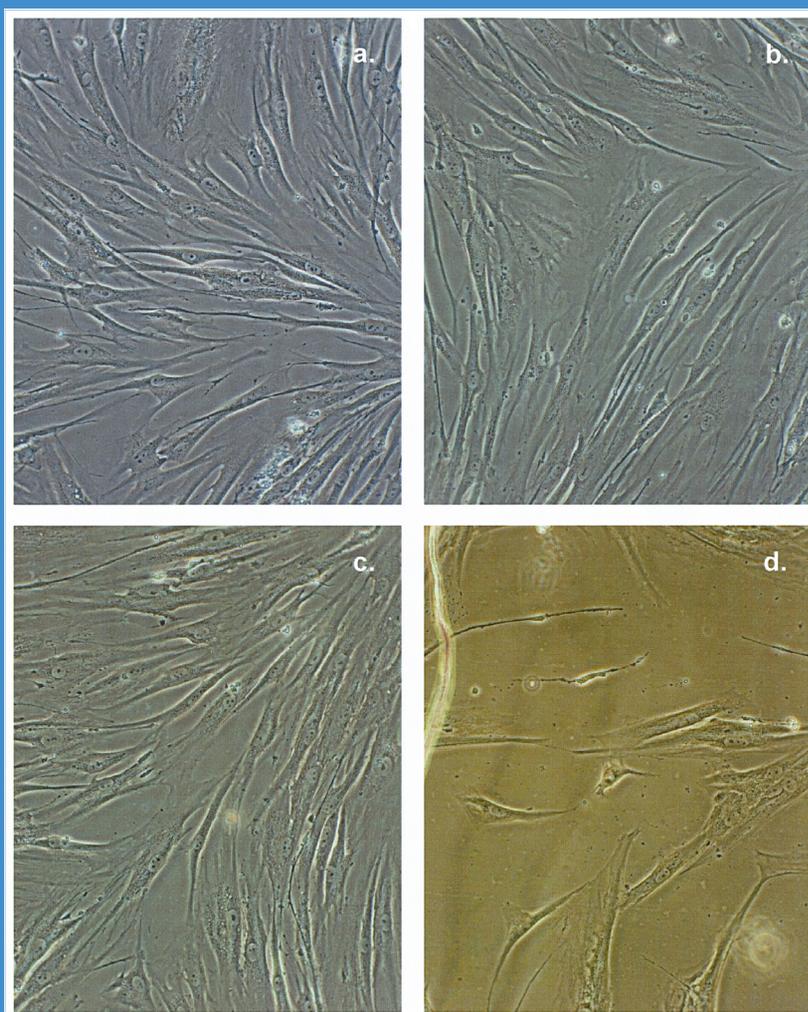


# Swedish Dental Journal

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The effect of Swedish and American smokeless tobacco extract on periodontal ligament fibroblasts *in vitro*

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Helm S, Seidler B. Timing of permanent tooth emergence in Danish children. *Community Dent Oral Epidemiol* 1974; 2:122-9

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# The effect of Swedish and American smokeless tobacco extract on periodontal ligament fibroblasts *in vitro*

Gunilla Andersson<sup>2</sup>, Åsa Wahlin<sup>1,3</sup>, Gunilla Bratthall<sup>1</sup>

## Abstract

© Use of moist snuff is widespread in Sweden. In 2004 ≈800 000 Swedes were daily users which corresponds to 22 % of the male population and 3 % of the female population. The aim of the present study was to evaluate the effect of Swedish moist snuff extract on PDL fibroblast growth and hard tissue production and compare with moist snuff extract from USA.

Periodontal ligament cells (PDL-cells) were obtained from 3 healthy subjects (1 female 14 years, 2 males 14 and 17 years) from the root surface of premolars extracted for orthodontic reasons. The cells were isolated from explants and grown in Dulbecco's Modified Eagle's Medium® (DMEM) supplemented with 10 % fetal calf serum (FBS) and cultivated in 37°C with 5 % CO<sub>2</sub> in air.

Snuff extract in concentrations 0.3 %, 1 % and 3 % (in DMEM with 1 % FBS) was tested. Cells from each individual were tested three times, each time in triplicate. Photographs were taken at 0 and 24 hours with a digital camera and analysed in terms of growth and morphology. Then the cell suspension was frozen and later thawed for examination of the production of alkaline phosphatase after exposure to different snuff concentrations.

This *in vitro* study has shown that PDL cells from 3 different subjects demonstrated a reduced number of cells at exposure to 3 % of both Swedish and American snuff extract. The production of alkaline phosphatase after 2 hours was similarly reduced from cells exposed to 3 % snuff extract.

Further studies have to be made to understand the effect of smokeless tobacco on periodontal tissues. However, from this study can be concluded that smokeless tobacco has biological effects in terms of reduced PDL cell growth and production of alkaline phosphatase

## Key words

*Smokeless tobacco, periodontal ligament fibroblasts, cell/tissue incubator, alkaline phosphatase*

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## Effekt av snusextrakt på paradontalligamentceller

Gunilla Andersson, Åsa Wahlin, Gunilla Bratthall

### Sammanfattning

☉ I Sverige är bruket av vått snus mycket vanligt. År 2004 snusade ≈800 000 svenskar, varav 22 % av männen och 3 % av kvinnorna använde snus regelbundet. Målet med föreliggande arbete var att studera effekten av svenskt vått snusextrakt på paradontalligamentceller (PDL-celler) avseende växt och hårdvävnadsproduktion och jämföra det med vått snusextrakt från USA.

PDL-celler utvanns från 3 friska individer (1 flicka 14 år och 2 pojkar 14 och 17 år) från rotytan på premolarer, som skulle extraheras av ortodontiska skäl. Cellerna isolerades från vävnadsbitar, "explants", och fick tillväxa i Dulbecco's Modified Eagle's Medium® (DMEM) med tillskott av 10 % fetalt kalvserum (FBS) and odlades i 37°C med 5 % CO<sub>2</sub> i luft.

Snusextrakt i koncentrationerna 0,3 %, 1 %, 3 %, testades i DMEM med 1 % FBS.

Celler från varje individ testades 3 gånger, varje gång i triplikat. Foton togs vid 0 och 24 timmar med en digitalkamera och analyserades avseende förändringar i växt och morfologi. Sedan frystes cellsuspensionen och tinades senare för undersökning av produktion av alkaliskt fosfat efter exponering för olika snuskoncentrationer.

Denna *in vitro*-studie har visat att PDL celler från 3 olika individer uppvisade ett reducerat antal celler vid exponering för 3 % av både svenskt och amerikanskt snusextrakt.

## Introduction

Several studies have shown an association between smoking and loss of periodontal attachment and bone destruction (5, 13). Nicotine, which is a major component of cigarette smoking, can be detected on root surfaces of periodontally affected teeth (11). Studies on the effect of nicotine on human periodontal ligament (PDL) fibroblasts show, that nicotine can affect functions of these cells *in vitro* in a dose-dependent manner (7).

Smokeless tobacco in different forms such as chewing tobacco, dry snuff and moist snuff is used worldwide. Use of moist snuff is widespread in Sweden. In 2004 ≈800 000 Swedes were daily users which corresponds to 22 % of the male population and 3 % of the female population (18). The effect of smokeless tobacco on periodontal health has mainly focused on attachment loss manifested as gingival recessions at the site where the tobacco is regularly placed adjacent to the snuff dipper's lesion (2, 4, 10, 17, 19, 20). The recession has been postulated to be a result of mechanical trauma. However, in a more recent *in vitro* study it was shown that smokeless tobacco extract can stimulate peripheral monocyte cells to produce prostaglandins (6). In a study from USA aqueous extracts of chewing tobacco, dry and moist snuff was found to induce inflammatory changes in endothelial cells that may promote recruitment of leukocytes (9). No studies on the effect of extract from Swedish moist snuff on periodontal ligament fibroblasts *in vitro* have been published.

The aim of the present study was to evaluate the effect of Swedish moist snuff extract on PDL fibroblast growth and hard tissue production and compare with moist snuff extract from USA.

## Material and methods

### Preparation of PDL cells

Periodontal ligament cells (PDL-cells) were obtained from the root surface of premolars extracted for orthodontic reasons from healthy patients, 14-17 years of age. The patients and their parents were informed and the parents gave written consent. The study was approved by the Human Ethical Committee at Lund University, Lund, Sweden.

The teeth were extracted under sterile conditions and washed in phosphate buffered saline (PBS) with 1 % Penicillin Streptomycin solution® (PEST) and 0.5 % Gentamicin (10 mg/ml). Then the periodontal ligament was gently scraped off from the middle third of the root surface to avoid contamination from the gingival and apical tissues. The tissue explants

were transferred to 21 cm<sup>2</sup> cell culture dishes with Dulbecco's Modified Eagle's Medium® (DMEM) supplemented with 10 % fetal calf serum (FBS), 1 % PEST and 0.5 % Gentamicin. The explants were covered with sterile glass slips and the dishes were placed in a cell/tissue incubator in 37°C with 5 % CO<sub>2</sub> in air for one week. The cells were allowed to migrate from the explants and after reaching about 50 % confluence the cells were washed twice with PBS, and trypsinated with Trypsin - EDTA solution® (0.5 g trypsin, 0.2 g EDTA/l). Then DMEM was added and the suspension was centrifuged at 1000 rpm for 5 minutes. The pellet was suspended in supplemented DMEM and transferred to cell culture flasks (passage 1). After passage 3 the cells were trypsinated and frozen at -86°C in 69 % DMEM, 20 % FBS, 1 % PEST and 10 % dimethyl sulfoxide, DMSO (Hybri-Max®), in a concentration of roughly 500 000 cells per ml medium.

### Preparation of snuff extract

Swedish moist snuff (Ettan Gothia Tobak AB, Sweden) with a pH of 8.5, water content 55 % and nicotine level of 2.1 % and Kentucky reference snuff (the only available American moist snuff for preparing extract) with a pH of 7.2, water content of 52 % and nicotine level of 2.6 % was used in the preparation of snuff extract. A pH of 8.5 is valid for the three largest brands in Sweden (Ettan, Grovsnus, General). The extracts were made by a standardized procedure (12). A slurry of 100 g snuff in 300 ml distilled water was agitated for 1 hour and then centrifuged at 3500 rpm for 30 minutes. The supernatant was filtered through a 00H filter (Munktel, Stora Grycksbo, Sweden) and then through a 0.2 mm filter (Vacucap 90, Gelman Sciences, KEBO, Stockholm, Sweden). The sterility of the solution was checked by inoculation on agar plates. The extract was stored frozen at -20°C in 2 ml aliquots each of which was subsequently thawed and used in the experiments.

In the extract from Swedish snuff the tobacco specific nitrosamines (TSNA) level was 0.3 µg/ml (0.3 ppm) and the nicotine content 10.6 mg/ml (1.06 %). The corresponding figures for extract from American snuff was a TSNA level of 1.5 µg/ml (1.5 ppm) and a nicotine content 15.8 mg/ml (1.58 %).

In the experiments the snuff extract was diluted in DMEM in the following concentrations: 1µl/ml, 3µl/ml, 10µl/ml, 30µl/ml and 100µl/ml as described below.

### Biochemical analyses

The production of alkaline phosphatase after snuff

exposure of PDL cells was determined with an ELISA assay according to *Morishita et al.* (16) and read in a spectrophotometer at 405 nm. The amount of protein was examined according to Bio-Rad Laboratories protein assay (Richmond, CA).

#### *Experimental design*

In a *first series of experiments* the effect of different tobacco concentrations on PDL cells from one subject (female 13 years) after different times of exposure was established. The effect of serum free medium was also examined. Cells from passage 3 were used.

PDL cells were plated at 30 000 cells per well and grown in DMEM with 10 % FBS or 4 % bovine serum albumin (BSA). Smokeless tobacco extracts in the concentrations 0.1 %, 3 %, 1 %, 3 % and 10 % together with a negative control (culturing media) were tested. All tests were run in triplicate and photographs were taken at 0, 1, 3, 6, 9, 24 and 48 hours using a digital camera. The photographs were analysed for changes in growth and morphology and the production of alkaline phosphatase 48 hours after snuff exposure in DMEM with 4 % BSA was measured.

Low concentrations 0.1 % and 0.3 % of Swedish and American snuff extract showed an increased number of PDL cells when grown in DMEM with 10 % FBS but not in DMEM with BSA. Vacuolisation was recorded after 24 and 48 hours with 1 % snuff extract in serum free media. This was not recorded in the presence of 10 % FBS. Exposure to 10 % snuff extract caused cell death after 3 hours. After 9 hours all cells were dead.

In this experiment the production of alkaline phosphatase was reduced after exposure to 3 % snuff extract whereas 0.3 % stimulated the production compared to a negative control.

Based on the findings above Swedish and American smokeless tobacco extract in concentrations 0.3 %, 1 % and 3 % (in DMEM with 1 % FBS) was tested. Cells (passage 3) from lower premolars of three different individuals (2 females 14 years, 1 male, 17 years) were used. All experiments were run 3 times, each time in triplicates and performed according to the description below.

*Day 0.* PDL cells were thawed and diluted with DMEM with 10 % FBS and applied in 9.5 cm<sup>2</sup> microtiter plates. The cells were cultivated in 37°C with 5 % CO<sub>2</sub> in air and the concentrations of cells per well differed between 108 000 - 130 000 in the different runs.

*Day 1.* The medium was changed to new DMEM with 10 % FBS

*Day 2.* The medium was changed to DMEM with 1 % FBS

*Day 3.* The medium was removed from the wells and the different concentrations of smokeless Swedish and Kentucky tobacco was added. DMEM with 1 % FBS was used as a negative control. All wells were photographed in 200 x magnification with a digital camera (Olympus DP 11). The pH of the medium and different snuff concentrations varied between 7.50 and 7.55 for Swedish smokeless tobacco compared to 7.16 - 7.50 for Kentucky reference tobacco.

*Day 4.* All wells were photographed 24 hours after exposure of tobacco extract.

Then the wells were washed twice with PBS and trypsinated with 1.5 ml trypsin-EDTA solution®, 37°C, to each well. Besides, 3 ml DMEM with 10 % FBS was added to each well, the material was transferred to 15 ml test tubes and centrifuged at 1000 rpm for 5 minutes. The pellets from each concentration were pooled and mixed with 500 µl 0.1 % Triton in diethanolamine buffer (DEA, 1 M/l diethanolamine, 0.5 mM/l Mg Cl<sub>2</sub>, pH 9.8) and frozen in -18°C.

For the production of alkaline phosphatase and the amount of protein this cell suspension was thawed, diluted 1:2 with DEA buffer and 1 ml of alkaline phosphatase substrate (1mg/ml) was added. The amount of alkaline phosphatase/amount of protein was recorded at baseline and after 30 minutes and 2 hours.

#### *Statistical methods*

The comparison against control is made by means of the Wilcoxon signed rank test (two-sided). The comparison between Swedish and American snuff is made by means of the Wilcoxon rank sum test (two-sided). A p-value less than 0.05 is considered statistically significant. Each experiment was used as the unit for analyses.

#### **Results**

The photographs were evaluated by 3 calibrated examiners and the result based on the findings of at least 2 observers and 2 wells.

