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Periodontal status of adults with systemic sclerosis: case-control study

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Periodontal status of adults with systemic sclerosis: case-control study

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Running title: Systemic sclerosis: periodontal status

Key findings:

Hong Kong Chinese adults with systemic sclerosis seemed to exhibit higher levels of periodontal inflammation and wider radiographic periodontal ligament spaces than age- and sex- matched controls despite experiencing similar level of inadequate plaque control when compared to unaffected individuals.

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ABSTRACT

Background: Systemic sclerosis (SSc) is a systemic autoimmune disease that affects connective tissue in the skin, blood vessels and major organs of the body. This project aimed to compare the periodontal status of dentate Hong Kong Chinese with and without SSc.

Methods: Thirty-six non-smoking adults with SSc (35 women; 50.6 ± 11.7 years, free from Sjogren's syndrome) attending a teaching hospital were age- and sex-matched to systemically healthy controls attending a dental hospital. Both groups had similar demographic characteristics but a lower proportion of SSc patients were working or studying ($p < 0.05$). Twenty-three (32.0%) of all participants were regular dental attendees. Orthopantomogram rediograph were taken. Participants were surveyed and periodontally examined.

Results: Both groups had a similar number of erupted teeth, proportion of sites with detectable plaque, and mean full-mouth probing attachment level, whereas controls had less bleeding on probing (BOP(%), 49.3 ± 22.6 *vs.* 78.4 ± 19.6; $p < 0.001$) and a shallower mean full-mouth probing pocket depth (PPD(mm), 1.92 ± 0.44 *vs.* 2.52 ± 0.58; $p < 0.001$). Radiographically, SSc patients had wider periodontal ligament spaces. (PDL (mm), 0.36 ± 0.06 *vs.* 0.33 ± 0.03, $p < 0.01$)

Conclusion: Hong Kong Chinese SSc adults seem to exhibit higher levels of periodontal inflammation and wider radiographic PDL spaces than age- and sex- matched controls. Future studies are warranted to further investigate any associations between these

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periodontal features and SSc.

KEY WORDS

Case-control study; periodontal diseases; scleroderma, systemic

Systemic sclerosis (SSc), or scleroderma, is a systemic autoimmune disease that affects connective tissue in the skin and underlying tissues, including blood vessels and major organs of the body. The pathology of SSc is likely to involve the activation of immune cells and subsequent fibrotic changes in the skin, internal organs, and small blood vessels.[1] Two types of SSc, limited and diffuse, have been described. Patients with limited SSc may present with calcinosis, Raynaud's phenomenon, esophageal dysmotility, sclerodactyly, and telangiectasia, together known as CREST. Patients with diffuse SSc develop skin thickening over all parts of the body, including the trunk, and are more likely than patients with limited SSc to develop severe organ problems. Only a short interval elapses between the onset of Raynaud's phenomenon and significant organ involvement (Walker et al. 2007).[2]

The reported prevalence of SSc ranges from 4 to 286 per million and the incidence rate varies from 0.6 to 122 per million per year.[3] The peak age of onset of SSc is between 30 and 50 years.[4] The wide ranges of these figures may reflect differences in disease definition, susceptibility to SSc on a genetic basis, or exposure to putative environmental triggers. Nevertheless, a high female to male ratio is a consistent finding. SSc may also coexist with other autoimmune conditions. For example, simultaneous presentation of systemic lupus erythematosus or polymyositis, or both, with SSc is termed "mixed connective tissue disorder".[5] In addition, up to 14% of SSc patients may have secondary

Sjögren's syndrome, particularly those with limited cutaneous SSc.[6]

There is currently no effective treatment to control the overproduction of fibrotic tissue in individuals with SSc. Management approaches mainly focus on relieving symptoms and limiting organ damage.[7] Anti-inflammatory drugs and immunosuppressants are often used to treat underlying rheumatological problems.[8] Vasodilators, calcium channel blockers, and angiotensin converting enzyme inhibitors can control symptoms of visceral complications and Raynaud's phenomenon,[6] while analgesics can control joint and muscle pain.[7] Stretching exercises under the instruction of physiotherapists and occupational therapists can maintain joint mobility.[7]

