP (45). Insertion of implants was avoided during erosive phases of OLP. After implantation and follow-up, erosions and ulcerations were treated with clobetasoldipropionate (0·05%). To avoid remissions, patients were advised to use clobetasoldipropionate thrice daily. The authors concluded that in patients with dental implants and OLP peri-implantitis and other complications such as impaired wound healing or pain are as uncommon as in patients without oral mucosal diseases.

Table 2. Number of implants, implant systems/characteristics, type of prostheses, implant survival rate (%), duration of follow-up (months) (n. a. not announced)

Authors	N implants	Implant systems/characteristics	Prostheses	Survival rate	(Mean) follow-up (months)
Esposito et al. (40)	2	Brånemark system, machined surface	Overdenture	0%	32/60
Esposito et al. (41)	4	Straumann TL, micro-rough surface	Overdenture	100%	21
Öczakir et al. (5)	4	Straumann TL micro-rough surface	Fixed complete denture	100%	72
Reichart (42)	10	HaTi (n = 2), Camlog (n = 1), micro-rough surface ZL-Duraplant (n = 1), micro-rough and anodically oxidised surface, n. a. (n = 6)	Fixed partial prostheses	100%	156 (n = 4) 36 (n = 2) n. a. (n = 4)
Czerninski et al. (43)	3	n. a.	Fixed partial prosthesis	0%	36
Gallego et al. (44)	2	n. a.	Overdenture	0%	36
Hernandez et al. (45)	56	Nobel Biocare, micro-rough and anodically oxidised surface	Fixed partial prostheses	100%	53·5
Czerninski et al. (46)	54	n. a.	n. a.	100%	63
López-Jornet et al. (47)	56	n. a.	3 overdentures 13 fixed partial prostheses	Implant survival rate: n. a. peri-implant mucositis: 10 peri-implantitis: 14 bone loss: 10 mobility: 2	42
Total	191			0–100% weighed mean 95·3% SD ±21·2	Weighed mean 53·8 SD ±18·3

Table 3. Demographic and clinical data of patients with SjS; number of implants, implant systems/characteristics, implant survival rate (%), duration of follow-up (months) (n. a. not announced)

Authors	Number of patients	Age	Gender	Number of implants	Implant systems and characteristics	Implant survival rate	Follow-up (months)
Payne et al. (48)	3	38–40	Female	26	Brånemark, machined surface	88·5%	>18
Isidor et al. (17)	8	53–70	Female	54	Brånemark, machined surface	87%	48
Binon et al. (49)	1	67	Male	6	Brånemark, not further specified	100%	156
Öczakir et al. (5)	2	63/64	Female	12	Straumann TL micro-rough surface	100%	24/60
Weinländer et al. (50)	4	n. a.	n. a.	21	Camlog, micro-rough surface	100%	57·7
de Mendonça Invernici et al. (51)	1	58	Female	2	Systhex, micro-rough surface	100%	72
Total	17			121		87–100% weighed mean 91·7% SD ±5·97	>18–156 weighed mean 48·6 SD ±28·7

A retrospective study of 14 patients with OLP and 54 implants was published in 2013 (46). Comparison of clinical manifestations and symptoms in patients with OLP with and without implant rehabilitation during an observations period of 12–24 months revealed no statistical difference of both groups.

Table 4. Number and age of patients with EB, number of implants, implant systems/characteristics, implant survival rate (%), duration of follow-up (months)

Authors	Number of patients	Age	Number of implants	Type of implants and prosthesis	Implant survival rate	Follow-up (months)
Peñarrocha-Diago et al. (52)	4	26–35 mean 30·2	15	Straumann TL, micro-rough surface, overdentures	100%	15–58 mean 30·8
Peñarrocha et al. (53)	3	29–49 mean 38·7	27	Straumann TL, micro-rough surface, overdentures	97·7%	15–60 mean 36
Peñarrocha et al. (54)	6	23–44 mean 33·8	38	Straumann TL, Centerpulse, micro-rough surface, 3 patients: overdentures, 3 patients: fixed prostheses	97·9%	15–108 mean 66
Lee et al. (55)	1	29	8	Straumann TL, micro-rough surface fixed prostheses	100% prostheses framework fracture	>13
Larrazabal-Moron et al. (56)	1	52	2	Defcon, micro-rough surface fixed partial prosthesis	100%	18
Oliveira et al. (57)	1	13	2	Pilar, mirco-rough surface, fixed single crowns	100%	48
Müller et al. (58)	1	n. a. (>20)	10	Intra-mobile cylindric implant, TPS-coated surface bar-retained removable prostheses	100%	≥48
Peñarrocha-Oltra et al. (59)	6	24–55 mean 37·3	32	Defcon impladent, Straumann TS, micro-rough surface fixed complete prostheses	100%	15–48 mean 27
Peñarrocha-Oltra et al. (60)	4	27–55 mean 44·2	23	Defcon impladent, Straumann TS, micro-rough surface fixed partial or complete prostheses	100%	15–48 mean 27·8
Agustín-Panadero et al. (61)	1	19	8	Defcon impladent, micro-rough surfacefixed partial prostheses	87·5% early implant loss prior to prosthetic treatment	18
Total	28		165		87·5–100% weighed mean 98·5% SD ±2·7	>13–108 weighed mean 38·3 SD ±16·9

According to these authors, implantation in patients with OLP is not contraindicated as survival rates are comparable to those of edentulous patients.

