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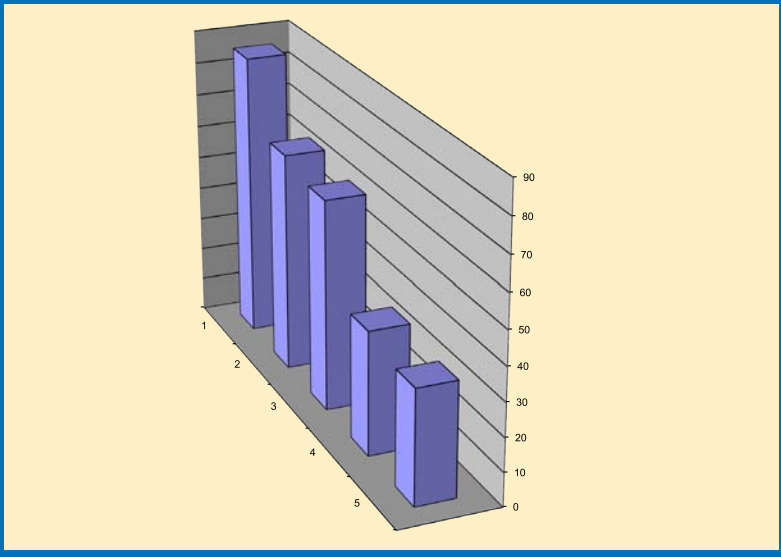

Dental appearance, with focus on the anterior maxillary dentition, in young adults with bilateral cleft lip and palate (CLP). A follow up study.

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Cost-analysis of an oral health outreach program for preschool children in a low socioeconomic multicultural area in Sweden

INGER WENNHALL[1,2], ANDERS NORLUND[3], LARS MATSSON[2], SVANTE TWETMAN[4,5]

Abstract

◉ The aim was to calculate the total and the net costs per child included in a 3-year caries preventive program for preschool children and to make estimates of expected lowest and highest costs in a sensitivity analysis.

The direct costs for prevention and dental care were applied retrospectively to a comprehensive oral health outreach project for preschool children conducted in a low-socioeconomic multi-cultural urban area. The outcome was compared with historical controls from the same area with conventional dental care. The cost per minute for the various dental professions was added to the cost of materials, rental facilities and equipment based on accounting data. The cost for fillings was extracted from a specified per diem list. Overhead costs were assumed to correspond to 50% of salaries and all costs were calculated as net present value per participating child in the program and expressed in Euro.

The results revealed an estimated total cost of 310 Euro per included child (net present value) in the 3-year program. Half of the costs were attributed to the first year of the program and the costs of manpower constituted 45% of the total costs. When the total cost was reduced with the cost of conventional care and the revenue of avoided fillings, the net cost was estimated to 30 Euro. A sensitivity analysis displayed that a net gain could be possible with a maximal outcome of the program.

In conclusion, the estimated net costs were displayed and available to those considering implementation of a similar population-based preventive program in areas where preschool children are at high caries risk.

Key words

Cost-analysis, early childhood caries, immigrants, fluoride tablets, prevention

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En kostnadsanalys av ett tandhälsoprogram riktat mot förskolebarn i en multikulturell stadsdel av Malmö

INGER WENNHALL, ANDERS NORLUND, LARS MATSSON, SVANTE TWETMAN

Sammanfattning

◎ Syftet med studien var att beräkna kostnaderna för ett förebyggande tandhälsoprogram riktat till förskolebarn i en karies-belastad multikulturell stadsdel i Malmö samt att studera kostnaderna i en sensitivitesanalys. Programmet startade vid 2 års ålder med en regelbunden utåtriktad verksamhet med fokus på tandborsning och fluortabletter och uppvisade en kariesreduktion på 27% vid 5 års ålder i jämförelse med en historisk referensgrupp.

De direkta kostnaderna för förebyggande insatser och konserverande tandvård i samband med projektet mellan åldrarna 2 till 5 år summerades retrospektivt och jämfördes med det konventionella omhändertagandet i referensgruppen. Personalkostnaderna per minut adderades till de beräknade kostnaderna för material, lokalhyra och utrustning. Kostnaderna för fyllningsterapi inhämtades från en specificerad per diem lista och overheadkostnaderna antogs motsvara 50% av de samlade lönekostnaderna. Alla kostnader uttrycktes per barn och angavs i Euro.

Resultaten visade en beräknad total bruttokostnad upp till 5 års ålder på 310 Euro för varje barn som inkluderats i tandhälsoprogrammet. Hälften av kostnaderna fördelades på det första året (mellan 2 och 3 års ålder) och personalkostnaderna utgjorde 45% av alla kostnader. Den motsvarande kostnaden för referensgruppen och värdet av de inbesparade fyllningarna uppgick sammantaget till 280 Euro och nettokostnaderna för preventionsprogrammet blev således 30 Euro per barn. En känslighetsanalys visade dessutom att en nettovinst var möjlig vid ett maximalt utfall av programmet.

Sammanfattningsvis har total- och nettokostnaderna för ett kariesförebyggande program för förskolebarn i ett område med hög kariesprevalns redovisats. Resultaten kan ligga till grund för kommande beslut om tandhälsofrämjande insatser i liknande områden.

Introduction

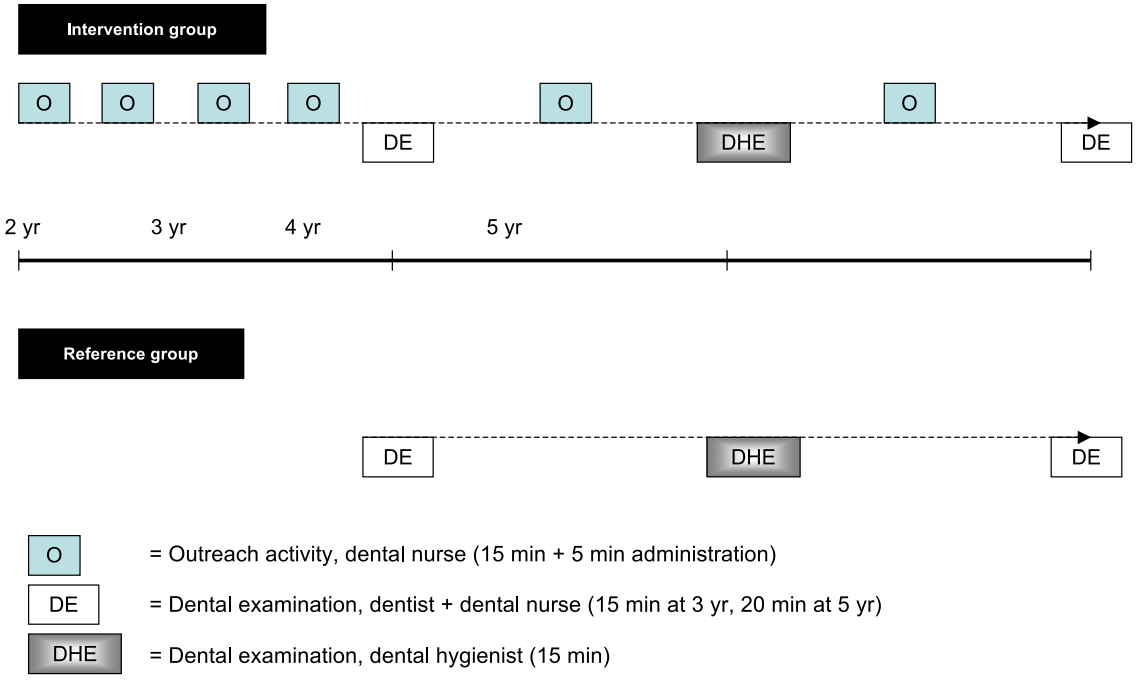
Oral health is an important part of general health and well-being but parts of the child population are left behind. Early childhood caries (ECC) is a public heath problem in many developing countries as well as among minorities in developed countries (13, 20). The treatment of ECC is costly and severe cases may need specialist care in hospital settings (2). Thus, preventive programs at an early age are crucial and the effectiveness of common measures has recently been reviewed (19). It is generally anticipated that an early intervention is cost effective but this is more based on beliefs than on facts since health economic evaluations of ECC preventive programs are sparse. In a narrative review, Lee et al. (10) have concluded that early preventive visits can reduce the need for restorative and emergency care during pre-school ages especially among high-risk children. On the other hand, another study evaluated the cost-effectiveness of fluoride varnish during well-child visits and concluded that the concept was not cost saving in the first 42 months of life in low-income populations (14). As our research group recently has presented the final outcome of a comprehensive oral health program directed to preschool children living in low socioeconomic community with a high prevalence of ECC (24), it was of interest to gain knowledge on the economic aspects of that program. There were three aims of the present study; i) to calculate the total costs for the implemented 3-year program up to the age of 5 years, ii) to estimate the net costs when adjusted for the costs of the conventional care and revenue of avoided fillings, and iii) to make estimates of expected costs in a sensitivity analysis.

Material and methods

Background project

Economic data were applied retrospectively to a comprehensive 3-year oral health outreach program for preschool children conducted in a low-socioeconomic multi-cultural urban area in southern Sweden. The study had a non-randomized prospective design with a historical reference group (23). The reference group consisted of children with a similar background from the same area that was born immediately before the implementation of the project. In brief, a cohort of around 800 2-year-old children were enrolled and regularly recalled to an outreach facility for diet information and tooth

Figure 1. Flow-chart of the 3-year preventive program and historical reference group. The boxes denote the type and number of visits as well as the consumed time.



brushing training. Other key elements were provision of free fluoride tablets and fluoride toothpaste. A flow-chart of the study design with regards to the type and number of visits, and time per visit is presented in Figure 1. The final outcome at the age of 5 years was reported by Wennhall and co-workers (24) and displayed a prevented defs fraction of 27%. The mean caries prevalence in the intervention and reference groups was 8.2 and 11.2 defs, respectively.

Calculations of costs

The calculations of costs were limited the direct costs for prevention and dental care. Since accounting data were only partly specified for the dental prevention program, a pragmatic solution was to calculate costs of labour (dentists, dental nurses, dental hygienists) according to official statistics (15). Cost of labour was added up for the ratio of patient-related time to total working time being 79% for dentists and hygienists (17). It was assumed that this proportion was applicable also for dental nurses and hygienists.

The basic model used a calculated cost per minute of dental employees, a standardized cost for materials used per intervention, and costs for renting and equipment based on accounting data. Overhead costs were assumed to correspond to 50% of the salaries, following the method used for the Swedish Dental Care reform of 2008 (18). Costs for specific materials were calculated according to specified per diem costs shown in Table 1. Cost for a filling of one surface of a molar or a pre-molar was adopted from the same report (18). Caries data (defs) were extracted from the final project article (24). Depreciation costs for equipment were calculated as an annuity with 3% discount rate, for an expected depreciation period of 3 years. Costs for project management based on accounting data were included and specified separately. In the sensitivity analysis, net costs were calculated on the 95% confidence interval of the absolute risk reduction at 5 years of age. All costs were calculated as net present value (3% discount rate) in the price-level of 2008 in SEK and transformed to Euro at the average exchange rate for that year (1 Euro = 9.6055 SEK).