A common oral complication in SSc is constriction of the oral orifice.[6] Progressively limited mouth opening eventually leads to so-called "fish mouth". SSc is reported to be associated with an increased risk of dental caries, oral ulcers, and fungal infections,[9] as well as loss of tongue mobility with fibrotic indurations,[10] dry mouth (salivary hypofunction), and telangiectasia.[11] Facial bones may sometimes become eroded, as has been reported in individual studies and case reports showing osseous resorption at the mandibular angles, coronoid processes, and zygomatic arches.[12, 13]

Furthermore, SSc is associated with a high prevalence of periodontal disease.[9] Supporting evidence includes radiological findings such as widening of periodontal ligament spaces,[13-16] abnormalities in periodontal microcirculation observable using

periodontal capillaroscopy,[17] and loss of gingival attachment and prominent buccal

mucosal crenations.[10] However, a comprehensive report on the exact clinical periodontal

status of SSc patients is lacking. The aim of this cross-sectional case-control study was

therefore to compare the periodontal conditions of dentate adults with SSc and those of

age- and sex-matched non-SSc controls.

MATERIALS & METHODS

Participants

This convenience sample was drawn from 77 Chinese SSc patients (73 women, 4 men),

free from Sjogren's syndrome, attending the Rheumatology Clinic of the Department of

Medicine during 2008, at Queen Mary Hospital, a medical teaching hospital of The

University of Hong Kong, serving approximately 40% (0.6 million) of the population in

western Hong Kong Island. Twenty-one patients could not participate in this study because

they were either hospitalized or institutionalized. Of the 56 ambulatory SSc patients, 43

indicated their availability but 2 of them were edentulous while one was current smoker.

These three cases were therefore excluded. At the end of the clinical examination period, a

total of 36 dentate SSc patients (35 women and 1 man) were recruited, four did not attend

the dental examination arranged. Their age ranged from 29 to 76 years (mean 50.6 ± 11.7

years); and 25 had limited SSc and 11 had diffuse SSc. In addition, 14 (38.9%) were

receiving prednisolone, 6 (16.7%) azathioprine, 9 (25.0%) hydroxychloroquine, 11 (30.6%)

penicillamine, and 7 (19.4%) colchicines. Overall, the patients had had SSc for 12.3 years

(SD, 9.8 years; range 1 - 37 years). None of the controls had any systemic diseases or were

currently taking any drugs.

All eligible patients were invited by telephone to participate in this study, given the

opportunity to ask questions and receive clarification about the project, and invited to

attend an oral examination at the Prince Philip Dental Hospital (PPDH), the dental teaching

hospital of the Faculty of Dentistry, the University of Hong Kong. Age- and sex-matched

dentate, non-SSc controls who were systemically healthy were drawn prospectively from

the newly admitted pool of Chinese patients at the Reception and Primary Care Clinic of

the PPDH over 3 months after the recruitment of SSc patients had ended. All control

subjects should be non-smoker, without any prior history of autoimmune condition or

systemic disease and were under no concurrent medication.

Diagnosis of SSc

SSc was classified as limited or diffuse depending on the extent of skin involvement

according to LeRoy and co-workers.[18] Patients who had concurrent autoimmune

conditions such as systemic lupus erythematosus, polymyositis, and Sjogren's syndrome

were excluded from study. Disease duration was measured from the first onset of

manifestations apart from Raynaud's phenomenon.

Ethics

The ethical principles defined by the World Medical Association Declaration of Helsinki

were followed in this study. The Institutional Review Board of The University of Hong

Kong approved the study (UW 08-305). Written informed consent was obtained from each

participant before study admission.

Examination

On the day of the oral examination, SSc and control participants completed a questionnaire

regarding demographic characteristics, medical history, dental attendance, and oral hygiene

habits. The questionnaire was checked for completeness and content and any queries were

clarified before the examination. The medical status of the SSc patients was confirmed

from Queen Mary Hospital Rheumatology Clinic patient records. No attempt was made to

mask the patient group from the examiner because the physical features of SSc are easily

recognizable.