Although the number of patients with OLP treated with dental implants is still small, it may be concluded that loss of implants in some cases is not due to OLP but to, for example parafunctions, poor bone quality or transformation of OLP to OSCC. Therefore, a thorough risk assessment prior to implant therapy planning and decision-making should consider advantages versus disadvantages or possible complications as well as treatment costs (65). More studies are needed with longer follow-up and high level of evidence to show that implant survival and success rates in patients with OLP are comparable to those with healthy oral mucosa. All authors (42, 45, 46) agree that implantation should only be carried out in phases of remission of OLP. In addition, meticulous oral hygiene and regular and frequent follow-up appointments (66) are important for long survival of implants in patients with OLP, to rule out inflammatory tissue response (peri-implant mucositis and peri-implantitis) as well as to early detect malignant transformation into OSCC also in the vicinity of dental implants (67, 68). In the

Table 5. Number and age of patients with SSc, number of implants, implant systems/characteristics, implant survival rate (%), duration of follow-up (months) (n. a. not announced)

Authors	Number of patients	Age	Number of implants	Type of implants and prosthesis	Implant survival rate	Follow-up (months)
Jensen et al. (62)	1	39	9	n. a. fixed complete prosthesis	88·9% (1 implant failure, 2 implants were not prosthetically used)	24
Raviv et al. (63)	1	65	3	Brånemark, machined surface bar-retained overdenture	100%	>24
Öczakier et al. (5)	1	64	8	Straumann TL micro-rough surface overdenture (maxilla) fixed partial prostheses (mandible)	100%	60
Weinländer et al. (50)	1	n. a.	6	Camlog, micro-rough surface complete fixed prosthesis	100%	46
Zigdon et al. (64)	1	45	12	MIS, micro-rough surface complete fixed-detachable prostheses (mandible and maxilla)	100%	>36
Total	5		38		88·9–100% weighed mean 97·4% SD ±4·8	24–60 weighed mean 38·3 SD ±13·4

year 2000, Esposito et al. (40) published a case report with loss of implants, where besides OLP parafunctions and poor quality bone were diagnosed. Another case report on two patients with successful outcomes was published in 2003 (41). Two implants had been inserted in the area of the lower canines, the overdentures were retained by o-ring attachments. Patients were positive concerning function and aesthetics as well as long-term osseointegration and less development of erosive lesions. Öczakir et al. (5) described one patient with a complete mandibular prosthesis on four implants. During follow-up of 6 years, no complications were observed. Reichart (42) reported on three patients with gingival OLP (follow-up 13 years) receiving implant-prosthetic rehabilitation without complications.

In two studies of patients with OLP (43, 44) peri-implant oral squamous cell carcinoma (OSCC) developed; partial mandibular resection included the implants. The authors stressed the fact that peri-implantitis may resemble OSCC. Early diagnosis and follow-up of at least 3 months is mandatory in such cases.

Sjögren's syndrome

Patients with SjS suffer from several sicca symptoms including hyposalivation. To overcome mucosal burning sensation, pain or ulcerations while wearing mucosal-borne dentures, implant-prosthetic treatment might be considered. On the other hand, hyposalivation should not only be considered a risk factor for higher score of decayed, missing, filled teeth and more severe periodontal conditions (19), but also implant treatment might be suspected under higher risk of peri-implant mucosal diseases, including peri-implantitis. However, the few studies on implant therapy in patients with SjS, identified within this systematic review, report on relatively high implant survival rates. Payne et al.(48) inserted 26 machined surface threaded implants in three patients (13 implants were inserted into the maxilla) with a success rate of 88·4%. Isidor et al. (17) reported a success rate of 84% in eight female patients with cover denture and follow-up of 4 years. Eighteen implants were inserted into the maxilla, of which five were lost. Binon et al. published a case report on a 67-year-old male patient with SjS and cover denture with follow-up of 13 years. No complications occurred over the period of observation. The patient reported that he felt improvement in function and aesthetics (49). Öczakir et al. (5) published 100% implant survival for two patients suffering from SjS (one suffered from systemic sclerosis additionally), who received seven implants in the maxilla and five implants in the mandible. Furthermore, Weinländer

et al. published a case series of 22 patients suffering from rheumatic disorders, among them four with SjS, who received 21 micro-rough surfaced implants (13 were placed into the maxilla), wearing two fixed partial prostheses, one overdenture and one complete denture, respectively. Implant survival rate was 100% after a weighed mean follow-up duration of 57·7 months (50). de Mendonça Invernici *et al.* (51) reported on a successful treatment of a patient with SjS, receiving two implants in the posterior maxilla to restore two missing adjacent teeth with two connected implant-retained crowns.

