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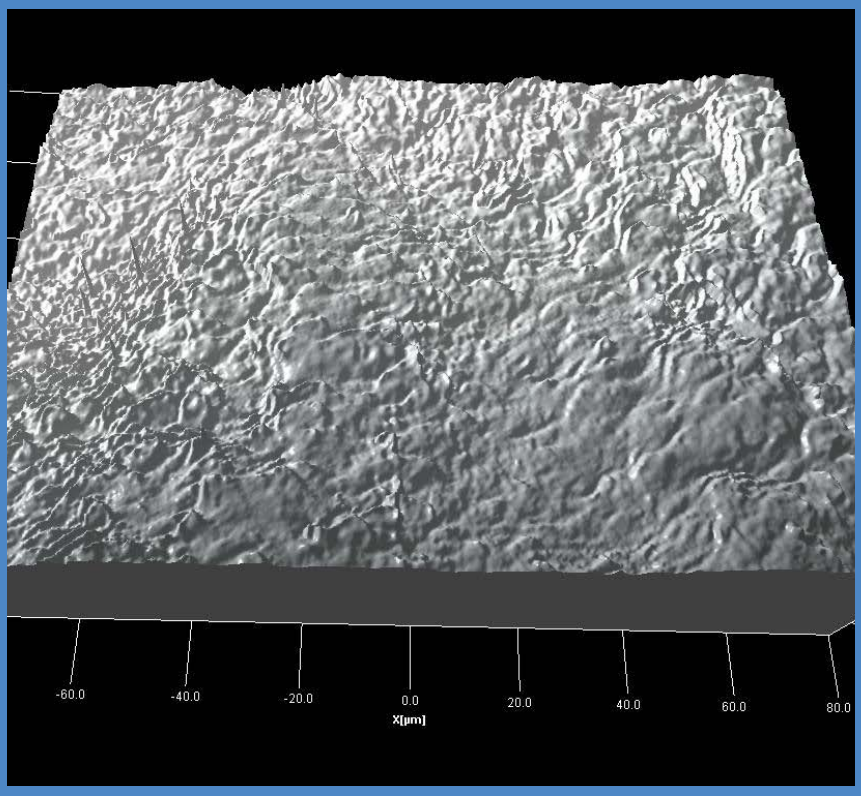

Micro-topography of dental enamel and root cementum

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Carina Frohm, Tfn +46 (0)8 666 15 16
carina.frohm@tandlakarforbundet.se

Editorial address
Swedish Dental Journal
Odontologiska Institutionen
Box 1030, SE-551 11 Jönköping, Sweden
Tfn: +46 (0)36 32 46 04
Fax: +46 (0)36 71 22 35

Subscription/business address
Swedish Dental Journal
Box 1217, SE-111 82 Stockholm, Sweden
Tfn: +46 (0)8 666 15 00
Fax: +46 (0)8 662 58 42
e-mail: SDJ.tlt@tandlakarforbundet.se
Bank: Skandinaviska Enskilda Banken
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Instructions to authors

Introduction

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Dentists and eating disorders – knowledge, attitudes, management and experience

ANN-KATRIN JOHANSSON[1], EVA NOHLERT[2], ANDERS JOHANSSON[3], CLAES NORRING[4], ÅKE TEGELBERG[2,5]

Abstract

◉ The aims of the present study were to explore the level of knowledge and attitudes among dentists in relation to patients with eating disorders (ED) and evaluate the extent to which patients with ED are identified and/or treated in the dental setting.

A postal questionnaire was constructed and sent to all dentists (n=367) in two Swedish counties during November 2005. The questionnaire comprised 29 questions or statements in the following categories: demographics, general knowledge of ED and its oral consequences, experience of and attitudes towards patients with ED and interaction within the health care system, for example, referrals and treatment options regarding this patient group.

The response rate was 70% (n=258). Perceived knowledge about ED was most commonly obtained from media sources, namely newspapers, television, etc. Few dentists knew that there existed specialized referral units for ED patients in their county. The majority of dentists stated that they had seen only a few such patients during their practice. Even though the perceived level of general knowledge about ED among female dentists appeared to be better than among male dentists, they also found it more difficult to inform the patient/relatives about their suspicion of the condition. Female dentists referred to specialists significantly more frequently than did males. Eighty-six percent of responders reported that they needed more training in dental management of patients with ED.

Knowledge and clinical experience of dentists as regards patients with ED were found to be low. The level of education in this area needs to be improved, which would have the potential to encourage dentists to become more involved in secondary and tertiary prevention and management of ED.

Key words

Attitude, dentists, eating disorders, knowledge, questionnaire

[1]Department of Clinical Dentistry – Cariology, Faculty of Medicine and Dentistry, University of Bergen, Bergen, Norway
[2]Centre for Clinical Research, Uppsala University, Västerås, Sweden
[3]Department of Clinical Dentistry – Prosthodontics, Faculty of Medicine and Dentistry, University of Bergen, Bergen, Norway
[4]Stockholm Center for Eating Disorders, Stockholm County Council, and Centre for Psychiatry Research, Karolinska Institutet, Stockholm, Sweden
[5] Faculty of Odontology, Malmö University, Malmö, Sweden

Tandläkare och ätstörningar – kunskap, attityder, behandling och erfarenhet

ANN-KATRIN JOHANSSON, EVA NOHLERT, ANDERS JOHANSSON, CLAES NORRING, ÅKE TEGELBERG

Sammanfattning

◉ Målsättningen med studien var att utforska graden av självrapporterad kunskap, attityder och erfarenhet bland tandläkare i relation till patienter med ätstörning samt att evaluera i vilken grad patienter med ätstörning identifieras och/eller behandlas inom tandvården.

Ett frågeformulär utarbetades och skickades till alla tandläkare (n=367) i två svenska landsting, Örebro och Västmanland, under november 2005. Frågeformuläret omfattade 29 frågor eller påståenden inom följande kategorier: demografi, allmänna kunskaper om ätstörningar och dess orala konsekvenser, erfarenhet av och attityder till patienter med ätstörning och samverkan inom hälsosystemet, exempelvis remissvägar och behandlingsmöjligheter för dessa patienter.

Svarsfrekvensen var 70 % (n=258). Kunskap om ätstörningar hade tandläkarna i huvudsak fått från media källor som exempelvis tidningar och television. Bara ett fåtal tandläkare kände till förekomsten av de specialiserade remissinstanser för patienter med ätstörningar som fanns inom deras närområde. Majoriteten av tandläkarna hade mött enbart ett fåtal patienter med ätstörning i samband med sin yrkesverksamhet. Även om de självupplevda kunskaperna om ätstörning föreföll vara bättre bland kvinnliga tandläkare än bland manliga upplevde kvinnorna att det var svårare att informera patienter/anhöriga vid misstänkt ätstörning. Kvinnliga tandläkare remitterade oftare till specialistvård än sina manliga kollegor. 86 % av tandläkarna rapporterade att de behövde mer utbildning i det odontologiska omhändertagandet av patienter med ätstörningar.

Konklusionen från denna studie var att självrapporterad kunskap och klinisk erfarenhet hos tandläkare avseende patienter med ätstörning var liten. Utbildningsnivån inom detta område bör höjas och det skulle kunna bidra till att tandläkare blir mer involverade i prevention och behandling av patienter med ätstörningar.

Introduction

Eating disorders (ED) are psychosomatic disorders in which severe medical/psychiatric complications often necessitate the involvement of a large number of different healthcare specialities in their management (10). Oral health problems and disabilities (e.g. dental caries and erosion, impaired salivary function, parotid gland enlargement) are common findings with ED and many of the oral signs or symptoms, either singly or in combinations, are relatively specific for this group of patients (8, 11). Treatment, therefore, needs to take a multi-disciplinary approach, and would frequently include psychiatric and medical teams, as well as dental healthcare providers.

Eating disorders are frequently associated with guilt, shame and denial of illness. These individuals, therefore, tend to avoid contact with healthcare professionals, or, when they do visit, they persistently conceal the true origin of their problem (13, 16). Secondary prevention, which involves early detection of the disease, is considered to be of great value in preventing or reducing not only oral complications but also the somatic and psychological implications. In fact, early detection is considered to be of utmost importance for the outcome, progression and treatment of the disease (2). It is, therefore, within the scope of all healthcare professionals, and especially so among the dental profession. Through their recall system, dentists are more likely to come across such presumptive patients, and so identify the disorder even if it is not revealed by the patient. In such a situation, the most important goal for the dental professional would be to ensure that the patient gets professional help for her primary disease (ED). To facilitate this, knowledge regarding both oral physiological signs and psychological characteristics of ED and the attitude of dental professionals towards this group of patients are of great importance (4). In this regard, it has been reported that American dentists and dental hygienists have a low level of knowledge of oral and physical signs of anorexia nervosa and of physical signs of bulimia nervosa (6). Studies have also shown that healthcare professionals are reluctant to inform patients about the suspicion that they suffer from ED (3, 7).

In Sweden, guidelines for medical teams who manage patients with ED were introduced in 2005 (15). Although the guidelines include general oral health considerations, no specific guidelines for the dental profession regarding dental management of patients with ED have to date been established.

The aims of this study were to explore the level of knowledge and attitudes among dentists in relation to ED and also to evaluate the extent to which dentists identify and/or treat patients with ED in the dental setting.

Material and methods

Subjects

A questionnaire was constructed and sent by post to all dentists (n=367) in the two Swedish counties of Västmanland (n=193) and Närke (n=174). The two counties are located in central Sweden, are relatively densely populated and each county has one relatively large city (>100.000 inhabitants). They are often considered to be representative of Sweden as a whole due to nationally average values in, e.g., age distribution, ethnicity, and various socioeconomic factors (14). The inclusion criterion was that the dentist should be working in a clinical setting ≥ 20 h/week. Public Dental Health Service (PDHS) dentists (n=159) and private general practitioners (n=152), as well as senior consultants and/or dentists in specialist training (n=56) were included.

Questionnaire

The questionnaire comprised 29 questions or statements. Most of the questions had a multiple choice format. In 12 questions, the subjects had the possibility to give an optional open answer. The questions were divided under the following categories: sociodemographic data about the dentists, e.g. personal data, including year of birth, gender, and year of professional exams; general knowledge of eating disorders and its oral consequences; experience of, and attitudes towards patients with eating disorders; and their interaction within the health care system, e.g. referrals and treatment options regarding this group of patients. The questionnaire was sent by post during November 2005. Those who did not respond received a reminder by post 6 weeks later.

Piloting the questionnaire

Ten Swedish dentists from various places outside the counties of the study were asked to respond and comment on the questionnaire. The final questionnaire was adjusted according to the responses and comments from the pilot.

Statistical analyses

Descriptive statistics were carried out and Mann-Whitney U-test was applied for 2 group tests. Wilcoxon Signed Ranks Test was used for paired observations. All statistics were calculated on a personal

computer using the Statistical Package for Social Sciences (SPSS, version 15.0). Significance level was set to $p<0.05$.

Results

Response rate and demographics

The overall response rate was 70%. Mean age of responding dentists was 48 years (range 24-73) and 43% were females. There were no statistically significant differences between responders (n=258) and non-responders (n=109) as regards professional affiliation (general practitioner or senior consultant), or gender.

The distributions of the respondents as regards professional affiliation and workplace, number of years working as a dentist are shown in Table 1. General practitioners constituted 85% of the responding dentists and those employed in the PDHS had a significantly shorter working experience as a dentist ($p<0.01$) compared to private general practitioners and senior consultants. The majority of female dentists worked as general practitioners in the PDHS, while the majority of males worked as private general practitioners.

Knowledge

The perceivedself-reported general knowledge about ED was significantly higher among females than males ($p<0.01$; Table 2). There was no significant difference between different professional affiliations or between number of years working as dentist and perceived general knowledge about ED. Both general knowledge about ED and knowledge about the relationship between ED and oral health were mostly obtained from common media sources (e.g. newspapers, television etc.) followed, in decreasing order, by own and professional experience, undergraduate training, self-studies and continuing dental education (Table 3).

Dentists with a shorter professional experience (<5 years, n=26) had acquired their general knowledge about ED, as well as knowledge of its oral health implications, during their undergraduate training significantly more frequently than dentists with longer

Table 1. Professional affiliation/workplace, gender distribution and years in service among the dentists

	Total		Female		Years in service as dentist		
	N	%	N	%	$\bar{x}$	Range	≥ 5 yrs
General PDHS* practitioner	115	44.6	68	59.1	18	0.5-40	77%
General private practitioner	104	40.3	23	22.1	24	6-49	100%
Senior consultants/dentists in special traning	39	15.1	20	51.3	24	5-39	100%
Total	258	100.0	111	43.0			

*PDHS=Public Dental Health Service

Table 2. Self-reported general knowledge about eating disorders among dentists by gender. P denotes difference

	Females			Males	
	N	%	P	N	%
Very Good	7	6.3		4	2.7
Good	33	29.7		27	18.5
Relatively good	45	40.5	<0.01	61	41.8
Poor	25	22.5		51	34.9
Very poor	1	0.9		3	2.1
Total	111	100.0		146	100.0

Table 3. Sources of acquired knowledge regarding general and oral health in patients with eating disorders. More than one response was allowed. P denotes difference between general and dental knowledge

	Knowledge of general health			Knowledge of oral health	
	N	%	P	N	%
Media	191	74.3	<0.01	144	56.3
Own experience	102	39.7	NS	113	44.1
Dental school	85	33.1	<0.01	100	39.1
Self studies	55	21.4	<0.01	70	27.3
Courses	31	12.1	<0.01	39	15.2
Other sources	26	10.1	NS	30	11.7

Table 4. Levels of difficulty expressed when having to inform patients with suspected ED, and/or their parents, about the situation. *P* denotes difference between females and males in the first 4 categories

	Females N=111			Males N=147	
	N	%	P	N	%
No, never difficult	3	2.7		25	17.2
Yes, sometimes difficult	26	23.6		29	20.0
			<0.001		
Yes, often difficult	16	14.5		15	10.3
Yes, always difficult	26	23.6		19	13.1
Never been in the situation	39	35.5		57	39.3
Total	110	100.0		145	100.0

professional experience (p<0.05).

About half of the respondents (56%) believed that they could detect an anorectic person in a setting outside the dental office, while the corresponding figure for a bulimic person was only 10%. Two out of three dentists in the study personally knew someone with ED (67%), and most commonly it was a friend. Five responders (3 females and 2 males) reported having suffered from an ED themselves. Nine percent were aware of that there existed special referral dental clinics for ED patients in their county, 40% were not and about half of the dentists (51%) did not know. The corresponding figures for availability of special ED centres were 31%, 3% and 66%, respectively.

Attitudes and management

The most common perceived causes for acquiring ED were psychological (92%) and socio-cultural factors (67%), while heredity factors as a cause of ED was only reported by 6% of the respondents. There were no differences between genders or between professional affiliations on these aspects.

Fifteen percent of respondents felt that the dental care system provided sufficient means for managing ED patients. Eighty-three percent believed that ED patients had more dental problems than ordinary patients, while 16% believed that they had not.

The majority of respondents (84%) thought that dental treatment would be of benefit in the general medical management of ED patients, but 86% reported that they needed more training in the dental management of such patients. There were no differences between genders and professional affiliations on these issues.

The levels of difficulties expressed by dentists when having to inform a patient or a parent with suspected ED are shown in Table 4. Females found it more difficult when an actual situation occurred than males (p<0.001), and dentists with shorter professional experience found it more difficult than those with longer experience (p<0.01).

The responses to management options when a dentist suspects that a patient has an ED are shown in Table 5. About half of the dentists recommended the patient to seek medical care. Although few dentists referred the patient to other healthcare professionals, females referred to senior dental consultants to a greater extent than males (p<0.05).