Results

The calculated cost of the various components of the preventive program divided per year is shown in Table 2. The total direct cost per child included in the 3-year program was estimated to 310 Euro. Almost half of the total costs were attributed to the first year

Table 1. Basic resource utilization used for dental prevention program

Type of resource/age	Specification and costs (SEK)	Euro
Fluoride tablets per year		
2-3 years of age	365 tablets * 0.34 = 124.10 (per year)	12.92
3-4 years of age	2* 365 tablets * 0.34 = 248.20 (per year)	25.84
4-5 years of age	2* 365 tablets * 0.34 = 248.20 (per year)	25.84
Consumables per visit	Toothbrush, toothpaste, toy, pamphlet = 25.00	2.60
Consumables once	Booklet = 4.00	0.42
Rental costs per visit	60,000 SEK per year, per day 240 SEK (for 250 days open/year) 30 SEK per hour (8 hours/day) 10 SEK per visit (20 min/visit)	1.04
Equipment including electric cables	60,000 SEK in total as investment, depreciation during 5 years at 3% interest rate, cost per year (60,000* 0.218355) = 13,101 SEK, distributed as for rental costs above gives per visit = 2.20 SEK	0.23
Costs for planning and management of project	100,000 SEK distributed on all included children (n = 804) Cost per child 124.40 SEK	12.95
Overhead charges for general administration	+ 50 % on salaries *	
Cost of a filling, one site of molar/premolar	645 SEK*	67.15

* According to the Swedish Dental Care Reform 2008 (18)

of the program. The costs of manpower, excluding those of project management, corresponded to 45% of the total costs. In order to estimate the net costs, the costs of the conventional care in the reference group and the revenue of avoided fillings in the intervention group were subtracted from the total costs. The estimated cost per child for dental care in the reference group up to 5 year of age was 96 Euro and the net present revenue for an average of three avoided fillings per child was estimated to 184 Euro (67.15 Euro per filling). Consequently, the expected net cost of the preventive program was 30 Euro per included child in the project.

In the sensitivity analysis, the 95% confidence interval of the risk reduction was used to estimate a minimum and maximum outcome of the program. Ranging from defs 1.66 to 4.34, the net costs of a minimum outcome was 109 Euro per child. At the maximal defs outcome however, a net gain of 61 Euro per child was to be expected.

Discussion

In the current era of evidence-based medicine, the management of diseases is not just about doing things right but doing the right things right. Thus, economical analysis of population-based measures is a core element in decision-making but unfortunately, such reports are still relatively rare in preventive paediatric dentistry. A majority of those that are available are focused on schoolchildren or adolescents and retrospective applications of costs which likely may lead to an underestimation of the true costs (4, 8, 12, 16). Another shortcoming with several health-economical evaluations is that the costs and possible benefits only are calculated during the course of the project which is a short perspective in preventive medicine. For example, it is shown that low caries prevalence in the primary dentition is associated with less caries in adolescence (1) and that the individual caries incidence pattern is relatively linear in time (3), a fact that indicates long–term savings from preventive measures in early childhood. The present attempt was no exception from the above mentioned problems and it should be underlined that neither indirect nor intangible costs were included. Furthermore, the costs were divided with the number of children that was enrolled at two years of age in the program in spite of a 19% attrition rate over the 3-year study period (24). We chose to include the costs for the implementation and management of the project in the present calculations. In the event of a permanent operation of the preventive program, such management costs would not be needed. The project was supported by free samples of fluoride toothpaste but the estimated over-the-counter prices were added to the present calculation. The reference group was offered regular and conventional preventive care and the direct costs were unproblematic to calculate while the estimation of the true value to avoid conservative treatment naturally was more uncertain.

Based on our model for calculation, the expected cost of the preventive program up to 5 years of age was estimated to around 310 Euro per included child. However, when this cost was reduced with the conventional care and the costs of avoided fillings, the net cost was estimated to around 30 Euro. Interestingly, these figures were of the same magnitude as those of a previous paper from England estimating the cost to save a tooth from a carious attack following a fluoride toothpaste program (5). The expected costs of future fillings were based on one filling per decayed surface and did not include any replacements although there are reports of a high frequency of restorations among schoolchildren and adolescents (6, 11, 21). Thus, the evaluation of the revenue of avoided future fillings was likely rather conservative. Almost half of the total budget was staff costs, the majority of those (72%) were salaries for dental nurses. The overhead charges were based on a fixed percentage (50%) of the costs of salaries, a model recently proposed for the Swedish Reform

Table 2. Calculated costs per child (net present value, NPV) and age group for the 3-year preventive program. The costs are denoted in Euro and structure of costs (SC) is given in percent.

	2 - 3 yrs	3 - 4 yrs	4 - 5 yrs	total costs NPV	SC (%)
Dental nurse	63.55	12.99	25.23	101.77	--
Dental hygienist	0	7.10	0	7.10	--
Dentist	0	14.10	17.87	31.97	45.5*
Material	10.82	3.56	1.47	15.85	5.1
Rental	3.95	0.81	1.57	6.33	2.0
Equipment	0.91	0.22	0.22	1.35	0.4
Overhead	31.78	17.10	21.55	70.43	22.7
Fluoride tablets	12.92	25.08	24.36	62.36	20.1
Project management	0	0	0	12.95	4.3
Total costs				310.11	100.0

* includes all costs of dental employees

of Dental Care (18). Other calculations of overhead costs are possible; for instance the Swedish Public Dental Service utilizes 20.5% on all costs i.e. not only on salaries (8). Using that alternative model would reduce the total costs of the program from 310 Euro to 281 Euro per included child. The corresponding net result would be a cost of 6 Euro per child.

A notable finding of this project was that the caries-preventive effect was most prominent during the first year of the program (23, 24). Thus, the comparatively high initial costs between 2 and 3 years (41% of the total program) resulted in an immediate and significantly improved dental health in this first phase of the program. This reinforces previous findings that an early start of a preventive intervention is more cost-effective than later efforts (7, 10), an important message to communicate in current times of limited resources. Likewise, our sensitivity analysis disclosed that even a theoretical net gain was possible at a maximal outcome of the preventive program. It is however important to stress that the present cost-analysis was based on findings in a high caries area (22) and the estimations of net cost per child may not be valid for a similar project in populations with low or moderate prevalence of dental caries.

In conclusion, the present retrospective cost analysis of a 3-year preventive program directed to preschool children living in a low-socioeconomic multi-cultural area indicated a net cost of approximately 30 Euro per child up to the age of 5 years. Continuing follow-ups in the permanent dentition are required in order to investigate the long term revenue of the preventive program.

Acknowledgement

This study was supported by grants from Region Skåne, Sweden and from The Public Dental Service, Skåne, Sweden.

Conflicts of interest

The authors declare that they have no conflict of interest. The authors alone are responsible for the performance and evaluation of the study protocol as well as for the content and writing of the paper.

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The preventive effect of a modified fluoride toothpaste technique on approximal caries in adults with high caries prevalence. A 2-year clinical trial

HELAL SONBUL, DOWEN BIRKHED

Abstract

◎ The preventive effect of a modified fluoride (F) toothpaste technique was investigated. Both the incidence and progression of approximal caries among Saudi adults with a high caries prevalence were evaluated after 2 years.

A total of 175 adults were randomly assigned to a test group and a control group and 106 completed the study. In the test group (n = 54), the patients were asked to use the provided F toothpaste twice a day. They were instructed to use the "modified F toothpaste technique" as follows: (1) to use 2 cm of the toothpaste, (2) to brush for 2 min, (3) to swish the toothpaste slurry around the dentition with active movements of the cheeks, lips and tongue, forcing the slurry into the approximal area for about half a minute, before spitting it out, and (4) no post-brushing rinsing and no eating/drinking for 2 hr. The patients in the control group (n = 52) were instructed to continue using their regular F toothpaste twice a day without any further instructions. Approximal caries and filled surfaces were scored on bitewing radiographs at baseline and after 2 years.

The mean (SD) total caries incidence for the test and control group was 1.15 (1.49) and 3.37 (2.57) respectively ($p < 0.001$). In general, the control group displayed a higher progression rate than the test group with regard to enamel lesions to dentine (NS), enamel lesions to filled surfaces ($p < 0.05$) and filled surfaces that had recurrent caries (NS).

To conclude, the "modified fluoride toothpaste technique", as practised over the 2 years in a Saudi population with a high caries prevalence, had a caries preventive effect on the incidence of approximal caries, but not on the progression.

Key words

Adults, approximal caries, dental restorations, fluoride toothpaste, Saudi Arabia

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Den förebyggande effekten av en modifierad fluortandkrämsteknik på approximalkaries hos vuxna med hög kariesprevalens: en 2-årig klinisk studie

HELAL SONBUL, DOWEN BIRKHED

Sammanfattning

◎ Den förebyggande effekten av en modifierad fluortandkrämsteknik undersöktes. Båda incidensen och progressionen på approximalkaries utvärderades hos en grupp vuxna i Saudiarabien med hög kariesprevalens efter 2 år.

Totalt rekryterades 175 individer, som slumpmässigt delades in i en test- och krontrollgrupp; 106 slutförde studien. I testgruppen (n=54) instruerades deltagarna att använda den tilldelade fluortandkrämen 2 gånger/dag. De rekommenderas att använda en s.k. "modifierad fluortandkrämsteknik" på följande sätt: 1) att applicera 2 cm på borsten, 2) att borsta tänderna under 2 min, 3) att sila runt tandkrämsskummet mellan tänderna med aktiva tung-, läpp- och kindrörelser under ungefär en halv minut innan det spottades ut, 4) att inte skölja med vatten efteråt och att inte äta/dricka på 2 tim. Patienterna i kontrollgruppen (n=52) uppmanade att fortsätta använda sin ordinarie fluortandkräm 2 gånger/dag, men fick inga övriga instruktioner. Karies och fyllningar på approximalytorna utvärderades på bitewingbilder vid baseline och efter 2 år.

Medelvärdet (SD) av den totala kariesincidensen i testgruppen var 1,15 (1,49) och i kontrollgruppen 3,37 (2,57) ($p<0.001$). När det gäller kariesprogressionen utvecklade individerna i testgruppen generellt snabbare karies i emaljen och dentinet och fick mer fyllningar och sekundärkaries än i testgruppen, men det vara endast signifikant för progressionen från emaljkaries till fyllningar ($p<0.05$).

Sammanfattningsvis visar denna 2-årsstudie att den "modifierade fluortandkrämstekniken" hos en grupp vuxna i Saudiarabien med hög kariesprevalens hade en förebyggande effekt på incidensen men inte på progressionen av karies på approximalytorna.

Introduction

In spite of the decline in caries during the past few decades, particularly in western countries, there are many children and adults with high levels of caries. The prevalence of approximal enamel lesions is still underestimated (16, 20). In developing countries, such as Saudi Arabia, the same problem exists (21) .

The daily use of fluoride (F) toothpaste is considered to be the most effective method for preventing dental caries (11, 24). Some studies have shown that toothbrushing frequency and post-brushing rinsing behaviour are correlated with caries prevalence and incidence (1, 2). As a result, it has been postulated that patients should be advised to rinse with a small amount of water, or not to rinse at all, after toothbrushing with F toothpaste (4, 25). The amount of water rinsing after toothbrushing might increase F clearance and thereby reduce F availability in saliva and dental plaque. In individuals with different post-brushing rinsing behaviour, the level of F intraorally might differ accordingly (3).

In a previous study by *Sjögren et al.* (19), the approximal caries in preschool children was reduced by an average of 26% after using the so-called "modified toothpaste technique". The individuals were instructed to swish the toothpaste foam together with a sip of water (approximately 10 ml) around the dentition by active cheek movements.

The aim of the present study was to evaluate the caries preventive effect of the "modified fluoride toothpaste technique" on the incidence and progression of approximal caries in a Saudi adult population with a high caries prevalence.

Material and Methods

Study population

All adult patients visiting the Emergency Dental Clinic at the Faculty of Dentistry, King Abdulaziz University, Jeddah, and the Dental Health Clinic of Internal Security, Makkah, Saudi Arabia, from February through May 2006, were screened clinically for the following criteria: 1) at least 20 teeth, 2) a minimum of seven teeth with dental restorations and 3) willingness to participate in the study. One hundred and seventy-five of a total of 511 patients fulfilled the three inclusion criteria and were included in the study. The caries prevalence and risk profile of this population were reported to be high in a previous study (21). Moreover, the type and quality of the restorations have been investigated (22). In the present trial, the 175 patients were randomly assigned to two groups (test and control) according to a pre-randomised list. After 2 years, drop-outs totalled 69 patients (Table 1). Consequently, 106 patients, 54 in the test group and 52 in the control group, completed the trial. Informed consent was obtained prior to the start of the study and the local ethics committee approved the study (code number 29/1/1419).

Table 1. (A) Number of patients included in the study (n = 175) and drop-outs. (B) The baseline characteristics of the 106 patients who completed the 2-year trial are given as the mean (SD). The total number of scored approximal surfaces is also presented.