The oral examination was conducted at the PPDH Periodontology Clinic by WKL.

The number of erupted teeth was recorded, and a periodontal examination was performed

on six sites of each standing tooth (mesio-buccal, mid-buccal, disto-buccal, mesio-lingual,

mid-lingual, disto-lingual) using a manual probe.[19] The percentage of sites with detectable

plaque (Pl%) and with bleeding on probing (BOP%), and the probing pocket depth (PPD)

and probing attachment level (PAL) were recorded.   The periodontal ligament (PDL)

widths around selected teeth in orthopantomogram[**] were studied as described by

Alexandridis and White,[16] except measurements were done using digitized image and

computer software.   The selected teeth were a maxillary central incisor, a mandibular

lateral incisor, a mandibular canine, a mandibular first premolar, a maxillary second

premolar, a maxillary first molar, and a mandibular second molar. The PDL widths were

measured at one third and two thirds of the distance between the cemento-enamel junction

and the apex of each tooth as located by a Schei ruler, both on the mesial and on the distal

surface of each selected tooth.

The radiographs were scanned and digitized at a resolution of 1000 dpi[††]. An image

processing program[‡‡] was used to measure the width of the PDL space (in mm). Before

each measurement, the system was calibrated with an optical meter (396 pixels/mm). The

measurements were taken by one author (KWSY) who was trained in the measurement

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[**] Kodax Lanex regular extra-oral image screen plus panelisp films, taken with a Gendex
Orthoralix SD Ceph machine, 70-72 kV, 9-10 mA, 10-12 seconds exposure, 1.23×
magnification.
[††] Perfection V700 Photo scanner with Dual Lens™ System; Epson, Suwa, Nagano, Japan.
[‡‡] ImageJ, National Institutes of Health, Bethesda, Maryland, US.

procedures, and was unaware of the patient grouping. Two independent measurements at

each position were made at least a week apart and averaged.

Statistical Analysis

Data were analyzed using the statistical software package SPSS (16.02), and were initially

tested for normality with the Kolmogorov-Smirnov test. The paired *t*-test was used to

compare dental, periodontal, and radiographic data between SSc and control groups. Chi-

square test was used to analyze categorical data among SSc and control groups. A

predetermined chi-square probability of 0.05 or less, that is alpha level of significance

(0.05), was set for rejecting the null hypothesis.

RESULTS

Although a lower proportion of SSc patients than of controls were working or studying,

other demographic characteristics, dental attendance, and oral hygiene habits were

generally similar (Table 1). Similar proportions of the SSc patients and controls (27.8%

and 36.1%, respectively) had made their last dental visit within the previous year. The

majority of both groups reported brushing their teeth twice daily.

There were no significant differences between control and SSc groups in the number

of teeth remaining, Pl%, percentage of sites with a PPD of 6 mm or greater, and mean full-mouth PAL. However, SSc patients had a significantly higher BOP%, mean full-mouth PPD, and percentage of sites with a PPD of 4 to 5 mm than the controls (Table 2).

As described by Alexandridis and White,[16] maxillary central incisors, second premolars, first molars and mandibular lateral incisors, canines, first premolars, second molars were selected for radiographic analysis (Table 3). The SSc group appeared to have wider mean PDL spaces overall, and separately by anterior, posterior, upper, or lower position (Table 3).

DISCUSSION

One of the limitations of this study is the SSc people and the controls were not from the same sub-population of university general hospital attendees. However, this is very difficult to obtain in a clinical study like the current one. This case-control study has revealed some periodontal characteristics that are associated with SSc. Although the survey consisted of a convenience sample of ambulatory SSc patients without other concurrent autoimmune conditions attending a university hospital, the controls were age- and sex-matched, and also convenience sample of attendees at a university dental hospital. The groups were generally also matched by socio-demographic data, with the two groups

reporting similar dental visit, and brushing habits. However, as the current sample size was

small, care should be taken when interpreting association between SSc and poor oral

health.