Thirty-eight percent considered that dental healt-

hcare professionals with special training for ED patients should manage these patients, followed, in decreasing order, by those who felt that general dentists (27%), a combination of dentist/dental hygienist (23%), dental hygienists (6%) and senior consultants (4%) should do so.

Experience with ED patients

Over the preceding year, 25% of respondents had been informed by a patient or the patient's parent that he or she had an ED. For the whole group, the average number was 2 patients (range 1-10), of whom 92% were women.

Seventy-six percent knew that they had treated ED patients in their dental clinics, with a majority having treated on the average 5 such patients (range 1-50). Significantly more ED patients were treated by dentists with longer experience. Seventeen dentists (9 females and 8 males) had had referrals of between 1 and 3 ED patients during the past year.

Thirty percent of the dentists had not suspected any diagnosis of ED during the past year, a finding that was more common among those in PDHS than among private general practitioners ($p<0.05$). On the other hand, of those who had had a suspicion of ED in a patient, one-third had not informed the patient/parent, one-third had told the patient/parent and had the diagnosis confirmed, and one-third had told the patient/parent but not had the diagnosis confirmed. On this aspect, no differences were seen between genders but more dentists with shorter professional experience had suspected ED patients without informing the patient/parent compared to dentists with longer experience ($p<0.05$). Private general practitioner dentists had more frequently told the patient/parent about their suspicion and had the diagnosis of ED confirmed compared to those in the PDHS ($p<0.05$).

Examples of dentists' experiences with ED patients are shown in Table 6. Only 5% and 3% of the female and male dentists, respectively, had ever been consulted by specialized ED centres.

Discussion

An overall response rate of 70%, as achieved in this study, has to be considered good. Non-responders and responders did not differ significantly in their professional affiliation/workplace and gender. The results could, therefore, be regarded as representative for the general population of Swedish dentists even though it is possible that the responders were more interested in the topic of ED than the non-responders.

The overall findings of this study show that the self-reported knowledge of, and experience in managing ED patients, is insufficient. Nevertheless, the perceived knowledge about ED among female dentists was significantly greater than among males, although professional affiliation, number of years of practice and general knowledge about ED did not differ. An explanation for this finding could be that ED affects more women than men and that female dentists, therefore, have a greater focus and interest in such problems. It is still unsatisfactory, however, that nearly one-fourth of female dentists and nearly one-third of male dentists judged their self-reported knowledge about ED as poor or very poor. A low level of eating disorder knowledge among dental professionals was also found by *DeBate et al.* (6). However, it has to be emphasized that the actual knowledge of the responding dentists was not assessed in the present study.

The finding that media was the dentists' major source for obtaining knowledge about ED indicates that their actual knowledge was low. It also clearly suggests that a more professional, targeted training

Table 5. Suggested management options for a patient with a suspected eating disorder (ED). More than one response was allowed. P denotes difference between females and males

	Females N=111			Males N=147	
	N	%	P	N	%
Treat as an ordinary patient	15	13.5	NS	25	17.1
Treat as an ordinary patient until sure about ED	51	45.9	NS	71	48.6
Inform relatives (in children)	50	45.0	NS	61	41.8
Recommend the patient to seek medical care	46	41.4	NS	52	35.6
Refer to:					
Senior consultants	16	14.4	<0.05	13	8.9
Medical care	8	7.2	NS	13	8.9
Eating disorder clinic	10	9.0	NS	22	15.1

Table 6. Percentage distribution of responses to questions relating to dentists' experience of ED patients

	Never/ sometimes	Often	Very often/ always
Q. *Supposed reaction from ED patients when informed that her/his oral status could be indicative of ED*			
Get insulted	68	22	11
Denies ED	28	37	36
Seeks other dentist	89	8	3
Admits ED*	72	20	8
Feels good that someone has understood*	53	35	13
Seeks additional help for ED*	75	18	7
Gets a chance for improved oral health	34	42	24
Doesn't mean anything/no reaction	86	12	3
Q. *The dentists' experience of ED patients as dental patients*			
Difficult to get in contact with	61	27	12
Difficult to get along with	75	20	5
Difficult to treat	64	24	13
Wants to talk about their ED*	93	6	1
Listen to information	57	29	14
Q. *Frequency of estimated problems experienced by ED patients*			
Aesthetics	28	34	37
TMD (temporomandibular disorders)	72	23	5
Dentine hypersensitivity	11	41	48
Dental fear	39	38	24
Fear for detection of the ED from the dental team	45	32	23
Fear for high dental costs	37	28	35
Fear to speak about their ED with the dentist	41	37	23
Worry for what may happen during dental treatment	45	33	22

* Significantly more male dentists responded often/very often/ always than females ($P<0.05$)

for dentists in this important area of clinical practice is required, in order to more scientifically improve dentists' knowledge, attitudes and behaviour.

Dentists with shorter professional experience had gained their general knowledge about ED and oral health from their undergraduate education at dental school more often than dentists with longer professional experience. While this commends modern dental education, it is also partly explained by the fact that BN, as one of the key diagnoses of ED, was only relatively recently established (1979) (12) and consequently not included in older dental curricula. In addition, most of the dental research in ED has been published more recently even though the first classical study was published by Hellström as early as 1977 (8).

Slightly more than half of the respondents (56%) believed that they could detect an anorectic person if met outside the dental office environment, while the corresponding figure for a bulimic person was 10%. The reason for this may be that AN patients exhibit typical "thin" physical characteristics while BN patients do not. In fact, BN patients most often have a normal weight, which makes the immediate identification of the disorder very difficult.

Respondents' awareness of the existence of special referral centres for ED patients in their county was low, as was the case for awareness of special dental clinics. In fact, both counties have specialized ED centres and one county also has a specialized dental facility. This suggests that available special care facilities, with the possibility of providing successful psychiatric, medical and dental management (1), are being under-utilized. The finding that private general dental practitioners, compared to those in the PDHS, more often informed the patient/parent about their suspicion and had the ED diagnosis confirmed, suggests that private practitioners may follow their patients more regularly. Their longer experience than those in the PDHS might also add to the tendency to inform. That not all dentists inform the patient of their suspicion of an ED has been found earlier (3, 7), and should be alarming due to the importance of early detection and intervention (2).

That female dentists' perceived self-reported general knowledge about ED was significantly better than that of male dentists has been found before (7). The female dentists also found it more difficult to inform the patient/relatives about their ED suspicions. A plausible explanation for this is not easy to propose, but it may be that women may have more difficulty in informing about a condition with which they may feel greater familiarity.

Although three-quarters of our sample claimed to have treated ED patients in their dental offices, the number seen by most was small, on average 5 patients. Not surprisingly, most of the respondents felt that they needed more training in managing such patients, an educational gap that the overall findings of this study seem to have identified. Furthermore, dentists' opinions on their likely reaction to, experience of and their own estimation of the magnitude of problems that could be encountered in managing ED patients showed wide variation. While this may mirror the uncertainty of dentists and even their lack of experience in managing this group of patients, it could also reflect the fact that patients with ED represent a diverse group of patients with a wide range of symptoms. On the other hand, as many as 83% of the sample thought that patients with ED had more dental problems than other patients, and a similar number (84%) considered dental care to be important in the general management of the disease.

In a national Swedish survey carried out in 2003 (9), all specialized clinics for eating disorder affiliated to the National Resource Centre for Eating Disorder (n=40), treating a total of more than 2500 patients annually, were asked by means of a questionnaire to estimate the significance of dental care for patients with ED. Thirty-eight of the 40 clinics responded, with 60% of them reporting that dental problems were frequently seen in ED patients. In addition 82% believed that providing dental care for ED patients was important for their comprehensive management, and 4 out of 5 clinics deemed it important to implement national guidelines for the dental management of ED patients. The conclusion drawn was that the level and manner of cooperation between dental and medical/psychiatric teams involved in the management of ED should be stronger and more structured. The present study showed that the dentists' self-reported knowledge and experience in managing ED patients generally was insufficient. In agreement with earlier studies (5, 9) it is therefore reasonable to propose the implementation of well-structured training programs for the dental team in the management of patients with ED.

Conclusion:

The self-reported knowledge and clinical experience of dentists, as regards patients with ED, was found to be low. Education in this area of dental practice needs to be enhanced so as to improve the quality of care, e.g. secondary and tertiary prevention, which dentists can provide to those with ED.

Acknowledgements

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Address:
Dr Ann-Katrin Johansson
Department of Clinical Dentistry – Cariology,
Faculty of Medicine and Dentistry, University of Bergen,
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Prosthodontic treatment of patients with disabilities at dental specialist clinics in the County of Västra Götaland

CARL-OTTO BRAHM[1], GUNILLA KLINGBERG[1], ANDERS EKFELDT[1,2].

Abstract

◎ In 1998 the Swedish Parliament decided about increased financing of dental support and service given to persons with disabilities who were dependent on nursing personnel or others in their activities of daily life including oral hygiene procedures. One part of the legislation called "Necessary dental care, group 3" (NDC3) includes persons with intellectual disabilities and disabilities due to brain damage, autism and autism-like disorders, and persons with lasting mental and physical disabilities not related to normal ageing. The objectives where to investigate persons affected by this legislation; how many and what patients covered by NDC3 in Västra Götaland County received prosthodontic therapy from 2001 through 2004, at hospital dental clinics or dental specialist clinics. Patients treated with prosthodontic restorations covered financially by the county council under the terms of NDC3 were identified through the county council´s registers. The application forms for NDC3 were retrieved and information about patient characteristics and type of treatments were compiled.

It was shown that 57 patients covered by NDC3 in Västra Götaland County received prosthodontic therapy at dental specialist clinics and 50 were treated at the hospital dental clinics for extensive prosthodontic treatment needs. The mean age for the patients rehabilitated with removable dentures was higher (56.2 years) compared with patients treated with single tooth implants (39.7 years). About 30 patients, representing 1 to 2 % of the NDC3 population in Västra Götaland County were rehabilitated with more advanced prosthodontic restorations in hospital dental clinics or dental specialist clinics each year. In conclusion and with respect to the probably large need for prosthodontic therapy among persons with disabilities, the use of NDC3 has not been properly utilized.

Key words

Prosthodontic treatment, disability, dental care.

[1]Mun-H-Center, Odontologen, National Orofacial Resource Centre for Rare Disorders Götborg, Sweden
[2]Department of Prosthetic Dentistry and Oral Function, OD, ICO University of Oslo, Oslo, Norway

Oralprotetisk behandling av personer med funktionshinder inom specialist- och sjukhustandvården i Västra Götalandsregionen

CARL-OTTO BRAHM, GUNILLA KLINGBERG, ANDERS EKFELDT

Sammanfattning

◎ Den första januari 1999 infördes ett nytt tandvårdsstöd i Sverige. Detta innebar att nödvändig tandvård erhölls till samma avgifter som inom den öppna hälso- och sjukvården för vissa patientgrupper, bland annat för människor som omfattas av lagen för stöd och service för vissa funktionshindrade (LSS), men också för människor på särskilda boenden, människor med stort vårdbehov i hemmet, samt människor med allvarligt psykiskt funktionshinder.

Syftet var att kartlägga hur många och vilka människor inom LSS-gruppen som fick oralprotetisk behandling utförd som ”nödvändig tandvård grupp 3 (N3)” i Västra Götalandsregionen från 2001 till och med 2004, utförd på sjukhustandvårds- eller specialisttandvårdskliniker.

Uppgifter om oralprotetisk behandling på patienter som omfattas av N3 hämtades från beställarenhetens register i Västra Götalandsregionen. Bland de personer som omfattades av N3 erhöll 57 patienter oralprotetisk behandling utförd på specialisttandvårdsklinik och 50 på sjukhustandvårdsklinik. Antalet behandlade patienter ökade under hela perioden från 2001 till 2004. Ökningen var som störst mellan 2001 och 2002. Olika typer av oralprotetisk behandling utfördes men implantatstödda konstruktioner gjordes endast på specialistkliniker. Medelåldern för de patienter som bettrehabiliterades med avtagbara protetiska konstruktioner var 56.2 år jämfört med 39.7 år ($p<0.001$)för de patienter som behandlades med singelimplantat. Fler män än kvinnor erhöll behandling i denna studien. Varje år fick cirka 30 patienter behandling, med mer avancerade oralprotetiska konstruktioner utförd inom N3, vilket utgör 1-2% procent av LSS-populationen i Västra Götalandsregionen.

Trots ett förväntat högt oralprotetiskt behandlingsbehov hos personer med allvarliga psykiska funktionshinder, utnyttjades möjligheten till oralprotetisk behandling finansierad som nödvändig tandvård sparsamt inom sjukhustandvården och specialisttandvården. Om denna slutsats stämmer innebär detta att patienter som omfattas av LSS troligen inte får den oralprotetiska tandvård som de har rätt till enligt tandvårdslagen. Få av dessa patienter erhöll behandling eller blev remitterade till någon specialistklinik i Västra Götaland.

Introduction

Individuals with mental and physical disabilities may have difficulties practicing oral preventive care. With time, diseases of the oral cavity such as caries and periodontitis may develop, leading to an increased need for dental care (8). Periodontitis is the most common cause of tooth loss in patients with Down syndrome and among persons with intellectual disabilities unable to co-operate with dental treatment (13). An increased risk of dental caries is seen in patients with diet-related problems and in persons with mild intellectual disabilities (9, 11). The latter often live on their own with little need of assistance, contrary to persons with moderate or severe disabilities who need, and receive, more assistance in daily living. Impaired oral-motor function may decrease the ability to self-clean the teeth through the use of lips, cheeks, and tongue (12). Further, the underlying medical condition e.g. cerebral palsy may entail an increased risk of dental trauma (15). A common need for prosthodontic rehabilitation is extensive dental wear. The etiology of dental wear is multifactorial (6) and may be caused by erosions because of reflux disease in e.g. patients with cerebral palsy (22) and/or from bruxism (21, 33). Studies of tooth wear among psychiatric patients have also been presented (1). Moreover, medication may contribute to dryness of the mouth, which increases the risk of dental caries (14).

Carrying out dental care in people with disabilities is often difficult owing to behavioral or medical problems associated with the diagnosis. Thus, there is an obvious risk for unmet treatment needs and emergency dental visits. The treatment regimes are affected and there is a risk that teeth are extracted more often than in healthy individuals. A continuous deterioration of the dentition towards edentulousness in patients who is utterly incapable of coping with the wearing of prostheses has also been reported (20).

In most of these patients, anomalies, neurological impairment, different diseases and trauma have affected function, anatomical structure and general conditions. This may cause orofacial dysfunction, such as eating problems, bruxism and drooling. In combination with these conditions, there is often a great need for dental treatment. However, only a few studies have described prosthodontic rehabilitation of patients with disabilities (2, 3, 5, 7, 19, 32,). Case reports may thus provide us with some knowledge in previously unfamiliar areas (4).

In 1998 the Swedish Parliament decided about Reformed Dental Care Subsidy (25) in order to increase the financial support and the service given to persons with disabilities who were dependent on nursing personnel or others in their activities of daily life including oral hygiene procedures. The legislation concerns persons with mental and physical disabilities, either congenital or acquired, with an increased need of nursing and care at home or at community based living. The concept "necessary dental care" was established. People entitled to "necessary dental care" (NDC) are categorized into four target groups. Group three (NDC3) includes persons with intellectual disabilities, autism and autism-like disorders, and intellectual disabilities due to brain damage in adulthood, and persons with lasting mental and physical disabilities not related to normal ageing. The treatment that is covered by NDC is determined for each individual on the basis of general health, dental health and the benefits of the treatment. NDC must contribute to a better ability to assimilate nutrition and, failing that, the goal is then to reduce pain and discomfort. The National Board of Health and Welfare has provided guidelines on types of treatments to be included in NDC and suggests that the use of crown and bridgework should be not subsidized in molar regions, and that implants should be subsidized only in special cases (30).