##### **Patient 1, female, 14 years**

Control - increased number of cells after 24 hours.  
0.3 % snuff extract - unchanged number of cells after exposure to both Swedish and American smokeless tobacco.

1 % snuff extract - unchanged number of cells after

exposure to Swedish snuff extract; increased number of cells after exposure to Kentucky reference snuff.

**3 % snuff extract** – reduced number of cells after exposure to both Swedish and American smokeless tobacco.

**Patient 2, male, 17 years**

**Control** - unchanged number of cells after 24 hours.

**0.3 % snuff extract** - unchanged number of cells after exposure to both Swedish and American smokeless tobacco.

**1 % snuff extract**– unchanged number of cells after exposure to both Swedish and American smokeless tobacco.

**3 % snuff extract**– reduced number of cells after exposure to both Swedish and American smokeless tobacco.

**Patient 3, female 14 years**

**Control** - increased number of cells after 24 hours.

**0.3 % snuff extract** - increased number of cells after exposure to Swedish snuff extract; unchanged number of cells after exposure to Kentucky reference snuff.

**1 % snuff extract** - unchanged number of cells after exposure to Swedish snuff extract; increased number of cells after exposure to American snuff extract.

**3 % snuff extract** reduced number of cells after ex-

posure to both Swedish and American smokeless tobacco.

*Comparison and conclusion of cell growth*

In PDL cells from two subjects cell cultivation for 24 hours without snuff extract (control) showed an increased number of cells, where exposures to 0.3 % snuff extract either were unchanged or increased. Further an increased number of cells were seen also at exposure of 1 % American snuff extract

In PDL cells from one subject there was no change either in the control, the 0.3 % extract exposure or the 1 % exposure.

A reduced number of cells at exposure for 3 % of both Swedish and American snuff extract was demonstrated in PDL cells from all three subjects.

In this experiment with 1 % FBS in the culture medium no clear-cut difference could be demonstrated between Swedish and Kentucky reference snuff in terms of cell growth.

Fig1. shows representative photographs of PDL cells after 24 hours incubation with different concentrations of Swedish and Kentucky reference snuff. DMEM with 1 % FBS from the same culture plate was used as a negative control.

*Alkaline phosphatase*

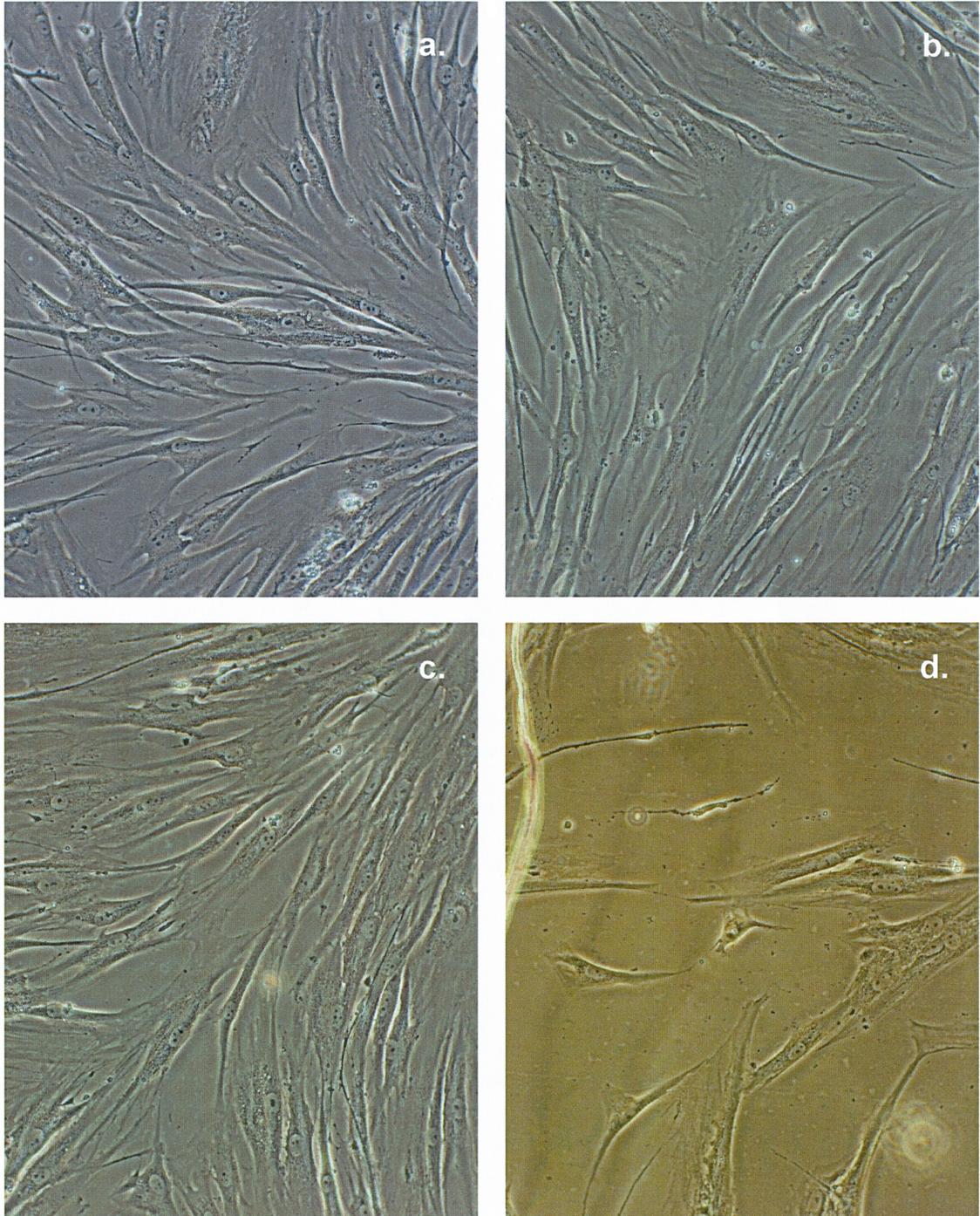
Exposure to 0.3 and 1 % Swedish and American

⊙ Table 1. The production of alkaline phosphatase/amount of protein compared to the control (Ctr) after 30 and 120 minutes' incubation of cells earlier exposed to Swedish (Sw.) and American (Am.) snuff extract.

Conc.	Time	Sw.		Sw. Ctr		Am.		Am. Ctr		Sw-Ctr <sup>1</sup>		Am-Ctr <sup>2</sup>	
		Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
0.3%	30	1.01	0.20	0.98	0.16	1.03	0.24	1.01	0.19	0.03	0.15	0.02	0.07
		P-value								0.5781		0.2461	
	0.8590												
	120	3.16	0.48	3.00	0.33	3.14	0.55	3.03	0.39	0.16	0.43	0.11	0.21
P-value								0.2031		0.1289			
0.7239													
1%	30	0.97	0.23	0.98	0.16	1.01	0.23	1.01	0.19	-0.01	0.20	-0.00	0.08
		P-value								0.7422		0.8750	
	0.6910												
	120	3.00	0.60	3.00	0.33	3.05	0.46	3.03	0.39	-0.00	0.56	0.02	0.23
P-value								0.8203		0.9102			
0.6588													
3%	30	0.87	0.16	0.98	0.16	0.93	0.18	1.01	0.19	-0.11	0.09	-0.08	0.04
		P-value								0.0039		0.0039	
	1.0000												
	120	2.70	0.36	3.00	0.33	2.76	0.42	3.03	0.39	-0.30	0.25	-0.27	0.12
P-value								0.0039		0.0039			
0.5959													

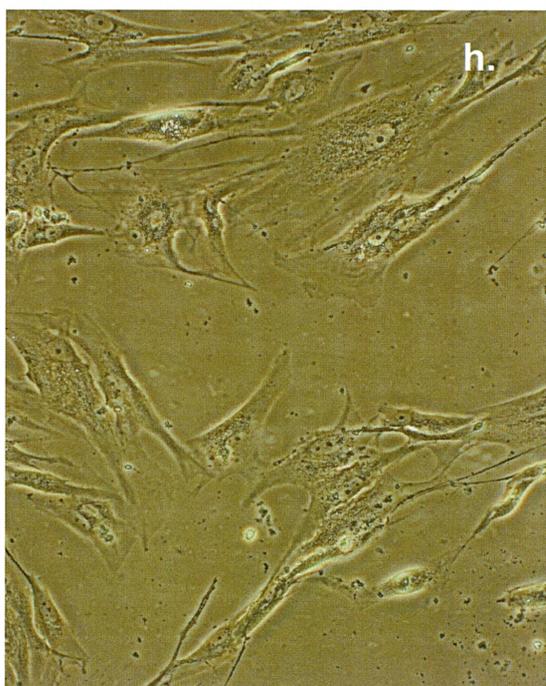
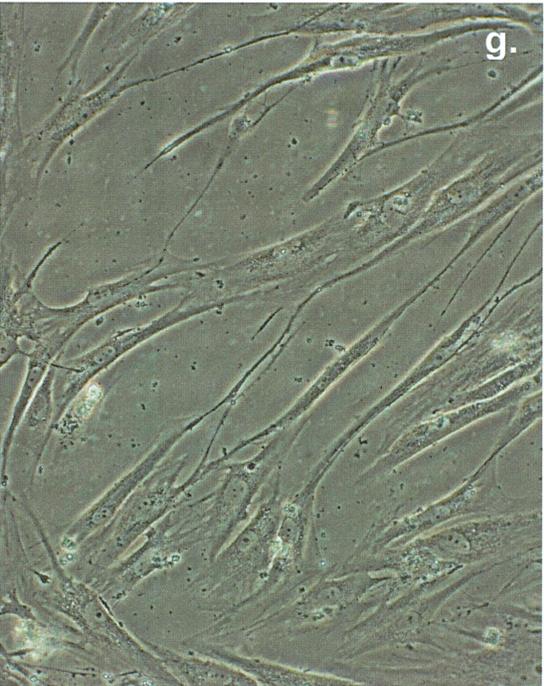
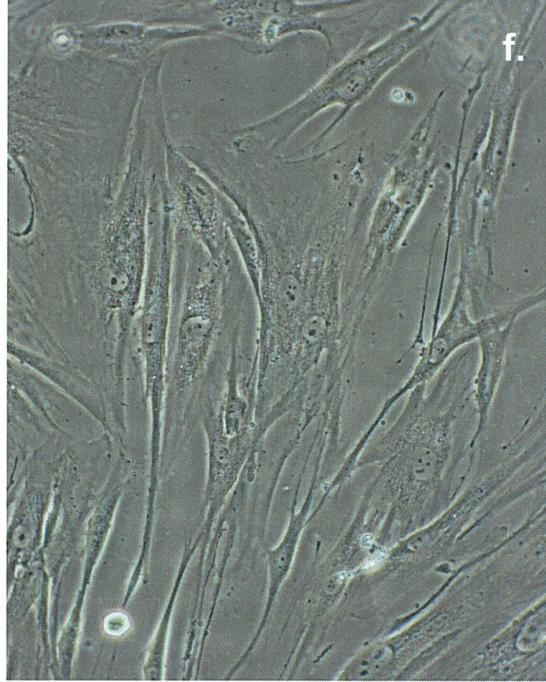
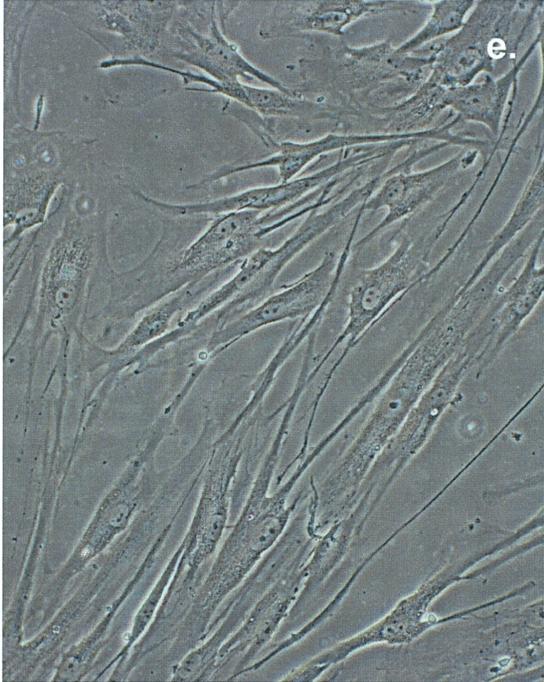
<sup>1</sup> Swedish snuff - Swedish control

<sup>2</sup> American snuff - American control



© **Figure 1.** Representative photographs of PDL cells after 24 hours incubation with different concentrations of Swedish and Kentucky reference snuff. DMEM with 1% FBS from the same culture plate was used as a negative control.

**a-d.** Swedish snuff.  
a. negative control b. 0.3 %, c. 1 % and d. 3 % snuff extract



**e-h.** Kentucky reference snuff  
e. negative control, f. 0.3 %, g. 1% and h. 3 % snuff extract.

snuff extract did not show any statistically significant difference in alkaline phosphatase production compared to the control at 30 minutes or two hours incubation. Nor was there any significant difference between Swedish and American snuff extract. Exposure to 3 % snuff extract, however, resulted in a statistically significant reduction in alkaline phosphatase/amount protein both after 30 minutes ( $p=0.0039$ ) and 2 hours ( $p=0.0039$ ) with no difference between Swedish and American snuff extract (Table 1.)

### Discussion

In the present study human periodontal ligament (PDL) cells have been exposed to different concentrations of Swedish and Kentucky reference snuff extract. There was no difference between Swedish and Kentucky smokeless tobacco concerning morphological changes and production of alkaline phosphatase from PDL cells in this *in vitro* model.

These results can partly be compared to *Johnson et al.* (14) who examined the effect of an aqueous smokeless tobacco extract (STE) on gingival keratinocyte production of prostaglandin E<sub>2</sub> (PGE<sub>2</sub>) and interleukin-1 (IL-1), mediators involved in periodontal destruction and keratinocyte proliferation. Ten % STE significantly ( $p < 0.05$ ) depressed cell numbers and viability. Lower tobacco concentrations did not affect cell numbers or viability, but significantly ( $p < 0.05$ ) increased PGE<sub>2</sub> and IL-1 levels.

*Alpar et al.* (1) studied the cytotoxicity of nicotine on human primary oral fibroblast cultures and found that the toxic effects of nicotine became irreversible in the range between 10.5 and 15.5 mM, whereas at lower concentrations cells recovered after the withdrawal of nicotine. The acute effects of nicotine on the formation and resorption of bone were examined in cultures of different rat osteogenic cells at concentrations that occur in the saliva of smokeless tobacco users (22) The results suggested that nicotine might have critical effects on bone metabolism.

Nicotine is absorbed into the blood stream via transfer across various oral membranes including the buccal mucosa. Observations by *Furie et al.* (9) suggest that smokeless tobacco may induce inflammatory changes *in vivo* by activating endothelium in a manner that promotes recruitment of leukocytes, which may contribute to tissue damage. A study by *Mavropoulos et al.* (15) showed that acute exposure of snuff induced a rapid increase in gingival blood flow that was higher than the increase in blood pressure, indicating an active vasodilatation. In a recent study on Swedish snuff it was shown that

nicotine is one of the substances in snuff that has a biological effect on the oral mucosa (3) which also seems to be valid for PDL cells. The results of the present *in vitro* study have shown that PDL cells from different subjects demonstrated a reduced number of cells at exposure for 3 % of both Swedish and American snuff extract. The production of alkaline phosphatase was similarly reduced from cells exposed to 3 % snuff extract .