	Test	Control	Total
(A) Number of patients			
Start of the study	88	87	175
Drop-outs	34	35	69
Reasons for drop-outs:			
Radiographic failure (unreadable/not taken)	2	5	7
Could not be reached or left the city	17	13	30
Quit the study	15	17	32
End of the study (after 2 years)	54	52	106
(B) Baseline characteristics (n=106)			
Total number of months for the whole study	25 (1.4)	24 (1.2)	24 (1.4)
Age	30 (10.3)	27 (8.7)	29 (9.7)
Gender (female/male)	42/12	38/14	80/26
Number of teeth	25.4 (2.2)	25.5 (2.2)	25.4 (2.2)
Number of scored approximal surfaces/patient	18.9 (3.9)	19.4 (3.5)	19.2 (3.7)
Total number of scored approximal surfaces	1024	1006	2030

Modified fluoride toothpaste technique

At the start of the study, patients in the test group were instructed to use the F toothpaste twice a day using the "modified fluoride toothpaste technique" as described by *Sjögren et al.* (19). However, in the present trial, the technique was slightly modified, as the amount of toothpaste was 2 cm (~1g) instead of 1 cm and the post-brushing rinsing with water was completely omitted. The technique can therefore be summarised as follows: 1) 2 cm of the toothpaste was squeezed over wet toothbrush bristles, 2) the patients were asked to brush for approximately 2 min and were told not to spit out more than necessary during brushing, 3) after brushing, the remaining toothpaste foam and saliva, here called "slurry", was swished around in the dentition with active movements of the cheeks, lips and tongue, forcing the slurry in between the teeth for about half a minute before spitting it out, 4) no post-brushing water rinsing and no eating/drinking for a minimum of 2 hrs post-brushing was emphasised. To clarify all the steps in detail, they were described on a set of coloured photographs printed as a pamphlet that was given to the patients.

Study design and compliance

All the patients in the test group were instructed to follow "the modified fluoride toothpaste technique" described above when brushing their teeth. The F toothpaste used in this clinical trial was Colgate Maximum Cavity Protection (Colgate, Piscataway, USA), which contains 1450 ppm F. It is a common brand available in Saudi Arabia.

The patients in the control group were instructed to continue using their regular F toothpaste twice a day without any further instructions. The type of F toothpaste was identified prior to the trial. All toothpastes contain 1450 ppm F. At the start of the trial, 7 patients in the control group, who never used any F toothpastes, were given Colgate Maximum Cavity Protection F toothpaste.

During the entire 2-year period, the patients in the test group were recalled every six months to be reminded about the "modified fluoride toothpaste technique". The instructions were reinforced while the patient was performing the technique and the coloured pamphlet was given at the end of the session. Four tubes of the toothpaste (120 ml) were distributed on each recall visit. On the last visit, each patient in the test group was monitored by a well-trained dental assistant while performing the technique step by step and the patients' compliance was assessed. The amount of toothpaste, brushing time and post-rinsing behaviour were reported. In addition, the patients were interviewed to evaluate their compliance regarding the regular use of F toothpaste and refraining from eating/drinking for a minimum of 2 hr during the study.

All patients in the control group were also recalled every 6 months. On each recall visit, the use of F toothpaste twice a day was emphasised and one toothbrush was distributed to each patient. The regular use of F toothpaste during the 2 years was assessed by interviewing the patients at the end of the study.

Caries registration

In all patients, four bitewing radiographs were taken, both at baseline and at the end of the trial. Using a light desk and a magnifying viewer, the films were evaluated and scored blindly according to *Gröndahl et al.* (8) by one of the authors (H.S.), who was calibrated at the Department of Radiology, University of Gothenburg. All the approximal surfaces from the distal surface of the first premolar to the mesial surface of the second molars were included, making a total of 24 surfaces/patient. For intra-examiner reliability, a total of 120 radiographs from 35 individuals were re-evaluated after one month by the same examiner (Cohen's kappa value = 0.77). Approximal restored surfaces (FSa) and recurrent caries (DrecSa) were scored. Distinct radiolucency at the gingival margins of the existing approximal restorations was diagnosed as recurrent caries. Only approximal surfaces that could be evaluated on both examinations were included. However, surfaces that were unreadable at baseline but were scored as sound at follow-up were considered to be caries free at baseline. Any sound surface at baseline that had turned into enamel (DiSa), a dentine lesion (DmSa)

Table 2. Number of patients using F toothpaste at baseline and follow-up for both the test and control groups. The plaque index is presented as the mean (SD).

	Test n=54		Control n=52	
	Baseline	2-year	Baseline	2-year
Number of patients:				
using F toothpaste	45	54	45	52
not using F toothpaste	9	0	7	0
Plaque index	1.2 (0.5)**	1.0 (0.5)	1.3 (0.4)**	1.1 (0.3)

** p<0.01

or a filled surface (FSa) was defined as "caries incidence"; the "total incidence" was calculated after pooling all these data. A change in score from enamel to dentine, from enamel to filled, or from filled to recurrent caries was regarded as "caries progression".

Plaque index

Before the start of the study and after 2 years, the plaque index (PI) was scored for all patients according to *Silness and Löe* (17). Four tooth surfaces were examined on the following teeth: 16, 12, 24, 36, 32 and 44.

Statistical analysis

All the data were analysed using the SPSS statistical package (version 17.0, SPSS Inc., Chicago, IL, USA). The caries prevalence, including mean and standard deviation, was calculated for both groups at baseline and at the end of the study. Student's t-test was used to compare the test and control groups with regard to caries incidence and caries progression. Paired t-test was used to compare the mean of the plaque score within the test and control group between the baseline and after 2 years. Statistical significance tests were performed at individual level and not at site level. A power analysis with an assumption significance level of 5%, standard deviation of 3.0 and a power of 90% to detect at least 2.0 differences was performed, a sample size of 48 individuals per group was obtained. Differences giving a p-value of < 0.05 were considered statistically significant.

Results

The reasons for drop-outs are given in Table 1. Around 15 and 17 patients in the test and control group respectively quit the study. Unwillingness to continue was the main reason for quitting in both groups.

As a result of the interview, all the patients in the test and control group used the F toothpaste regularly during the whole trial. The score for plaque improved after 2 years within both the test and control groups ($p < 0.01$) (Table 2).

The mean caries prevalence at baseline and after 2 years is presented in Table 3. At the end of the study, there were no statistically significant differences when comparing the test group and the control group, apart from approximal recurrent caries (DrecSa) and total DFSa ($p < 0.05$).

Table 4 shows the caries incidence after 2 years in the test and control groups with regard to new

Table 3. Caries prevalence at baseline and after 2 years for the 106 patients.

Caries variables	Test n=54		Control n= 52		p-value
	Baseline	2-year	Baseline	2-year	2-year
DiSa	4.76 (2.75)	4.63 (3.16)	4.62 (2.47)	5.79 (3.71)	
DmSa	0.85 (1.22)	1.20 (1.46)	1.00 (1.16)	1.29 (1.85)	
DrecSa	0.87 (1.26)	0.70 (1.28)	0.79 (1.18)	1.35 (1.83)	< 0.05
FSa	5.70 (4.21)	6.63 (4.72)	4.33 (3.70)	6.62 (4.27)	
DFSa	12.19 (4.47)	13.17 (4.50)	10.73 (3.23)	15.04 (3.36)	< 0.05

a = approximal; i = initial/enamel lesions; m = manifested/dentine lesions; rec = recurrent caries; D = decayed; F = filled; S = surface

Table 4. Mean (SD) of approximal caries incidence for the total 106 patients in the test and control groups after 2 years. The total caries incidence includes new enamel lesions, dentine lesions and new filled surfaces.

	Test n=54	Control n=52	p-value
New enamel lesions	0.72 (0.94)	2.27 (2.17)	< 0.001
New dentine lesions	0.19 (0.55)	0.17 (0.43)	
New filled surfaces	0.24 (0.73)	0.92 (1.74)	< 0.01
Total incidence	1.15 (1.49)	3.37 (2.57)	< 0.001

Table 5. Mean (SD) of approximal caries progression for the total 106 patients in the test and control groups after two years. Total progression includes enamel lesions → dentine, enamel lesions → filled and filled surfaces → recurrent caries.

	Test n=54	Control n=52	p-value
Enamel lesions → dentine	0.35 (0.83)	0.56 (0.92)	
Enamel lesions → filled surfaces	0.33 (0.80)	0.75 (1.14)	< 0.05
Filled surfaces → recurrent caries	0.26 (0.56)	0.46 (0.92)	
Total progression	0.94 (1.28)	1.77 (1.66)	< 0.01

enamel lesions, filled surfaces, dentine lesions and the total incidence. A significant difference was found when comparing new enamel lesions in the test group, 0.72 (SD 0.94), and the control group, 2.27 (SD 2.17) ($p < 0.001$). When all the data were pooled, the control group showed a higher total caries incidence than the test group ($p < 0.001$).

After 2 years, the control group displayed a higher total progression rate than the test group ($p < 0.01$) (Table 5). After excluding the approximal enamel lesions that had been filled from the total progression, the difference between the test and control groups was not statistically significant.

According to the patients' compliance assessment in the test group, around 85% (n = 46) of the patients had refrained from water rinsing post-brushing, while the rest had either rinsed with a sip of water and/or failed to avoid eating or drinking for approximately 2 hr after brushing. Regarding the brushing time, around 94% (n = 51) of the patients brushed their teeth for ≥ 1.5 min. The percentage of the patients using ≥ 1.5 cm of the toothpaste was 96% (n = 52).

Discussion

The main finding in the present study was that "the modified fluoride toothpaste technique" had a preventive effect on approximal caries in a Saudi adult population with a high caries prevalence. The most profound difference was found in the incidence of new approximal enamel lesions. The preventive fraction in the present trial was around 66%, i.e. the difference in caries incidence between the test and control groups expressed as a percentage of the incidence in the control group. This percentage is higher than that reported by *Sjögren et al.* (19) and is probably due to differences in study population and compliance. The patients involved in the present trial were all adults with a high caries prevalence, which might accentuate the preventive effect of F toothpaste. *Marinho et al.* (11) found that the effect increased with higher baseline levels of DMFS. In a recent review of F toothpaste, strong evidence of a preventive effect was found in young permanent dentition, while there was incomplete evidence in the primary dentition (24). This might indicate that the "modified fluoride toothpaste technique" could have a greater preventive effect in adults than in children.

It should be pointed out that the recall visits every 6 months played a major role in improving the oral hygiene of the patients in the test and control groups at the end of the study. Nevertheless, the test group had a lower approximal caries incidence than the control group. In this context, the way of using the F toothpaste, "the modified fluoride toothpaste technique", could be the factor that contributed to the caries reduction in the test group. Another interesting observation in the present trial was that the majority of patients in the test group succeeded in complying with the instructions, which might indicate that the technique as a whole is easy for adults to adopt. It is, however, important to mention the extreme effort that was made during the six-month recall visits to emphasise the instructions relating to the "modified fluoride toothpaste technique". These recall visits clearly improved the patients' compliance at the end of the study. However, the most common comment from the patients who rinsed with a sip of water post-brushing was that they could not get used to the strong taste of the toothpaste slurry that was left after brushing.

The caries reduction observed in the present study could be related to several factors involved in this particular technique of using F toothpaste. However, the avoidance of post-brushing water rinsing and refraining from eating or drinking for 2 hr after brushing could be of interest. Studies have shown that the cariostatic effect of topical F is partly related to the sustained presence or release of low F concentrations in the oral environment (5, 7). A prolonged low concentration of F in saliva and plaque might enhance the rate of remineralisation (6). *Issa & Toumba* (9) demonstrated that, by avoiding water rinsing, particularly in adults, the salivary F level could remain high for up to two hours post-brushing. A recent study has shown that the F concentration in interdental saliva and plaque was higher without post-brushing water rinsing (15). Since the toothbrush itself does not reach the approximal area, slurry rinsing through active movements of the cheeks could result in the rapid transport of F into the interdental plaque. This could enhance remineralisation and inhibit the demineralisation of approximal tooth surfaces (23). There is, however, some controversy regarding the effect of post-brushing water rinsing per se on caries development. The difference between the mean caries increments with and without rinsing was only 0.8 DS in a longitudinal clinical trial and had no statistical significance (10). In that study, however, the population was not made up of caries-prone individuals, as it was in the present trial. In addition, there was no informa-

tion about whether the children were instructed not to eat or drink post-brushing. This might be an important factor when it comes to maintaining a high F level in the oral cavity after refraining from water rinsing. *Sjögren & Birkhed* (18) found that eating/drinking directly after brushing reduced the F concentration considerably.