The National Board of Health and Welfare maintains a statistical database regarding persons with certain functional impairments, covered by NDC, in the Västra Götaland County. Each year, approximately 1,000 people receive advice and support from the county council and between 8,000 and 9,000 people receive services from the municipalities in the County of Västra Götaland. Approximately 3,000 of whom are under the age of 22 (26, 27, 28, 29). The total population of Västra Götaland County is approximately 1.5 million

In 2005, the National Board of Health and Welfare published an evaluation of the NDC system (31) and found that only about 54% of the target population in fact received the dental care they were entitled to. Further, removable prostheses were more common than in the background population, and men received more comprehensive dental care than women.
The financing of the NDC is administrated by the responsible dental care unit, (TVE) of the Västra Götaland County, (Table 1). Despite the fact that the legislation has been in force for a number of years, information is lacking on how the dental care for persons eligible for NDC3 is carried out, what kind of treatment is carried out on regional basis.

The aim of this study was to investigate patients eligible for NDC3 in Västra Götaland County, how many were treated with dental prostheses, fixed or removable, from 2001 through 2004 and whether this treatment was carried out by hospital dental clinics or dental specialist clinics.

Table 1. Total number of patients entitled to dental care according to NDC3, and the yearly cost for that treatment in Västra Götaland County 2001 to 2004.

Year	Number of patients	Cost in million (SEK)
2001	2 273	5.4
2002	3 329	11.2
2003	3 701	12.3
2004	3 848	12.4

Material and Methods

Patients receiving prosthodontic treatment covered financially by the county council under the terms of NDC3 were identified through the register at the responsible dental care unit, (TVE) of the Västra Götaland County using the following inclusion criteria:

1. Prosthodontic rehabilitation provided to patients covered by NDC3 from 2001 through 2004 who received removable, fixed, and/or implant supported fixed or removable prostheses.
2. Dental care carried out at a dental specialist clinic, at a cost exceeding SEK 7,000.
3. Dental care carried out at a hospital dental clinic at a cost exceeding SEK 15,000.

This study sought patients with disabilities with a history of extensive prosthodontic treatment, limits for treatment costs were set at SEK 7,000 and SEK 15,000 at the dental specialist clinics and the hospital dental clinics, respectively, to facilitate identifying these patients in the register. These amounts are substantial, and should be associated with major treatment involving oral prosthetic devices. The higher amount was chosen for hospital dental clinics, since the total cost of patient treatment there could also include basic dental care.

Based on the register each treatment invoice was reviewed based on verification number and invoice identification to verify the required procedure code. Further age, gender, and psychiatric and medical diagnoses were retrieved. Dental specialist clinics included clinics in prosthetic dentistry, maxillofacial surgery and the Institute of Odontology at Univesity of Gothenburg, including Mun-H-Center. In Mun-H-Center the prosthodontic treatment was provided by a specialist in prosthetic dentistry.

The SPSS software edition 14, was used for all statistical analyses. Independent Student´s t-test was used to analyze differences in age between patients receiving different types of prosthodontic treatment.

The study was approved by the Ethical committee in Gothenburg, University of Gothenburg (S 361-02).

Results

A total of 107 patients covered by NDC3 in Västra Götaland County were treated between 2001 and 2004 in accordance with the criteria for inclusion. The number of patients who received treatment with dental prostheses at dental specialist clinics was 57, while 50 were treated at the hospital dental clinics (Table 2). The hospital dental clinics provided the majority of removable and fixed-tooth–supported prostheses whereas implant -supported prostheses were carried out exclusively at the dental specialist clinics.

Between 2002 and 2003 the total number of patients decreased by 25 per cent, the number of patients treated in hospital dental clinics declining by half, while the number of patients treated in dental specialist clinics increased. The highest number of treatments with removable prostheses occurred in 2002, while the highest number of implant-supported prostheses were placed in 2004 (Table 3). Only one implant-supported prosthesis was registered in 2001.

Table 2. Number of NDC3 patients receiving prosthodontic rehabilitation dental specialist clinics and hospital dental clinics in Västra Götaland 2001 to 2004.

	Dental specialist clinics N	Hospital dental clinics N	Total N
2001	5	3	8
2002	15	24	39
2003	18	12	30
2004	19	11	30
Total	57	50	107

Table 3. Number of NDC3 patients by type of oral prostheses and treatment year.

Year	Removable prostheses	Removable and tooth-supported fixed prostheses	Fixed tooth-supported	Implant-Supported				Total
				over-denture	single tooth	partial prostheses	full arch prostheses	
2001	3	2	2	1	0	0	0	8
2002	15	1	12	1	6	2	2	39
2003	5	4	11	0	4	3	3	30
2004	5	1	9	1	7	1	6	30
Total	28	8	34	3	17	6	11	107

Table 4. Mean age (years) of patients rehabilitated by treatment year and type of oral prostheses.

Type of treatment	Mean age in years				
	2001	2002	2003	2004	2001-2004
Removable prostheses	46.7	59.4	54.6	54.2	56.2
Removable and tooth-supported fixed prostheses	46.5	52	60.5	53	53.0
Fixed tooth supported prostheses	57.5	49.2	52.5	45.6	51.2
Overdenture implant-supported	59	60	-	59	59.3
Single tooth implant	-	35.2	43	41.7	39.7
Implant-supported partial prostheses	-	50.5	35	56	47.2
Implant-supported full arch prostheses	-	50.5	58.7	51.1	55.4

***$p < 0.001$

Of the 57 patients treated in dental specialist clinics, 19 were patients at the Mun-H-Center and 15 were patients at the Institute of Odontology at the University of Gothenburg, and for those 34 patients dental records were available for analyses. Twenty-one out of 34 patients were diagnosed with learning disability (Am. mental retardation) only. One had learning disability and schizophrenia and the rest displayed neurological, psychiatric or neuropsychiatric diagnoses including schizophrenia, Asperger syndrome, autism, Down syndrome, myotonic dystrophy, epilepsy, Fragile X syndrome, cerebral palsy and Rett syndrome.

The 107 patients identified comprised 61 men and 46 women with an average age of 51.6 and 49.3 years, respectively (medians 53 and 50.5 years, respectively). The mean age of patients differed somewhat with different types of prosthodontic restorations (Table 4). The mean age of the patients rehabilitated with removable dentures was higher (56.2 years) than of those treated with single tooth implants (39.7 years) ($p < 0.001$).

Discussion

This study presented data from 107 patients with disabilities covered by NCD3 that had received prosthodontic treatment in the Västra Götaland County from 2001 through 2004. Fifty patients were treated at hospital dental clinics and 57 at dental specialist clinics. At hospital dental clinics removable and tooth-supported fixed prostheses were in most cases the treatments of choice. At specialist dental clinics patients were also treated with implant-supported prostheses. The results indicate that an increasing number of patients were treated between 2001 and 2004, the greatest increase occurring between 2001 and 2002. The study has also shown that more men than women were treated and that implant-supported single tooth restorations were carried out in younger individuals than in older, where removable dentures were more common.

The finding in our study that more men than women had received prosthodontic treatment is supported by the findings in the National Board of

Health and Welfare report (31). Another explanation could be that there are more men than women in the group covered by NDC3.

The original data analyzed was from the register at the responsible dental care unit. Neither the dental history nor the dental status that led to different options of oral prosthodontic treatment for these patients were registered in the in their database, and thus not retrievable.

The causes of oral rehabilitation in general are multifactor and can coarsely be divided into primary and secondary oral defects. The former are congenital, i.e. defects in tooth mineralization, tooth agenesis, defects in left clip palate, syndromes, and acquired defects, i.e. dental trauma and dental losses. The later are defects caused by long term medication and chronic conditions where the ability to self care is impaired (16).

One could expect the need for prosthodontic rehabilitation to be high in patients with intellectual disabilities, due to periodontitis, caries and problems with cooperation (10, 13). However there are rarely any studies on the need of dental treatment in patients with disabilities. The need of oral rehabilitation has to be considered according to tooth mortality. One longitudinal study reports an average tooth mortality of 1.82 teeth during 8.5 years (10). Two thirds of the lost teeth were molars. In a retrospective study the tooth mortality was even higher – 3.72 teeth during a 10-year-period (8).

Statistics Sweden has published cross-sectional data on the dental status of the total population. The report showed that 7.2 % in the age group 25-64 years old had some sort of prosthodontic device and "not only their own teeth". The corresponding figure for the 65-84 years old was 49 % (23). In the same publication, data on dental status in persons with disabilities was also presented. The disabilities were categorized into different groups, and in the group of persons "in need of assistance" the corresponding figures were 23.7 % in 25-64 years old, and 65.8 % in 65-84 years old (23). This group of people with disabilities probably included subjects with similar diagnoses and living under the same conditions as the patients included in the present study.

It is plausible that there is an extensive latent need for oral prosthetic rehabilitation in the NDC3 population, but there is a lack of sufficient data or epidemiological studies displaying that. If this is reality it is a serious matter and utterly against the legislation. The Swedish Dental Service Act (24) states that all Swedish citizens are entitled to good quality equal dental care on equal terms. Many of these people are not aware of their legal rights and not capable of arguing them against authorities which make them vulnerable in the society. Therefore it comes naturally that dental professionals should respect the legislation, not making any deviations concerning people with disabilities.

It is a problem that the NDC does not automatically include the same dental treatment options that are available for the rest of the population. Many dentists have a clinical experience of patients having problems accepting removable prostheses, and of the prostheses frequently disappearing and not found. There could of course be several reasons for this, but for some of these patients fixed prostheses including implant-supported prostheses may be accepted easier. These patients are often difficult to treat and imply a challenge to dentist both from a behavioral and odontological point of view. It is therefore essential that these kinds of treatments are indeed possible to carry out, but then preferably restricted to specialists clinics where systematic evaluations of treatment are part of the clinical routines.

Six dental specialist clinics specializing in prosthetic dentistry, including the Mun-H-Center, are established in the Västra Götaland County. More than half of the patients included in this study were treated in the dental specialist clinics. One third of the patients covered by NDC3 who were rehabilitated with implant supported fixed prostheses, received dental treatment at the Mun-H-Center, a national orofacial resource centre for rare disorders. The treatment with implant-supported prostheses fixed or removable in patients with neurological disabilities has been shown to be successful and it is likely to even function better than removable prostheses for these patients (5, 7, 19, 32). Therefore, the finding of a rather low number of patients actually receiving this treatment is bothersome. As it is likely that the treatment needs are greater in patients with disabilities the scarce use of implant-supported rehabilitation indicates that these patients actually do not receive dental care on the same conditions as others.

Approximately half of the 107 patients had received their prosthodontic rehabilitation after a referral to a dental specialist clinic in Västra Götaland County. There could be several possible reasons why so few patients, in the NDC3 system were referred to a dental specialist clinic. The patients' medical and/or psychiatric status may have presented an obstacle; in other words, there may have been reluctance to subject patients due to medical risks that may

jeopardize their health. The treatability of patients while they are awake varies, and sedation or general anesthesia may be necessary in certain cases, even though this may involve a risk of medical complications. Naturally, financial factors are decisive, since such treatment requires more resources than ordinary or basic dental care. The costs associated with implant treatment are often high, and the responsible dental care units (TVE) in many counties do not approve reimbursement of these costs to patients subjected to NDC. Difficulties motivating patients to practice good oral hygiene required to prevent infection may also be a reason for not referring these patients to a dental specialist clinic. Ongoing dental problems, such as extensive dental caries and periodontitis, may be another reason for not referring for prosthodontic rehabilitation. Of course, patient motivation and interest in asking for advanced oral rehabilitation are also influenced by people in close relationship to that patient e.g. personal caretaker and for some of these patients, a person legally responsible for that person The accessibility to dental care for people with disabilities can be limited for several reasons. Two obvious reasons include the reduced capacity to, or even inability to, express pain and discomfort, and also difficulties in assessing the patients' dental treatment needs by others, i.e. the nursing staff (16).

The register obtained from the responsible dental care unit, (TVE) of the Västra Götaland County did not contain data about the patients' medical and/or psychiatric diagnoses. Access was restricted to dental records for only 34 patients who all had learning disability (Am. mental retardation) and/or neurological, psychiatric or neuropsychiatric diagnoses. Among the other patients included in this study there might be other diagnoses present that are not displayed here. Hence there is a risk that the distribution of diagnoses is skewed. In the group diagnosed with learning disability, there are likely to also be additional diagnoses but these have not always been established owing to partly diagnostic possibilities when these patients were young (birth, childhood), and as these patients have grown older the patient, family or doctor has not seen a need for further medical investigations. This is a common finding in adult populations of people with learning disabilities. If they had been children today, many would probably have had more diagnoses including different syndromes and neuropsychiatric disorders. Thus, these adult patients often have more complex conditions than disclosed by the diagnosed learning disability.

We found no reasonable explanation why more men than women were rehabilitated during the study period. It appears that the older part of the population was rehabilitated with removable dentures or implant-supported prostheses in partial or totally edentulous jaws, while the trend for the younger part was fixed tooth supported prostheses and single tooth implants. The increased use of implant-supported prostheses for rehabilitation in this group from 2001-2004 should be viewed in light of the now more general application of that technique in healthy individuals (17). Implant procedures were done exclusively in the dental specialist clinics because the necessary expertise was there.

About 30 patients were rehabilitated with more advanced oral prosthetic restorations in hospital dental clinics or dental specialist clinics each year, representing 1 to 2 % of the NDC3 population in Västra Götaland County. Does the low frequency of such treatment reflect a small need for prosthodontic rehabilitation in general or is this group of patients undertreated? We believe the latter is the case, and consider that there is a great need to inform both general and specialist dentists of the great need for oral prosthodontic rehabilitation of those patients covered by NDC. There is also a need for further research on prosthodontic rehabilitation in NCD populations with respect to follow-up and epidemiology.

Concluding remarks

The present study shows that only a limited number of patients with disabilities included in NDC3 receive prosthodontic rehabilitation despite a believed high need. This is a problem as these patients should be entitled to the same level of dental care as the rest of the population.

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Address:
Dr Anders Ekfeldt
Department of Prosthetic Dentistry and Oral Function
Institute of Clinical Dentistry
University of Oslo
P.O Box 1109 Blindern
NO-0317 Oslo, Norway

E-mail: anders.ekfeldt@odont.uio.no

Uniformity in selection for subsidized orthodontic care – focus on borderline treatment need

NABIL MOCKBIL, JAN HUGGARE

Abstract

◉ In the county of Stockholm, subsidized orthodontic care is offered to roughly 25% of persons under the age of 19. Stockholm County Council has signed contracts with experienced orthodontists (consultants) to carry the responsibility of screening and offering subsidized treatment to those having the most urgent treatment need. For this purpose the orthodontist is free to use whatever yardstick he/she finds most useful. The Swedish Medical Board Index (SMBI) is most commonly used, and was used by the consultants in this study.

It is obvious that the selection process under these conditions must be affected by a subjective opinion and consequently the inter-examiner variation would be large, especially for subjects presenting with borderline treatment need.

The aim of the study was to evaluate the uniformity in selection of subjects for subsidized orthodontic care with focus on borderline treatment need. Six consultant orthodontists volunteered to participate. Each orthodontist was asked to recruit patients whom they considered to have borderline treatment need. 34 adolescents; 25 girls and 9 boys (mean age 14,5 ±1,68 years), were recruited. These patients were individually assessed by each orthodontist.