In the manufacturing of moist snuff in Sweden a heat treatment process is used while a fermentation process is used in USA. The American snuff has a lower pH but somewhat higher nicotine content than the Swedish product. Since more nicotine is free if the snuff has a higher pH value the biological effects of nicotine on the PDL cells in the two products should be similar as found in the present study. This is also in accordance with *in vitro* studies from Sweden where the results implied minor or no differences between the snuff extract from Sweden and USA in terms of direct toxicity (21).

The most prevalent effects of smokeless tobacco are localized to the site of placement, in the form of gingival recession and white mucosal lesions. Whether the use of smokeless tobacco may affect periodontal tissues in general is not known, even though a recent epidemiological study has discussed a relationship between smokeless tobacco and periodontal disease. In a US population-based study of 12932 adults participating in the Third National Health and Nutrition Examination Survey the association between smokeless tobacco use and severe active periodontal disease, defined as an individual having at least 1 tooth with 6 mm or more attachment loss and bleeding on the same tooth, was evaluated (8). It was reported that adults currently using smokeless tobacco were twice as likely to have severe active periodontal disease as adults who never used smokeless tobacco. The authors conclude that their results indicate that smokeless tobacco may be an important risk factor for severe active periodontal disease.

Further studies have to be made to understand the effect of smokeless tobacco on periodontal tissues. However, from this study can be concluded that smokeless tobacco has biological effects in terms of reduced PDL cell growth and production of alkaline phosphatase.

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# Cost of composite and glass ionomer class II molar restorations and theoretical analyses of cost per year of function at Public Dental Services in Sweden

PETTERI SJÖGREN

## Abstract

© The aim was to evaluate the cost of direct composite and glass ionomer class II molar restorations, and the theoretical cost per year of function, at Public Dental Services (PDS) in Sweden, years 2000 and 2005. Costs for patients, Social Insurance Offices (SI; Försäkringskassan), and total cost, were calculated based on fee schedules from all PDS in Sweden. Theoretical cost per year calculations were based on the median survival times (MST) of failed direct composite and glass ionomer class II molar restorations, derived from a set of clinical studies conducted in Nordic general practices. Due to lack of national statistics from SI, the number of direct restorations including more than one surface, made in adults, in general dentistry at PDS in the county of Halland were studied. From the year 2000 to year 2005, the total cost of composite class II molar restorations increased by 25 %, whereas the total cost of glass ionomer restorations more than doubled. Theoretical calculations implied a higher cost per year of function for composite restorations in year 2000, whereas in year 2005, glass ionomer restorations had a higher cost per year of function. The cost of direct composite and glass ionomer class II molar restorations increased from year 2000 to 2005, at PDS in Sweden. In the context of planning public health care funding, theoretical models for cost prediction may prove useful.

## Key words

*Dental restoration, dentistry, economics, general practice, public health*

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## Kostnaden för glasjonomer och komposit klass II fyllningar på molarer, samt teoretiska analyser av den årliga funktionella kostnaden i svensk folktandvård

PETTERI SJÖGREN

### Sammanfattning

◎ Syftet med denna studie var att utvärdera behandlingsekostnaden för klass II fyllningar på molarer utförda med glasjonomer och komposit i svensk folktandvård, samt att illustrera den årliga funktionella kostnaden med hjälp av teoretiska kostnadsberäkningar. Kostnadsberäkningarna baserades på tandvårdstaxor från folktandvårdens samtliga huvudmannaområden i Sverige åren 2000 och 2005. Kostnadsberäkningarna delades in i patientkostnader, Försäkringskassans kostnader såväl som totalkostnaden i svensk folktandvård. Median överlevnadstider (MST) för klass II fyllningar på molarer, från tidigare studier utförda vid allmäntandvårdskliniker i de nordiska länderna, användes i de teoretiska kalkylerna för att beräkna den årliga funktionella kostnaden med glasjonomer eller komposit. På grund av avsaknad av nationell åtgärdsstatistik från Försäkringskassan, beräknades det totala årliga antalet flerytsfyllningar (enligt tandvårdstaxans åtgärd 55), i allmäntandvård för vuxna, i Folktandvården Halland, åren 2000 och 2005. Totalkostnaden för klass II fyllningar på molarer med komposit ökade med 25 %, från år 2000 till 2005, medan totalkostnaden för glasjonomer mer än fördubblades. År 2000 hade kompositfyllningar en högre initial kostnad än glasjonomerfyllningar, men år 2005 var initialkostnaderna ungefär desamma för glasjonomer och kompositrestorationer. De teoretiska kalkylerna indikerade att klass II fyllningar utförda på molarer med komposit har en lägre funktionell kostnad i svensk folktandvård än glasjonomer. Teoretiska modeller för kostnadsuppskattning kan vara av värde vid planering av samhällsfinansierad tandvårdsstöd.

## Introduction

During the past decades, composite and glass ionomer restorations have successively taken over the role of amalgam as routine posterior restorative material in Sweden (14). In the current Swedish dental health insurance system, introduced in 1999, amalgam was decided to no longer be subsidised by the Social Insurance Offices (SI, i.e. Försäkringskassan) as a common environmental strategy to eliminate mercury pollution (6, 14, 25). Thus, the routine use of dental amalgam in Sweden as a direct restorative material has almost completely been replaced by mainly composite and glass ionomer materials (14).

Although information about the longevity of failed restorations in general practice is available (5, 23), a majority of the efficacy studies on restoration longevity have been conducted in academic centres or at specialist clinics (13, 15, 16). While most of the efficacy studies have focused on failure or survival rate over time, some restoration longevity studies have used the median survival time (MST) as an outcome measure (5). In a systematic review by *Downer et al.* (5) it was concluded that studies using the MST as outcome measure were the most feasible for comparison. Moreover, various outcome measures and study designs make the results difficult to compare (5). In previous reviews (5, 23), only a handful studies describing the MST of dental restorations at general practices in the Nordic countries were located (2, 7, 11, 12, 15, 18, 19). However, restorative treatment contributes to about one third of the practice at Public Dental Services (PDS) in Sweden (22, 24). Interestingly, national statistics on the number, or costs, of different dental restorations subsidised by the public dental health insurance system in Sweden (i.e. SI) are not available, due to absence and incompleteness of data (personal communication, Försäkringskassan, Stockholm, Sweden). Hence, although the total annual cost of the Swedish public dental health insurance is known, the SI is unable to specify the economic value of subsidisation for any specific dental procedure. Therefore, it seems highly relevant for the community and the dental health insurance system (i.e. SI in Sweden) to analyse the cost over time of routine dental restorations in general dental practice. In a previous study, the MST of direct class II molar restorations in the Nordic countries was analysed in relation to the initial cost and the cost per year of function for patients, SI, and total cost, at PDS in Sweden in 2000 (23). The aim of this study was to further analyse the cost of direct composite and glass ionomer class II molar restorations at PDS

in Sweden in the years 2000 and 2005, focusing on initial costs, as well as on theoretical costs per year of function of treatment, for patients, for SI, and total cost. Since national data about the annual number of SI subsidized dental procedures in Sweden were not available, an additional aim was to analyse the number of direct restorations (more than one surface) made in adult dentistry, in general practices of one PDS provider (county) in total.

## Material and methods

### *Literature searches and estimated restoration longevity*

The Medline database (Entrez PubMed) and the Cochrane Library databases were searched (July 2005), to identify a sample of relevant publications about the survival time of routine dental restorations in general dentistry in the Nordic Countries (i.e. Denmark, Finland, Iceland, Norway, Sweden). The literature searches were focused on the search headings (5): 'dental restoration', 'longevity', 'failure', 'durability', 'survival analysis' and 'life table analysis', restricted to 1990-2005, and 'clinical trial'. The inclusion criteria for the studies were: Country: Sweden (but due to lack of relevant studies the searches were expanded to include all Nordic countries); Outcome measure: MST of direct composite or glass ionomer class II molar restoration in general practice, in permanent teeth in adults (studies with mixed samples of children and adults were included if restorations in permanent teeth were studied); Study design: randomised controlled trial, non-randomised longitudinal study, or cross-sectional study. The estimated time for replacement of restoration was calculated as weighed averages of the MSTs presented in each study that met the inclusion criteria (7, 11, 15, 19), with respect to the number of restorations.

### *Initial and relative costs*

Fee schedules for year 2000 and 2005 were obtained from all (n=21) local authorities, county councils and regions that provide dental care within the Public Dental Services (PDS) in Sweden. In the current (and year 2000) dental health insurance system in Sweden, the total fee is composed of the patient fee and the fee for SI. The SI part of the fee is the cost for the dental health insurance system, being the same at all PDS in Sweden, whereas the patient fee varies between providers of dental care (i.e. PDS). As in a previous study (23), the fees were considered from the payers' perspective. Thus, described as costs for patients, for SI and total costs. The PDS fee

© **Table 1.** Total initial cost (in Swedish crowns) of composite and glass ionomer class II molar restorations at all Public Dental Services (PDS; n=21; year 2000 and 2005) in Sweden.

PDS	2000		2005	
	Composite	Glass ionomer	Composite	Glass ionomer
Blekinge	655	236	745	745
Dalarna	570	320	840	840
Gävleborg	710	445	901	901
Gotland	502	300	788	788
Halland	647	318	811	465
Jämtland	693	250	860	860
Jönköping	475	317	725	725
Kalmar	554	216	857	857
Kronoberg	650	280	671	671
Norrbottn	700	306	895	895
Örebro	801	297	775	775
Östergötland	725	326	845	845
Skåne	591	253	760	760
Sörmland	752	361	761	761
Stockholm	740	346	870	870
Uppsala	610	316	900	900
Västra Götaland	721	309	814	814
Värmland	542	361	672	672
Västerbotten	590	328	740	740
Västernorrland	694	227	965	965
Västmanland	710	216	895	895

schedules (n=21) were extracted for data about the initial costs for composite and glass ionomer class II molar restorations (two surface, mesio-occlusal or disto-occlusal) (Table 1), and mean initial costs were calculated (16, 23). In all cases, when two alternative total costs were specified in the fee schedule (e.g. complicated-, or normal restoration), the lowest fee (normal) was chosen, whereas when three different total costs were present (e.g. complicated-, normal-, or simple restoration), the second lowest fee (normal) was selected. The cost for patients, for SI, and total cost were analysed separately. Moreover, for year 2005, the cost for senior citizens ( $\geq 65$  years) was analysed, as this group received an additional subsidy from the dental health insurance system (i.e. SI) in year 2005, which did not apply in year 2000. The relative costs were calculated, giving the cost of a composite class II molar restoration the monetary designation 1.0 x, as previously described (4, 23).

#### *Cost per year of function*

Theoretical cost per year of function was calculated for composite and glass ionomer class II molar restorations as a quota between the mean initial cost (obtained from all PDS in Sweden, n=21, in 2000 and

2005) and the estimated MST of the restoration, in accordance to previous reports (16, 23).

#### *Sensitivity analyses*

To illustrate the variation in the theoretical costs per year based on different estimated MSTs, the costs per year of function of composite and glass ionomer class II molar restorations were calculated using the shortest and longest MSTs for each restorative material, derived from the sample of studies that met the inclusion criteria (7, 11, 15, 19).

#### *Cost for SI at Public Dental Services in the county of Halland*

The SI was contacted to obtain National statistics about the total number of restorations made, or subsidised by the SI in Sweden, but statistics were not available due to absence and incompleteness of data (personal communication, Försäkringskassan, Stockholm, Sweden). Instead, statistics about the annual number of restorations made in adults, (birth years:  $\leq 1980$ , in year 2000, and  $\leq 1985$  in year 2005), in adult general dentistry at the PDS practices in the county of Halland (population 285,868 in 31/12/2005), were collected from local clinic data-

© **Table 2.** Longevity studies of composite and glass ionomer class II molar restorations conducted in general practice setting in the Nordic countries 1990-2005, using median survival time (MST) as an outcome measure.

Study	MST in years		Study design	N <sup>†</sup>
	Glass ionomer	Composite		
Qvist <i>et al.</i> , 1990 (19)	-	1-6	Cross-sectional	2,542(-)
Jokstad <i>et al.</i> , 1994 (7)	-	3-5*	Cross-sectional	10,091(575)
Mjör, 1997 (15)	3	6	Cross-sectional	974 (-)
Mjör <i>et al.</i> , 2000 (11)	2-4	6*	Cross-sectional	6,761 (-)
MST used in this study (class II) <sup>‡</sup>	3.0	4.7		

\* MST of class II restorations explicitly stated. <sup>†</sup> Number of restorations (patients within parentheses, when stated). <sup>‡</sup> MST of class II molar restorations calculated as weighed averages with respect to the number of restorations in each study.

© **Table 3.** Mean initial costs (in Swedish crowns) and relative costs (within parentheses, giving composite the monetary designation 1.0 x) of composite and glass ionomer class II molar restorations at all Public Dental Services (n=21; year 2000 and 2005) in Sweden. [Initial cost range within brackets].

Material	2000			2005		
	Patient	SI <sup>*</sup>	Total	Patient	SI <sup>*</sup>	Total
Glass ionomer	245 (0.5 x) [160-389]	56 (0.4 x)	301 (0.5 x) [216-445]	667 (1.0 x) [335-835]	130 (1.0 x)	797 (1.0 x) [465-965]
Composite	519 (1.0 x) [345-671]	130 (1.0 x)	649 (1.0 x) [475-801]	684 (1.0 x) [514-835]	130 (1.0 x)	814 (1.0 x) [671-965]
<i>Senior citizens (≥ 65 yrs)</i>						
Glass ionomer	245 (0.5 x) [160-389]	56 (0.4 x)	301 (0.5 x) [216-445]	602 (1.0 x) [270-770]	195 (1.0 x)	797 (1.0 x) [465-965]
Composite	519 (1.0 x) [345-671]	130 (1.0 x)	649 (1.0 x) [475-801]	619 (1.0 x) [476-770]	195 (1.0 x)	814 (1.0 x) [671-965]

\* Social Insurance Offices, Sweden.

bases (n=20; County Council of Halland, Sweden). Since all different categories of dental restorations were not possible to analyse separately, all direct restorations involving more than one tooth surface were included (i.e. the Swedish dental fee procedure no. 55). The statistics were used to translate, and analyse the regional cost for SI in year 2005 at PDS in the County of Halland.

**Results**

*Literature searches and estimated restoration longevity*

Four cross-sectional studies were identified for this study, fulfilling the inclusion criteria, conducted in Nordic general practices between 1990 and 2005, using MST of composite or glass ionomer class II molar restorations as outcome measure (Table 2). The originally reported and the calculated MSTs (i.e. the weighed averages used in this study) are presented in Table 2.

*Initial cost*

The initial cost of composite class II molar restorations increased from year 2000 to 2005 by 32 % for patients, remained unchanged for SI, and increased

by 25 % in total cost, whereas the initial cost of glass ionomer restorations more than doubled for patients, for SI, and total cost (Table 3). For senior citizens (≥ 65 years) the initial cost of composite class II molar restorations increased from year 2000 to 2005 by 19 % for patients, by 50 % for SI, and by 25 % in total cost, whereas the initial cost of glass ionomer restorations more than doubled for patients, increased more than three-fold for SI, and more than doubled in total cost (Table 3).