The number of enamel lesions that progressed into dentine was somewhat higher in the control group than in the test group, although the difference was not statistically significant. The reason could be that the rate of approximal caries progression per se is slow in young adults (12, 13). A 2-year trial is therefore not long enough to evaluate caries progression, particularly in adulthood. Moreover, in a group of patients with a large number of FS, such as those in the present trial, the inclusion of enamel lesions that had been filled during the trial in calculations of progression might be disputed. It was difficult to trace whether they had first progressed into the dentine. As a result, the total progression was re-calculated, excluding this event. The difference between the control and test groups was not statistically significant.

Many filled surfaces had recurrent caries at the end of the study and the frequency was higher in the control group than the test group. In general, recurrent caries does not differ from primary caries with regard to aetiology. In this context, it could be concluded that F apparently prevents recurrent caries development. Moreover, recurrent caries is one of the most common reasons for the failure of dental fillings (14). Consequently, the investigated "modified fluoride toothpaste technique" might be beneficial in preventing recurrent caries or at least interrupting its progression. This could eventually improve filling longevity.

In conclusion, the "modified fluoride toothpaste technique" as practised in the present study had a preventive effect on approximal caries in a Saudi adult population with a high caries prevalence. We therefore believe that this could be a useful technique for preventing both primary and recurrent caries in adults. Changing people's behaviour when using an existing method, such as F toothpaste, is both simple and cost effective at population level.

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Effect of chlorhexidine gel on approximal caries increment in adolescents with high caries risk using professional flossing compared to individual trays

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Abstract

◉ The aim of this study was to evaluate the effect of chlorhexidine gel treatment on approximal caries development during a three year-study in children with expected high risk of caries. New caries of this group was compared to the caries development in two groups with assumed moderate or low caries risk. One hundred and sixty-nine of 201 twelve-year-old children fulfilled the trial. A group of 77 children showed no caries experience and was expected to be a low caries risk group (R1). Ninety-two children had at least one approximal lesion and their salivary numbers of mutans streptococci (ms) were quantified. Forty-six of those showed less than $3x10^5$ ms per ml saliva and were supposed to have a moderate caries risk (R2). Forty-six children, with high levels of ms, were expected to have a high caries risk (R3). Both R1 and R3 were treated with fluoride varnish every 18th month and R2 every 6th month. The R3 group was supplementary treated with 1% chlorhexidine gel (Corsodyl®) by using either flossing combined with polishing (Flossing group), or gel in individual trays (Tray group) every third month, in two subsequent days. The mean caries development during three years was for R1 and R2, 1.5 and 3.0, respectively. For R3, the corresponding caries incidence was 2.9 in the Tray group and 2.8 in the Flossing group. Significantly less new caries was found in the R1 compared to R2 and R3, but no significant difference was found between R2 and R3 or between the two groups of R3. In conclusion both methods of professional chlorhexidine gel treatments showed a caries development corresponding to the group with moderate caries risk and could both be used for caries prevention.

Key words

Approximal caries, caries risk, chlorhexidine gel, mutans streptococci

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Effekten av klorhexidingel på approximal kariesutveckling hos tonåringar med hög kariesrisk.

En jämförelse mellan flossing och gelskedar.

BIRGITTA LINDQUIST, HANS GISSELSSON, KERSTIN WENNERHOLM

Sammanfattning

◉ Avsikten med denna treårsstudie var att utvärdera effekten av gelbehandling med klorhexidin (CHX) på kariesutvecklingen på approximalytor hos en grupp barn med förväntad hög kariesrisk. Antalet nya kariesskador i denna grupp jämfördes med kariesincidensen hos två grupper, vilka ansågs ha medium respektive låg kariesrisk.

Etthundrasextionio av 201 tillfrågade svenska tolvåringar fullföljde studien. En grupp om 77 barn uppvisade ingen tidigare approximal kariesskada och ansågs ha en låg kariesrisk (R1). Nittiotvå barn hade en eller flera approximala kariesskador och deras saliv analyserades avseende deras antal av mutans streptokocker (ms). Av dessa 92 barn hade 46 mindre än 3x105 ms per ml saliv och ansågs ha en medium kariesrisk (R2). De resterande 46 barnen hade motsvarande eller mer än $3x10^5$ ms per ml saliv och förväntades ha en hög kariesrisk (R3). Grupp R1 och R3 behandlades med fluorvarnish var 18:e månad och R2 var 6:e månad. På kliniken tas rutinmässigt inga salivprov för analys av antalet ms utan man behandlar barn baserat på förekomsten av en eller flera approximala skador med fluorvarnish varje halvår. Gruppen R3 behandlades, förutom med fluorvarnish, med 1%-ig CHX gel genom att antingen kombinera flossing med polering av gelen (Flossing group) eller gel i individuellt framställda gelskedar (Tray group) var tredje månad. Medelvärdet av kariesincidensen var för R1: 1.5 och R2: 3.0. För R3 var motsvarande värden 2.9 i ¨Tray group¨ och 2.8 i ¨Flossing group¨. Signifikant lägre kariesincidens noterades i gruppen R1 jämfört med grupperna R2 och R3. Ingen signifikant skillnad fanns mellan grupperna R2 och R3 eller mellan de två CHX grupperna. Sammanfattningsvis visar studieresultaten att båda metoderna med professionell CHX-gelbehandling visade en kariesutveckling motsvarande gruppen med förväntad moderat kariesrisk och att båda dessa metoder kan användas för kariesprevention.

Introduction

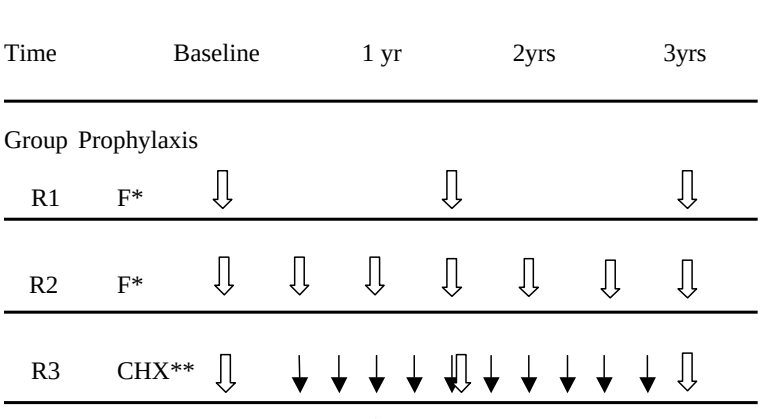
Dental caries has shown a declining trend during the last decades in many industrialised countries (17). However, previous studies have shown that caries prevalence in general is underestimated by dentists (25,28) and caries is still a concern among certain groups of individuals, showing a more warped distribution of the disease. Since caries is strongly polarised, it is a necessity of selecting groups with additional predictors for high risk of caries, when comparing different prophylactic treatments.

Several studies have shown that previous caries in children and adolescents is the strongest single predictor of new caries incidence (14,20). The use of different kinds of fluoride products in caries prevention and progression is a common clinical routine, when approximal caries lesions are diagnosed visually or by radiographs. The preventive effect of fluoride varnish is well documented and the caries reduction varies in different studies from 18 to 70% (for review, see 18). *Sköld etal* (29) showed a high reducing effect of fluoride varnish, when applied every 6th months to approximal lesions in the early phase and even to non-cavitated surfaces. Since also the progression rate is higher in dentine compared to the initial enamel lesion (20) it is of importance to find risk factors even before the initial lesion will become visible i.e. even to those children diagnosed as caries-free.

Initiating the caries process has been well correlated to the oral prevalence of colonizing mutans streptococci (ms) (15) and these bacteria are sensitive to chlorhexidine (CHX) (4). Due to the ability of the CHX to suppress ms, this bis-biguanide has been utilized in caries prevention on an individual basis in patients with high caries activity and high salivary numbers of ms, when conventional caries prophylactic methods have proved insufficient (12,32). Several clinical studies have confirmed the advantage of using CHX in controlling the microbial challenge associated with dental caries and thereby reduce the incidence of dental caries (6,8,33). Different methods of applying a CHX gel have been tested such as brushing (1), flossing (5,6,8), using form-fitting mouth trays (5,12,33) or a syringe into interproximal spaces (12).

Daily 5 min self application of 1% CHX gel in custom-made applicator trays for 14 days has been shown to depress ms counts for three months (2). Alternatively, a professional gel application in trays on two consecutive days is of similar effect (16). In an earlier study by *Emilson etal* (5), the effect of the CHX gel in trays was compared to the use of flossing the CHX gel alone or together with polishing. Their results showed a greater reduction of both salivary ms counts and total number of colonized sites of ms in the tray group compared to the flossing groups. The effect on ms in the combined polishing-flossing group approached the results of the tray group. The main purpose of this study was to compare two methods of CHX treatment using trays or a combined polishing-flossing method in caries prevention. The second purpose was to compare the caries development in these two groups of teenagers with a high

Fig 1. Design of the study
The procedure (yrs) of prophylactic treatments of fluoride (⇩) and/or chlorhexidine (↓) during the three-years-study in R1, R2 and R3.



caries risk, treated regularly with fluoride varnish supplemented with CHX with expected lower risk groups treated with fluoride varnish.

Material and Methods

Subjects

The risk of developing caries was evaluated according to the existence of approximal caries and salivary number of mutans streptococci (ms). A total of 201 twelve-year-old children living in a small industrial town (Eslöv) in the southern Sweden were selected. Informed consent was obtained from all participants and the experimental protocol was reviewed and approved by the Ethical Committee of the Medical Faculty, Lund University. The number of drop outs was 32 children. Thirteen of these total drop outs disappeared in the initial part of the study. The main reasons for the loss were: moving from the area, choosing other clinics or failure to locate and examine them. The taste of the CHX was well tolerated by all participants in the R3 group.

There was no significant difference between the study group and the drop outs in their baseline values of caries experience and salivary number of ms.

The children were examined by bite-wing radiographs and a low caries risk was expected, when no approximal caries lesions (including enamel and dentine lesions) or fillings could be detected. This group consisted of 77 children (R1) and these subjects were treated with professional fluoride varnish (Duraphat® Colgate Piscataway, Mass, USA) , every 18th month (Fig. 1).

The remaining children (n=92), showed one or more proximal caries and/or fillings and were selected for salivary analysis of ms. According to the Medical Board of the Swedish Government, they have decided the guidelines of prevention and a patient who shows 1-3 new caries lesions per year has to be defined as ´caries active´. More than 3 x 10^5 ms per ml saliva was decided as high numbers of these bacteria and a high caries risk (Table 1) with a need of a CHX retreatment (12,33). A moderate caries risk was expected, when at least one proximal caries and/or filling occurred, but the salivary numbers of ms were lower than 3 x 10^5 per ml. A total of 46 participating children corresponded to these criteria (R2). During the study period this group of R2 group was treated with fluoride varnish every 6th month.

A group of children with both proximal caries experience and more than 3 x 10^5 salivary levels of ms were accepted as a high risk group of developing caries (R3). The children were randomly distributed to two subgroups of prophylactic methods using CHX gel either in trays or by polishing in combination with flossing. Twenty-two subjects were included in the group of individually designed trays (group Tray) and 24 participated in the group of a combination of polishing and flossing (group Flossing). They were all treated every 3rd month from the age of 12 to 15 years with a total of 10 treatments. In both groups a 1% chlorhexidine gel (Corsodyl ®, GlaxoSmithkline & Smithkline, Beecham plc, Brentford, England) was used. No children were treated with placebo-gel, since the subject number of this group did not allow any statistical calculation for a third group to be included. In addition, since this group of teenagers was to be highly colonized by cariogenic bacteria the use of a placebo gel without any microbial effect seemed unethical.