The interexaminer agreement was tested by use of Cohen's kappa statistics (κ=0.324). Since all six orthodontists fully agreed in only one third of the cases the validity of the assessments with the present guidelines is insignificant, at least in subjects with borderline treatment need.

Key words

Orthodontic index, clinical, treatment need

[1]Department of Dental Medicine
[2]Division of Orthodontics
[3]Karolinska Institutet, Stockholm, Sweden

Grad av kongruens mellan olika bedömare vid urval till subventionerad tandregleringsbehandling i Stockholms län

NABIL MOCKBIL, JAN HUGGARE

Sammanfattning

◎ I Stockholms Läns Landsting erbjuds subventionerad ortodontisk behandling till 25% av alla barn och ungdomar till och med 19 års ålder. Stockholms Läns Landsting har kontrakterat ett antal erfarna ortodontister att utföra urvalet av patienter och erbjuda subventionerad ortodontisk behandling till patienter med störst behandlingsbehov. Dessa ortodontister / urvalstandläkare är fria att använda vilka hjälpmedel de vill för att utföra urvalet. Det vanligast förekommande är dock att Socialstyrelsens Index används, vilket också gjordes av samtliga ortodontister i denna studie.

Det ter sig uppenbart att urvalet i sig påverkas av ortodontisternas subjektiva bedömning och således bör en stor spridning ses mellan olika bedömare, särskilt när det rör sig om patienter med ett s.k. borderline treatment need, dvs. gränsfall för bedömning av subvetionerad/ icke subventionerad ortodontibehandling då patienterna har ett otydligt behandlingsbehov.

Målet med denna studie var att granska graden av kongruens mellan olika ortodontister vid bedömningen av patienter som ansågs ha ett otydligt behandlingbehov. Sex urvalstandläkare anmälde sitt intresse till att medverka. Varje urvalstandläkare ombads att rekrytera patienter som de ansåg vara gränsfall beträffande indikation för subventionerad vård. 34 patienter; 25 flickor och 9 pojkar (medelålder 14,5 ± 1,68 år) medverkade. Samtliga patienter undersöktes indiviuellt av var och en av urvalstandläkarna.

Graden av kongruens (interexaminer agreement) mellan urvalstandläkarna testades med hjälp av Cohen´s kappa statistik (=0.324). Eftersom samtliga sex urvalstandläkare var ense i en tredjedel av alla fall är tillförlitligheten av deras bedömningar svag, i alla fall när det rör sig om patienter med ett otydligt behandlingsbehov/ gränsfall för subventionerad ortodontibehandling.

Introduction

Numerous Fennoscandinavian studies have been published on the need for orthodontic treatment (10, 13, 22, 11, 19, 9, 14, 25, 12). They report that between 25% and 40 % of children are in obvious need of treatment.

Having third party financing, which is common particularly in the Scandinavian countries, there is great pressure in limiting the number of patients receiving orthodontic care. That is why a lot of emphasis has been devoted to the development of treatment need indices in Scandinavia.

The "Swedish Medical Board Index (SMBI)" was developed in 1966 in collaboration between the Orthodontic Section of the Swedish Dental Association and the Swedish Society of Public Service Orthodontists (18,30). It groups morphological traits into 4 categories of need; very urgent, urgent, moderate, little need. It was later revised by *Linder-Aronson et al.* 1976, (19) whereby a fifth category comprising subjects with no treatment need at all was added (Figure 1). It has been shown that applying the SMBI, roughly 25% of a child cohort in Stockholm County aged 8-16 years fall into categories 3 and 4 (very urgent/urgent treatment need) (20). Since Stockholm County has budgeted for treatment of 25% of all children and youths up to the age of 20, only those patients with the greatest need will be offered subsidized treatment.

The routines for the selection of patients to be offered subsidized orthodontic treatment is as follows: The patients are examined yearly by the general dental practitioners. If a patient is considered to have an urgent need for orthodontic treatment, an orthodontist under contract with Stockholm County is consulted. There are three fractions of orthodontists in Stockholm County; orthodontists from the educational sector (Karolinska Institutet), orthodontists from the public sector (Folktandvården Stockholms Län AB) and orthodontists from the private sector. All three fractions are represented in the group of orthodontists who are under contract with Stockholm County to consult and deliver care to potential orthodontic patients. Screenings take place where

Figure 1. Swedish Medical Board Index.

4) **Very Urgent Need.** Appearance and/or functionally handicapping anomalies, e.g. cases with cleft lip and palate, extreme post- and prenormal occlusion, impacted maxillary incisors, extensive aplasia.

3) **Urgent Need, e.g.** Prenormal anterior forced bite, deep bite with gingival irritation, extremely open bite, crossbite and scissorsbite causing transverse forced bite, severe frontal crowding or spacing, impacted canines, cosmetically and/or functionally disturbing rotations.

2) **Moderate Need,** e.g. Esthetical and/or functionally disturbing proclined or retroclined incisors, deep bite with gingival contact without gingival irritation, pronounced crowding or spacing, infraocclusion of primary molars and permanent teeth, moderate frontal rotations.

1) **Little Need.** Minor deviations from normal (ideal) occlusion, e.g. prenormal occlusion with little negative overjet, postnormal occlusion without other anomalies, deep bite without gingival contact, open bite with little frontal opening, crossbite without occlusal interference, mild crowding or spacing, inversion of single teeth without forced guidance, slight rotations of only little esthetical and/or functional significance.

0) **No Need.**

The subjective need of treatment: Patient and/or parents perception of treatment need should be graded from 1 to 4, where 4 represents very large need and 1 represents only slight need.

The assessment of treatment need should be a balance between the subjective treatment needs i.e. the patient's wishes, and the evaluation of the examiner. There could be anomalies which seem to be of little treatment need to the examiner, but which are a burden for the patient. This treatment need index should be used as a basic guide.

the orthodontist examines each such patient for approximately ten minutes and makes a decision as to whether the patient should be offered subsidized orthodontic treatment or not. Although the consultants are free to use whatever yardstick he/she wishes, the SMBI is most commonly used.

Unlike most other counties in Sweden, Stockholm County has allowed for private orthodontists to treat this group of 25% who are offered subsidized care. The patients are free to actively choose the orthodontist whom he/she prefers to be treated by. Since the number of patients to receive subsidized care per year is set based on the number of children born and living in Stockholm, the decision as whether to offer subsidized treatment or not has to be taken directly upon screening i.e. the patient is not put on a waiting list were a cut off point will decide the decision of treatment at a later date, as is the case in other Swedish counties. To make this system fair for the patients it would be most important that the method of patient selection possesses high intra- and interexaminer reproducibility, which will be expressed as good interexaminer uniformity.

The aim of this study was to assess the uniformity of selection in patients with a borderline need for orthodontic treatment.

Materials and Methods

A meeting was held with the consultant orthodontists of Stockholm County whereby the planned study was described, and the orthodontists were invited to volunteer for the study. Six orthodontists volunteered; three from the educational sector, two from the private sector and one from the public sector. All were experienced orthodontists and consultants. Three of the consultants were calibrated through meetings of the Stockholm County consultants where cases with borderline treatment need were regularly discussed. Each orthodontist was asked to offer a "second opinion" assessment to adolescents at the clinics they were consulting. This offer was given to subjects with "borderline malocclusion" (malocclusions doubtfully belonging to category 3 according to the Swedish Medical Board Index).
Further criteria for inclusion were:

- Early permanent dentition
- Good oral hygiene
- Patients should be self motivated for treatment

Thirty-six patients were selected and invited to participate in the second opinion assessment. However, two patients cancelled their appointments and were therefore excluded (Table 1).

All thirty four patients convened at the clinic of the Section of Orthodontics, Department of Dental Medicine, Karolinska Institutet for a second consultation. Each orthodontist individually examined the patients in the same manner and for the same amount of time as during a regular consultation. The orthodontists were free to use any aids they deemed necessary to decide the outcome of their selection (subsidize treatment or not). The consultant orthodontist filled in a form for each patient (Figure 2).

Each orthodontist independently examined each patient for ten minutes. The forms for each patient were submitted immediately after each examination, thus the results remained unknown for the other orthodontists.

Impressions for study casts were taken and the patients were photographed (three intraoral photographs; right- left- and front views with teeth in occlusion and three extra oral photographs; en face, en face smiling, and profile). These were to be used retrospectively if needed, to examine the extent of the malocclusions.

The interexaminer agreement was tested by use of Cohen's kappa statistics (28). Kappa is a value showing the quality of agreement (Table 2), Cochran's Q test was used to assess systematic disagreement within a group (29).

Table 1. Number Age and sex distribution of subjects recruited for second opinion treatment need assessment.

	Total	Girls	Boys
n	34	25	9
Age range (years)	11-18	13-18	11-15
Mean age (years)	14,5 ±1,68	14,75 ± 1,73	13,75 ± 1,38

Figure 2. Orthodontists Questionnaire

- Diagnosis?
- Would you offer subsidized care: yes / no
- Motivate your assessment

Table 2. Kappa values and their meanings (Landis and Koch, 1977)

Kappa Value	Quality of agreement
0.00< kappa ≤0.40	Inadequate agreement
0.40< kappa ≤0.60	Adequate agreement
0.60< kappa ≤0.75	Good agreement
Kappa >0.75	Very good agreement

Results

Six orthodontists screened 34 patients, making a combined 204 assessments. The results were based on the combined assessments for each patient i.e. a patient could have six votes for treatment or six votes against treatment and all the combinations in between. The results shown in Table 3 reveal the distribution of votes.

The Kappa value (κ) for all six orthodontists was 0.3240. The subgroup of calibrated orthodontists had a Kappa value (κ) of 0.294, while the uncalibrated orthodontists had a Kappa value (κ) of 0.371

Total agreement was said to exist when all six orthodontists were in agreement as to whether the patient was to receive subsidized treatment or not (i.e. the number of votes were either 6-0 or 0-6). Partial agreement was said to be when at least one orthodontist was opposed to the majority's assessments but not when the votes were tied (i.e. the vote distribution was 5-1, 4-2, 2-4 or 1-5). Total disagreement was said to be when the votes were tied at 3-3. Table 4 explains the uniformity of the assessments.

Using Cochran's Q test, a value of p=0.126 was obtained. Thus, no systematic disagreement was seen within the group of orthodontists nor within the subgroups of calibrated or uncalibrated orthodontists ; p=0.8 and p=0.63 respectively. No systematic disagreement was seen between the two subgroups either; p=0.61.

Table 3. Distribution of assessments regarding subsidized/ non subsidized orthodontic treatment among six consultant orthodontists in Stockholm County

Assessments for treatment-against treatment	n	%
6-0	4	12
5-1	4	12
4-2	3	8
3-3	5	15
2-4	7	21
1-5	5	15
0-6	6	17

Table 4. Uniformity of selection of 36 subjects with borderline treatment need.

	n	%
Total agreement	10	29
Partial agreement	19	56
Total disagreement	5	15

Discussion

The Dental Service Board of the Stockholm County Council stipulates that patients belonging to categories 3 and 4 of the Swedish Medical Board Index (SMBI; urgent treatment need and very urgent treatment need respectively) should be offered treatment. Category 2 patients should not routinely be offered treatment. However, the SMBI also states that esthetic, functional and psychosocial aspects should be taken into account when deciding upon possible treatment. This calls for subjective views and evaluations to be considered. It has been shown that inter-examiner reliability is strongest when applying the SMBI to the patients possessing major or minor anomalies, but not so strong in moderate anomalies (21). Unlike in *Malmgren´*s study,(21) all of our patients were eager and willing to undergo orthodontic treatment. This fact enabled us to focus on the objective treatment need only which would apparently simplify the decision making for the orthodontist. On the other hand, it has been shown in numerous studies that crowding seems to be the anomaly with lowest inter-examiner reliability (23, 7, 24). Since most of the subjects in the present study express mild to moderate crowding, this could be a feasible explanation for the lack of uniformity in assessment in this study.

Previous studies show significantly better results regarding uniformity of intraoral malocclusion assessments (24). For this study specific calibration procedures were designed immediately prior to trial; both on study casts and intraorally, whereas in our study the calibration comprised a more general form of case discussions not specificly designed for study purposes. In other studies assessments were made on study casts (2). Some studies have shown that the comparison between a clinical examination and study casts differ (7).

The number of patients and orthodontists taking part in this study could be discussed. 36 patients were thought to be the maximum number of patients that could be screened in this way during a single day, for practical and logistical reasons. Yet possible weaknesses of this study lie not on the number of patients but rather on the number of consultants. A drawback of only having six orthodontists could be that one of them would be extreme in his/her assessment; either very generous or very restrictive in offering treatment. This would invariably skew the results. The Cochran Q test dispelled this possibility.

It was expected that the subgroup of calibrated orthodontists would have a better interexaminer

agreement compared to the uncalibrated orthodontists, yet this was not so. Both subgroups showed inadequate agreement, with no systematic disagreement within or between the subgroups.

Having six orthodontists, the patients endured the screening for one hour, then stayed an additional half an hour in order to be photographed, have impression taken, and answer the patient questionnaire. For ethical reasons, we felt this was a substantial amount of time for the patient, considering how a routine screening would take no more than 10 minutes. Furthermore we felt these six orthodontists, all with many years of screening experience, were able representatives of their respective working sectors (educational, private and public).

The orthodontists were asked to motivate the reasons behind offering subsidized treatment or not. However, this was not commented on in the results as no systematic disagreement was seen.

A previous study, excluding subjects with borderline treatment need, shows that approximately 25% of children and youths in Stockholm County have an urgent need for orthodontic treatment. This figure includes all subjects belonging to categories 3 and 4 of the SMBI (20). It is, however, important to be aware of the fact that using the SMBI, one third of all possible patients belong to the category of moderate treatment need (4), assumably those expressing equivalent traits of occlusal deviations as the subjects of our current study. Using other indices such as IOTN (3), the results are the same; a third of all potential patients belong to the category of borderline or moderate treatment need (5).

There is a general agreement among orthodontists that indexes cannot be completely validated (26). Evidence for psychosocial effects of malocclusions and their treatment are incomplete (27, 31) and recent studies are contradictory. According to *de Oliveira & Sheiham* (6) adolescents having completed orthodontic treatment have less oral health impacts on their daily lives than those not having had orthodontic treatment whereas *Kenealy et al.* (16) report no long-term psychological health improvement related to orthodontic treatment.

Selection and ranking of patients differ depending on the index used since some indexes are more suited for estimating treatment outcome than treatment need (1). In indices operating with a broad scale, as for instance the Index of Orthodontic Treatment Need (IOTN), cut off points can also limit the number of patients to receive treatment, depending on where in the index they are placed (8,15).

Although there was complete agreement in only one third of our subjects, this figure would probably drop even more if it was applied to the real life setting of Stockholm County. The availability of resources in real life depends on the number of patients already offered treatment at any given time of the year i.e. resources are bountiful at the start of the year and most often limited during the later part of the year. In our study, the resources were taken to be unlimited. This results in a situation which at best can be described as unfair to the patient. He/she will be assessed differently depending on who is assessing, and when the assessment is being made.In conclusion, since full agreement was achieved only in one third of subjects with borderline treatment need, the validity of the assessments with the present guidelines is insignificant.

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Address
Dr Jan Huggare
Department of Dental Medicine
Division of Orthodontics
Karolinska Institutet
141 04 Huddinge
Sweden
E-mail: jan.huggare@ki.se

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Orofacial and general disorders in oral medicine patients

Oral and medical history

INGER MC LUNDSTRÖM

Abstract

◉ The aim of this study was to discover possible connections between general diseases and oral mucosal disorders, and between different oral symptoms by studying the prevalence of various such conditions in oral medicine patients.