Although there exists evidence that biofilm formation is enhanced on micro-rough implant surfaces compared to smooth or machined implant surfaces when exposed to the oral environment or in experimentally induced peri-implantitis (69–71), in a systematic review recently published peri-implant mucositis did not seem to be a condition related to the implant system or surface topography of the implant, but more to the amount of biofilm accumulation and patient susceptibility (72). Enhanced susceptibility to biofilm-related peri-implant mucositis and related diseases of the peri-implant tissues due to hyposalivation in patients with SjS should be taken into account while therapy planning and patient information as well. Nevertheless, within the limits of this investigation, the implant surface roughness did not seem to have an impact on the implant survival rate. However, in view of the very limited number of single case reports analysed here, It is certainly still too early to give recommendations for dental implantations in patients with SjS.

Nevertheless, regular recall for control, maintenance and – if necessary – remotivation for oral hygiene has to be provided due to higher susceptibility for periodontal diseases (19) as well as for – supposed – peri-implant mucosal diseases because of hyposalivation.

In patients with secondary SjS and advanced rheumatoid arthritis, evaluation of manual abilities is important. After accomplished implant-prosthetic treatment, these patients must be able to perform adequate oral hygiene. Apart from that, possible necessity of anti-inflammatory as well as immunosuppressive drug administration should be taken into account, which might interfere with peri-implant mucosal integrity and might enhance susceptibility for peri-implant mucosal inflammation.

Epidermolysis bullosa

Involvement of oral- and gastrointestinal mucosa cause problems in swallowing and oesophageal stenosis with reduced food intake, loss of blood and proteins, anaemia and impaired growth. Oral manifestations include recurrent bulla formation, scar formation, microstomia, ankyloglossum, shallow vestibular sulci, severe periodontitis, resorption of alveolar bone, atrophy of maxilla and pre-disposition for OSCC. Oral hygiene measures or dental treatment may result in severe bulla formation and ulcerations. Apart from that, cover-dentures may cause ulcerations in areas of friction in some patients (52). In 18 of 28 patients with EB reported, neither peri-implantitis nor bulla formation adjacent to the implants was observed. Quality of life in patients with EB and dental implants improved. Peñarrocha *et al.* (54) stated that satisfaction of patients with fixed prosthetic rehabilitation and those with implant-supported cover-dentures was slightly higher in the former group (fixed prosthetic rehabilitation).

According to the present few studies of patients with EB and dental implants, no contraindication of implants seems justified. In contrast, quality of life seems to largely improve.

Systemic sclerosis

Very few reports on treatment with dental implants in patients with SSc have been published (5, 50, 62–64), of which those listed in Table 5 provided with follow-up data. Until the year 2011, implant survival data exceeding a follow-up period of 24 months (mean 38 months) of five patients who had received 38 dental implants have been reported. Although the survival rates seem to be promising, the level of evidence in this group of patients was considerably low (level 4; case series including poor quality cohort and case–control studies), and clinical recommendations cannot be given. Implant-prosthetic treatment in patients with SSc is challenging and decision-making should include an individual risk–benefit evaluation involving interdisciplinary consultation.

Limited mouth opening and enhanced susceptibility for caries and periodontal disease due to hyposalivation, microstomia, ankyloglossia but also minor manual skills due to the SSc are interfering with oral hygiene ability, access for oral hygiene as well as treatment steps (32,73–75).

Summary

The present review was focused on the outcome of dental implants in patients with oral mucosal disorders including oral lichen planus, Sjögren's Syndrome, epidermolysis bullosa and systemic sclerosis. Implant survival rates seem comparable to those of healthy patients. Nevertheless, further clinical investigations by comparative studies including control groups with healthy patients are necessary to allow for preliminary conclusions. Due to the small number of publications – including single case reports – in all these disorders, no evidence-based treatment guidelines are presently available. However, according to this systematic literature review, no strict contraindication for the placement of implants combined with an overdenture or implant-supported prosthesis seems to be justified, neither in cases of OLP, SjS, EB nor SSc. In contrast, periods of implant survival seem to be comparable to those of patients without oral mucosal diseases. In principle, treatment guidelines as for dental implantation in patients with healthy oral mucosa should be followed. Whether particular modifications for the individual disorder of the oral mucosa will in future be necessary can only be stated after more case series of cases with OLP, SjS, EB and SSc have been published. Doubtlessly, meticulous follow-up in these cases is *conditio sine qua non*.

Conflict of interest

No conflict of interest declared.

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