Both patient and control groups had inadequate oral hygiene and similar levels of a

mean high level of periodontal destruction[20] possibly reflective of the nature of the subjects

recruitment protocol.[19] However, interestingly, SSc patients experienced a higher BOP%

and deeper full-mouth PPD. The latter was probably due to a higher proportion of pockets

of 4 to 5 mm, and may have meant that SSc patients suffer from different clinical

presentation of the plaque induced inflammatory periodontal disease.

Using capillaroscopy, Scardina et al.[17] examined periodontal mucosa

microcirculation in SSc patients. They reported an increased capillary caliber and a

reduced number of visible capillary loops in SSc. A recent study of gingival biopsies by

Ozceilk and co-workers[21] showed that SSc samples had an increased level of gingival

infiltration and an increased microvessel density but reduced levels of VEGF-A and VEGF-

C proteins expression, suggesting vessel degeneration. Findings from both studies are

consistent with the current observations of higher BOP% in the SSc group than in the

controls. Nevertheless, the reasons why SSc subjects had deeper full-mouth mean PPD

while the mean full-mouth PALs of both test and control groups remained comparable are

yet to be elucidated.

Similar to previous studies,[13, 14, 16, 22] this study found a widening of PDL space in SSc patients. SSc is an autoimmune disease of collagen-vascular disorder characterized by increased collagen production and tissue fibrosis. Alexandridis and White[16] reported overall mean PDL space width of 0.292mm in progressive systemic sclerosis subjects whereas their controls had overall mean of 0.220 mm. Both our SSc as well as control groups appeared to have a larger PDL space of 0.357mm or 0.331mm, respectively. The different between the previous and current study perhaps is due to the different radiological protocol of image acquisition. Further investigations are needed to clarify the differences in PDL width measurements. However, taking into consideration of limitations of both studies, the measured PDL space dimensions could be considered as similar and the differences measured between test and control group could be considered genuine. Auluck,[23] Haers and Sailer[24] hypothesized the increased collagen production leads to hypertrophy of masticatory muscles. This produces excessive biting force and causes occlusal trauma to teeth, resulting in the widening of the periodontal ligament space in the absence of palpable periodontal disease. Rout et al.[13] reported about one third of SSc people have the widening of the periodontal ligament space because hypertrophy of masticatory muscles does not occur in all patients. However, Mehra[25] did not agree such hypothesis. He suggested the increased fibrosis of masticatory muscles and associated blood vessels of SSc people can cause ischemia and atrophy of masticatory muscles, which can reduce but not increase the

biting forces. In addition, signs of occlusal trauma, such as angular bone defect and

mobility of teeth, were not seen in patients with systemic sclerosis. Gonzale and

Coleman[26] suggested increased collagen synthesis in the periodontal ligament leads to

increase in the bulk of the ligament. This is accommodated at the expense of alveolar bone,

causing an increase in the width of the periodontal ligament space. Further investigations

are needed to identify the underlying reason of such radiographic observations.

CONCLUSION

This cross-sectional study adds to the observation that Hong Kong Chinese SSc patients,

despite exhibiting similar levels of inadequate plaque control, mean full-mouth PAL, and

number of standing teeth to non-SSc controls, they experienced a higher level of gingival

inflammation, deeper mean full-mouth PPD, and widened radiographic PDL space. Such

altered oral features, although conceivably attributable to gingival connective tissue and

vascular changes in the SSc state, require continued investigation to elucidate the true

biology behind the oral effects of this autoimmune disorder.

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ACKNOWLEDGMENTS

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Table 1.