For this study 2640 consecutive patients (841 men, 1799 women) were interviewed concerning orofacial and systemic symptoms and diseases. The report includes all patients and the main diagnostic groups were: oral lichen planus/lichenoid (OLP), oral dysfunction (OD), recurrent aphthous stomatitis (RAS), oral candidosis (CAN), hyposalivation (HSA), reactive lesions (REA), and leukoplakia (LEU). Results were compared to a reference group (REF) and the normal population (NOP)(when possible).

Fifty-eight per cent of all patients experienced oral smarting and orofacial pain and 36% subjective dryness. Women were more often affected. The OD, OLP, RAS and HSA groups reported significantly more orofacial pain and headache than the REF group. Tobacco was used by 17%. LEU and CAN patients had the highest frequencies, 65% and 39%. In the total patient sample cardiovascular diseases were noted in 24%, gastrointestinal disorders in 48%, skin symptoms in 45%, diabetes in 6% and thyroid diseases in 10%. The HSA and OD patients had significantly more gastrointestinal and the HSA and CAN more endocrine disorders than the NOP and REF groups. Forty-seven per cent of the women were postmenopausal and 28% reported vaginal complaints. Vaginal symptoms were most common in HSA patients (45%), 58% of them also stating dry eyes. Prolonged general pain was frequent, especially in HSA, OD, and OLP patients where significant differences were noted to the references. Women were most often affected. Psychological problems were recorded for 53% and were correlated to oral smarting, orofacial and back pain.

Orofacial and general pain, symptoms from other epithelial organs, and psychological problems as well as correlation between the different disorders were frequent in oral medicine patients.

Key words

Burning mouth syndrome, medical history, mucosal diseases, orofacial diagnoses, orofacial symptoms, systemic diseases

Department of Oral Medicine, University Hospital, Linköping, Sweden

Orofaciala och allmänmedicinska sjukdomar och symtom hos oralmedicinska patienter

Oral och medicinsk anamnes

INGER MC LUNDSTRÖM

Sammanfattning

◉ Syftet med studien var att kartlägga möjliga samband mellan allmänna sjukdomar och orala slemhinnesymtom och också mellan olika orofaciala besvär genom att rapportera prevalens av sjukdomar och symtom samt eventuell korrelation mellan dessa hos ett oralmedicinskt patientklientel.

Med hjälp av ett standardiserat formulär intervjuades vid första undersökningstillfället 2640 konsekutiva remisspatienter (841 män, 1799 kvinnor) angående orofaciala och systemiska sjukdomar och symtom. Redovisningen omfattar den totala patientgruppen och gruppering efter orala huvuddiagnoser: oral lichen planus/lichenoid (OLP), oral dysfunktion (OD), recidiverade aftös stomatit (RAS), oral candidosis (CAN), hyposalivation (HSA), reaktiva nybildningar (REA) och leukoplaki (LEU). Resultaten jämfördes med en referensgrupp (REF) och, där så var möjligt, med normalpopulationer (NOP).

58% av alla patienter hade besvär av munsveda, orofacial smärta uppgavs också av 58% och 36% kände sig muntorra. Kvinnor hade oftare besvär än män. OD-, OLP-, RAS- och HSA-grupperna hade signifikant oftare orofacial smärta och huvudvärk jämfört med REF-gruppen. Totalt använde 17% tobak. Flest tobaksanvändare sågs i LEU- och CAN-grupperna (65% respektive 39%). I det totala patientmaterialet noterades kardiovaskulära sjukdomar hos 24%, gastrointestinala hos 48%, hudproblem hos 45%, diabetes hos 6% och thyroideasjukdom hos 10%. Gastrointestinala besvär var signifikant vanligare hos HSA- och OD-patienterna och både HSA och CAN hade signifikant fler endokrina sjukdomar än NOP- och REF-grupperna. 47% av kvinnorna var i menopaus och 28% hade vaginala slemhinnebesvär. Vaginala problem var vanligast hos kvinnorna I HSA-gruppen (45%), där också 58% hade besvär av ögontorrhet. Långvarig muskuloskelettal värk var vanligt, speciellt bland HSA-, OD- och OLP-patienter, där signifikanta skillnader sågs jämfört med referensgrupperna. Värk var vanligare hos kvinnor än män. Psykologiska problem angavs av 53% och kunde korreleras till oral sveda, orofacial värk och rygg-nackbesvär.

Orofacial och generell smärta, psykologiska problem och symtom från andra epiteliala organ än munhåla, liksom korrelation mellan de olika besvären noterades ofta hos de oralmedicinska patienterna, vilket bör beaktas vid utredning och behandling.

Introduction

The aetiology of several oral mucosal lesions and other symptoms involving the mucosa is still uncertain or unknown. In general, local and systemic factors may contribute to the disorders. Locally, traumatic, toxic, infectious and allergic irritants have been reported for the main diagnoses e.g. oral lichen planus, aphthous stomatitis, candidosis, leukoplakia, xerostomia and burning mouth syndrome (BMS) (42-45, 47, 56, 66). Systemic diseases such as cardiovascular changes (26, 57) and nutritional disorders, like deficiencies (8, 14, 15, 31, 46, 47, 66), hormonal changes and gastrointestinal problems have been demonstrated (6, 13, 41, 44). The presence of these and other local and systemic factors have, however, often been described in rather limited patient groups or with regard to only a few factors, which makes it difficult to draw reliable conclusions. Consistently recorded full anamnestic information in patients referred to an oral medicine department has to our knowledge not been published previously. So the large consecutive patient material in this investigation may significantly improve our knowledge

Patients and methods

The study comprised 2640 consecutive patients, 1799 females and 841 males, who had been referred for diagnosis of mucosal symptoms to the Department of Oral Medicine at the University Hospital in Linköping, Sweden (Figure 1). After accomplished examination oral and any new medical diagnoses were recorded. Presented findings are reported for the total group as well as for the largest subgroups based on each patient's main clinical oral diagnosis. The subgroups were *oral lichen planus/oral lichenoid lesions (OLP), oral dysfunction (OD)* including myofascial pain with and without joint symptoms, *recurrent aphthous stomatitis (RAS), oral candidosis (CAN), hyposalivation (HSA)* including primary and secondary Sjögren's syndrome, *reactive lesions (REA)* and *leukoplakia (LEU)*. Table 1 lists number, sex, age of the patient groups, and debut and duration of symptoms.

OLP, RAS, LEU and REA diagnoses are based on the clinical appearance of the lesions and according to WHO's definitions (34); histopathological verification (PAD) was also made in atypical cases and in cases where dysplasia or malignancy had to be excluded. CAN was verified by cultivation, the effect of fungistatic treatment, or both. HSA was defined by a very low secretion rate, < 0.10 ml/min, of whole resting saliva. The Sjögren patients within the HSA group (67 women, 8 men) were diagnosed according to the Copenhagen criteria (49) but also fulfilled the criteria proposed by the American-European Consensus Group (72). Diagnoses of OD with myofascial pain with and without joint symptoms were based on the Research Diagnostic Criteria for Temporomandibular Disorders, RDC/TMD, (18). Besides myalgia with or without joint symptoms, all OD patients had symptoms at the mucosal sites but no specific lesions except signs of dysfunction like impressions at the borders of the tongue, lips or cheeks or marked tooth attrition.

Figure 1. Age and sex distribution of 2640 consecutive patients referred for diagnosis to the Oral Medicine Department, University Hospital, Linköping, Sweden

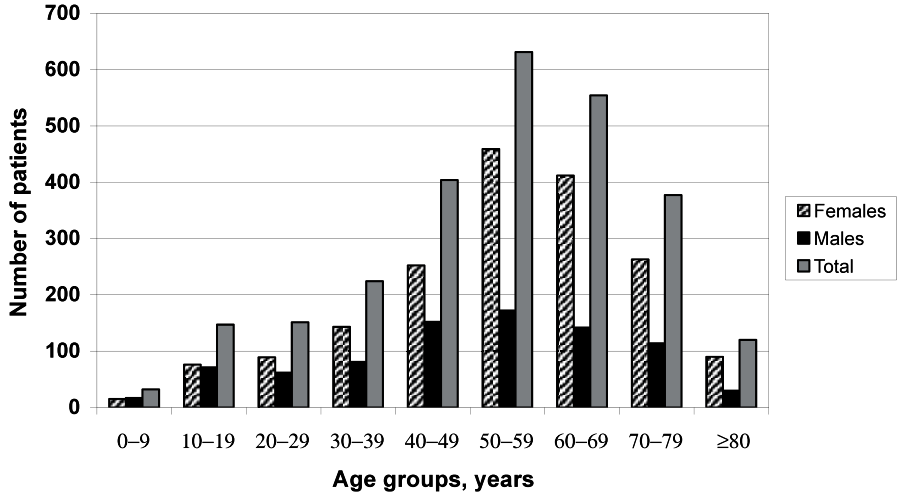

Table 1. Gender, number investigated, age at first examination, age at the debut of symptoms, and mean values (m) of disease duration in all oral medicine patients, in the main diagnostic groups, and in the reference group

Diagnosis	Sex	N inv	Age m years	Age range	Age debut m years	Duration m years
All ptts	F	1799	54.7	2-94	49.9	4.8
	M	841	49.6	2-92	44.8	4.8
	Tot	2640	53.1	2-94	48.3	4.8
OLP	F	514	59.8	14-93	56.1	3.7
	M	289	55.7	15-90	52.0	3.7
	Tot	803	58.3	14-93	54.6	3.7
RAS	F	139	32.6	6-90	20.2	12.5
	M	104	27.8	7-78	15.3	12.6
	Tot	243	30.6	6-90	18.1	12.5
CAN	F	84	54.2	7-89	50.8	3.4
	M	34	60.1	13-85	54.7	5.4
	Tot	118	55.9	7-89	52.0	4.0
OD	F	402	55.6	12-89	50.8	4.8
	M	107	52.1	11-81	47.7	4.4
	Tot	509	54.9	11-89	50.1	4.8
HSA	F	241	57.2	19-92	51.3	5.9
	M	39	53.3	15-80	48.6	4.8
	Tot	280	56.7	15-92	51.0	5.7
REA	F	54	52.4	6-88	50.3	2.3
	M	43	45.9	11-91	42.2	4.0
	Tot	97	49.6	6-91	46.7	3.0
LEU	F	29	56.2	22-83	53.7	2.5
	M	39	52.1	26-87	50.0	2.1
	Tot	68	53.8	22-87	51.6	2.3
REF	F	33	54.0	15-78	-	-
	M	17	49.0	14-78	-	-
	Tot	50	52.3	14-78	-	-

OLP, oral lichen planus/lichenoid lesions; RAS, recurrent aphthous stomatitis; CAN, oral candidosis; OD, oral dysfunction; HSA, hyposalivation; REA, reactive lesions; LEU, leukoplakia; REF, reference group; F, females; M, males

At the first examination, a standardized protocol was used to interview all patients regarding orofacial and systemic symptoms and diseases. If necessary, additional information was retrieved from patients´ medical records. Orofacial status was recorded concerning clinical symptoms from the mucosa, extra- or intra-oral muscles, joints, dentition, and salivary function. All patients were examined by the author. Protocol data were entered into a database. This article reports the prevalences of the anamnestic diseases and symptoms and comparisons are made between the different diagnostic subgroups and with a reference group (REF). The REF group comprised 50 patients with no oral soreness, ulcers, or other mucosal lesions. They had been referred to the Maxillofacial Unit for non-acute dentoalveolar surgery and were age- and sex-matched with the investigation group (Table 1). Results for some health factors, systemic symptoms and diseases were also compared with prevalences for the Swedish normal population (NOP) in the actual region when such information was available (53, 54). The study database also contains orofacial status, blood analyses, implemented treatment, and treatment results, which will be reported in future papers.

Statistical methods

The chi-square test was used to determine differences regarding various diseases and symptoms depending on diagnosis groups as well as between each diagnosis group and the REF group. The chi-square test was also used to analyse possible differences in symptoms between REF cases and the entire patient group. Logistic regression analyses were used to control for age in analyses between the RAS and REF groups. Possible relationships to age-matched Swedish normal population samples were studied using the chi-square goodness-of-fit test. Analyses of the

normal population included gender as a variable for chosen symptoms. The level of significance was set at 5% for all tests.

Results

Age, gender and disease duration

At the first examination, patients' mean age was 53.1 years (Table 1). Mean age varied between 50 and 58 years in all groups except the RAS group, where mean age was 30.6 years. Sixty-eight per cent of all patients were female; females also predominated in most groups and predominance was highest in HSA (86%) and OD (79%). Sex distribution in the RAS group was more even (57% females), and only in LEU patients did males predominate (57%). Longest duration (mean 12.5 years) and earliest debut of symptoms (mean 18.1 years) occurred in the RAS group.

Orofacial history

Ulcers, smarting, orofacial pain

Recurrent ulcers or blisters were reported by 43% of all patients and of course, by 100% of those with RAS (Table 2), 67% of whom had ulcers occurring more than once a month. Forty-five per cent and 53% of the OLP and CAN groups, respectively, reported ulcerations that, with the exception of RAS, differed significantly from the other diagnostic groups ($P < 0.01$).

Smarting with or without visible lesions was reported by 58% of the all patients. RAS patients had significantly more problems with smarting than the other groups ($P < 0.001$), followed by OD patients. Sixty-five per cent of the OD patients complained about smarting and soreness despite only 28% of them reporting occasional ulcerations or other mucosal lesions. Smarting was reported more often by

Table 2. Relative frequencies (%) of subjective orofacial symptoms and tobacco use in all oral medicine patients, in the main diagnostic groups, and in the reference group

Diagnosis	Sex	N inv	Ulcers	Smarting	Orofac pain, headache			Dryness	Swelling	Tobacco
					Orofacial	Head	Tot			
			%	%	%	%	%	%	%	%
All ptts	F	1799	44	62	48	41	64	42	34	14
	M	841	41	48	30	28	45	22	24	24
	Tot	2640	43	58	43	37	58	36	31	17
OLP	F	514	50	69	43	37	60	32	25	13
	M	289	37	43	31	27	46	19	15	24
	Tot	803	45	60	39	33	55	28	21	17
RAS	F	139	100	95	41	44	60	17	29	4
	M	104	100	94	23	31	46	7	25	7
	Tot	243	100	95	33	38	54	12	27	5
CAN	F	84	54	60	26	25	40	46	27	32
	M	34	50	56	12	21	29	44	12	56
	Tot	118	53	58	22	24	37	46	23	39
OD	F	402	28	67	67	55	82	43	49	15
	M	107	30	58	58	42	72	36	37	27
	Tot	509	28	65	65	52	80	42	47	17
HSA	F	241	37	48	56	48	70	94	34	14
	M	39	28	26	33	41	56	92	31	18
	Tot	280	36	45	53	47	68	94	34	15
REA	F	54	15	11	19	28	37	20	19	17
	M	43	16	0	12	7	16	5	12	23
	Tot	97	15	6	15	19	28	13	15	20
LEU	F	29	28	17	21	24	34	31	10	55
	M	39	23	26	31	23	41	15	15	72
	Tot	68	25	22	26	24	38	22	13	65
REF	F	33	-	-	15	21	36	27	0	9
	M	17	-	-	0	12	12	6	6	6
	Tot	50	-	-	10	18	28	20	2	8

OLP, oral lichen planus/lichenoid lesions; RAS, recurrent aphthous stomatitis; CAN, oral candidosis; OD, oral dysfunction; HSA, hyposalivation; REA, reactive lesions; LEU, leukoplakia; REF, reference group; F, females; M, males

women (62%) than men (48%) (P < 0.001).