Table 1. The number of approximal caries experience in each study group and their total number of mutans streptococci (ms) per ml of saliva in each group:
R1, R2 and R3, their participants and drop-outs.

Risk group	DFSa (e+d)*	Number of ms	children	drop-outs	participants
R1	0	-	93	16	77
R2	≥1	< 3 x 10^5	53	7	46
R3	≥1	≥ 3 x 10^5	55	9	46

* = enamel and dentine lesions

Saliva samples

An initial stimulated salivary sample was collected from the children with past caries experience (R2 and R3) and another sample was collected from those in the CHX-group with high salivary numbers of cariogenic bacteria (R3).

Additional salivary sampling was performed before the first four gel treatments and thereafter every 6th month (Fig 1). Before each sampling session, the subjects were told to refrain from tooth brushing the same morning and from eating and drinking one hour before sampling.

Paraffin stimulated whole saliva was collected for 5 min, and one ml of the saliva was transferred to 4.2 ml of VMG ll transport medium (21). The saliva samples were coded and sent by mail to the Department of Cariology in Göteborg and processed within 24 hrs. The code for each treatment group

was not broken until bacteriological data had been examined.

It was not possible to collect saliva samples from all children at all occasions. The main reason was lack of fulfilling the criteria for sampling, such as eating or tooth brushing before the sampling procedure. A number of 28 of all planned 368 salivary samples (8%) were missing during the study period (17 samples in the Flossing group and 11 samples in the Tray group).

For practical reasons the antimicrobial effect was not evaluated immediately after the CHX treatment. Instead bacterial samples were collected before the new treatment 3 months later. In this way the number of visits to the clinic were reduced from 21 to 14 during the period of CHX applications.

Bacteriological procedures

The samples were dispersed on a Whirlimixer (Whirli VIB 1, Inter Med, Roskilde, Denmark) for 20 s, serially diluted in 0.05M phosphate buffer (pH 7.3) and plated on mitis-salivary-blood agar (MSB agar) (9) for estimation of ms (CFU/ml). Each agar plate was incubated at 37 Co in 95% N2 and 5% CO2 for 48 hours. The number of ms was counted and identified by their colony morphology (3).

Radiographic dental examination

All bite-wing radiographs taken during the 3-year-period were scored at one occasion using a light desk and a magnifying viewer (19). They were coded and sent for examination to one of the authors (HG), who was not aware of the group assignment of the subject.

In order to evaluate the reliability of registration of caries a new assessment was done by HG. Bite-wing radiographs from 41 individuals in the test groups were available for second assessment. At the first registration 384 caries lesions were registered, and at the second 360 lesions were in agreement with the first one (94%). Twenty enamel caries lesions were not registered at the second assessment and 4 new ones were observed. All dentin caries was in accordance with the first registration.

Approximal caries lesions and fillings were diagnosed from the distal surface of the canines to the mesial surface of the second molars. Approximal caries lesions in enamel, including those just reaching or passing the enamel-dentine junction, were defined as enamel caries lesions (e). Lesions which clearly reached into the dentine were defined as dentine lesions (d). This distinction corresponds to lesions in enamel (D1 and D2) or dentine lesions (D3) according to recommendations made by the Swedish National Board of Health and Welfare (30).

Fluoride treatment

A trained dental nurse performed the applications of fluoride varnish. All the approximal surfaces, from the distal site of the canines to mesial site of the second molars were treated with a total amount of 0.3 ml varnish each time. Application of fluoride varnish was according to a standard method for all children at the regular check-up including children without any detectable caries defects.

Gel treatment

The two antimicrobial treatments with CHX gel started when all dentine caries had been restored. The two gel treatments were performed by a trained dental nurse in 2 consecutive days. After the treatments, the subjects were instructed not to rinse their mouths or to eat for at least 30 minutes after the treatment and also not to brush their teeth during the treatment days. No changes upon their usual oral hygiene or dietary habits were imposed.

Initially, before the gel treatments started, the individual trays were produced. The two CHX groups started at the same time with their gel treatments. Consequently this made a total of 10 CHX treatments during the three-year study period (Fig 1).

The Flossing group

Before the gel treatment, cotton rolls were placed in the vestibulum and the four quadrants were treated one by one after being dried with compressed air. The buccal, lingual and occlusal tooth surfaces of each subject received professional tooth cleaning by using CHX gel in a rubber cup on a hand-piece. Afterwards CHX gel was applied with a syringe into the interproximal spaces using the buccal and lingual approach. The approximal surfaces of all teeth were then exposed to the gel by means of a flat dental floss (Dentotape ®, ribbon floss waxed, Johnson & Johnson, New Brunswick, N.J., USA). Each tooth surface was flossed about 10 times and approximately 1.0 ml of 1 % CHX gel was applied. The treatment was carried out by a trained dental nurse and the time required per visit was nearly 10 minutes.

The Tray group

Individually designed maxillary and mandibular vacuum-adapted polystyrol trays were filled with 3 ml of 1 % CHX gel and applied to the teeth at the same

occasion three times for 5 minutes. Between each 5 minute application the participants rinsed carefully with approximately 10 ml of water and the trays were cleaned and new fresh CHX gel was placed into the trays.

Preventive program

All children in the groups, R1, R2 and R3 participated in the normal dental routines with yearly controls, preventive activities such as health education and restorative dental treatment by the Public Dental Service in Eslöv. They were recommended to use a fluoride dentifrice twice a day and encouraged to use a dental floss at home. Each dentist had full responsibility over the decision, whether and when to treat caries with a restoration, but in general a conservative approach towards restorative care was adopted.

Statistical analysis

Salivary counts were transformed to log 10 values in order to normalise their distributions and variance. The means and standard deviations were calculated. Analysis of variance (ANOVA) was used to test differences between means in the subgroups. The χ test was applied for the significance of difference and the differences were considered statistically significant at $p<0.05$.

Results

Caries prevalence and caries incidence

The group of R1 did not show any caries lesions at the age of 12 years, but at the age of 15 a mean number of 1.5 new approximal caries lesions was detected (Table 2). In the R2 and R3 group the mean baseline of approximal caries experience was 2.7 and 3.2, respectively. Three years later at the age of 15 years, the R2 and the R3 group showed a mean caries prevalence of 5.8 and 6.0 respectively.

The caries lesions detected at the age of 12 and 15 years were significantly lower in the low risk group (R1), compared to the two R2 and R3 groups ($p< 0.05$).

The number of children without any new caries development from the age of 12 to 15 years was significantly higher ($p< 0.05$) in the low caries risk group (R1) compared to the other two groups (R2 and R3) (Table 3).

In Table 4, the mean numbers of approximal caries prevalence at the age of 12 and 15 years are presented for the two groups of children with CHX treatments (R3), together with the caries increment during the study period. The number of lesions found, including initial and frank lesions showed no significant difference.

The effect of salivary mutans streptococci

In Table 5, the mean log numbers of salivary ms are presented at each sampling collections for the groups of children belonging to the Tray and Flossing group. During the study period the levels of

Table 2. The mean caries prevalence DFSa, including enamel (e) and dentine lesions (d) of the children in the risk group of R1, R2 and R3 at the age of 12 and 15 years (yrs) with standard deviations within the parenthesis. Vertical lines show a significant difference ($p< 0.05$).

Risk group	DFSa (e+d)	
	12 yrs	15 yrs
R1	0 (0.0)	1.5 (2,5)
R2	2.7 (1.6)	5.8 (4.6)
R3	3.2 (1.7)	6.0 (4.0)

Table 3. The number of participants in each group without any new proximal caries increment between the age of 12 to 15 years. Vertical lines show a significant difference ($p< 0.05$).

Group	No of children	Per cent
R1	48 / 77	62
R2	14 / 46	30
R3	16 / 46	35
Tray	6 / 22	27
Flossing	10 / 24	42

Table 4. The mean number of approximal caries prevalence and incidence (DFSa) in the two high risk groups (R3); the Tray and the Flossing group, at and between the age of 12 and 15 years (yrs). Enamel (e) and dentine (d) lesions. Standard deviations are within the parenthesis.

Group	DFSa		
	12 yrs	15 yrs	12-15 yrs incidence
Tray			
(e+d)	3.3 (1.8)	6.2 (3.0)	2.9 (2.3)
(d)	0.1 (0.2)	0.3 (0.6)	0.2 (0.5)
Flossing			
(e+d)	3.0 (1.7)	5.8 (4.8)	2.8 (4.2)
(d)	0.2 (0.5)	0.5 (0.7)	0.3 (0.6)

ms were gradually reduced and after 3 months the difference was significantly reduced in both groups ($p< 0.05$), when compared with baseline values and the mean value after two years. No significance was found between every three months´ values of ms.

Discussion

In earlier studies made by our group the effect on caries increment using different flossing method was examined (6,7,8). The results showed that the most positive anti-cariogenic effect was obtained using flossing with CHX gel combined with polishing and CHX gel in individual trays. The subjects in these earlier studies were preschool children together with children at 11-12 years of age and the prophylactic treatments were given to the whole group of children without any selection. The principal aim of this study was to compare the two antimicrobial methods in a selected group of children at the age of 12 years based on the assumption that two factors were accepted as true indicators of caries development; prevalence of approximal caries experience together with high number of salivary mutans streptococci. These groups were to be compared with lower caries risk groups in the same area.

Since a reduced prevalence of caries among children has been reported in Sweden as well as other countries, there is a need for using high-risk strategy of selecting groups, when comparing different prophylactic treatments. Several studies have shown that previous caries in children and adolescents is the strongest single predictor of new caries incidence (16,22). *Mejàre etal* (22), reported that 11- to 12-year-old children with one approximal caries lesion run 2.5 times greater risk of developing new caries compared to children without any initial or frank approximal caries. Our study also confirmed earlier observations that low caries occurrence predicts low caries risk. The group R1 with no lesions detected showed a significant lower caries incidence compared to the two groups with approximal caries at baseline.

The study period of three years was chosen to make it possible to compare the caries incidence found to other preventive methods used in a low caries risk population. We found the caries increment to be low for all groups (1.5-3.0). The probable main reason for this is the comprehensive fluoride preventive treatment given to all children in the study by the Public Dental Health Service, prior to and during the treatment period. This finding is in accordance with other Swedish three-year studies of measuring the approximal caries incidence in children at the same age (23,24). Also our high risk group of R3 showed a similar caries incidence when comparing to a group of teenagers within a high risk area using a fluoride varnish programme in a study by *Sköld etal* (29). In spite of the low caries development, this study shows a positive effect of two professional CHX treatments on salivary ms levels during the antimicrobial treatments and on caries increment in a group of children expected to have a high risk for caries development during the 3-year study period. This positive effect was true for both CHX treatments with a similar caries increment compared with the group considered to be of moderate risk, i.e. children with at least one approximal lesion found, but with low salivary ms level. One study group (R1) had no carious experience and was therefore expected to be at a low risk for developing caries lesions during the 3-year-study-period. They were treated according to the clinical routines of using professionally applied fluoride varnish every 18th month. The dental clinics did usually not take any salivary samples for bacterial analyses, but if the children at the age of 12 years showed any caries experience the every 18th month varnish treatment was intensified to every 6th month. In this study the 12-year-old children with at least one approximal lesion/filling and with a low number of ms detected were treated according to the routines of the clinic based on the approximal caries experience (the group R2). For this group with known low number of cariogenic bacteria the risk for future caries development was considered moderate compared to the group being highly colonized by ms.

The children having at least one approximal caries experience and high level of salivary ms (>3 x 10^5

Table 5. The mean log of salivary number of mutans streptococci (ms log) in the Tray and the Flossing group during the period of CHX treatment. Standard deviations are within the parenthesis. Vertical lines show significant difference ($p<0.05$).