Characteristics of study participants

Characteristic	Categories	Controls		Cases (SSc)		p-value[a]
		n	(%)	n	(%)	
Marital status	Never married	12	(33.3)	10	(27.8)	0.765
	Married	23	(63.9)	24	(66.7)	
	Separated/Divorced/Widowed	1	(2.8)	2	(5.6)	
Education	Non/pre-school	3	(8.3)	3	(8.3)	0.621
	Primary	11	(30.6)	12	(33.3)	
	Secondary	20	(55.6)	16	(44.4)	
	Tertiary or above	2	(5.6)	5	(13.9)	
Occupation	Working/studying	26	(58.3)	15	(41.7)	0.027
	Housewife	5	(13.9)	13	(36.1)	
	Unemployed/retired	5	(13.9)	8	(22.2)	
Monthly family income (HK$)[b]	≤ 9,999	14	(38.9)	9	(25.0)	0.411
	10,000 - 24,999	11	(30.6)	10	(27.8)	
	≥ 25,000	6	(16.7)	7	(19.4)	
	Refused to disclose	5	(13.9)	10	(27.8)	
Last dental visit	≤ 1 year for check-up	13	(36.1)	10	(27.8)	0.550
	≤ 1 year for dental problem	6	(16.7)	9	(25.0)	
	1 – 3 years	8	(22.2)	5	(13.9)	
	> 3 years or never visited dentist	9	(25.0)	12	(33.3)	
Brushing	≥ 2 times daily	24	(66.7)	28	(77.8)	0.565
	1 time daily	7	(19.4)	5	(13.9)	
	Occasionally	5	(13.9)	3	(8.3)	
Flossing	Every day	4	(11.1)	12	(33.3)	0.076
	Occasionally	9	(25.0)	7	(19.4)	
	Never	23	(63.9)	17	(47.2)	

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[a] Chi-square test

[b] USD $1.00 = HKD $ 7.80

Table 2.

Clinical characteristics of study participants

Characteristic	Controls (Mean ± SD)			Cases (SSc) (Mean ± SD)			95% CI *Diff*	Lower	Upper	p-value[a]
Erupted teeth (n)	23.7	±	6.0	24.9	±	5.2	1.2	-0.46	2.86	0.151
Pl(%)	65.0	±	12.5	69.3	±	18.0	4.3	-1.11	9.71	0.116
BOP(%)	49.3	±	22.6	78.4	±	19.6	29.1	26.94	31.27	< 0.001
Mean full mouth PPD(mm)	1.92	±	0.44	2.52	±	0.58	0.6	0.43	0.77	< 0.001
% sites PPD = 4 - 5 mm	4.77	±	4.80	12.36	±	8.24	7.59	7.15	8.03	< 0.001
% sites PPD ≥ 6 mm	0.76	±	1.41	1.34	±	2.23	0.58	-0.13	1.29	0.106
Mean full mouth PAL(mm)	3.17	±	1.29	3.19	±	0.94	0.02	-0.18	0.22	0.843

[a] Paired t-test

Table 3.

Radiographic periodontal ligament (PDL) width (mm)

Teeth	Controls				Cases (SSc)				95% CI			
	No.[a]	Mean	±	SD	No.[a]	Mean	±	SD	*Diff*	Lower	Upper	p-value[b]
Anterior												
Maxillary central incisor	36	0.315	±	0.062	33	0.373	±	0.090	0.057	0.014	0.100	0.010
Mandibular lateral incisor	36	0.309	±	0.075	34	0.324	±	0.073	0.014	-0.025	0.053	0.467
Mandibular canine	36	0.327	±	0.044	36	0.343	±	0.070	0.015	-0.015	0.045	0.302
Overall (Anterior)	108	0.317	±	0.039	103	0.346	±	0.060	0.029	0.002	0.056	0.038
Posterior												
Maxillary second premolar	31	0.331	±	0.080	32	0.353	±	0.086	0.022	-0.020	0.064	0.303
Maxillary first molar	32	0.343	±	0.070	34	0.391	±	0.109	0.049	0.010	0.088	0.015
Mandibular first premolar	35	0.337	±	0.072	35	0.338	±	0.076	0.001	-0.032	0.034	0.952
Mandibular second molar	34	0.346	±	0.060	32	0.403	±	0.081	0.057	0.031	0.074	< 0.001
Overall (Posterior)	132	0.339	±	0.042	133	0.370	±	0.063	0.031	0.010	0.052	0.005
Maxillary teeth	99	0.330	±	0.046	99	0.372	±	0.076	0.043	0.012	0.073	0.008
Mandibular teeth	141	0.330	±	0.035	137	0.351	±	0.058	0.021	0.001	0.041	0.043
Overall	240	0.330	±	0.032	236	0.360	±	0.057	0.030	0.010	0.050	0.005

[a] No. = number of teeth measured

[b] Paired t-test