Orofacial pain including frequent headache or symptoms from the jaws, cheeks or the temporomandibular joints was noted in 58% of all patients (Table 2). Like smarting, more females reported aching pain than males (P < 0.001). Eighty per cent of the OD group had symptoms of pain: 52% had headaches of tension and/or migraine type and 65% had problems related to jaw dysfunction. Overall and concerning headache and orofacial pain, frequencies were significantly higher in the OD group than in all other groups, including the REF group (P < 0.001). In OD patients with joint symptoms, frequencies of headache (58%) and orofacial pain (71%) were significantly higher than in OD patients with no joint symptoms (41% and 54%, respectively) (P < 0.001). OLP, RAS and HSA patients were also frequently affected as over 50% of them complained about some kind of pain (Table 2). Headache (P < 0.05) and orofacial pain (P < 0.01) were also significantly more common in these groups than in the REF group.

Subjective dryness, taste, swelling, and tobacco use

Thirty-six per cent of all patients and 94% of the HSA group with objectively registered hyposalivation reported inconvenience because of *oral dryness* (Table 2). CAN, OD, and OLP patients also reported that the feeling of dryness was common, especially the women; in the original sample, women experienced dryness more often than men (P < 0.001). Significant differences were noted between the HSA

Table 3. Relative frequencies (%) of registered diseases and subjective symptoms regarding cardiovascular diseases, totally and hypertension (HTN), and gastrointestinal, vaginal and skin disorders, and dry eyes in all oral medicine patients, in the main diagnostic groups, and in the reference group

Diagnosis	Sex	N inv	Cardiovasc		GI			Vaginal	Skin	Eyes
			Tot	HTN	Upper	Lower	Tot			Dry
			%	%	%	%	%	%	%	%
All ptts	F	1799	25	19	34	36	53	28	46	12
	M	841	22	15	27	19	37		43	3
	Tot	2640	24	18	31	31	48		45	9
OLP	F	514	35	23	30	33	50	29	47	4
	M	289	34	16	25	17	34		50	0
	Tot	803	35	20	28	28	44		48	3
RAS	F	139	13	9	27	27	42	21	47	3
	M	104	3	1	21	17	34		40	2
	Tot	243	9	5	24	23	39		44	2
CAN	F	84	45	26	33	32	48	23	49	11
	M	34	41	21	21	21	38		41	9
	Tot	118	44	25	30	29	45		47	8
OD	F	402	25	13	41	43	62	27	41	6
	M	107	29	15	36	28	50		40	4
	Tot	509	26	14	40	39	60		41	5
HSA	F	241	37	20	43	49	64	45	56	61
	M	39	36	26	36	38	54		67	38
	Tot	280	37	21	42	47	63		59	58
REA	F	54	26	20	24	19	35	19	24	4
	M	43	16	9	14	5	19		19	0
	Tot	97	22	15	20	12	28		22	2
LEU	F	29	24	17	31	38	59	31	34	0
	M	39	23	13	31	10	38		33	0
	Tot	68	24	15	31	22	47		34	0
REF	F	33	24	18	30	33	48	9	24	21
	M	17	24	24	24	18	35		29	0
	Tot	50	24	20	28	28	44		26	14

OLP, oral lichen planus/lichenoid lesions; RAS, recurrent aphthous stomatitis; CAN, oral candidosis; OD, oral dysfunction; HSA, hyposalivation; REA, reactive lesions; LEU, leukoplakia; REF, reference group; F, females; M, males

group and all other groups including the REF group ($P < 0.001$) and, excluding the HSA group, between the two groups CAN and OD and all other groups ($P < 0.01$). A significant correlation was also noted between subjective dryness and orofacial pain ($P < 0.001$). Only 13% of all patients reported impaired or altered taste. The problem was more common in HSA and OD patients than in the REF group ($P < 0.01$). Periodically, almost one-third of the patients (31%) felt that their lips or tongue were *swollen* (Table 2), sometimes in relation to *hypo- or paraesthesia* (10%). Swelling was most frequent in the OD group ($P < 0.001$), but also the OLP, RAS, CAN and HSA groups differed from the REF group ($P < 0.05$). Rather few patients, 17%, used *tobacco* (i.e. smoking, snuff, or chewing tobacco) (Table 2) and the frequency did not significantly differ from the 19% found in the NOP and the 8% in the REF group. However, patients with LEU (65%) and CAN (39%) were more often smokers than other patients and the REF group ($P < 0.01$), and men more than women ($P < 0.001$). RAS patients reported the lowest incidence of tobacco use, a significant difference compared with the other diagnostic groups ($P < 0.001$) but not with the REF group or with the same age group in the normal population.

General medical history

Cardiovascular disorders

Twenty-four per cent of the patients had some cardiovascular disease that required medication (Table 3). The highest prevalence occurred in CAN patients who significantly differed from the REF group ($P < 0.05$). Cardiac disorders were present in 13% of all cases, the main diagnoses being myocardial infarction, angina pectoris, and arrhythmias. This frequency is higher than the 4% to 7% observed in the same age group in the NOP and the 10% noted in the REF group, but the differences are non-significant. Systemic hypertension, with or without heart disease, occurred in 18% of all cases and in 20% of the REF group, which exceed the 7% to 10% in the NOP, but the differences were non-significant.

Gastrointestinal diseases and symptoms

Gastrointestinal (GI) problems occurred in 48% of the oral medicine patients (Table 3) and were fairly evenly distributed between the upper and the lower GI tract. These findings correspond with those in the REF group. The incidence of GI problems in HSA (63%) and OD (60%) patients was, however, significantly higher than in the REF group and all other diagnostic groups ($P < 0.05$). Controlled for age, all groups had a significantly higher frequency of GI disorders than the 2% to 6% seen in the NOP ($P < 0.01$). Overall, women reported symptoms more often than men ($P < 0.001$). Dyspepsia was the main disorder of the upper tract and occurred in 18% of the original sample; an additional 10% had diagnoses of gastritis, ulcers, or both. Regarding bowel symptoms, 18% of the total sample had problems with periodic or chronic diarrhoea and 11% with constipation. Irritable bowel symptoms had been diagnosed in 8% and inflammatory bowel diseases (Crohn's disease, ulcerative colitis and coeliac disease) in 5%. Only 5% of the OLP and 1% of the RAS patients had verified inflammatory disease. Also with regard to bowel symptoms, the incidences were significantly higher in the HSA and OD groups than in other diagnostic groups and the REF group ($P < 0.05$).

Endocrine diseases and conditions

Diabetes mellitus had been diagnosed in 6% of the total sample (Table 4). The prevalence was approximately the same in the various groups except for in CAN (12%) and LEU (10%) patients. Although no group differed significantly from the REF group, CAN patients differed significantly from their matched age group in the NOP ($P < 0.05$). The relative frequencies of insulin dependent (3%) and non-insulin dependent diabetes (3%) in the total sample was fairly equally distributed in the groups. *Thyroid disease* occurred and was treated in 10% of the total sample (Table 4). The highest incidence was noted for HSA patients (18%) and within this group thyroid disease occurred in 27% of the Sjögren cases. The prevalence in the HSA group was significantly higher than in the REF group ($P < 0.05$), and women were more affected than men ($P < 0.001$). Forty-seven per cent of all female patients were *postmenopausal* compared to 64% of the women in the REF group (Table 4). Almost one-third of the female patients took systemic oestrogen, often in combination with gestagen, which can be compared to 12% of the REF women ($P < 0.05$).

Other symptoms and diseases with ekto- and endodermal relation

Dryness and smarting in the vaginal mucosa was reported by 28% of all women (Table 3). Symptoms were significantly most frequent in the HSA group (45%) compared to all other groups and the REF group ($P < 0.001$). LEU, OLP and OD women also

had more vaginal problems than REF women ($P < 0.05$). Vaginal symptoms were positively correlated to subjective oral dryness ($P < 0.001$).

Forty-five per cent of all patients reported some kind of recurrent or chronic *skin disorder* (Table 3), and all diagnostic groups had significantly more disorders than the NOP ($P < 0.05$). Even here, the highest incidence, 59%, occurred in the HSA group ($P < 0.05$), and all groups, except REA and LEU, had higher incidences than the REF group ($P < 0.05$). Unspecific symptoms like recurrent rashes or papules, dry skin and itching were most common and registered for 29% of the patients. Nine per cent had or had had eczema (REF 6%), 3% psoriasis (REF 4%) and 5% lichenoid skin lesions (REF 0%). In the OLP group, 13% had been diagnosed with lichen and 4% with psoriasis.

Totally, 9% had problems with *dry eyes* (Table 3). HSA patients had significantly more problems (58%) than the other diagnostic groups and the REF group ($P < 0.001$). *Renal diseases* and *recurrent urinary tract infections* were rather infrequent in the total patient sample (3% and 8%, respectively). The HSA group had the highest occurrence of renal disease (10%) and infections (12%) but only with regard to infections, the difference to the 2% in the REF group was significant ($P < 0.05$).

Nine per cent of all patients had *pulmonary diseases*, often of chronic obstructive type or asthmatic bronchitis. The respiratory disorders were most frequent in CAN patients (23%) compared to the other groups ($P < 0.05$) and the REF group (6%) ($P < 0.01$). CAN and HSA (16%) patients also had more respiratory problems than the NOP ($P < 0.05$). Only 4% of all patients had had problems with recurrent *throat infections*. In the RAS group, however, several episodes of tonsillitis were reported to have preceded the onset of aphthae in 24% of the patients. The differences between RAS and all other groups, including the REF group, were significant ($P < 0.001$).

In nine patients, *oral squamous cell carcinoma* was the main diagnosis at their first visit. Three per cent of the patients and 10% of the REF group had been treated for *non-oral cancers*, but the difference was non-significant.

Additional anamnestic findings

Prolonged pain from body muscles and joints occurred in 27% of all patients. The highest prevalence was in HSA patients (59%) (Table 5) and was significantly higher than in all other diagnostic groups, the REF group, and age-matched groups in the NOP ($P < 0.001$). Women had significantly higher frequencies than the NOP ($P < 0.05$). *Back pain* was registered in 50% of the total sample. Higher incidences were found among OD, HSA, and OLP patients than among REF patients ($P < 0.05$), and all groups except REA had significantly more back problems than the NOP ($P < 0.01$). Neck problems were common and occurred in 42% of the original sample; OD and HSA patients again had significantly higher incidences than the other diagnostic groups ($P < 0.001$) and the OD, HSA, and OLP patients higher than the REF patients ($P < 0.01$). Women had significantly more often muscular and joint pain, back pain, and neck pain than men ($P < 0.001$). Various *allergies* (Table 5) were recorded in a third of the patients and there

Table 4. Relative frequencies (%) of endocrine diseases, postmenopausal women, and women treated with oestrogen and/or gestagen hormones in all oral medicine patients, in the main diagnostic groups, and in the reference group

Diagnosis	Sex	N inv	Diabetes %	Thyroid %	Postmeno %	Oest/gest %
All ptts	F	1799	6	13	47	30
	M	841	6	2		
	Tot	2640	6	10		
OLP	F	514	6	13	56	28
	M	289	7	2		
	Tot	803	6	9		
RAS	F	139	1	4	17	38
	M	104	2	0		
	Tot	243	1	2		
CAN	F	84	12	11	46	23
	M	34	12	9		
	Tot	118	12	10		
OD	F	402	5	13	52	32
	M	107	3	0		
	Tot	509	5	11		
HSA	F	241	7	20	62	31
	M	39	10	5		
	Tot	280	8	18		
REA	F	54	4	15	37	35
	M	43	7	2		
	Tot	97	5	9		
LEU	F	29	3	21	52	31
	M	39	15	3		
	Tot	68	10	10		
REF	F	33	6	6	64	12
	M	17	6	6		
	Tot	50	6	6		

OLP, oral lichen planus/lichenoid lesions; RAS, recurrent aphthous stomatitis; CAN, oral candidosis; OD, oral dysfunction; HSA, hyposalivation; REA, reactive lesions; LEU, leukoplakia; REF, reference group; F, females; M, males

were no significant differences between the groups or to the REF group. The prevalence in the OLP, OD and HSA groups, however, significantly exceeded that of the NOP ($P < 0.001$).

Fifty-three per cent of all patients reported *psychological problems* (Table 5). Prevalences in the OLP, OD, HSA, and LEU groups were significantly higher than in the REF group ($P < 0.01$) and NOP ($P < 0.001$). Stress or anxiety were the most common symptoms and noted in 32%, while depression had been diagnosed in 8%. Positive correlations between psychological disorders and each of the variables oral smarting, orofacial pain, and back pain were observed ($P < 0.001$) in the original sample. A significant correlation between orofacial pain and psychological symptoms ($P < 0.01$) was also found in the OLP, OD, and HSA groups. Patients with psychosocial problems also reported more gastrointestinal symptoms ($P < 0.05$). Some kind of *medication* was taken in 57% of the patients and 58% of the REF cases. Antihypertensives, antidepressants, or both were also taken by similar shares of all patients studied (29%), the REF group (36%) as well as the HSA group (36%). In the total patient group intake of such saliva decreasing drugs was significantly correlated to the feeling of oral dryness ($P < 0.001$).

Table 5. Relative frequencies (%) of general pain, allergies and psychosocial symptoms (stress/anxiety and depression) in all oral medicine patients, in the main diagnostic groups, and in the reference group

Diagnosis	Sex	N inv	Pain			Allergy	Psychosocial		
			Joints/Musc	Back	Neck		Tot	Stress/anx	Depress
			%	%	%	%	%	%	%
All ptts	F	1799	33	55	49	38	56	34	10
	M	841	15	39	29	27	45	28	3
	Tot	2640	27	50	42	34	53	32	8
OLP	F	514	29	54	44	38	53	38	6
	M	289	18	42	30	25	46	34	2
	Tot	803	25	50	39	33	50	37	4
RAS	F	139	22	42	34	32	38	24	6
	M	104	10	30	17	29	36	31	0
	Tot	243	17	37	27	30	37	27	3
CAN	F	84	24	40	31	42	43	20	10
	M	34	15	35	24	21	32	9	6
	Tot	118	21	39	29	36	40	17	8
OD	F	402	33	71	60	40	71	41	16
	M	107	15	58	51	25	60	35	20
	Tot	509	29	68	58	37	69	40	17
HSA	F	241	61	68	58	38	60	27	15
	M	39	44	62	46	38	51	26	8
	Tot	280	59	67	56	38	59	27	14
REA	F	54	15	26	15	37	31	24	6
	M	43	9	14	9	28	21	12	0
	Tot	97	12	21	12	33	27	19	3
LEU	F	29	24	45	31	38	66	41	10
	M	39	15	41	23	26	54	28	5
	Tot	68	19	43	26	31	59	34	7
REF	F	33	36	36	27	39	30	24	12
	M	17	29	29	6	41	18	18	6
	Tot	50	34	34	20	40	26	22	10

OLP, oral lichen planus/lichenoid lesions; RAS, recurrent aphthous stomatitis; CAN, oral candidosis; OD, oral dysfunction; HSA, hyposalivation; REA, reactive lesions; LEU, leukoplakia; REF, reference group; F, females; M, males

Discussion

Age, gender and disease duration

Age and gender distribution and age at symptom onset in the diagnostic groups agree with other reports (4, 13-15, 28, 35, 39, 44, 64, 65, 67). Females dominated in the total sample and in all groups except the LEU group where males' more frequent tobacco use may have influenced the distribution. In the HSA group 89% of the patients with Sjögren's syndrome were females, which is a common finding (17, 45, 73). Interestingly though, the sex distribution in the other HSA patients was similar as 85% of them were women. This may reflect a hormonal effect and that salivary secretion rates decrease earlier in women than men (11, 12, 19, 36, 58, 67).