Months	Group	
	Tray	Flossing
0	6.09 (0.4)	6.05 (0.4)
3	5.58 (0.7)	5.65 (0.6)
6	5.55 (0.6)	5.39 (1.0)
9	5.31 (0.9)	5.51 (0.9)
12	5.22 (1.0)	5.66 (0.9)
18	5.27 (0.7)	5.12 (1.1)
24	5.29 (0.9)	4.99 (0.7)

per ml of saliva) were expected to have a higher caries increment compared to the other groups. They were selected for two different CHX gel treatments in combination with the basic routines of the clinics using fluoride varnish every 18th month as a supplement to the different CHX gel treatments. High numbers of salivary levels of ms are likely to reflect a high number of colonized dental sites by cariogenic bacteria (13,31) and such individuals are generally recognized to be of increased risk of new dental caries (17). Additionally, a higher number of ms have been shown in presence of active caries than in subjects with inactive lesions (22). The knowledge of the salivary ms level may enhance the opportunity for selecting subjects with active lesions, which is limited when only using radiography.

The level of ms may be reduced successfully for various periods of time depending on the frequency of exposure and the concentrations of CHX (26,27,33). The best caries reduction has been obtained, when persons highly colonized with ms have been treated with CHX gel and the results of the antimicrobial measures have been verified by microbial examinations. The caries reduction was around 60% when high-caries-risk subjects were treated and this could be compared to the reduction of 40% among unselected patients (4,32). These results have influenced the preventive strategy in this study.

The 1% CHX gel treatment was performed intensively during two days every third month, since a single application has shown a lower suppression of ms and repeated CHX procedures has resulted in a caries reducing effect (10,12,33).

There were no children treated with a placebo-varnish or -gel, due to the fact that the number of subjects in this area with expected high risk of caries increment according to the selection criteria, was too low to include any placebo-treatments.

Since the number of ms in the high risk group (R3) was successfully reduced, this group became more and more similar to the group (R2) with moderate caries risk and they also showed a similar caries developmnet. There was no statistical difference between the two CHX groups, considering their caries increment during the three years. A somewhat higher proportion of the children in the flossing group showed no new lesions (44%), compared to the tray group (27%), but, again, without any significant difference.

To conclude, this study indicates that treatment with chlorhexidine gel with a flossing technique seems to be as effective as the tray method in caries prevention to individuals at high caries risk. The caries incidence was moderate in both groups, but caries still developed in spite of the frequent CHX topical treatments

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Dental appearance, with focus on the anterior maxillary dentition, in young adults with bilateral cleft lip and palate (CLP). A follow up study

WORANUCH CHETPAKDEECHIT, DIMITRIOS STAVROPOULOS, CATHARINA HAGBERG

Abstract

◎ Bilateral CLP interferes with both facial and dental development. Surgical and orthodontic treatments help in optimizing facial and dental appearance. In order to improve the quality of treatment one of the keys is to evaluate the physical outcome. The aim of the present study was to evaluate the longitudinal treatment results in young adults born with a bilateral CLP during 1975-1991 in the south-west region of Sweden. Records and casts (13, 16 and 19 years) were evaluated for 35 persons with total bilateral CLP:s. They all belonged to the CLP team of Gothenburg. Occlusion, congenitally missing laterals, peg shaped laterals, impacted canines, midline, implants, prosthetic treatment and maxillofacial surgery were among the recorded variables. Unilateral or bilateral missing laterals were common (40%) as were peg shaped laterals (40%). Six children had impacted canines. A good symmetry and a straight midline between jaws were found after treatment for 60% of the young adults. It was more common to have canines positioned in the region for a missing or extracted lateral compared to having the lateral replaced with an implant or other prosthetic treatment. Asymmetrical maxillary frontal appearance and an acceptable occlusion are not always achieved. Awareness of and effort to solve this problem are important in reducing factors that are likely to negatively affect the harmony of the face.

Key words

Cleft lip and palate, dentition, occlusion, dental anomalies

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Longitudinell utvärdering av behandlingsresultatet för unga vuxna med dubbelsidig LKG

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Sammanfattning

◎ Dubbelsidiga läpp-käk-gomspalter (LKG) påverkar i hög grad både ansikts- och bettutveckling. Kirurgiska korrektioner och ortodontisk behandling normaliserar avvikelserna. Utvärderingar av behandlingsresultat är viktiga som kvalitetskontroll men även för att ge kunskap om vad som kan göras för ytterligare förbättring av behandlingsresultaten.

Avsikten med denna studie var att longitudinellt utvärdera behandlingsresultat för unga vuxna med dubbelsidig LKG. Alla barn som var kaukasier och fullständigt registrerats enligt ett standardiserat protokoll och behandlats av LKG teamet i Göteborg, Sahlgrenska universitetssjukhuset under 1975-1991 följdes upp. Antalet barn som uppföljde kriterierna var 35. Journaler och modeller på käkar/tänder (13,16 och 19 års modeller) utvärderades. Variabler som analyserades var ocklusion, avsaknad av laterala överkäksincisiver, tapptandsformade lateraler, retinerade hörntänder i överkäken, mittlinjediskrepans mellan käkarna, förekomst av implantat eller andra protetiska ersättningar i överkäksfronten. Resultaten visade på att en enkel- eller dubbelsidig avsaknad av lateral överkäksincisiv var vanligt (40%). Tapptandsformade laterala överkäksincisiver var lika vanligt (40%). Sex barn hade haft retinerade hörntänder. En god symmetri mellan sidorna i överkäksfronten och en rak mittlinje mot underkäken efter avslutad tandregleringsbehandling sågs i 60% av fallen hos de unga vuxna. Det var vanligare att hörntänderna i överkäken placerats på platsen för en avsaknad eller extraherad överkäkslateral jämfört med ersättning med hjälp av implantat eller annan protetisk konstruktion. Behandlingen ledde dock inte alltid fram till en symmetrisk jämn överkäksfront och en acceptabel ocklusion. Sannolikt påverkar en asymmetrisk ojämn överkäksfront och en avvikande ocklusion ansiktes harmoni negativt. Det är viktigt att ha detta i åtanke och att försöka behandla bettet så optimalt som möjligt för ett allmänt gott estetiskt slutresultat.

Introduction

Scars, a wide and/or flat nose, and a short columella are features that often persist to some extent after completed treatment of a total bilateral cleft lip and palate (CLP). Dental appearance is important. Evenly aligned teeth in normal occlusion help in harmonizing the face.

Maxillary dental midline deviations and asymmetric dental arch forms can be found in children with a CLP (21). In a qualitative interview study that included people with bilateral clefts, the core category found was "hoping to be like other people" (4). Feelings about the aesthetic appearance of the upper frontal teeth are likely to have been reflected in some other categories described in the study, such as "experiencing deviations from others", "regarding oneself as being different from others" and "low self-esteem".

For an optimal result, the anterior maxillary dentition should have a midline that is straight against the lower incisors and aligns symmetrically around the facial midline. Clefts of the primary palate may interfere with normal tooth development. When the embryonic facial processes fail to unite and a cleft develops, there is also the risk of disturbance and disruption of the embryonic processes of dental lamina formation. Aberrant dental traits include variation in the number, morphology, enamel formation and eruption of the teeth in the cleft area (3,16,19).

The most frequent orthodontic procedures carried out in patients with CLP with mixed dentition include maxillary expansion to correct transverse deficiencies and proclination to remove crowding in order to improve incisor alignment and anterior cross-bites (7,19). An important issue to be dealt with is the disturbed eruption of the teeth adjacent to the cleft areas, a keystone factor for upper dental arch symmetry (17). An important goal must be to plan orthodontic treatment periods carefully so that a child with a repaired cleft does not have to be under treatment from more or less constantly from birth till adulthood. Young adults with either bilateral CLP or an isolated cleft palate have described how they missed school because of various treatments related to their cleft and how this made them feel different from their schoolmates (4).

The primary lip and palate surgical repairs performed during infancy and early childhood provide the foundation for normal speech, occlusion and facial appearance at the expense of varying amounts of maxillary growth restriction due to iatrogenic scar tissue formation (11). Concerns to avoid decreased maxillary growth caused by early surgery are important. Restriction of maxillary development may continue throughout the growing period and, thus, the situation worsens with age (19). In severe cases of maxillary hypoplasia, the basic orthognathic procedure is a Le Fort I osteotomy, sometimes in combination with mandibular set-back, after completion of facial growth (1,15).

After the primary lip and palate surgical repairs, a residual perialveolar oronasal bony defect through the alveolar ridge, anterior part of the hard palate and the floor of the nose can be addressed by an alveolar bone graft (14). Late alveolar bone grafting (i.e. during the mixed dentition) is now being carried out (2), giving an opportunity for the developing tooth (permanent lateral or canine) adjacent to the grafted area to erupt through the graft to its final position in the dental arch.

Total bilateral CLP:s are uncommon, with an incidence value of 0.3/1000 live births (8). In Sweden, all newborns with CLP are registered and regularly followed with a standardized protocol until 19 years of age. No private care is available and the Gothenburg CLP team takes care of all children with clefts in the south-western part of Sweden. The aim of this study was to review dental conditions and treatment results, focusing on the anterior maxillary dentition in young adults with total bilateral CLP living in this region of Sweden.

Material and methods

All Caucasian children with a total bilateral CLP who had followed the complete Gothenburg registration and treatment protocol from the beginning as newborns until 16–19 years of age were included in the study. They were born between 1975 and 1991 and were treated by the CLP team at the Sahlgrenska University Hospital, Gothenburg, Sweden. No children with craniofacial syndromes or severe malformations were included. The resulting study group consisted of 35 individuals.

The treatment protocol followed for all patients was lip adhesion at 3 months, soft palate closure at 6 months and lip-nose repair at 12–18 months of age. Hard palate closure and simultaneous bone grafting was done at 8–9 years of age. Bone grafting was done on one side at a time. When the clefts were very wide, a lip adhesion was made at each side at different times. At least 3 months later, surgery was carried out on the other side of the cleft lip, combined with the closure of the soft palate.

The pre-surgical variables that were registered were: the presence of a Simonart's band, treatment with palatal plates, and the use of nose plugs. A Simonart's band was defined as a string of tissue with a length of less than 5 mm that connected the lateral and central parts of the cleft lip on each side.

The main focus of interest was on the appearance of the upper frontal teeth. Information was collected from patient records, dental casts and photos, with emphasis on data from 13, 16 and 19 years of age. Orthodontic treatment was reviewed in terms of early incisor correction, early expansion of transverse discrepancies, and corrective orthodontic treatment at ages 13, 16 and 19 years. Overbite, overjet, missing front teeth, tooth form, implant placement, prosthetic treatment, intra-maxillary symmetry, midline deviations between the jaws, and maxillofacial surgery were recorded. Information about congenitally missing lateral incisors was drawn from the patient records, as was data regarding extracted laterals. The laterals were verified as missing on the casts.

The inter-maxillary midline was evaluated by looking at the last casts available from 19 or 16 years of age in case that the person was not yet 19 years old. A midline discrepancy between the jaws of 0 to 3 mm was recorded as straight. Symmetry of the upper front was assessed by comparing the central and lateral incisors and the canine on the left side to the corresponding teeth on the right side. The final sagittal, vertical, and transversal dental diagnoses were checked for overbite and overjet.

All cases were checked by the same experienced orthodontist. Photos were used to complement the casts and the records; an assessment of the aesthetic outcome using photos of the upper front teeth will be published as a separate study. This study was approved by the Regional Ethical Committee of Gothenburg (149-08).

Statistics

Descriptive statistics in terms of frequency as percentages (%), median values and ranges for the different variables was calculated.