*Relative cost*

In year 2000, composite class II molar restorations had a relatively higher initial cost than glass ionomer restorations, for patients, for SI, and the total cost, whereas in 2005 the initial costs for composite and glass ionomer class II molar restorations were relatively similar for patients, for SI, and total cost (Table 3). Equally, for senior citizens (≥ 65 years), in year 2000, composite class II molar restorations had a relatively higher initial cost than glass ionomer restorations, whereas in year 2005 the relative initial costs of composite and glass ionomer restorations were relatively same for patients, for SI, and the total cost (Table 3).

© **Table 4.** Mean cost\* per year of function of composite and glass ionomer class II molar restorations at all Public Dental Services (n=21; year 2000 and 2005) in Sweden.

Material	2000			2005		
	Patient	SI <sup>†</sup>	Total	Patient	SI <sup>†</sup>	Total
Glass ionomer	82	19	100	222	43	266
Composite	110	28	138	146	28	173
<i>Senior citizens (≥ 65 yrs)</i>						
Glass ionomer	82	19	100	201	65	266
Composite	110	28	138	132	41	173

\* Costs in Swedish crowns. <sup>†</sup> Social Insurance Offices, Sweden.

© **Table 5.** Cost\* per year of function of composite and glass ionomer class II molar restorations at all Public Dental Services (n=21; year 2000 and 2005) in Sweden, calculated with the shortest and longest median survival time (MST) described in the studies that met the inclusion criteria.

	2000			2005			≥ 65 yrs 2005			Ref.
	Patient	SI <sup>†</sup>	Total	Patient	SI <sup>†</sup>	Total	Patient	SI <sup>†</sup>	Total	
Glass ionomer										
MST 2-years	123	28	151	334	65	399	301	98	399	(11)
MST 4-years	61	14	75	167	33	199	151	49	199	(11)
Composite										
MST 1-year	519	130	649	684	130	814	619	195	814	(19)
MST 6-years <sup>‡</sup>	87	22	108	114	22	136	103	33	136	(11)

\* Cost in Swedish crowns. <sup>†</sup> Social Insurance Offices, Sweden. <sup>‡</sup> MSTs of class II molar restorations. When MST of class II restorations was not explicitly stated, MST for molar restorations was used

#### *Cost per year of function*

The theoretical cost per year of function of composite class II molar restorations increased from year 2000 to 2005, by 33 % for patients, and 25 % in total cost, whereas the costs for SI remained unchanged (Table 4). The cost per year of function for glass ionomer restorations more than doubled for patients, for SI and total cost (Table 4).

For senior citizens (≥ 65 years), from year 2000 to 2005, the cost per year of function of composite class II molar restorations increased by 20 % for patients, 46 % for SI, and by 25 % in total cost, whereas for glass ionomer restorations the cost per year of function more than doubled for patients, increased more than three-fold for SI, and more than doubled in total cost (Table 4).

#### *Cost per year of function - sensitivity analyses*

In order to illustrate the maximal variation in the cost per year of function calculations, based on the outcomes of the included studies, the costs were calculated using the shortest and the longest MSTs for each restorative material (23).

Using the shortest MSTs, the cost per year of function of class II molar restorations for patients, for

SI, and the total cost, were lowest for glass ionomer restorations in both year 2000 and 2005, whereas the cost of composite restorations was more than 4-fold higher in year 2000, and approximately twice as high in year 2005 (Table 5). For senior citizens (≥ 65 years), in year 2005, using the shortest MSTs a lower costs per year of function was seen for glass ionomer class II molar restorations for patients, for SI, and the total cost, whereas the cost of composite restorations was about twice as high (Table 5).

Using the longest MSTs, in year 2000, a lower cost per year of function was seen for glass ionomer class II molar restorations than for composite, for patients, for SI, and total cost. In contrary, in year 2005, the cost per year of function for patients, for SI, and total cost, was lower for composite restorations. Moreover, for senior citizens (≥ 65 years), using the longest MSTs, in year 2005, a lower costs per year of function were seen for composite than for glass ionomer (Table 5).

#### *Cost for SI at Public Dental Services in the county of Halland*

Statistics from PDS general practice databases (n=20), in the county of Halland for year 2000, and

2005, revealed 16,613 direct restorations involving more than one tooth surface made in adults during year 2000, and 24,143 similar restorations in year 2005. Composite and glass ionomer restorations were not separable in the statistics for year 2000, but could be analyzed separately for year 2005. Thus, in year 2005 the total cost for SI of direct composite restorations involving more than one tooth surface in adults, at PDS in the County of Halland in year 2005, was 2,901,600 Swedish crowns ( $n=22,320$ ), whereas the cost of glass ionomer restorations was 225,030 Swedish crowns ( $n=1,731$ ).

### Discussion

The initial cost of composite class II molar restorations, at Swedish PDS, increased from the year 2000 to 2005 by 32% for the patients, and by 25% in total cost, whereas the cost for SI remained unchanged. However, from the year 2000 to 2005, the initial cost of glass ionomer restorations had more than doubled for patients, for SI and in total cost. Theoretical cost calculations based on initial costs, and estimations of restoration (treatment) longevity may prove useful for simulation of economic outcomes of different funding strategies, especially when public dental health insurance systems are planned or reorganised.

The estimated MSTs used in this study were derived from a sample of longevity studies conducted in general practice settings in the Nordic countries (7, 11, 15, 19). Due to the lack of feasible studies conducted at Swedish general practices, studies from all Nordic countries were included. The aim of the literature searches was not to locate all restoration longevity studies, but to identify a sample of longevity studies suitable to illustrate theoretical cost calculations.

The costs of class II molar restorations at Swedish PDS in year 2000 and 2005 were analysed based on fee schedules obtained from all PDS in Sweden (23). Private dental clinics were not included in this study since all individual private clinics in Sweden have their own fee schedules. In a national health insurance context, it is considered important to demonstrate the costs and cost development over time, in relation to the survival time of different restorative treatment alternatives (13, 15). Therefore, theoretical models were used to illustrate the cost per year of function, and sensitivity analyses were made to illustrate the maximal cost variation related to the outcome of the included studies (23).

Clinical restoration longevity trials from the

Nordic countries using failure or survival rates as an outcome measure are available for composite and glass ionomer restorations (e.g. 1, 8, 9), and a number of longevity studies have been conducted in general practice settings (e.g. 2, 6, 12, 18, 19, 20). As previously shown (16, 23), some of these studies have explicitly described the MST of composite or glass ionomer molar restorations (7, 11, 15, 19). Thus, for general practitioners restoration longevity data drawn from settings similar to their own practice are available, although recent studies are scarce (6, 20). Moreover, the most recent studies have not explicitly described the MST of molar restorations (6, 20). For evaluating treatment effects, the recommended study design is a prospective, randomised controlled trial (RCT) (21, 22). None of the longevity studies that met the inclusion criteria of this study was longitudinal or an RCT (5, 21). The apparent lack of longitudinal studies may be explainable by the fact that such studies suffer from difficulties with patient selection and loss of patients over time, making follow up over several years difficult in general practice (24). All of the included studies were cross-sectional, describing the functional time of dental restorations (7, 11, 15, 19). Although not as valuable as longitudinal trials, cross-sectional studies may provide a useful alternative when studying restoration longevity and reasons for replacement (13, 15, 21), especially in a quality assurance context. Cross-sectional studies have proven useful in complex clinical situations, where problems are encountered by several independently operating clinicians and where long-term follow-ups are less likely to be successful (15). However, restoration longevity comparisons based solely on data from cross-sectional studies are prone to uncertainty regarding differences in material characteristics or operator skills. In addition the MSTs can only reflect the survival time of failed restorations. To correctly reflect the MST, the sample of participants (or patient records) needs to contain recently made restorations, as well as restorations with potentially long functional lifetimes. Since a common reason for placement of a glass ionomer restoration is a temporary restoration, the MST analysis may become biased due to a large amount of early failures. Moreover, glass ionomer is not considered suitable for permanent restorations in the literature (10, 26). Thus, the indications for placing glass ionomer are often in less stress bearing cavities, or only as a long term provisional restoration in stress bearing cavities (10). Composites, however, are considered more suitable for posterior, more stress bearing restorations,

but require a more time consuming and technique sensitive treatment procedure (10). There is also a wide variation in the material composition within the groups of restorative materials (i.e. composites and glass ionomers), further contributing to heterogeneity. Comparisons between MSTs from different studies are further complicated by individual clinical decisions on when to replace a restoration, as also by the influence of the size of the restoration on its longevity (11, 12, 15). Therefore, since the included studies were heterogeneous and prone to several sources of bias, on account of their non-randomised and non-blinded study designs (5, 21), all available studies were included in the calculations in an attempt to reduce the magnitude of bias that might have been incorporated into any single study (23).

Although the here presented MSTs are largely in line with a recent literature review (10), this study was not intended as a systematic review on restoration longevity, thus the MSTs presented in this study should be interpreted with caution. It should also be emphasised that some of the here included studies were conducted for more than a decade ago, and due to a continuous restorative material development, extrapolation of longevity data from earlier studies is very difficult (7, 19). The rapid development of new restorative materials has, at least partly, evolved due to profit interests among the manufacturers and sales organisations, necessitating continuous launch of novel products, but also, and equally by a willingness among dental professionals to accept virtually untested materials for routine use in clinical practice.

Theoretical calculations imply that, in year 2005 composite class II molar restorations were a more economical long term alternative than glass ionomers in all categories at Swedish PDS general practice, although the opposite was seen in year 2000. In light of these findings, and previous reports (10, 26), the subsidisation of glass ionomer as a permanent restoration in a public dental health insurance system, seems questionable. This is also important since it has been shown that the funding system in itself may influence the decision to replace a restoration (3), or as evident with the use of dental amalgam in Sweden, the selection of the restorative material (14).

Theoretical cost estimations are useful when public dental health insurance system costs are planned or evaluated, since economical short-term solutions may lead to significantly higher costs over time (12, 13, 16). However, to be valid these evaluations should

be performed from different perspectives, taking account of scientific evidence, applicability to the intended clinical situation, and patient preferences, as well as biological aspects and general effects on public health and the environment. Moreover, due to the apparent lack of clinical evidence derived from longitudinal studies conducted in general practice settings, it seems urgent to develop clinical research organisations, or collaborations, involving general dental practices where the vast majority of dental care interventions are provided.

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# Oral health and treatment need among older individuals living in nursing homes in Skaraborg, Västra Götaland, Sweden

ELSEBETH SÖDERPALM ANDERSEN<sup>1,2</sup>, BJÖRN SÖDERFELDT<sup>2</sup>, MATS KRONSTRÖM<sup>3</sup>

## Abstract

© The aim of this study was to describe the oral health among residents living in seven nursing homes in Skaraborg, Västra Götaland, Sweden.

The study was cross-sectional and included two parts; a clinical examination and a patient questionnaire. To be included in the study, each subject should be able to understand and answer simple questions about their general and oral health, and also be able to participate in a clinical examination. In all, 172 individuals were included in the study sample.

Edentulousness was prevalent, and more than 50% of the subjects were edentulous in the maxilla. Poor denture stability and retention were observed among the majority of the edentulous subjects, while fractured/decayed teeth and remaining roots were common among the dentate subjects.

47% had oral mucosal lesions. Mucosa friction index was high, and good oral hygiene was registered for 12 % of the dentate subjects.

The majority of the patients with remaining teeth brushed their teeth twice a day, while those wearing dentures brushed more seldom.

The majority of the respondents claimed, they had not received help from the program included in the Swedish National Dental Insurance System, introduced in 1999. The intention with the program was to promote good oral health among individuals, who due to medical- or social conditions, were not able to attend the regular oral health care system.

## Key words

*Oral health, elderly, dentures, teeth, treatment need.*

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## Oral hälsa och behandlingsbehov bland inneboende på vissa äldreboenden i Skaraborg, Västra Götaland, Sverige

ELSEBETH SÖDERPALM ANDERSEN, BJÖRN SÖDERFELDT, MATS KRONSTRÖM

### Sammanfattning

☉ Syftet med denna studie var att beskriva det orala hälsotillståndet hos äldre och handikappade boende på sju utvalda sjukhem i Skaraborg, Västra Götaland.

Studien genomfördes som en tvärsnittundersökning med både en klinisk undersökningsdel samt ett frågeformulär. Selektionen av sjukhemmen samt deltagarna styrdes av inklusionskriterierna, vilka innebar att den äldre skulle kunna klara en klinisk undersökning, samt förstå och kunna svara på enkla frågor angående egen hälsa samt tandhälsan. Sammanlagt medverkade 172 personer.

Majoriteten av de undersökta personerna var tandlösa – och speciellt var tandlösheten i överkäken markant. Stabilitet och retention av proteserna utvisade ett stort objektivet behandlingsbehov. Dessutom hade klientelet kvarvarande rotrester samt karies. 47% av de undersökta hade orala mukosala läsioner. Det mukosala friktionsindexet var högt. 12% av individerna med egna tänder uppvisade god munhygien.

Betandade individer borstade i genomsnitt sina tänder två gånger om dagen, medan de som bar avtagbara proteser borstade dessa mera sällan.

Trots att det infördes regler under år 1999, i vilka de som bor på sjukhem är berättigade till ett gratis, förstärkt tandvårdsstöd, sade endast en liten del av studiedeltagarna och att de hade mottagit detta erbjudande. Resultatet av studien visade således på att ringa resurser ägnats åt att undersöka och förbättra munhälsan hos dessa äldre och sjuka individer.

## Introduction

The normal ageing process involves changes in oral functions (13), for example reduced salivary capacity, which could result in increased risk of caries, periodontal disease and fungus related infections in the oral mucosa (2). Oral health status is important, and elderly peoples' self-reported chewing-problems are related to their general state of health (21,25). Today, most individuals in the industrialized countries maintain most of their natural teeth throughout their life (3), and good oral health is considered an important quality-of-life aspect (4,17,18,9).

In Sweden, as well as in most countries in the Western world, the proportion of elderly is increasing (20). The municipalities in Sweden have an obligation to offer sheltered dwellings to sick and/or disabled individuals, primarily old people. In 1999, a new regulation within the National Dental Insurance System (NDIS) was introduced. The purpose of the new regulation was basically to create a care system to improve oral health for people, who were in need for extended care and nursing including those, who because of illness or disability were not able to attend regular dental care (22).

Even if statistics continuously have been gathered, little is known about the oral health in this population of elderly and handicapped individuals (8). Furthermore, previous studies have shown that a need for extensive dental care exists among that group of individuals (11,1,10).

Therefore, a project was initiated in the autumn of 2002, with the objective to study and analyze oral health factors among elderly living in nursing homes in the county of Skaraborg, Västra Götaland, Sweden.

The aim of this study is to report the oral health status among those individuals with special concern for prosthodontics.