Orofacial history

Smarting and soreness were frequent findings in OLP, RAS, CAN and HSA patients but also in OD patients despite lack of obvious clinical lesions. Moreover, OD patients reported the highest frequencies of orofacial pain and recurrent headaches. The frequency of headache in the OD group (52%) highly exceeds the 10% and 23% noted for men and women in a Swedish normal population (51). Several reports have diagnosed patients with only subjective mucosal symptoms and pain as BMS, which is actually a non-diagnosis. BMS should probably be classified according to various aetiologies where oral dysfunction may be one of the largest groups. Previous investigations of BMS corroborate this view (10, 23, 24, 26, 56, 57). Persons with TMD symptoms have also reported more mucosal symptoms like dryness, ulcers, and soreness than persons without TMD, which is in concordance with the correlation between subjective dryness and orofacial pain noted here. This was, for instance, demonstrated by Johansson et al (32) in a study of 50- and 60-year-olds from the same region as our patients. In their report 12% of the population reported TMD symptoms, which may be compared to 43% of our oral medicine patients. Apart from the OD group, OLP, RAS and HSA patients also had high frequencies of orofacial pain and headaches and the sore mucosal regions indicated by the patients corresponded well to those of their muscular pain. Altered blood flow and nutrition and higher levels of inflammatory substances and lactic acid in tense overactive muscles may cause increased dryness and a feeling of swelling, pinpricks, and numbness (7, 20, 26, 38, 52, 56), symptoms which were common in the OD group. Affected taste is a well-known problem in patients with decreased saliva (11, 45, 73) and was reported by one-quarter of our HSA and OD cases. The correlation found between subjective oral dryness and antihypertensive/antidepressant drugs corresponds with the report by Scully (61).

Tobacco use, mainly smoking, was significantly more common in CAN and LEU patients, a finding that corresponds well with previous reports on oral candidosis and leukoplakia (2, 3, 66). Only 5% of the RAS patients used tobacco, which partly reflects their younger age but also that smoking may inhibit or reduce RAS (5, 60). The prevalence noted in the RAS group agrees with earlier reports (33, 63). In the total patient material tobacco use did not exceed the 17% to 28 % noted in samples of the Swedish population with comparable age and sex distribution during the actual study period (54).

General medical history

Cardiovascular disorders

Cardiovascular disorders may affect the oral mucosa in two ways: (i) diminished circulation may impair nutrition and (ii) antihypertensive medication may reduce saliva. In this study, cardiovascular disease prevalence was not significantly exceeding that of the NOP and hypertension per se corresponded to the prevalence of 10% to 18% found in Swedish populations of equal age (54, 59, 75). OLP patients (13, 65) and patients with hyposalivation (12, 68) are reported to have relatively high incidences of cardiovascular disease and hypotensive medication use. But as in this study, *Gorsky et al* (22) found no correlation between OLP and cardiovascular illness.

Gastrointestinal diseases and symptoms

Gastrointestinal symptoms were common in the oral medicine patients *and* the REF group but specific verified diseases were rather rare. Only OD and HSA patients had significantly more problems than the other groups. This may be related to the increased stress and anxiety noted in these cases and the greater risk for chronic gastritis in the HSA patients with Sjögren's syndrome (55). Despite rather frequent occurrence of oral ulcerations in bowel diseases (25, 71), only 5% of the OLP and 1% of the RAS patients in this study had verified inflammatory bowel diseases. *Veloso & Saleiro* (70) noted that 16% of their RAS patients had coeliac disease without subjective symptoms, so a thorough examination of patients with diffuse symptoms may yield more exact diagnoses.

Endocrine disorders

The observed prevalences of diabetes mellitus in the CAN (12%) and LEU (10%) groups were significant-

ly higher than the 4% to 5% reported from the same age group in Swedish normal populations (30, 50, 54, 75). Although diabetes may enhance the risk of oral dryness (69) and candidosis (36, 66), the frequency of diabetes mellitus in the OLP patients in this study was not significantly higher than in the REF group, which contradicts our observations of another OLP patient group (41) but is similar to later reports (13, 62, 65). The results of this study, however, are based upon medical histories, and completing blood analyses may alter the prevalence. Tests of thyroid function, especially for hypothyreosis, is recommended since it particularly may impair metabolism in cells with a high turnover rate, such as lymphocytes, glandular cells, and mucosal cells. It may also be important in BMS cases (21) like in some of the OD group here.

Other symptoms and diseases with ekto- and endodermal relation

Wardrop et al (72) reported more oral discomfort in peri- and postmenopausal than in premenopausal women and a relation to psychological symptoms, a finding in accordance with that seen here, where vaginal symptoms furthermore were related to subjective oral dryness. Females in groups with no smarting oral mucosal symptoms, REA and REF women, had significantly less often symptoms from the skin, dry eyes and dry vaginal mucosa and were not taking systemic sexual hormones to the same extent as women in the other groups which may indicate that their need was lower. The incidence of cutaneous lichen in the OLP group (13%) agreed with the report of *Ingafou et al* (28) but not with our earlier report where 56% had or had had cutaneous lichen (44). The actual figure may, however, be higher since most patients with skin symptoms had not been examined by a dermatologist. The relatively high frequency of recurrent tonsillitis that preceded symptom onset in the RAS group indicates that the infection may be important in T-cell activation in RAS (27, 33). Due to the referral system, only a few patients in this study were primarily diagnosed with oral carcinoma. In this region, most patients with suspected oral malignancies are referred to the otolaryngeal department. The frequency of non-oral cancers corresponded well with the 2% found in a Swedish normal population (50, 53).

Additional anamnestic findings

Recurrent or chronic pain of musculoskeletal, back, or neck origin was common and as in Swedish normal populations (59), women were more often affected than men. *Psychological symptoms* were almost twice as common in the patient sample as in the REF group and in the NOP. The patients related most symptoms to stress and anxiety. The occurrence of depression was similar to in the REF group and various Swedish normal populations (50, 54, 59). Stress and anxiety were previously reported to induce or aggravate OLP and RAS lesions (16, 29, 40, 48, 76) and to increase xerostomia (9, 12). Stress will also affect muscular tension and thereby promote aching in the back, neck, head, and jaws and initiate oral lesions. *Wray et al* (76), for instance, reported increased local trauma in RAS cases. Parafunctional habits, anxiety, and depression have often been reported in BMS patients (11, 16, 56, 57). *Chaudhary* (16) noted that OLP and BMS cases were equally affected, and the symptoms and frequencies reported correspond well with those found in the OD and OLP groups here.

Conclusion

Any factor, that impairs nutrition, may affect the development of oral mucosal symptoms. This study found several local and systemic factors to be common in oral medicine patients. An important finding is the large number of patients with orofacial and general pain and psychological symptoms. The correlations between these factors and oral smarting, and subjective dryness in groups both with and *without* obvious mucosal lesions indicate that oral dysfunction /TMD, stress and anxiety may contribute to oral mucosal symptoms. The correlation between different ekto- and endodermal disorders may also indicate a common epithelial influence. This study will provide a foundation for assessing what kinds of diseases and symptoms will be relevant for future examination and treatment of patients with oral mucosal problems. Additional reports of these patients' oral and medical status and treatment results may further elucidate the connections between reported symptoms and diseases.

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Address:
Dr Inger M C Lundström
Maxillofacial Unit, Oral Medicine
University Hospital
SE-581 85 Linköping
Sweden
E-mail: Inger.Lundstrom@lio.se

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Micro-topography of dental enamel and root cementum

THORSTEN EDBLAD[1,2], MARIA HOFFMAN[3], MAGNUS HAKEBERG[4], ULF ÖRTENGREN[1,5], PERCY MILLEDNING[1], ANN WENNERBERG[3,6]

Abstract

◎ The focus for the present study was to characterise dental enamel and cementum at the cervical region of healthy teeth by use of interferometry. The effect of a protein-dissolving enzyme, used for cleaning (Neutrase®) on the surface topography, was also evaluated. Knowledge about the normal variation of surface topography of natural teeth is limited. In the design of artificial surfaces, intended to replace the function of lost biological surfaces, detailed knowledge of the latter is therefore of great importance. Nine health caries free premolars were used. The root cementum of three teeth was used for evaluation of Neutrase® on the surface. On the six remaining teeth, the differences between the surface textures of enamel and root cementum were evaluated using 3D Interferometry. No statistical significant effect of Neutrase® was identified. A significant difference between enamel and root cementum concerning surface topography using the different 3D parameters was recorded. When comparing values from the literature, the topography of artificial materials used in dentistry show similarities with the topography of the enamel and root cementum surfaces evaluated.

Key words

Dentistry, enamel, cementum, micro topography

[1]Department of Prosthetic Dentistry/Dental Materials Science, Institute of Odontology, Sahlgrenska Academy, University of Gothenburg, Göteborg, Sweden

[2]Public Dental Competence Centre for North Norway (TkNN)Tromsø, Norway

[3] Department of Biomaterials Research, Institute for Surgical Sciences, University of Göteborg, Göteborg, Sweden

[4] Oral Behavioral Sciences. Institute of Odontology, Sahlgrenska Academy, University of Gothenburg, Göteborg, Sweden

[5] Institute of Clinical Dentistry, Faculty of Medicine, University of Tromsö, Tromsö, Norway

[6] Faculty of Odontology, Malmö University, Malmö, Sweden

Mikrotopografi av emalj och rotcement

THORSTEN EDBLAD, MARIA HOFFMAN, MAGNUS HAKEBERG, ULF ÖRTENGREN,
PERCY MILLEDING, ANN WENNERBERG

Sammanfattning

◎ Genom användande av interferometri, för karakterisering av yttopografi fokuserar denna studien på en topografisk analys av emalj och cement ytor. Dessutom studerades effekten på yttopografin av Neutrase®, ett proteolytiskt enzym för rengöring, Kunskapen om den naturliga topografin på tandytor är begränsad. Vid tillverkning av artificiella ytor för ersättande av förlorad biologisk vävnad, kan kunskap om de senare kan vara av stor vikt för ett lyckat resultat. Nio kariesfria premolarer användes i studien. Tre stycken användes för utvärdering av effekten av Neutrase®. På de sex återstående tänderna studerades yttopografiska skillnader mellan emalj och cement med hjälp av 3D interferometri. Ingen statistisk signifikant effekt av Neutrase® kunde registeras. Ytstrukturen hos emalj och cement skiljde sig signifikant åt. Yttopografin på artificiella material utförda i andra studier uppvisar likheter med den värden som erhållits på emalj och cement i denna studie.

Introduction

The identification and characterization of optimal surface properties for various dental reconstructive biomaterials have drawn increasing interest from the scientific community in the last decade (13). Surface chemistry, bioactivity and surface topography are examples of topics that have been thoroughly investigated (7).

In order to design artificial surfaces of materials in contact with tissues intra orally, attention to surface roughness of the material has been of particular interest (15). Still, knowledge about the normal variation of surface topography of natural teeth is limited. In the design of artificial surfaces, intended to replace the function of lost biological surfaces, detailed knowledge of the latter could therefore be of great importance. Studies on the enamel-cement junction using replica technique and SEM have been conducted (3). Still, using SEM seems to have its limitation as a method for topographical evaluations on tooth substances. A few studies have described the topography of tooth surfaces before and after bleaching or laser treatment (5, 9, 10, 20). However, topographical descriptions have in general been limited to 2D reports of height-descriptive parameters. Reported roughness averages, height deviation (Ra) of enamel vary between 0.45 μm (19) and 9.15 μm (6). To our knowledge, only one published study has attempted to characterize the roughness of root cementum and reported Ra values of 2–3 μm (9).

In the literature, one 3D study was found that measured spatial and hybrid parameters of enamel (17). That study reported an average surface roughness (Sa) of 1.27 μm, number of summits 1271/mm2 and a surface enlargement of 47%. No study at present has reported 3D topographical characterization of root cementum.

A detailed 3D description is obtained by interferometry, a non-destroying optical reading of the surface topography, allowing repeated measurements. The main advantage of 3D analysis compared to 2D evaluation is the substantially higher amount of collected data, allowing a reliable mean value to be calculated, giving an accurate surface description (16, 18). By using well-described 3D topographical characterization, of healthy, erupted tooth surfaces, not affected by dental treatment or long time function, the cervical region can be studied. This region is of interest since that area normally represents the interface area between tooth and mucosal- and bone-tissue and more information could therefore be added in the development of implantable biomaterials.

Aim

The main aim of the present study was to evaluate topographical characteristics in dental enamel and root cementum at the cervical region of healthy teeth. In addition the influence of a proteolytic enzyme on the surface topography of root cementum was studied.

Materials and Methods

Tooth material

Nine teeth were included in the present study, where of three teeth were used for an initial study of the effects of a proteolytic enzyme. The remaining six teeth were utilized for the study on enamel and root cementum. For collection of teeth needed, a specialist clinic was contacted, where healthy, non-carious premolars that had been extracted on orthodontic diagnose. From their deposit of collected teeth, premolars from youngsters were asked for. The extraction of the teeth had been performed following ordinary routines i.e. gently removed with forceps and a luxator. Immediately after extraction, the teeth were placed in physiological NaCl solution and stored in a refrigerator at 6±2°C. Only the teeth considered stored for not more than 2 months was used for analysis. No disinfection was performed.

Initial study of cleaning effect

After extraction, a protein layer is most likely to be present on the root surface. To minimize the influence on the surface roughness, removal is desirable. However, there may be a risk that the surface will be affected by a cleaning procedure itself. Three teeth were randomly chosen to investigate whether enzymatic treatment with the protein-dissolving enzyme Neutrase® (Novozymes, Bagsvaerd, Denmark) influenced the surface of root cementum. Neutrase is a neutral bacterial protease produced by a selected strain of *Bacillus amyloliquefaciens* with an optimum activity around pH 5.5 – 7.5. The cementum surface was analyzed at the upper 1/3 of the buccal side. Measurements were performed before and after cleaning at 5 randomly selected positions in a narrow, defined, area on each tooth using an interferometer (MicroXam™, ADE Phase Shift, Tucson, Az USA) as described below. The same topographical parameters (Sa, Ssk, Sdr and Sds) were used for evaluation of the effect of Neutrase®, as for the study of the differences between the surfaces. The topographical method and parameters are described below. The microscopic photographs in Figures 1 and 2 illustrate the surface of one site before and after cleaning.

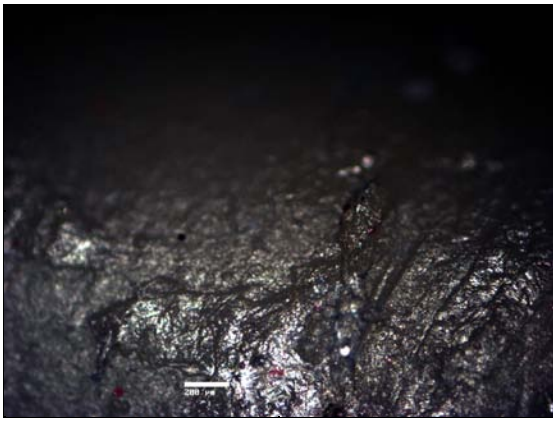

Figure 1. Microscopic picture of root cementum surface before cleaning with Neutrase® (Novozymes, Bagsvaerd, Denmark). Tooth fixed in place, surface roughness (Sa) ≈ 0.95 µm.

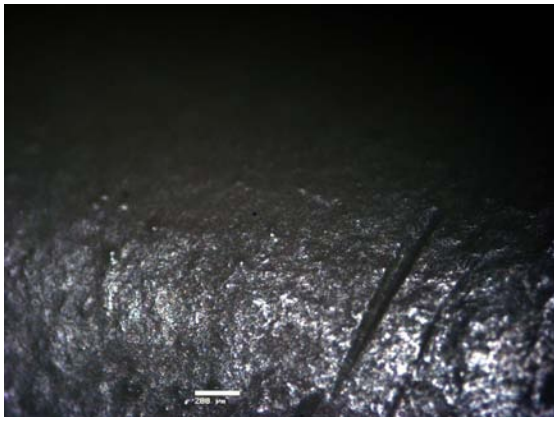

Figure 2. Microscopic picture of root cementum surface after cleaning with Neutrase® (Novozymes, Bagsvaerd, Denmark). Tooth fixed in place, surface roughness (Sa) ≈ 0.46 µm.