Results

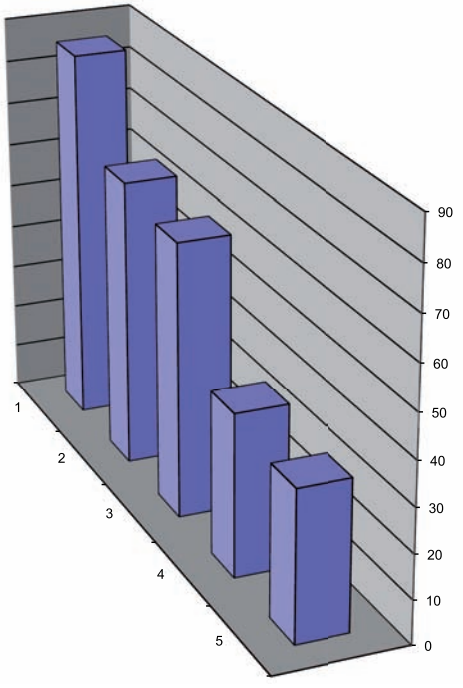
There were 9 girls and 26 boys with total bilateral CLP. In 7 cases the last casts were taken at 16 years of age, as they were younger than 19 years at the time of the study. In the total study group of 35 children, 2 had a bilateral and 7 had a unilateral Simonart's band (26%). All children except 2 had been treated with plates and nose plugs both before and after the first surgical lip adhesion.

Congenitally missing lateral incisors occurred in 14 children (40%) and peg-shaped laterals had the same frequency. These findings included both unilateral and bilateral deviations from normal. Five children had one impacted upper canine and 1 child had two. The canines were surgically exposed before orthodontic treatment. Two children had a transposition that included one upper canine.

Early orthodontic treatment with removable and/or fixed appliances was common. Thirty children had early correction of their upper frontal teeth (Fig. 1). The median age was 8 years (range 6–10 years). Early transverse expansion of the upper jaw

Figure 1. Frequencies (%) for different orthodontic treatments in 35 individuals with bilateral CLP.

1. Early correction of the maxillary frontal teeth
2. Early treatment with transverse expansion
3. Active early treatment with fixed appliances (13 years of age)
4. Orthodontic treatment with canines positioned in the region of the missing or extracted lateral incisors on both sides
5. Number of 16-year-old patients in retention after orthodontic treatment



was performed in 23 children, who had a median age of 8 years (range 5–11 years). Twenty-two children had active orthodontic treatment when they were 13 years old (Fig. 1). Thirteen were treated so that the canines were positioned in the region of a missing or extracted lateral incisor on both sides (Table 1, Fig. 1). Only 3 children had a clear midline deviation and 1 had a straight midline but appeared asymmetrical because of an open space distal to the canine on one side (Table 1). It was more common to have canines positioned in the region of a missing or extracted lateral than to have an implant.

At the time for the study, only 4 young adults had single implants in the upper front. Three were waiting for implants or prosthetic therapy. Severe root resorption and periodontal problems in the upper front occurred in 2 cases. Twelve young adults were in their retention phase as 16 year olds (Fig. 1). At the same age, 10 (28%) were under active orthodontic treatment. Only 2 were treated at the age of 19 years. The final casts for the total study group (N=35) showed a normal sagittal relationship with a positive overjet in 28 cases (80%) combined with a positive vertical overbite for 20 persons (57%) (Table 2). Lateral crossbites were registered in 12 cases (34%); 6 bilateral and 6 unilateral crossbites (Table 2).

The final casts for 22 (71%) showed a straight midline between the jaws. Four young adults with casts after maxillofacial surgery were not included (N=31). Out of these, 19 (61%) were assessed as looking symmetrical on the cast when the right side of the upper front was compared to the left side. There

Table 1. Upper canines positioned in the region of missing or extracted lateral incisor. The dental midline was denoted by a line between the upper central incisors (11, 21) compared with a line between the lower central incisors (31, 41). S= straight midline, D= deviating midline, Sym= symmetrical upper front, Asym=asymmetrical upper front, F=female, M=male

Gender	Agenesis	Extraction	Peg shaped	Impacted 13,23	Midline	Symmetry
F	12,22				S	Sym
M	12,22				S	Sym
M	12	22			D	Asym
M		12,22		13,23	S	Sym
F		12,22	12,22	13	S	Sym
M	12,22				S	Sym
M		12,22	12,22		S	Sym
M	12	22			S	Sym
M		12,22			S	Sym
M		12,22	12,22		S	Sym
F	12,22				D	Asym
M	12,22				D	Asym
M	22	12			S	Asym

Table 2. Sagittal, vertical and transversal relationships between the dental arches evaluated on the last dental cast for all persons in the study. N= number of cases. * = Dental casts from 4 persons who received maxillofacial surgery were included in this number.

Sagittal	Vertical	Transversal	N
normal/positive overjet	normal	normal	18*
normal/positive overjet	open bite /negative overbite or edge to edge	normal	3
normal/positive overjet	open bite /negative overbite or edge to edge	crossbite	4
normal/positive overjet	deep bite/overbite at least +5mm	normal	1
normal/positive overjet	normal	crossbite	2
mesial/edge to edge or negative overjet	open bite /negative overbite or edge to edge	crossbite	4
mesial/edge to edge or negative overjet	normal	crossbite	1
mesial/edge to edge or negative overjet	normal	normal	1
mesial/edge to edge or negative overjet	deep bite/overbite at least +5 mm	crossbite	1

were both cases where the canines were bilaterally positioned as substitutes for missing (congenitally or extracted) lateral incisors and cases with natural laterals with or without prosthetic adjustments and implants that were considered to have a symmetrical appearance. In total, 11 persons (31%) in the study group were assessed as candidates for a combined orthodontic and maxillofacial surgical treatment after completed growth. Only 4 persons (11%) had undergone this treatment at the time of the study.

Discussion

In the present study there were more boys than girls with total bilateral CLP. This is in line with a previous epidemiological study of 251 children in the county of Stockholm, Sweden, where 31 children had bilateral clefts and 10 were females and 21 males (8).

All except 2 children in the present study had presurgical treatment as newborns with nose plugs in order to form the alar cartilages. They were also treated with passive palatal acrylic plates that covered the cleft in the hard palate. The same treatment protocol including a two-stage repair of the cleft palate with delayed closure of the hard palate was applied for all patients. With respect to that treatment, the procedures were similar for all patients included, and the study group was assessed as being fairly homogenous.

A confounder, in terms of the basic conditions for the development of dental asymmetry, is the presence of a Simonart's band. However, only 7 newborns had a unilateral Simonart's bands. Another 2 had bilateral bands that were less likely to cause lateral displacement of the premaxilla.

Hypodontia most frequently involves the upper lateral incisor and the second premolars in the upper and lower jaw. Absence of the upper lateral incisor appears to be in the range of 10–20% in the primary dentition and 30–50% in the permanent dentition (21). Our results support this, as we found missing lateral incisors in 40% of the study group. As a consequence of shorter dental arches, crowding commonly develops in the posterior dentition (21). One third of the persons in study had the canines in the position for a missing or extracted lateral incisor. In cases with peg-shaped small lateral incisors or enamel disturbances, extraction of the lateral incisors might be a good alternative to extraction of premolars.

The morphology of the canine is usually normal in cases of CLP, but it is often impacted. *Semb & Schwartz* (22) reported that canine impaction occurred 10 times more often in patients with complete CLP than in non-clefts, and it was common for the canine to be in a palatal position. The permanent canines and premolars may erupt in a palatal direction because of scar tissue formation in the palate (20). In our study, 6 children (17%) had impacted canines, a value 10 times greater than the figure of 1.7% reported for eruption disturbances of the canines in Swedish children without clefts (6).

In the present study, deviated maxillary incisor positions, palatal dental inclination and anterior crossbites were reasons for early correction of the upper frontal teeth. These children received orthodontic treatment with removable or, more often, fixed appliances early, either around 6–10 years of age or around 13 years of age. The goal was to align the upper front, correct the dental midline and create normal sagittal and vertical relationships. A normal transversal relationship between the jaws was also one of the goals. A harmonious, symmetrical upper front was not always easy to achieve. Forty % of the study group did not appear symmetrical on the final casts when the right and left sides were compared. One important factor is the high frequency of peg shaped or missing laterals, especially if one sided. This dental condition is likely to create a discrepancy between the midline of the face and the midline of the upper front. However, it could not be measured on the available photos. In a previous qualitative interview study, in which some of the persons in the present study participated, young adults with bilateral CLP were reported as looking upon themselves as "being different" even if a fairly normal morphology had been achieved (4). It is likely that symmetry is an important factor, along with the extra-oral surgical results for treatment of the lip and the nose, in "feeling normal".

Posterior crossbites persisted or relapsed quite frequently after treatment. Thirty-four % of the young adults had a diagnosed posterior crossbite when the final cast model was evaluated. Sixty-six % of the children had early transverse expansion in the early mixed dentition. The high frequency of posterior crossbites in younger children is in line with previous reports (5,9). The reasons for this maxillary transverse deficiency may include intrinsic maxillary developmental deficiencies in cleft patients, functional distortions due to the presence of the cleft, and postoperative scar tissue formation (9,19). However, recent studies indicate that negative functional consequences from crossbites are rare (12).

Few implants were noted in the present study. One reason could be that the volume of the grafted bone was not sufficient or that the space between adjacent teeth was not wide enough. When the final treatment procedure was delivered, around 1994 for the oldest participants in this study, treatment approaches with osseointegrated dental implants were not as developed as they are today, and conventional prosthetic bridgework was a more common choice at that time.

A person who had a lot of treatment as a child is later in life likely to reject recommendations of complicated surgical procedures, such as bone augmentation for implants or maxillofacial surgery. Therefore the timing and the quality of treatment is very important. The results showed that 11 persons (31%) were candidates for final treatment with combined orthodontic and maxillofacial surgical treatment after completed of growth. The suggestion was based on a deviant skeletal relationship between the jaws and clinical findings. Since only 4 of these patients accepted this option, cephalometry analyses were not included in the present study. In general, 25% to 50% of CLP patients are reported as needing maxillary advancement surgery (9,10). Maxillary retrusion percentages in CLP-treated patients who have reached growth maturation differ significantly between CLP centers delivering standardized treatment procedures and those offering ad hoc treatment regimens, often with many surgeons involved (13).

In conclusion, this study describes treatment results with a focus on frontal dental appearance. Most often a normal sagittal relationship with a positive or edge to edge overbite was achieved after treatment. However, a symmetrical maxillary frontal appearance was harder to achieve and likely to be affected by the high frequencies of missing and/or peg-shaped lateral incisors. Awareness of and efforts to solve this problem are important from a professional point of view, since it is likely to affect the harmony of the face. The subjective experience of the orthodontic outcome is an interesting topic for future research.

Acknowledgement

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Prevalence of malocclusion traits and sucking habits among 3-year old children

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Abstract

◎ The aim of the present study was to evaluate the prevalence of malocclusion traits and sucking habits among 3-year-old children. A sample of 457 3-year-old children (234 girls and 223 boys) was obtained from three Public Dental Health clinics in Örebro County Council, Sweden. Data from clinical examination and a questionnaire were used to determine malocclusion traits, sucking habits, snoring and breathing pattern including nocturnal breathing disturbances. The results showed that 70% had one or more malocclusion traits at 3 years of age. The most common malocclusion traits were anterior open bite (50%), Class II occlusion (26%), increased overjet (23%) and posterior crossbite (19%). The prevalence of sucking habit was 66 % and dummy sucking was dominating and in connection with more malocclusion traits than finger/thumb sucking. A significant association was found between the sucking habits and the most prevalent malocclusions, anterior open bite, Class II occlusion, increased overjet and posterior crossbite.

In conclusion, the prevalence of malocclusion traits in 3-year-old children was high. Sucking habits was highly prevalent and dummy sucking resulted in more malocclusion traits than finger/thumb sucking did.