## Materials and methods

The study comprised elderly living in nursing homes located in two towns, Skövde and Töreboda, Västra Götalandsregionen, Sweden. Töreboda is a small town with 10,000 inhabitants, while Skövde has about 49,000. One of the authors (ESA) contacted the local municipal authorities in Skövde and Töreboda and presented the protocol to the officials responsible for the nursing home care, who later approved the study. From a total of 15 nursing homes in Skövde, 4 were selected by the local officials and were included in the study. The selection of these nursing homes was based on information

about the present study protocol, with requirements of a certain health level of the patients – especially the inclusion criteria. Of the 4 nursing homes selected in Skövde, one had 52 residents, another had 87 and the two remaining had 20 residents respectively. Three homes were located in the center of the town, while one was in the outskirts.

In Töreboda, all three nursing homes in the municipality were included in the study. One of the nursing homes had 67 residents, and the two others had 44 and 47, respectively. After the selection procedure of the nursing homes was completed, the principal investigator (ESA) contacted the head nurses at the nursing homes and informed them about the purpose and methods of the study. It was agreed that the head nurse should forward the information she had received to the staff.

The study was approved by the Ethics Committee at Göteborg University (13-6-2002; 30-10-2003).

### *Inclusion criteria*

To be included in the study, the individuals should be able to understand and answer questions about their general and oral health and to participate in a clinical examination. The selection procedure was performed in collaboration with the head nurse at each nursing home, since she had information about each patient's medical and mental condition. A total of 162 individuals were excluded from the original study sample because of poor general health, and 3 did not want to participate. The remaining 172 individuals (51% of the original sample size) fulfilled the inclusion criteria and agreed to participate in the study and signed a consent form. The subjects in Skövde were examined in August-September 2002, and those in Töreboda in the spring of 2003.

### *Patient questionnaire*

A pilot study was performed in the summer of 2002 to test the questionnaire instrument. The pilot was done on a smaller sample of subjects living in nursing homes in another part of the county. The responses were evaluated and showed good discrimination, and it was concluded by the investigators that the questionnaire instrument contained relevant questions. Only a few alterations were made in the final questionnaire.

The study had two different parts; a questionnaire and a clinical examination. The principal investigator (ESA) asked all the questions and filled out the questionnaire. The questions were:

1. "Do you brush your teeth/dentures yourself?"

2. "If you are wearing a denture – how often do you brush the denture (-s)?"
  - "Do you take the denture(-s) out of your mouth for cleaning?"
  - "Do you sleep with the denture(-s) in your mouth?"
3. "If you have natural teeth – how often do you brush them?"
4. "Do you have any problems related to your teeth/dentures?"
5. "If yes, who is helping you out?"
6. "When did you last visit a dental clinic?"
7. "Did you have any assistance or dental treatment done by professionals during the last years?"

#### *Clinical Examination*

The clinical examinations were performed by the principal investigator in the nursing homes, using a dental mirror and a headlight. Several of the items in the protocol were identical to those used in earlier studies on oral health in Sweden (10). New items were added for evaluation of denture stability and retention, condition of remaining teeth, oral hygiene status and need for dental care. The examination aimed to register conditions such as oral hygiene status, oral mucosal status, denture fit, number of open cavities, fractured and mobile teeth. The intention was thus not to do a complete examination.

#### *Number of remaining teeth*

Individuals were classified into three groups according to the number of remaining teeth:

1. Complete *edentulous*, 2. A few remaining teeth (1-9) 3. Several remaining teeth (10 or more).

The degree of tooth mobility was registered when there was more than one millimetre mobility.

#### *Denture stability and retention*

An evaluation of denture stability and retention was made on those subjects, who were partially or completely edentulous and had dentures. On each patient, the examiner gently pressed her fingers on the occlusal surfaces of the acrylic teeth, in order to evaluate the denture stability. The following criteria were used: Good stability ( no or only slight denture movement when pressing gently), fair stability (some denture movement was detected during gentle pressing), and poor stability ( obvious vertical movements of the denture was registered during gentle pressing).

For evaluation of denture retention, the examiner gently tried to pull the denture off the alveolar

ridge in a horizontal direction by holding her fingers on both sides of the denture base. The following criteria were used: Good retention ( the denture had a firm contact to the denture supporting soft tissue and did not come loose when pulling gently), fair retention ( the denture came loose occasionally when pulling gently), and poor retention ( the denture did not stay in place).

#### *Oral mucosal status*

Evaluation of oral mucosal status included registration of any lesions or infections (swellings, redness) wounds or blisters and hyperplasia including both the lingual, buccal and palatal mucosa. In addition, suspected malignancies were registered.

#### *Oral hygiene status*

Oral hygiene status was recorded only for dentate subjects. Three different ratings were used: Good oral hygiene (no visible plaque or gingivitis), fair oral hygiene (visible plaque accumulations, but no gingivitis) and poor oral hygiene (abundant amount of plaque and severe inflammation of the gingiva).

#### *Mouth dryness*

Mouth dryness was evaluated using a 3-grade mucosal friction index (10).

#### *Medical status*

A medical record was available for some patients. Based on the diagnoses, the patients were registered in five groups: 1) Dementia and/or psychological problems 2) cancer or stroke 3) previous history of fractures, osteoporosis, problems with walking 4) diabetes, rheumatism, MS, Parkinson`s disease 5) high blood pressure/severe heart condition. A visual evaluation of the patients` general appearance was also done.

#### *Need for dental care*

Based on the findings from the clinical examination, each individual was divided into one of 4 groups based on the assessment of need for dental care: 1. No need for dental treatment; 2. Need for hygiene treatment; 3. Need for more extensive dental treatment; 4. Need for emergency dental treatment.

Furthermore, some of the individuals were categorized by the head nurse at the dwelling with respect to their ability to cope with everyday life (ADL-ability). Included in the classification is a professional assessment of the ability for each individual to cope with everyday life (ADL-ability).

**Statistical methods**

Data were analyzed in the SPSS statistical system. Descriptive statistics were calculated, and univariate variables presented. Differences between the number of teeth in maxilla, mandible were tested by calculation of Chi-2, where  $p <= 0.05$  was set as significance level. Rank order correlation, Spearman's rho, was calculated for some comparisons.

**Results**

The study sample comprised 125 women and 47 men with a mean age of 84.9 years ( range 63 to 97 years). Various medical diagnoses were registered among 89% of the individuals. Approximately 20% to 30% of the study sample were registered in one or more of the five medical record groups. One individual could be registered in more than one group.

Forty-one percent of the individuals were assessed by the nursing and medical staff in the nursing homes. Of those, 20% were regarded as having ADL-ability.

The results from the clinical examination showed that approximately 10% of the sample had remaining roots and decayed teeth in the maxilla, 13% in the mandible. Increase mobility was observed for 8% of all remaining teeth. The majority of the individuals were edentulous in the maxilla and the distribution of the remaining teeth is shown in tables 1 and 2. There was a close association between the number of teeth in the jaws.

Ninety-eight individuals (57%) had complete dentures in the maxilla and 62 (36%) in the mandible. Fifteen subjects had a removable partial denture (RPD) in either jaws ( Table 3).

Most of the dentures showed fair stability and retention. However, almost 20% of all complete maxillary dentures showed poor stability and retention, and the figures were even slightly higher for complete mandibular dentures (Table 4).

Oral mucosal lesions were observed in 48% of the mandibles and 45% of the maxillas. Good oral hy-

© **Table 1.** Number of teeth in maxilla, mandible and both jaws respectively (n=172 individuals). Column percentages.

	% Maxilla	% Mandible	% Both jaws
0 teeth	59	45	42
1-9 teeth	28	37	22
10-15 teeth	13	18	36
	100	100	100

© **Table 2.** Teeth in the maxilla related to the mandible (n=172 individuals). Total percentages.

Maxilla	Mandible		
	0	1-9	10->
0 teeth	43	15	1
1-9 teeth	2	20	7
10-> teeth	1	2	9

Chi-2=119.13, 4df,  $p < 0.0000$ .  $R_s = 0.72$

© **Table 3.** Distribution of maxillary and mandibular dentures. (n=172 individuals) Total percentages.

Maxilla	Mandible			Total
	Complete denture	RPD	No denture	
Complete denture	34	5	18	57
RPD	1	2	6	9
No denture	1	2	31	34
Total	36	9	55	100

giene was registered for only 12% of the individuals with remaining natural teeth, 47% had less good oral hygiene, and the majority had a moderate mucosal friction index (59%). The clinical examination revealed that 10% of the individuals had no need for dental care, while 54% were in need of hygiene treatment and 34% had conditions, which required some kind of dental treatment.

Of the total sample, 24% stated that they had some kind of oral problems. Sixty per cent of the dentate individuals and 42% wearing dentures reported that they brushed their teeth twice a day.

Twenty per cent reported that they had been ex-

© **Table 4.** Evaluation of denture retention and stability (in %). Row percentages.

	Retention					Stability				
	Good	Fair	Poor	%	n	Good	Fair	Poor	%	n
MxCD	27	55	18	100	96	22	60	18	100	96
MCD	2	72	26	100	61	3	74	23	100	61
RPD-	64	22	14	100	14	64	29	7	100	14
Max										
RPD-	31	38	31	100	13	33	42	25	100	13
Mand										

Complete denture in the maxilla (MxCD), mandible (MCD) partial denture in the maxilla (RPD Max) and mandible (RPD Mand).

mined by a dentist or hygienist within the last six months. Of the 172 individuals included in the study, 111 (65%) claimed that they had not been contacted by a dentist or hygienist and offered an examination at the nursing home within the new regulation stipulated in the National Dental Insurance System. Nine individuals had received one visit and 31 had received between two and eight visits.

### Discussion

The examination revealed that the overall oral health status among the subjects in the study was poor. About a third of all individuals reported that they had been examined by a dentist or hygienist during the last year. This implies that approximately 70% had not recently received any dental care/examination despite the fact, that several claimed they had problems related to their teeth or dentures.

As part of the NDIS, every individual in a nursing home should receive a free-of-charge visit from a dentist or hygienist responsible for evaluating the need for dental care of those living in sheltered dwellings in that municipality (16). This system involves two different public organisations. The municipality is responsible for the nursing homes, while the county council cased Public Dental Health Service is responsible for the delivery of dental care. The two systems are presumed to collaborate. Therefore, the outcome of their collaboration plays an important role in the individuals' oral health. According to the findings in the present study, the intention of the law seemed to have failed, since an extensive need for treatment was found among the majority of the individuals studied here and only a third had been examined within the new regulation in the NDIS. Furthermore, the importance of treating oral diseases and relieving pain from these individuals has been recognized earlier (15,7). Apparently most of the individuals included in the sample studied here had to handle their own oral care, including the contacts with dental services.

Conventional dental care is not always appropriate for people with poor oral health (7,12). The majority of the individuals in the present study needed prophylactic treatment. Further, several of them did not receive necessary dental treatment. Similar findings have been reported from other studies on dental treatments in geriatric population (15,7,14,5). It should however be noted that the studied sample was selected from individuals living in nursing homes, and therefore included also those who were medically compromised resulting in a higher risk of

having poor oral health. Consequently, the number of edentulous individuals was higher the Swedish average in the corresponding age group (19).

A majority of the edentulous and partly edentulous individuals had mucosal changes related mainly to ill-fitting removable prostheses. At the clinical examination quite a few ill-fitting dentures were observed.

Xerostomia was also evaluated and measured among the individuals. It has been shown, that people with problems related to dry mouth have been identified through the dental care (15). Treatment of xerostomia is important to maintain an acceptable oral function and it is important that these individuals are identified and given proper treatment to improve their oral health status.

Twenty percent of individuals in the present study had ADL capacity. The remaining 80% were dependent on professional assistance in daily oral hygiene and it is not known what impact that had on their overall oral health status. Other studies have recognized barriers in helping sick and disabled individuals living in nursing homes, barriers involving aides' attitudes, beliefs and values, which are important factors to include when evaluating oral health outcome (15,23,6,24).

The findings in the present study supports the opinion that it is necessary to evaluate the outcome of the new regulation within the National Dental Insurance System also in order to get information about how older and handicapped individuals' need for dental care is met. It should be remembered, that these individuals are very vulnerable, and there are very limited ways they can get legal assistance or forward complaints to officials (7). It is absolutely necessary for the health professions to continue their effort to involve dental care in the general health insurance system. It should further be discussed, if there is a need for county councils to improve the routines involving the new NDIS regulations with respect to follow-up and quality control aspects.

### Conclusion

The results from the present study revealed that the overall oral health status among the subjects was poor. The need for restorative and prosthodontic treatment was substantial, and most of the individuals showed a poor oral hygiene. Most of the elderly studied were left to arrange for their own dental care. Only 20% received a visit from dentists and hygienists according to the new system within the NDIS.

It is important for county councils and authorities to ensure that the regulation, which was stipulated with the intention of maintaining a good oral health for the population of elderly and disabled is beneficial and really serve those in need.

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# Quality managements and work environment in oral and maxillofacial surgery in Sweden

GÖRAN PILGÅRD<sup>1,2,3</sup>, JAN ROSENQUIST<sup>1</sup>, BJÖRN SÖDERFELDT<sup>2</sup>

## Abstract

© The aim of this study was to investigate if the Oral and Maxillofacial Surgery (OMFS) clinics in Sweden actively work with quality development and if so, which systems they use. A further aim was to explore the opinion of the employees about quality work.

Data were collected by way of a questionnaire with 67 questions, related to quality management at the clinic and to the content of healthy work. 22 clinics with 297 employees responded, 65 % of the clinics and 86 % of the employees.

More than half of the respondents stated that they worked with a management system, but there was uncertainty as to the type of a quality system. Only at two clinics, all the respondents agreed on the system. This showed that one of the most important aspects in a quality system, i.e. to inform everyone, was unsatisfactory.

The study showed that dental nurses and assistant nurses were more appreciative of quality as a tool for improvement than the maxillo-facial surgeons. There was no such difference concerning the importance of quality work. Dental nurses thought that the quality was more important for the working situation concerning the physical environment than did the maxillo-facial surgeons.

## Key words

*Quality management, physical environment, maxillofacial surgery*

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## Kvalitetssystem och arbetsmiljö inom käkkirurgin i Sverige

GÖRAN PILGÅRD, JAN ROSENQUIST, BJÖRN SÖDERFELDT

### Sammanfattning

◎ Målsättningen med studien var att studera om käkkirurgiska kliniker i Sverige använde sig av kvalitetssystem och i så fall vilket. En ytterligare målsättning var att ta reda på medarbetarnas inställning till kvalitetsarbete.

Frågeformuläret innehöll 67 frågor och berörde kvalitetsarbetet på kliniken och tillfredsställelsen av det goda arbetet. 22 kliniker med 297 medarbetare svarade, 65 % av klinikerna och 86 % av medarbetarna.

Studien visade att mer än hälften av de svarande arbetade med kvalitetssystem, men att det rådde en stor oenighet om vilket kvalitetssystem man använde. Det var bara två kliniker där alla medarbetarna var överens om vilket system man använde. En av de viktigaste aspekterna i kvalitetsarbetet är att informera alla och allas delaktighet.

Tandsköterskor och tandvårdsbiträden uppskattade i större utsträckning än tandläkarna kvalitetsarbetet som ett verktyg för förbättringar. Det var inte någon skillnad i åsikten att kvalitetsarbetet var viktigt för arbetssituationen vad avsåg vården. Tandsköterskorna och tandvårdsbiträdena ansåg i högre grad än tandläkarna att kvalitetsarbetet var viktigare för arbetsmiljön.