Soft tissue and bacterial layers on the teeth were removed by enzymatic treatment with 1% Neutrase® in separate containers for each tooth, placed in a water bath at 40 ± 2ºC for 2 hours. Following that procedure, the teeth were gently mechanically cleaned with a new soft toothbrush during 30±5 sec, while being rinsed in water. The same operator performed all of the procedures.

Topographical characterization

The remaining six teeth were analyzed, regarding enamel and root cementum surfaces, at randomly selected positions on each tooth. The measurements were done in a narrow area at the cervical 1/3 of the buccal side on enamel and root cementum. Since cleaning with Neutrase® did not show any significant changes in the surface textures (Table 1, 2).

The cleaning procedure, described above, was used for all teeth. After cleaning and carefully drying of the tooth with a soft paper napkin, the surfaces of each tooth were analyzed immediately at 30 positions, on enamel, and the same number on root cementum, with an interferometer (MicroXam™, ADE Phase Shift, Tucson, Az USA). The MicroXAM interferometer is a non-contacting optical technique for topographical characterisation thru surface mapping. The system measure the interference pattern between white light originating from a flat reference plane (a mirror) situated in the objective and the sample surface. Different parts of the surface cause phase changes in the reflected light, some waves cancel whereas others augument each other. This will result in a pattern with light and dark fringes. The surface roughness of the samples will produce irregularities in the interference pattern. The system measure height and spatial variation in the surface structure. The spatial resultion is limited to the light wavelength and is approximately 0.3 µm while the vertical resolution is as good as 0.5 nanometer. The size of each measurement area was 165 x 125 µm2. A 50x50-µm high pass Gaussian filter was used to remove errors of form and waviness during the evaluation process.

Recorded topographic parameters:

S_a (µm) The arithmetic mean deviation from a mean plane within the sampling area.

S_{sk} The skewness of the height distribution.

Table 1.

Before Neutrase	S_a(µm)	S_{sk}	S_{ds}(/µm²)	S_{dr}(%)
Mean	0.75	-0.22	0.21	41.92
Median	0.74	-0.30	0.21	45.00
Max	1.38	0.60	0.27	60.35
Min	0.48	-0.80	0.18	25.52
SD	0.22	0.35	0.03	10.14

Table 2.

After Neutrase	S_a(µm)	S_{sk}	S_{ds}(/µm²)	S_{dr}(%)
Mean	0.83	-0.53	0.27	47.81
Median	0.80	-0.31	0.27	49.14
Max	1.19	0.09	0.30	68.81
Min	0.35	-2.26	0.24	24.41
SD	0.26	0.61	0.02	16.01

A positive value indicates more peaks than pits and a negative value shows the opposite.
S_{ds} (%); The percentage of the developed surface area compared with a totally flat reference area.
Sds (1/µm2); Number of summits per square µm on the analyzed surface.

Statistical analysis
Means and standard deviations were calculated and statistical analysis between means was performed using General linear model. The level of significance was determined at 5%.

Results

Evaluation of the cleaning effect of Neutrase®
No significant differences in Sa, Ssk, Sdr or Sds ($p<0.05$) on the surfaces of the root cementum analysed before and after cleaning were observed thus 1% Neutrase® was used as cleaning method.

Evaluation of tooth surfaces
For all topographic parameters measured, a significant difference between the surfaces of enamel and cementum was recorded ($p<0.05$). With exception from the Ssk value, the significant difference between enamel and root cementum remained even though the differences between the teeth analysed was taken into consideration ($p<0.05$).

Enamel:
The average height deviation (Sa) was 0.42 µm, but demonstrated a variation from a moderate surface roughness to a smooth one, 1.57 to 0.13 µm. The height distribution (Ssk) was slightly negative, indicating the presence of pores.
The density of peak irregularities varied between 0.3/µm2 to 0.03µm2, i.e. a rather low density. The differences in height deviation and peak density resulted in a rather large difference in surface enlargement between the different measurements. Values from 0.5 % to 99 % were observed.
(Table 3), (Figure 3).

Table 3.

Enamel	S_a(µm)	S_{sk}	S_{ds}(/µm²)	S_{dr}(%)
Mean	0.42	-0.37	0.14	9.61
Median	0.37	-0.27	0.14	5.89
Max	1.57	0.91	0.30	99.01
Min	0.13	-2.22	0.03	0.55
SD	0.23	0.50	0.05	13.79

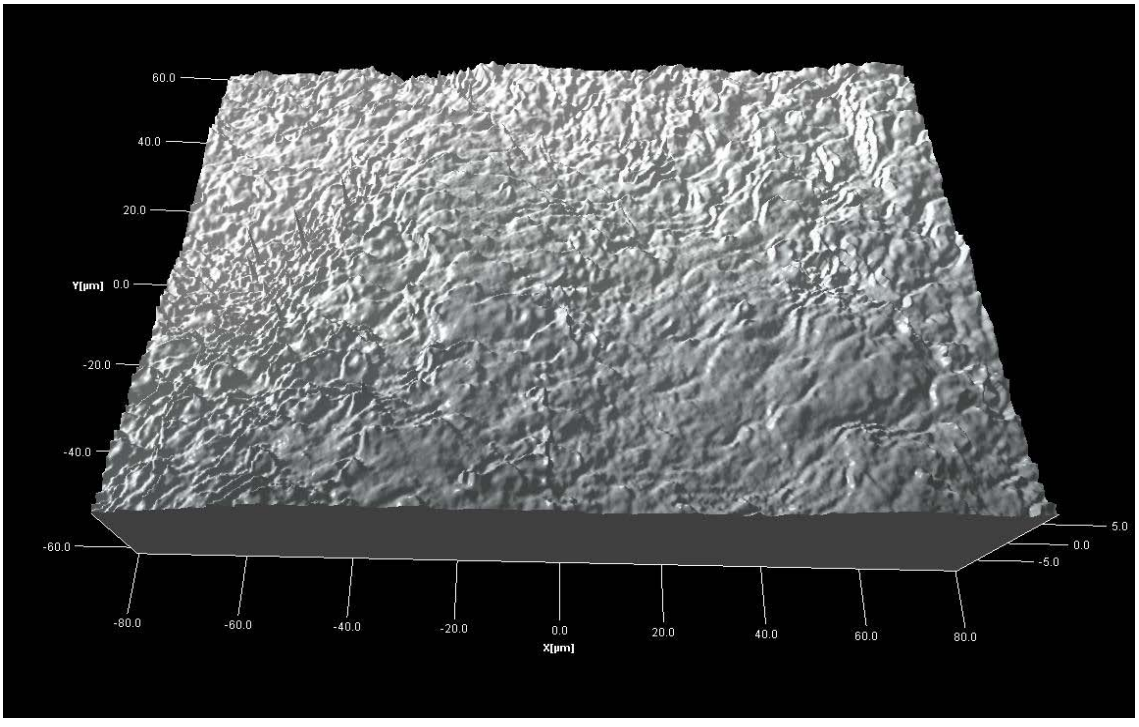

Figure 3. Digital interferometric image of enamel surface (MicroXam™, ADE Phase Shift, Tucson, Az USA). The surface roughness (Sa) of the specimen depicted was closest to the mean Sa for the group (group: mean Sa = 0.42 µm; specimen: Sa = 0.42 µm, Ssk = 0.12, Sal = 8.90 µm, Sds = 0.11, Sdr = 9.03%).

Cementum:
The cementum demonstrated an average height deviation (Sa) of 0.60 µm with less variation compared to the enamel. The negative values in the height distribution superseeded the positive values (151 out of 185), resulting in a slightly negative value for the parameter Ssk. The number of peaks per µm2 was similar between the different measurements and the mean value was 0.21/µm2.

In similarity with the enamel, the cementum demonstrated a large variation in terms of surface enlargement between the different measuring areas. The smallest enlargement was 5.5% and the largest 124% . (Table 4), (Figure 4).

Table 4

Root Cementum	S_a(µm)	S_{sk}	S_{ds}(/µm²)	S_{dr}(%)
Mean	0.60	-0.26	0.21	31.64
Median	0.56	-0.30	0.22	17.42
Max	1.21	3.46	0.28	124.34
Min	0.24	-1.80	0.11	5.54
SD	0.20	0.64	0.03	26.94

Discussion

Improved methodology including an efficient cleaning protocol and a non-contact laser topographical technique has resulted in a more comprehensive description of the tooths hard tissues in the present study than earlier publications. The result of the present study recored less surface roughness on the enamel surfaces than root cementum. The topographical characterization method used is a well established and reliable method for 3D characterisation of surfaces (1, 16). The present study is, however, one of only a few studies to our knowledge, which use a 3D topographical method to characterize tooth surfaces and also the only which describe the surface of root cementum.

To get reliable results, cleaning of the surface is essential and the cleaning must not have an effect on the surface texture. In that respect the root cementum may be more sensitive to cleaning procedures than the enamel, due to less surface hardness. In the present investigation Neutrase® was used and it has

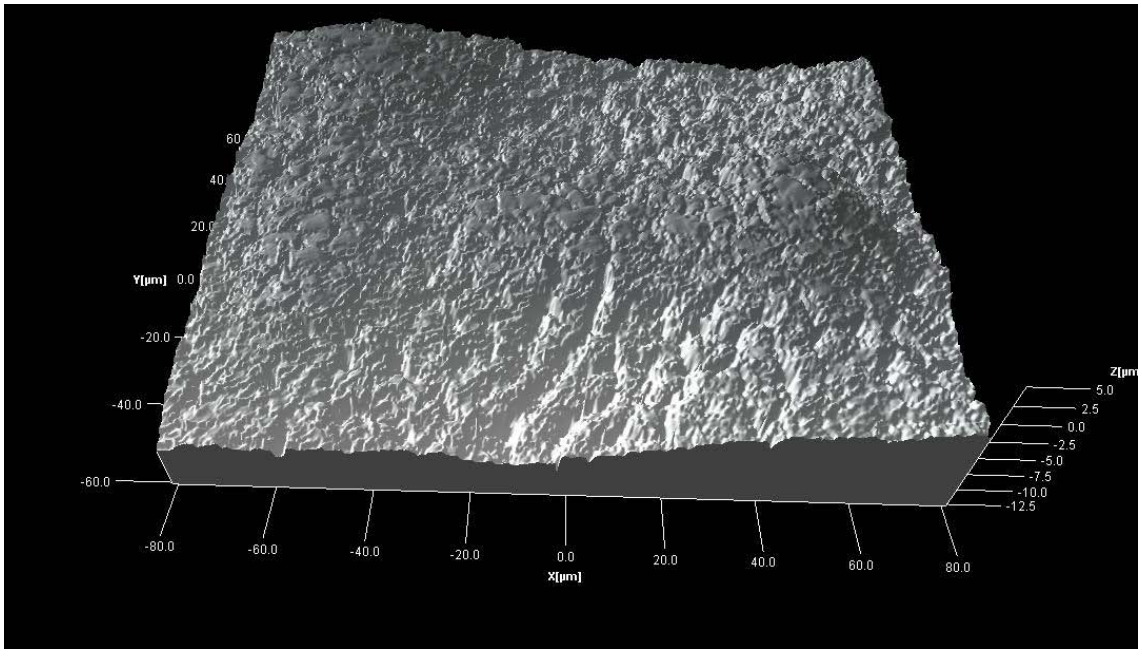

Figure 4. Digital interferometric image of root cementum surface (MicroXam™, ADE Phase Shift, Tucson, Az USA). The surface roughness (Sa) of the specimen depicted was closest to the mean Sa for the group (group: mean Sa = 0.60 µm; specimen: Sa = 0.61 µm, Ssk = 0.91, Sal = 13.25 µm, Sds = 0.21, Sdr = 27.33%).

previously been evaluated as a useful cleaning agent on tooth surfaces (2). Still, the effects on the topography of the surfaces (e.g. bone, enamel, cementum etc.) have not been studied before to the knowledge of the authors. In the present study Neutrase® did not have any effect on the surface topography of the root cementum. Thus the use of Neutrase® can be recommended in the future, as a proper cleaning agent of enamel and root cementum before topographical analysis.

The human maxillary premolar caries-free teeth displayed a mean surface roughness value (Sa) of 0.42± 0.2 µm on enamel, which is a lower value than earlier reported by *Zhang et al* (20) and *Hosoya et al* (6) but similar to the observations made by *Whitehead et al* (19) and *Eliades et al* (5). The high standard deviations of the surface parameter recorded in the present study are in accordance to other studies (6, 20). The comparatively low Sa value may in part, be an effect of the removal of the protein surface films before the analyses and in part be due to the limited time of exposure to intra-oral conditions. The root cementum was, in the present study, recorded as rougher than enamel (Sa 0.6 vs 0.42) and no smooth areas could be detected. The differences in roughness are in accordance to *Kocher et al.* (9). It is explained by the differences in chemical composition and texture between the enamel and the root. For both surfaces, negative Ssk values were recorded which may indicate porous structures of the surfaces and more pronounced on the rooth cementum. The large variation in enlargement found between the different areas measured, is probably due to natural variations of the organic surfaces studied.

Besides being descriptive, the results of this study may also be used as a possible reference for the surface quality of tooth restorative materials and implant surfaces. Surface roughness is generally considered to be of great importance for bone tissue integration and bacterial adhesion. The former is of advantage in treatment with implants, the latter increases the risk in development of mucositis.

A comparison of surface roughness values found in literature displays large variations between materials and surface finishing techniques. For research purposes, surface roughness values as low as 0.17 µm for polished densely sintered alumina has been reported (11), whereas untreated silicate-based veneer ceramics were found to vary in surface roughness between Ra= 2.0±0.6 µm and 6.8±6.0 µm (4). When ground, polished and glazed, all of the studied silicate ceramics attained a Ra-value of 0.3 – 0.6 µm.

Studied by interferometry the surface roughness of commercial zirconia abutments were reported to vary from 0.22±0.03 µm to 0.62 µm±0.33 µm between various locations (8,12,14). In comparison with the results of the present study on enamel the figures seem to be comparable. The surface of the root cementum in the present study displayed an average roughness comparable to turned oral implants, the gold standard for many years. The found roughness range was within values found for modern commercial oral implants (1).

Studies on the surface profile of composite resin materials and restoration surfaces only seldom include surface topographic analyses. Studies which have conducted such analysis show variations in surface roughness due to choice of material and technique as well as the finishing and polishing methods.

Comprising earlier and present findings reveal large variations in surface topographical factors and no consensus seem to exist as to the optimal surface roughness or the importance of other than Ra surface variables. A study in which various restorative materials were given a characteristic enamel-surface topography may give an answer to the question whether or not the characteristic surface topographical features possess a specific potential for e.g. soft tissue cell and tissue adaptation.

Conclusions

Natural variations in surface topography, within and between teeth, are considerable for root cementum and enamel. Enamel surfaces were slightly smoother than root cementum surfaces.Enamel and root surfaces had similarities with modern reconstructive materials. The roughness (Sa) of root cementum shows smaller variations than those of enamel.
Cleaning with Neutrase® did not did not influence the tooth surface topography.

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Address:
Dr Thorsten Edblad
Department of Prosthetic Dentistry/Dental Materials Science
Institute of Odontology, Sahlgrenska Academy
Göteborg University
Box 450, SE-405 30 Göteborg
Sweden
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