## Introduction

Oral and Maxillofacial Surgery (OMFS) is a dental speciality; the surgical treatment of pathological lesions and malformations of the jaws and surrounding tissues. It comprises minor procedures such as dentoalveolar surgery, and major procedures such as orthognathic surgery, temporo-mandibular joint surgery, traumatology and reconstructive surgery [11].

Quality has in recent decades attracted great interest. In many OMFS clinics, directors are increasingly focused on quality systems and total quality. The growing interest has its foundation in what is called Total Quality Management (TQM). There, the overarching goal is to meet the demands and expectations of the customers at the lowest price. This is achieved by encouraging everyone to take part in the process of continuous improvement. TQM is defined by ISO 8420 as:

“Management approach of an organisation centred on quality, based on the participation of all its members and aiming at long term success through customer satisfaction and benefits to all members of the organisation and to society.” (1)

*Bergman & Klefsjö* [3] use the expression *Progressive quality development* as synonymous to TQM. The term 'progressive' indicates active prevention, change and improvement instead of checking and repairing after a problematic event. The term 'development' indicates that quality work is a continuous process, not only for products and processes, but also for people.

The quality development usually includes both physical and social work environment as well as general environment. Satisfied patients and customers (quality), happy co-workers (social environment) and resource economy are intended to be the results of quality development. There is also a relationship between several work environment related factors and quality (1). Participation is one of the main factors affecting quality. Important keywords for participation are communication, delegation and education. To be able to perform good work, the employees must feel engagement, responsibility and pride in their profession. A management system is a system to establish policy and objectives, and to achieve those objectives. Management of an organization can include different systems, such as a quality management system (ISO 9000 [10]) or an environmental management system (ISO 14001 [8]).

In Sweden, an example of managerial development can be found in the emergence of the so called QUL (Quality-Development-Leadership), developed by the Swedish Federation of County Councils, the political organization responsible for health care

and public dentistry in Sweden. QUL is an instrument for leadership that involves the whole organisation, partly inspired by the Malcolm Baldrige National Quality Award. Another example is Organization Audit by SPRI (OG), the Swedish Planning and Rationalization Institute of the Health and Social Services. For use in Sweden, SPRI developed a quality system from the King's Fund Organisational Audit in England. It is an instrument to contribute to the quality development through feedback and professional opinion.

The aim of this study was to find out if the OMFS clinics in Sweden actively work with quality development and if so, which systems they use. A further aim was to explore the opinion of the employees about quality work.

## Material and methods

### Study base

A letter explaining the study was sent (January 2002) to all 34 heads of the hospital based OMFS clinics in Sweden (including one combined with a prosthodontic). If the heads of the clinics agreed that the clinic would participate, they were asked to acknowledge their participation by returning a list of names of their staff. Then a questionnaire was sent to each individual staff member during April 2003. Two reminders were sent in May 2003 and in September 2003. All employees at the clinics were involved. The questionnaires were sent to the heads of the clinics to be distributed to the employees. After having completed the questionnaire, the employees were asked to return it directly to the Department of Oral Public Health, Malmö University.

The study was approved by the Research Ethics Committees (March 2003).

### Questionnaire

The questionnaire contained of 67 questions. They concerned quality management at the clinic, health, work, working climate, working situation, profession, questions about the content of healthy work, the connection between physical environment and health, emphasis on physical environment, health and support.

The first question used here was about employee category – maxillo-facial surgeon, dental nurse, assistant nurse, dental hygienist, secretary, and dental technician. The second question concerned the age of the respondents. The response alternatives were structured in five year categories from below 25 to more than 60 years. The third question was about

© **Table 1.** The profession of respondents and non-respondents.  $\chi^2 = 1.006$ , 5df,  $p \leq 0.95$ .

Profession	Response %	Non response %
Maxillo-facial surgeon	32	22
Dental nurse	52	64
Assistant nurse	2	6
Dental hygienist	1	0
Secretary	11	8
Dental technician	2	0
n	296	50

© **Table 3.** Quality management systems used (n = 281).

Quality management system	% of employees
ISO 9000	16
ISO 14001	7
QUL	19
OG	1
Other	13
No	24
Do not know	21
	101

© **Table 2.** Clinic size as expressed as number of full-time staff and how the respondents answered.

Size of workplaces	No. of workplaces	Workplaces %	No. of employees	Employees %
-10	7	32	30	10
11-15	5	23	43	15
16-20	4	18	33	11
21-	6	27	188	64
n	22	100	294	100

gender. The fourth question was about the number of co-workers/staff at the clinic. The response alternatives were "less than 6 persons", "6-10 persons", "11-15 persons", "16-20 persons" or "more than 20 persons".

The following questions concerned the quality work at the clinic. The fifth question concerning the use of any quality management system at the clinic had "ISO 9000", "ISO 14000", "QUL", "SPRI's Organization Audit", "other", "none" or "do not know" as alternatives. If the answer was "other" the respondents were asked to tell which quality system they used. The sixth question asked if the quality work had changed the work. The response alternatives were "better", "the same", "worse", "do not know" or "have no quality work". The seventh question asked if quality work was regarded as important for the working situation concerning the clinical work and the physical environment. Both of these questions had their responses on Likert scales with five grades from "not important" to "very important". The answer could also be "I do not know".

#### Statistical methods

All data were processed in the statistics program SPSS. Statistical significance was assessed by means of the Pearson's chi-square test, with  $p < 0.05$  considered significant.

#### Results

Of the 34 clinics, four clinics never responded and another five declined participation. Three additional clinics declined participation when the questionnaires were sent out. Altogether 22 clinics (65 %) parti-

culated in the study.

Questionnaires were distributed to 453 persons at the 22 clinics. 40 persons had either left the clinic or had other duties and 66 worked at clinics that later declined participation. Of the remaining 347 persons, the net sample, 50 did not return the questionnaires and thus 297 persons responded, i.e. 86 %.

Out of the 297 respondents, 75 % were women and 25 % men, one third were maxillo-facial surgeons and more than half were dental nurses, with the other groups constituting 16 %. A non-response analysis showed no significant difference between respondents and non-respondents on this variable (Table 1). Of 295 respondents (2 missing data) 3 % were younger than 30, 17 % were 31-40, 35 % were 41-50, 37 % were 51-60 and 8 % were more than 60 years old. The size of the workplaces varied between fewer than six employees and more than twenty-one. The majority (64 %) worked at workplaces with more than twenty employees (Table 2) while the median size was 11-15 employees.

Of the respondents, 55 % stated that they worked with one of the listed quality management systems (Table 3). Of those who responded "other", 85 % (n=30) stated that they worked with their own system, two persons with Balanced Scorecard and 3 persons with an environmental system.

There are two units of analyses in this study, the employee and the clinic. In aggregating the responses of employees about presence of a quality assurance system, a variation was found at clinic level. This variation was categorized into an SD of 0,  $0 < SD < 2$ ,

© **Table 4.** The responses from the 22 clinics concerning the use of any quality management system and size of workplace. Management system response variation groups in SD versus size of workplace (n=22) ( $\chi^2=2.979$ , 5df,  $p\leq 0.563$ )

Size of workplace No. employees	Response variation group SD intervals			n
	0	0 <SD≤2	2<SD	
<10	1	4	5	10
11-20		5	3	8
21<	1	1	2	4
n	2	10	10	22

© **Table 5.** Has the quality work changed your work?

	Better	The same	Worse	Do not know	No quality work		n
Maxillo-facial surgeon %	12	29	4	32	22	99%	90
Dental nurse and assistant nurse %	27	31	1	23	17	99%	147
P=0.0319							
All %	21	31	3	27	19	101%	268

© **Table 6.** Do you think that quality work is important for your working situation concerning the physical environment?

	Not important			Very important		Do not know	n
	1	2	3	4	5		
Maxillo-facial surgeon %	2	2	19	38	29	9	99% 86
Dental nurse and assistant nurse %	0	1	11	33	49	6	100% 144
P=0.0226							
All %	1	1	14	34	41	10	101% 268

SD >2 and cross tabulated with clinic size in terms of number of employees. As stated in Table 4 the study showed that only at two clinics did all the respondents agree on their system. When the standard deviation (SD) exceeds 0 the employees disagree more.

The dental nurses and assistant nurses had a much more positive view on the ability of quality work as a means to improve their work than had the maxillo-facial surgeons (Table 5). There was no such difference in the opinion whether quality work is important for their working situation concerning the clinical work (71 % of the maxillo-facial surgeons and 78 % of the dental nurses), while there was a difference in the assessment of the importance of quality work for the working situation concerning the physical environment (Table 6). For a majority of the dental nurses the working situation concerning the physical environment was more important (82 %) than for the maxillo-facial surgeons (67 %).

**Discussion**

The study showed that more than half of the respon-

dents (55 %) stated that they worked with a quality system. These systems were ISO 9000, QUL, local systems and the environmental system ISO 14001. Of those, ISO 9000, ISO 14001 and QUL are national or international systems, mainly from industry and are well tested. The idea of quality assurance was inspired both from industry and from the theories of quality assurance models within the international health care (7). Only a few clinics in this study worked with local quality systems.

In ISO 9000:2000 the employees' commitment is discussed. Their full engagement leads to the employees' ability being used in the best interest of the organization. This is relevant for leadership [10]. However, the study also showed that the respondents did not agree on which quality system they worked with. Only at two clinics did all the respondents agree on their system. This showed that one of the most important aspects in a quality system, i.e. to inform everyone, was unsatisfactory. Working with a total quality system means that all employees should be involved, that all understand the importance of the

work. All personnel should be engaged, and quality thinking should involve the whole company as part of the company culture. (13, 4, 6, 5). All employees must be involved in the company's management, in order to provide a good model and create a feeling of participation (12). Quality involves everyone. There is obviously not full satisfactory attainment of this criterion in Swedish OMFS.

The study showed that dental nurses and assistant nurses were much more appreciative of quality as a tool for improvement than the maxillo-facial surgeons. There was no such difference in the opinion of the importance of quality work for their working situation concerning the clinical work.

*Erlingsdóttir* (7) showed that in the beginning, the doctors of the University Hospital of Lund were very sceptical to the introduction of a quality system and an external quality control. The reason was that they controlled their own work and that the standard for what was accepted or good relied upon their professional judgement, based on medical and humanitarian norms. The doctors meant that the quality system was connected to other norms and valuations. Quality assurance in health care had engaged more nurses than doctors – because nurses did not feel threatened by an external control in the way that doctors did. The nurses regarded the quality assurance as a way to improve their professional standing, raising their own job status. The result here may indicate that maxillo-facial surgeons' work is similar to that of the doctors, and a quality system might therefore be regarded similarly as a threat against values of the maxillo-facial surgeons. The difference between maxillo-facial surgeons and dental nurses could be explained by these mechanisms.

The dental nurses thought that the quality was much more important for the working situation concerning the physical environment than did the maxillo-facial surgeons (Table 6). This result can probably only be accounted for in multivariate analysis, considering gender and education. 27 % of the dental nurses answered that quality work had changed their work more than it had for the maxillo-facial surgeons (12 %).

In this study 86 % of the respondents answered, which is a high figure possibly reflecting a sense of importance in participating in the survey. In *Bejerot's* study 88 % of the maxillo-facial surgeons and 84 % of the dental nurses had completed the questionnaires (2). *Kivimäki et al* reported in a study of absence due to sickness among hospital physicians a response of only 55 % (9). This shows that the dental personnel are more interested in answering

questions about their physical environments than for example hospital physicians. In this study almost all respondents worked at hospitals.

Of the 34 OMFS clinics, altogether 22 clinics participated in the study. The study would have given a better image of the quality work and the physical environment on OMFS clinics if all 34 clinics participated. Maybe a questionnaire of this kind could be experienced as a threat in the situation of some clinics.

In conclusion, quality work in Swedish OMFS is well developed but uneven in its implementation.

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# Interocclusal appliances – Indications and clinical routines in general dental practice in Sweden

ERIK LINDFORS<sup>1,2</sup>, TOMAS MAGNUSSON<sup>1</sup>, ÅKE TEGELBERG<sup>2,3</sup>

## Abstract

© The aim of this study was to analyse what kind of interocclusal appliances that are used in general dental practice in Sweden, the indications for such treatment, to what extent a clinical status is recorded before treatment, as well as the routines for evaluation of treatment results.

The study was a retrospective analysis of patient records from 320 adult patients who had been treated by general dental practitioners in the Public Dental Service in Sweden. For comparison a group of 88 consecutive patients who had received interocclusal appliance therapy at a specialist clinic was used.

The most common indication for treatment with hard acrylic stabilisation appliances, as well as with soft appliances, was *occlusal wear due to tooth grinding*. The second most common indication for treatment with hard acrylic stabilisation appliances was *pain from masticatory muscles*, while the second most common indication for soft appliances was *tension-type headache*. Treatment with soft appliances was more often combined with other treatment modalities compared to treatment with hard acrylic stabilisation appliances.

Large variations were found between the 3 general dental clinics and the specialist clinic in respect of treatment indications, combinations with other treatment modalities, recording of clinical findings, follow-ups and evaluation of treatment results. General conclusion should, however, be made with caution due to the risk of selection bias.

From the results of this study it is obvious that treatment with soft appliances is common in general dental practice in Sweden, despite the lack of scientific support for their efficacy, as well as effectiveness, compared to hard acrylic stabilisation appliances. There is an obvious need for investigations of the decision-making processes among dentists when performing treatment with interocclusal appliances, as well as for randomised controlled studies concerning efficacy and effectiveness of soft appliances.

## Key words

*Temporomandibular disorders; treatment; splint; dentistry; Indications*

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## Bettskenebehandling – Indikationer och kliniska rutiner inom allmäntandvården i Sverige

ERIK LINDFORS, TOMAS MAGNUSSON, ÅKE TEGELBERG

### Sammanfattning

© I över ett sekel har bettskenor använts för behandling av bl.a. funktionsstörningar i käksystemet. Studiens syfte var att analysera vilka typer av bettskenor som används i svensk allmäntandvård, och vilka indikationerna är för behandling, samt i vilken utsträckning ett bettfysiologiskt status upprättats inför behandling och hur ofta behandlingen efterkontrollerats och utvärderats.

Studien var en retrospektiv journalanalys på 3 allmäntandvårdskliniker i Mellansverige. Trehundratjugo vuxna patienter som erhållit bettskeneterapi under åren 2000-2002 inkluderades i studien. Som jämförelsegrupp användes 88 konsekutiva vuxna patienter som erhållit bettskenebehandling vid en specialistklinik inom samma tidsperiod.

Endast vid var fjärde behandling i allmäntandvård hade ett bettfysiologiskt status upprättats inför behandlingen. Det förelåg stora skillnader i valet av bettskenetyp mellan de olika allmäntandvårdsklinikerna.

Den vanligaste indikationen för behandling med stabiliseringskena i hårdplast var *tandslitage till följd av tandgnissling*, följt av *smärta från käkmuskulaturen*. Den vanligaste indikationen för behandling med bettskena i mjukplast var också *tandslitage till följd av tandgnissling*, men för denna skentyp var *spänningshuvudvärk* den näst vanligaste indikationen. Behandling med bettskena i mjukplast kombinerades oftare med annan bettfysiologisk behandling jämfört med behandling med stabiliseringskena i hårdplast.

Stora skillnader förelåg mellan allmäntandvård och specialisttandvård när det gällde indikationer för behandling, kombination med annan bettfysiologisk behandling, upprättande av status, efterjustering, uppföljning och utvärdering. Generella slutsatser bör dock göras med försiktighet på grund av risken för selektionsbias.

Studien visar att bettskena i mjukplast är en ofta använd behandlingsform inom svensk allmäntandvård trots bristfälligare vetenskapligt stöd för dess behandlingseffekt jämfört med stabiliseringskenan. Det finns ett behov av studier för att utröna vilka faktorer som påverkar och styr tandläkaren i den kliniska beslutsprocessen inför en behandling med bettskena, och även av randomiserade kontrollerade studier som utvärderar den mjuka bettskenans verkningsmekanismer och behandlingseffekt.

### Introduction

Different kinds of interocclusal appliances have been used for treatment of e.g. bruxism and temporomandibular disorders (TMD) for more than a century (21, 24). A lot of different appliances have been described in the dental literature (6, 29). The most commonly used appliances in Sweden are the stabilisation appliance made in hard acrylic, also known as the Michigan appliance, and the soft appliance (32, 43) (Figure 1). It has been estimated that approximately 30 000 - 40 000 interocclusal appliances are being made every year in Sweden (29) making an incidence per year of approximately 0.42% to 0.57% in adult individuals.

The soft appliance is commonly used in TMD cases, despite the fact that studies evaluating its' efficacy are very sparse (50). In a study by *Harkins et al* (23) TMD patients were provided with a soft appliance to be used for 10-20 days while awaiting a hard acrylic stabilisation appliance. The majority of the patients reported that the use of the soft appliance gave a reduction of their symptoms, and for those who responded positively to the soft appliance, no less than 93% had good to excellent treatment result of the succeeding stabilisation appliance. The authors suggested that soft appliances could be used as a temporary treatment but also as a diagnostic tool for some TMD cases.

In a randomised clinical study, TMD patients treated with a soft appliance during a 6-weeks period had a statistically significant reduction of their symptoms compared to a matched control group (49). In another study TMD patients received either a soft appliance or a stabilisation appliance at random. During a treatment time ranging between 10-15 weeks, both groups had an equal reduction of jaw muscles tender to palpation (42). According to a case-report, a patient with a post-traumatic stress disorder had a further reduction of symptoms when a stabilisation appliance in the upper jaw was combined with a soft appliance in the lower jaw (51).

Some authors have expressed concern about the efficacy of soft appliances, e.g. *Nevarro et al* (38) who showed that stabilisation appliances had a superior treatment effect on TMD compared to soft appliances. In another study it was shown that patients who received a reduced EMG activity while wearing a stabilisation appliance had a statistically significant increased EMG activity when the appliance was changed to a soft one (40). Furthermore *Gray & Davies* stated that in approximately 10% of cases, these appliances will make the symptoms



© Figure 1. Examples of a hard acrylic appliance, Michigan type (Top) and a soft appliance (Bottom)

worse (22). In a comprehensive review by *DuPont & Brown* (11) a number of papers dealing with soft and/or hard acrylic appliances are presented. From this review, it is obvious that the scientific support for the hard acrylic appliances is superior to that of soft appliances. A drawback for all the cited studies is that the sample-sizes are small, why the scientific value is limited.

The following indications have been suggested for soft appliances (23, 29, 32, 50, 51):

- For young TMD patients with primary or mixed dentitions
- For day-time use
- As an acute or temporary treatment while awaiting the fabrication of a hard acrylic appliance
- As a diagnostic treatment
- As an alternative if the patient does not tolerate a hard acrylic appliance
- To protect the tongue in cases of a tongue thrusting parafunction
- In cases of removable complete dentures or implant supported fixed prostheses
- In combination with hard acrylic stabilisation appliances to gain further alleviation of TMD symptoms

It has been stressed that it is important that also a soft appliance is adjusted to even and stable contacts against the teeth in the opposing jaw. If this is not possible to achieve, a hard acrylic stabilisation

appliance is the treatment of choice (50). The same author also states that soft appliances should be avoided in cases of pronounced dental attrition.

Recently the efficacy of interocclusal appliances, including stabilisation appliances, has been questioned both in a controlled clinical trial (7) and in several review articles (3, 8, 19, 20).

However, a large number of other studies have claimed that a hard acrylic stabilisation appliance is an effective treatment tool for TMD. One investigation of the long-term effects of stabilisation appliances showed that TMD symptoms were cured or improved in spite of a continuation of nocturnal bruxism (45). The latter was also found in a short-term study where treatment with stabilisation appliances eliminated or reduced clinical signs of TMD but the bruxism continued (52).

Results from randomised, controlled short- and long-term trials have shown that stabilisation appliances have a favourable effect on TMD of both myogenous and arthrogenous origin (12-14, 16-18), as well as on secondary otalgia and TMD (28). Tension-type headache has been found to be correlated with TMD (30), and a positive effect on tension-type headache after treatment with stabilisation appliances has been reported (15, 31).

In a larger sample of 232 TMD patients, 41% were free from symptoms and another 43% reported reduction of their symptoms after stabilisation appliance treatment (27). However, patients with disk displacement in the temporomandibular joints (TMJs) had a poorer treatment outcome. The authors concluded that stabilisation appliance therapy might be a useful treatment modality in treatment of TMD, especially for patients without clinical evidence of disk displacement.

*Ramfjord & Ash* concluded in a review article (43) that there is scientific support for a positive treatment effect of stabilisation appliances in cases with pain from the TMJs, jaw muscle pain, tension type headache and bruxism.

In other review articles it has been stated that "the use of occlusal appliances in managing localised masticatory myalgia, arthralgia or both is sufficiently supported by evidence in the literature" (26) and that "occlusal splints are effective in reducing headache and muscle pain" (37).

In yet another review article *Türp et al* (47) concluded that most patients with pain from masticatory muscles experienced pain relief from a stabilisation appliance. However, treatment with soft appliances, non-occluding appliances, therapeutic jaw exercises

and acupuncture treatment seemed to give equal treatment results.

*Kotani et al* (25) found that the improvement of subjective symptoms was recognised earlier than the reduction of objectively measured EMG activity in patients with myofascial pain treated with stabilisation appliances.

The consequences of appliance usage have also been investigated (9). Patients with "a pain dysfunction syndrome" were divided in 3 groups. One group wore stabilisation appliances 24 hours/day, one group wore it only during the day, and the third group wore it only at night. All 3 groups showed a marked improvement by both subjective and objective assessment, but no difference could be found between the groups. Because of this, the authors recommend night-time use only.

In conclusion, the scientific support for the efficacy and effectiveness of hard acrylic stabilisation appliances is much better than that for soft appliances (39).

Despite the fact that many of the aforementioned studies have shown that stabilisation appliances have a positive effect upon TMD signs and symptoms, their mechanisms of efficacy have not been fully explained (32). Most likely, it is a combination of different mechanisms that lead to the positive end result (5, 11, 29, 32).

The indications that have been suggested for hard acrylic stabilisation appliances are many but the most prevailing once are:

- Symptoms and signs from TMJs and/or masticatory muscles (12-18, 29, 32)
- Tension-type headache (15)
- To prevent or delay tooth wear (32, 36, 43)

The aims of the present study were to investigate what kind of interocclusal appliances that are used in general dental practice in Sweden, the indications for their use, as well as the clinical routines for documentation of clinical signs and evaluation of treatment outcome. Comparisons have been made with a sample of adult patients treated with interocclusal appliance therapy at a specialist clinic.

#### Material and methods

The clinics included in the study were 3 general dental clinics in Public Dental Service located in 2 neighbouring counties in the middle part of Sweden. These clinics were randomly selected. One clinic is located in a larger town in county I (124000 inhabitants, Clinic A), and 2 clinics are located in a village and a smaller town in county II (7000 and

13000 inhabitants, respectively, clinics B and C). Seven, 4 and 8 dentists worked at the 3 clinics, respectively, and they were responsible for the regular dental care of 2600, 1500 and 4500 adult patients at the time period covered by the investigation. The patient group used for some comparisons constituted of consecutive patients referred to a specialist TMD clinic in the County of Jönköping, who had received an interocclusal appliance as a treatment. Two experienced TMD specialists and 2 dentists undergoing specialist training worked at the specialist clinic. All 4 clinics had the equipment necessary for fabrication of soft appliances at the clinic, while the hard acrylic appliances were made by dental technicians at different dental laboratories.

All case records from adult patients, over 20 years of age, who had been treated in one of the 3 general dental clinics during the 3-year-period 2000-2002 were scrutinised retrospectively. Data from all patients who had been treated with any kind of interocclusal appliance were collected and they included: gender and age of the patients, type of appliance made, indication(-s) for treatment, if a clinical status had been recorded before start of treatment or not, if other TMD treatments had been performed as an adjunct to the treatment with the appliance, number of subsequent adjustments of the appliances (if any), documented evaluation of treatment results (yes or no), as well as at which clinic the treatment had been performed. For comparisons, the same data were registered for 100 consecutive patients treated with interocclusal appliances at a specialist clinic within the same time period. Twelve of these patients were not over 20 years of age and were therefore excluded

from the study. Thus a group of 88 adult patients remained and was included in the study.

The results are presented as frequencies and mean values. For the statistical analyses of differences between variables and groups, Chi-square test, Mann-Whitney U-test as well as T-test have been used. A p-value <0.05 has been considered as a statistically significant difference.

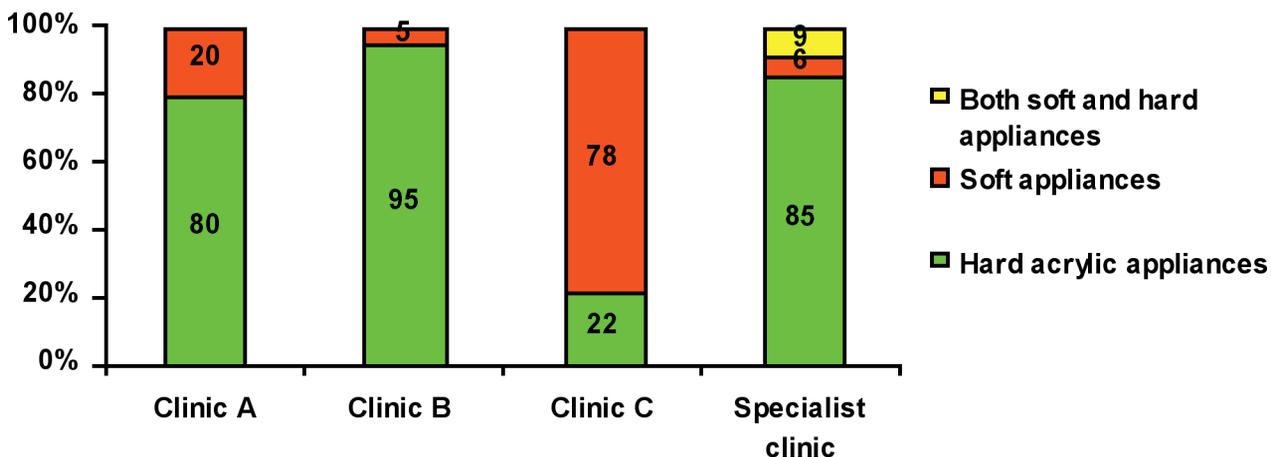
### Results

The total number of interocclusal appliances made in counties I and II during 2000-2002 was 1555 and 1687, respectively. Since the 2 counties cared for 75000 and 85000 adult patients during this time period, the yearly incidence for appliance treatment in adult dental patients was 0.69 and 0.66%, respectively. In county I, 20% of all appliances made were soft ones, and the corresponding figure in county II was 63%.

A total of 356 patients from the 3 general dental clinics fulfilled the inclusion criteria. Out of these, the case records could not be found in 36 cases (10%). All 88 case records from the specialist clinic were available. Thus, a total of 408 patients were included in the study. Both at the 3 general dental clinics and at the specialist clinic, the majority of the patients were women (66% and 77%, respectively). The mean age of the patients from the 3 dental clinics was 42 years (range: 21-89). The corresponding figure from the specialist clinic was 44 years (range: 20-93).

The incidence figures per year for appliance treatment at clinics A, B and C were 1.68, 0.42 and 1.25%, respectively. The distribution of the different types of interocclusal appliances made are presented in Fi-

© **Figure 2.** Percentage distribution of appliance treatment performed at 3 general dental clinics (n=131, 19 and 170, respectively) and a specialist clinic (n=88).



© **Table 1 A.** Indications in per cent for treatment with hard acrylic or soft appliances at the 4 different clinics. One treatment could have more than one indication.

Indications	Clinic A n=131	Clinic B n=19	Clinic C n=170	Total n=320	Specialist clinic n=88
No indication registered	11	42	9	12	0
Tooth wear due to bruxism	40	21	26	31	1
Frequent fractures of teeth and fillings due to bruxism	8	0	10	8	0
Sensitive/tender teeth due to bruxism	9	11	17	13	5
Pain from the masticatory system (not specified to muscles or joints)	2	0	3	2	17
Pain from jaw muscles	33	5	17	23	22
Pain from TMJs with or without joint sounds	21	11	7	13	34
Tension-type headache	14	5	24	19	34
Tongue-thrusting	1	5	1	1	3
TMJ-sounds without pain	1	5	5	3	0
Other indications	2	11	16	10	1

Figure 2. Out of the 320 appliances from the 3 general dental clinics, half (n=159) were soft appliances, and half (n=161) were hard acrylic ones, but the proportion between hard and soft appliances varied considerably between the 3 general dental clinics (Figure 2). Patients who received soft appliances were statistically significantly older compared to those who received hard acrylic appliances (p=0.005). Of the hard acrylic appliances, 159 (99%) were stabilisation appliances, one Shore plate and one mandibular positioning appliance.

The corresponding figures at the specialist clinic were 48 stabilisation appliances (55%), 27 Shore plates (31%), and 8 (9%) other types (3 anterior bite plates, 3 molar-supporting appliances and 2 mandibular positioning appliances). In 8 of these cases (9%), the hard acrylic appliance was combined with a soft appliance in the opposite jaw. Only in 5 cases (6%) were soft appliances used as a sole appliance.

#### Notes of indications for treatment

In 88% of the case records from the 3 general dental clinics, and in all cases from the specialist clinic, one or more indication(-s) for the treatment with an interocclusal appliance had been stated. There was no statistically significant difference between hard and soft appliances in this respect. The various indications for all appliance treatments, as well as for hard and soft appliances, respectively, are presented in Tables 1 A-C.

In cases with the indication *frequent fractures of teeth and fillings due to bruxism*, the use of soft appliances was 4 times more common than the use of hard acrylic appliances at the 3 general dental clinics (p<0.001), while this indication for treatment was never used at the specialist clinic. For the indications *pain from jaw muscles* and *pain from TMJs with or without joint sounds*, the 3 general dental clinics used hard acrylic appliances 3 and 5 times more often than soft appliances, respectively (p<0.001).

The only statistically significant difference that could be found between the 3 general dental clinics in respect of indication for appliance treatment was that clinic A used the indication *tooth wear due to bruxism* more frequently compared to the other 2 general dental clinics (p=0.023). This indication was the most frequently used indication at the 3 general dental clinics, but was rarely used at the specialist clinic (Table 1A). This difference was statistically significant (p<0.001).

The indications for appliance treatment also differed in several other respects between the 3 general dental clinics and the specialist clinic. The indications *frequent fractures of teeth and fillings due to bruxism* and *sensitive/tender teeth due to bruxism* were statistically significantly more common indications used at the 3 general dental clinics compared to the specialist clinic (p=0.005 and p=0.021 respectively), while the indications *pain from the masticatory system (not*

© **Table 1 B.** Indications in per cent for treatment with hard acrylic appliances at 3 general dental clinics and a specialist clinic, including 8 cases treated with both a hard and soft appliance at the specialist clinic. One treatment could have more than one indication

Indications	General dental clinics	Specialist clinic
	n=161	n=83
No indication registered	12	0
Tooth wear due to bruxism	32	1
Frequent fractures of teeth and filling due to bruxism	3	0
Sensitive/tender teeth due to bruxism	12	5
Pain from the masticatory system (not specified to muscles or joints)	1	18
Pain from jaw muscles	34	20
Pain from TMJs with or without joint sounds	22	33
Tension-type headache	17	36
Tongue-thrusting	1	4
TMJ-sounds without pain	3	0
Other indications	6	1

specified to muscles or joints) ( $p < 0.001$ ), pain from TMJs with or without joint sounds ( $p < 0.001$ ), and tension-type headache ( $p = 0.002$ ) were statistically significantly more commonly used at the specialist clinic.

Other indications were used in 32 cases (10%) at the 3 general dental clinics. The most frequent other indications were *wants to have a new appliance* (10 cases), *subjective awareness of tooth clenching* (7 cases), and *can't tolerate the hard acrylic appliance* (indication for soft appliances, 5 cases). Only once were other indications used at the specialist clinic; *anterior open bite* was used in one case together with the indications *pain from jaw muscles* and *tongue-thrusting*.

#### Recording of functional status/clinical signs

Only in one-fourth of the cases treated at the 3 general dental clinics had some kind of functional status/clinical signs been recorded before start of treatment. Such recordings were statistically significantly more frequently performed in cases where hard acrylic appliances were used compared to soft acrylic ones (40% and 11%, respectively,  $p < 0.001$ ). A functional status was also recorded more often before start of treatment when the indications for treatment were *pain from jaw muscles* (74%,  $p < 0.001$ ) and *pain from TMJs with or without joint sounds* (81%,  $p < 0.001$ ) compared to other indications. In all cases from the specialist clinic a functional status had been recorded before start of treatment.

#### Combinations with other treatment modalities

The appliance treatment was combined with other TMD treatment in 23% of the cases treated at the 3 general dental clinics. This was statistically significantly more common in cases treated with soft appliances compared to those treated with hard ones (32% and 15%, respectively,  $p < 0.001$ , Table 2). Combined treatments were much more common at the specialist clinic (73%,  $p < 0.001$ ), and with no difference between those treated with soft and hard appliances.

One common adjunct therapy used both at the 3 general dental clinics and at the specialist clinic was occlusal adjustment which was performed in 20% and 19% of the cases, respectively (Table 3). At the 3 general dental clinics, occlusal adjustment was especially common in cases treated with soft acrylic appliances (Table 2). Therapeutic jaw exercises and pharmacological treatments were common adjunct interventions at the specialist clinic, while these treatment modalities were much less commonly used by the general practitioners (Table 3).

When pharmacologic treatment was used, different NSAIDs were the prescribed drugs of choice both among the general practitioners and the specialists. In some cases, general practitioners had prescribed benzodiazepines. This was not used by the specialists during the time-period covered by the investigation. Intra-articular injection with corticosteroids was a fairly common therapy at the specialist clinic, and did not occur at all in general practice.

**Table 1 C.** Indications in per cent for treatment with soft appliances at 3 general dental clinics and a specialist clinic. One treatment could have more than one indication.

Indications	General dental clinics	Specialist clinic
	n=159	n=5
No indication registered	11	0
Tooth wear due to bruxism	31	0
Frequent fractures of teeth and fillings due to bruxism	14	0
Sensitive/tender teeth due to bruxism	15	0
Pain from the masticatory system (not specified to muscles or joints)	3	0
Pain from jaw muscles	11	40
Pain from TMJs with or without joint sounds	4	60
Tension-type headache	21	0
Tongue-thrusting	1	0
TMJ-sounds without pain	3	0
Other indications	14	0

**Table 2.** Distribution in per cent of other treatment modalities combined with hard acrylic and soft appliance treatment performed at 3 general dental clinics. One appliance treatment could be combined with more than one adjunct therapy.

Adjunct therapies	Hard acrylic appliances	Soft appliances
	n=161	n=159
Occlusal adjustment	7	32
Therapeutic jaw exercises	6	0
Pharmacological treatment	2	2

**Table 3.** Distribution in per cent of other treatment modalities combined with appliance treatment, irrespective of type of appliance, performed at 3 general dental clinics and a specialist clinic. One appliance treatment could be combined with more than one adjunct therapy.

Adjunct therapies	General dental clinics	Specialist clinic
	n=320	n=88
Occlusal adjustment	20	19
Therapeutic jaw exercises	3	52
Pharmacological treatment	2	24
Acupuncture	0	2
Biofeedback	0	2
TMJ surgery	0	1

#### Subsequent adjustments and clinical follow-ups

Subsequent adjustments of the appliances were performed in 43% of the treatments at the 3 general dental clinics. Readjustment of hard acrylic appliances were much more common compared to soft

appliances; 70% and 16%, respectively ( $p < 0.001$ ). In cases where hard acrylic appliances were readjusted, the number of adjustments varied between 1 - 5 times. When soft appliances were readjusted, this was limited to one subsequent adjustment. Ninety-one per cent of the appliances made at the specialist clinic were readjusted at least one time.

Some kind of documented evaluation of the treatment results were made in 22% of the treatments performed at the 3 general dental clinics with no statistically significant differences for different indications for treatment. However, as for readjustments, clinical follow-ups of treatment results were statistically more common in cases where the patients had been provided with hard acrylic appliances compared to soft ones (27% and 17%, respectively,  $p = 0.035$ ). All treatments performed at the specialist clinic were evaluated, and the treatment outcome was documented in the case records.

#### Discussion

Ten per cent of the case records could not be localised. The main reasons for this were that patients had changed clinic for their dental treatment, and their case records had been transferred to the new clinic. It is not likely that this loss of information has influenced the presented results.

The yearly incidence for appliance treatment was fairly even in the two counties (0.69 and 0.66 %), and it was higher in both counties compared to national incidence of appliance treatment in Sweden (0.42-0.57 %). For 2 of the general dental clinics included in the study, clinics A and C, the incidence

figures was more than twice as high compared to the national figures, while for one clinic, clinic B, the figure was in agreement with the national incidence.

The reason for the large difference between 2 of the general dental clinics and both local and national incidence figures for appliance treatment is difficult to identify. One possible explanation is that different clinics, and even different regions, have different traditions to which extent TMD patients are identified, and also different treatment traditions. However, one conclusion from these figures is that dentists from clinics A and C are likely to be more experienced in appliance treatment compared to the average Swedish dentist.

The treatment need of TMD has been estimated to be 1.5-9% in different investigations (2, 10, 44, 46) while figures on TMD treatment received are much lower than the estimated treatment need (48). The incidence figures of TMD treatments performed at 2 of the dental clinics correspond fairly well with the yearly incidence figure for such treatment of approximately 1% as reported by *Magnusson et al* (35).

In half of the cases treated by general dental practitioners, the patients had received soft appliances. Once again large differences could be seen both between the 2 counties and between the 3 different clinics. In county II, soft appliances were the dominating type (63%). This was also the case in clinic C, located in county II, where more than 3 out of 4 appliances were soft ones. In clinic B, also located in county II, soft appliances were rarely used. However, the total amount of appliances made at that clinic was very small. In the neighbouring county I, only 20% of the total amount of appliances made were soft ones, and exactly the same figure was found from clinic A, located in that county. Since the different indications for appliance treatments were fairly the same at the 3 clinics, the reasons for these differences are most likely different treatment traditions and strategies between regions and clinics.

It is interesting to note the frequent use of soft appliances among Swedish general practitioners in view of the fact that this type of appliance, in contrast to hard acrylic appliances (12-18, 29, 32, 36, 43), almost completely lacks scientific support for its efficacy and effectiveness (39).

At the specialist clinic, treatment with soft appliances was much less common compared to among general dental practitioners, and when they were used, it was in most cases in combination with a hard acrylic appliance.

When the general dental practitioners perfor-

med treatments with hard acrylic appliances, with rare exceptions, they used stabilisation appliances of the Michigan type. Stabilisation appliances were the most commonly used also at the specialist clinic, but to a much higher extent (42%), other types of hard acrylic appliances were used by the specialists. The explanation is probably that patients who had been referred to the specialist clinic were often more complex cases, compared to those treated by general practitioners, resulting in a greater need of other types of appliances. Another explanation is, of course, that the more experienced specialists are more familiar with more uncommon types of appliances and their specific indications. On the other hand, we agree with *Gray & Davies* (22) who have stated that "it is inappropriate to provide one particular type of splint all of the time: this approach is narrow and demonstrates lack of awareness of the range of appliances available". It is likely that the treatment of TMD cases in general dental practise could be further improved if general practitioners were familiar with more types of appliances and their specific indications.

Patients treated in general dental practice with soft appliances were on average older compared to those treated with hard acrylic appliances. A reason for this finding is difficult to give, but it can be speculated that older patients prefer the soft appliance for financial reasons. The cost for such a treatment in Sweden is approximately one-fifth compared to the cost for a hard acrylic appliance.

According to the rules set by the Swedish National Board of Health and Welfare, an indication for all treatment performed must be documented in the patients' case records (41). In not less than 12% of the cases treated by general practitioners, such a documented indication was lacking, and in one clinic such information was missing in more than 40% of the files. There is thus a need for an improvement of the written documentation in this respect.

Dentally related problems such as *frequent fractures of teeth and fillings* and *sensitive/tender teeth due to bruxism* were common indications for appliance treatment in general dentistry, while these indications were rare at the specialist clinic. From this finding, it is obvious that general practitioners have more focus on tooth related symptoms caused by overloading and also succeed in treating them. Thus these problems are rarely seen at specialist clinics (1, 4).

The most common indication for appliance treatment in general dental practice was *tooth wear*

*due to bruxism*. This was a documented indication for appliance treatment in 31% of all cases, and in no less than 22% this was the only indication. Once again, this was a very rare indication for treatment at the specialist clinic. Also this discrepancy might indicate that these patients are successfully managed by general practitioners. However, another more likely explanation is that clinical signs of tooth wear without pain or headache is an overtreated condition in general dentistry. It is a documented fact that tooth wear, with very sparse exceptions, is a normal and slow process (5, 34, 36). It is possible that the observance on tooth wear is somewhat too high in general dentistry, and that appliance treatment is introduced unnecessarily. Since this is almost always a slow process, the first clinical recommendation is to bide one's time. To take study casts to be used for a more objective comparison of eventual progression of the wear after 12-18 months is an effective measure. In most cases, no significant further wear will be noticed.

In cases where the tooth wear progresses, a protective treatment with an appliance is highly recommended. In the present study, the use of hard and soft appliances was equally common among general practitioners when used to prevent further tooth wear. It is our opinion that hard acrylic appliances should be used in these cases, since soft appliances quickly deteriorate due to continuing bruxism. In very severe cases, a treatment with a hard acrylic appliance in the upper jaw and a soft acrylic appliance in the lower jaw might be the treatment of choice. It should, however, be stressed that in cases with rapid loss of tooth substance, often other factors, except bruxism, are involved (36). In such extreme cases, extended examinations are warranted to identify other contributing factors.

In contrast to dentally related indications, different pain conditions from the masticatory system and TMJs, and tension type headache, were common indications for treatment at the specialist clinic, as has been shown before (1, 4). Such indications were much less frequent in general dentistry. One explanation to this finding might be that such patients are considered more difficult cases by the general practitioners and thereby are referred to a specialist. Another explanation is that a proportion of these patients are being referred from physicians, and they often chose to refer to specialist settings instead of to the patient's ordinary dentist.

In cases treated by general practitioners, where the indication for appliance treatment was some

kind of pain condition from jaw muscles or TMJs, hard acrylic appliances were statistically significantly more frequently used compared to soft appliances. This is in accordance with present knowledge and standards for TMD treatment (12-18, 29, 32, 36, 43).

Recordings of functional status/clinical signs were not common in general dentistry, while this was routinely done at the specialist clinic. However, when the reason for the treatment, performed in general dentistry, was pain from jaw muscles and/or TMJs, recording of functional status before treatment was statistically significantly more common compared to recordings in cases of dentally related indications. Nevertheless, such a status was lacking also in many cases where the treatment was performed due to some pain condition. This is surprising, since such a recording before treatment is a necessary tool in order to be able to evaluate treatment effect objectively. There is thus a potential for clinical improvement in this respect.

The necessity of subsequent readjustments of both hard and soft appliances is stressed in many textbooks (6, 32). In a majority of cases treated in general dentistry, no such readjustments were made, while almost all appliances made at the specialist clinic were readjusted. Since optimisation of retention, fit and occlusal stability is of probable importance both for therapeutic outcome and for comfort reasons, there is a potential for clinical improvement also in this respect.

An evaluation of treatment outcome seems as a reasonable minimal measure both in medicine and dentistry. However, only in 22% of all appliance treatments in general dentistry, an evaluation of treatment results was recorded. Once again, this was a routine at the specialist clinic. Even more surprising was the finding that such evaluations were equally uncommon in general practice irrespective of the indication for the appliance treatment. It could have been expected that at least treatments of different pain conditions would have been more frequently evaluated. One explanation for this low frequency of treatment evaluations might be that most patients at the 3 general dental clinics were subjected to regular check-ups with 1-2 years intervals. It is possible that the result of the TMD treatment was evaluated at these check-ups. If so, the result was, however, not documented in the case records. It is obvious that the routines for evaluation of treatment outcome can be improved.

The use of adjunct TMD therapies was much more common at the specialist clinic. This is proba-

bly a natural consequence of the fact that a specialist clinic often treats more difficult TMD cases. The most commonly used adjunct therapy performed by the general practitioners was occlusal adjustment. In general dentistry adjunct treatment modalities were much more frequent in patients who had received soft appliances compared to those who had received hard ones. One possible explanation for this might be that the efficacy and effectiveness of the soft appliance is inferior to hard acrylic appliances, resulting in a larger need of adjunct therapies.

One interesting finding was that therapeutic jaw exercises were rarely used in general dentistry, while more than half of the patients at the specialist clinic had received this treatment. Therapeutic jaw exercises have been found to have a treatment effect comparable to interocclusal appliances (33). Because of this, and since jaw exercises are cost effective treatments, this treatment alternative is warranted a greater role when managing TMD in general dentistry.

In conclusion, the present investigation shows that soft appliances are commonly used in general dentistry in Sweden despite the lack of scientific support for their efficacy and/or effectiveness. It is also obvious that there is an improvement potential in respect of indications for TMD treatment, routines for documentation as well as evaluation of treatment results. There is also an obvious need for investigations of the decision-making processes among dentists when performing treatment with interocclusal appliances, as well as for randomised controlled studies concerning efficacy and effectiveness of soft appliances.

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