Key words

Primary dentition, prevalence, malocclusion, sucking habits

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Prevalens av bettavvikelser och sugvanor hos 3-åringar

Lillemor Dimberg, Lars Bondemark, Björn Söderfeldt, Bertil Lennartsson

Sammanfattning

◎ Studiens syfte var att undersöka prevalensen av bettavvikelser och sugvanor hos en grupp 3-åringar. Ett material av 457 barn (234 flickor och 223 pojkar) från tre Folktandvårdskliniker i Örebro län undersöktes vid 3 års ålder. Klinisk undersökning och ett frågeformulär användes för att fastställa bettavvikelser, sugvanor och andningsmönster inklusive snarkning och andningsuppehåll nattetid. Vid 3 års ålder hade 70% en eller flera bettavvikelser. De vanligaste bettavvikelserna var frontalt öppet bett (50%), postnormalt bett (26%), stor horisontell överbitning (23%), och korsbett (19%). Prevalensen av sugvanor var 66%, nappsugning dominerade och var associerade med fler bettavvikelser än finger/tum sugning. Ett signifikant samband sågs mellan sugvanor och de vanligaste bettavvikelserna, frontalt öppet bett, postnormalt bett, stor horisontell överbitning och korsbett.

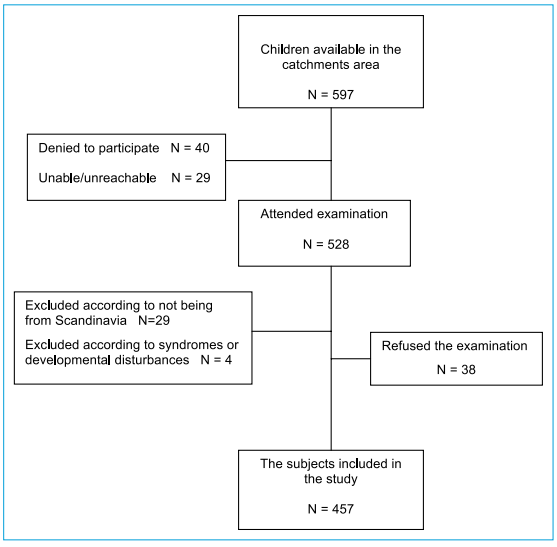
Sammanfattningsvis kan konstateras att prevalensen av bettavvikelser är hög hos 3-åringar. Prevalensen av sugvanor var också hög och nappsugning förknippades med fler bettavvikelser än finger/tumsugning.

Introduction

Malocclusion traits in three year old children have been described in earlier studies (6,12,16,18). The most common malocclusion traits found among preschool children are increased overjet, open bite, Class II occlusion and posterior crossbite. Several malocclusions are even more common among children with sucking habits (6,7,12,16,19,24,26,27) and prevalence of sucking-habits between 70-86% in preschool children has been reported (7,11,15,24). Over the years, the sucking habits have changed character. In the 1950-1970s, it was more common with thumb and/or finger sucking, while later in the 1980s, sucking dummy had become totally dominating (10).

The sucking pattern and muscular activity differ between dummy- and finger/thumb-sucking implying different influences on the dento-alveolar complex. Consequently, a dummy is more associated with transversal malocclusions like posterior crossbite while finger/thumb habits result in more pronounced effects in the incisal region (1,24,25). While earlier studies indicate that sucking habits have negative effects on occlusion in the primary dentition we know little about the duration of these sucking habits and development of malocclusion traits. This is also a limitation in the understanding of malocclusions in the primary dentition and the persistence into the mixed dentition (27). It has been claimed that as soon as the sucking habit has ceased, a good possibility will exist for spontaneous correction of the altered teeth and occlusion. Thus, studies have reported that the prevalence of open bite has changed from 51% in the primary dentition to 4% in the mixed and early permanent dentition due to spontaneous correction after the sucking habit has ceased (6,21). Also, spontaneous correction of posterior cross-bite occurs but is not clearly understood (8,9,13,20,22). In addition, data are also sparse considering the prevalence of malocclusion traits and sucking habits in three year old children. Therefore, the aim of the present study was to evaluate the prevalence of malocclusion traits and sucking habits among 3-year old children.

Figure 1. Flow-chart of the children in the study.



Material and methods

Subjects

The Ethics committee of the Örebro Health Care region, Sweden approved the study protocol and informed consent form in 2003(87/03).

The study sample was obtained from three Public Dental Service (PDS) clinics in Sweden. The clinics are located in three different small rural communities with a total of about 22 000 inhabitants in the catchment areas and in 2003, 597 3-year-old children belonged to those clinics. A number of subjects denied participating in the study (n=40) and 29 children were unreachable. Thus 528 children attended the clinical examination, which was performed in connection to the regular dental examination that every child routinely received at the age of 3. In order to reduce potential confounding factors like ethnic differences and environmental conditions, children not being from Scandinavia were excluded (n=29) and patients with syndromes or development disorders (n=4) were also excluded. Every child got at least two opportunities to attend the examination but 38 children refused the examination resulting in a final sample of 457 children (Figure 1).

A drop out analysis was made according to gender and clinics.

Clinical examination

The examination was performed by one experienced clinician (LD) between 2003 and 2005. The examination followed a specific protocol using a mouth-mirror and probe. No x-ray examination was performed. The method of Björk et al (2) and Foster& Hamilton (4), were used as guide for registration of malocclusion traits in centric occlusion. To determine the sagittal occlusion, the relation between the

primary canines was used according to the method by Foster&Hamilton (4). Overjet and overbite were measured by a stainless steel ruler with an accuracy of 0.5 mm.

Data on sucking habits, breathing pattern including nocturnal breathing disturbances were collected by a questionnaire that the parents were asked at the time for the clinical examination.

Measures

Class I relation (normal occlusion): The tip of the upper primary canine tooth in the same vertical plane as the distal surface of lower primary canine tooth in centric occlusion.

Class II relation (postnormal occlusion): The tip of the upper primary canine tooth in anterior relationship to the distal surface of the lower primary canine tooth in centric occlusion.

Class III relation (prenormal occlusion): The tip of the upper primary canine tooth in posterior relationship to the distal surface of the lower primary canine tooth in centric occlusion.

Overjet was measured at the most protruding upper incisor and was classified as normal in the range of 0-4 mm. Anterior crossbite was registered if one or more maxillary primary incisors occluded lingually to the lower incisors. A deep bite was registered when the maxillary incisors covered more than 2/3 of the mandibular primary incisors. A negative overlap in the vertical plane was recorded as an anterior open bite. All other vertical relations between the incisors were considered normal.

Posterior crossbite or scissorsbite was recorded and subdivided into unilateral and bilateral crossbite/scissorsbite.

Finally, supernumerary teeth, hypodontia and gemination/fusions were registered.

Questionnaire

The questionnaire comprised eight questions.

1. Has your child ever had a sucking habit?
   Response options: Yes No
2. Is the habit ongoing?
   Response options: Yes No
3. Is the habit terminated?
   Response options: Yes No
   If yes, at what age (in months) of the child did the sucking habit terminate?
4. What kind of sucking habit did your child have?
   Response options: Dummy
   Finger/thumb
   Other objects.
5. Duration- Estimate the rate of sucking habit during a day!
   Response options: Night+day (>16hours)
   Night (8-16hours)
   Part of night+day (< 8 hours)
6. Does your child normally breathe with the mouth open?
   Response options: Yes No
7. Does your child snore while sleeping?
   Response options: Yes,every night
   Sometimes
   No
8. Does your child have nocturnal breathing interruptions during sleep?
   Response options: Yes No

Statistical analysis

All data were analysed using the SPSS version 15.0 software program. T-test was used to assess differences in numerical data. Chi-square was used to describe the relationship between sucking habit and each malocclusion trait and in the drop out analysis to find differences between gender and clinics. Fishers exact test was used when testing the association between sucking pattern and malocclusion traits due to one cell with expected count less than 5. Differences with probabilities of less than 5% ($p<.05$) were considered to be statistically significant.

Results

General data

In the sample of the 457 children participated in the study, 234 were girls and 223 boys. The examination was performed as close as possible to 3 years of age and at the time of examination the average age was 2.9 years (SD 0.3). No significant difference in any of the variables used in the study was found between boys and girls. Consequently, the data for girls and boys were pooled and analyzed together. The dropout analysis showed that the dropout's subjects did not differ regarding gender or clinics to the final sample.

Malocclusion traits

A prevalence of 70% of one or more malocclusion traits was found and the most common malocclusion traits were anterior open bite, Class II occlusion, increased overjet, and unilateral crossbite (Table 1).

Anterior crossbite was found in 8 children, hypodontia in 2 (two teeth in each individual) and supernumerary teeth in one child, whereas fusion/gemi-

Table 1. The prevalence of different malocclusion traits and sucking habits of the subjects in the study (n=457).

Malocclusion traits	N	%
One or more malocclusion traits found	318	70
Sagittal relation at primary canines (valid n= 452)		
Class II	116	26
Class III	40	9
Overjet (valid n=439)		
>4 mm	99	23
<0 mm	5	1
Vertical relation		
Overbite (valid n=453)		
<0 (open bite)	226	50
>2/3 (deep bite)	29	6
Transversal relation (valid n=457)		
Unilateral crossbite	60	13
Bilateral crossbite	29	6
Scissors bite	0	0
Sucking habits (valid n=457)		
Ongoing sucking habit	301	66
Ceased sucking habit	62	14
Type of sucking habit (valid n=363)		
Dummy	334	92
Finger/thumb	24	7
Others (e.g. blanket, teddybear)	5	1

Table 2. Malocclusion traits and the association with sucking habit of the subjects in the study (n=457).

	No sucking habit (n=94) %	Sucking habit (n=363) %	P[1]
One or more malocclusion traits found	34	80	<0.001
Malocclusion traits with a significant association to sucking habits			
Class II relation	2	32	<0.001
Overjet >4 mm	4	27	<0.001
Overbite <0	1	63	<0.001
Posterior crossbite	1	24	<0.001

[1] P-value with the null hypothesis that there is no difference in the prevalence of malocclusion traits between children with no sucking habit and children with a sucking habit. Chi-Square test was used.

nation was found in 2(one tooth in each individual) of the subjects.

Sucking habits

The prevalence of sucking habits was 66%. The most common sucking habit was dummy sucking, while 14% of the children had ceased the sucking habit before the age of 3 years (Table 1).

Sucking habits and malocclusion traits

A strong association was found between sucking habits and malocclusion traits. In children without sucking habits the prevalence of malocclusion traits was 34% while 80% in those with sucking habits (Table 2). A significant association was found between sucking habits and anterior open bite, Class II occlusion, increased overjet and posterior crossbite.

When comparison was made between dummy and finger/thumb sucking habit a higher number of malocclusion traits (Class II occlusion and anterior open bite) was found in children with a former or ongoing dummy sucking habit (Table 3).

A significant association was only found between the duration of the sucking habit and posterior crossbite (Table 4).

Mouth breathing, snoring and nocturnal breathing disturbances

Mouth breathing occurred daily in 86 children (19%) and 9 % snored every night according to the parents. In 6 % of the 457 children the parents had expe-

Table 3. Dummy or finger/thumb sucking habit and the association to different malocclusion traits. Other habit (N = 5) is excluded.

Malocclusion	Dummy (n=334) %	Finger/thumb (n=24) %	P[1]
One or more malocclusion trait	82	54	0.001
Class II relation	34	4	0.003
Overjet >4mm	28	29	NS
Overbite <0	66	25	<0.001
Posterior crossbite	25	17	NS

[1]P-value with the null hypothesis that there is no difference in the prevalence of malocclusion traits between the group with dummy sucking and the group with finger/thumb sucking. Fisher's exact test was used according to one cell with expected count less than 5.
NS: not significant.

Table 4. The association between malocclusion traits and duration of the sucking habit.

Malocclusion	Duration			P[1]
	Only day %	Only night %	Day and night %	
One or more malocclusion trait (valid n=273)	74	81	86	NS
Class 2 relation (valid n=108)	24	36	34	NS
Overjet >4mm (valid n=92)	26	29	30	NS
Overbite <0 (valid n=219)	60	60	70	NS
Posterior crossbite (valid n=86)	17	23	31	0.043

[1]P-value with the null hypothesis that there is no difference in the prevalence of malocclusion traits between the three groups of duration. Chi-Square test was used.
NS: not significant.

rienced that the child was affected by a nocturnal breathing disturbance like breathing interruptions.

Discussion

The new knowledge gained from this study was that dummy sucking resulted in more anterior open bite and Class II occlusion than finger/thumb sucking did. A possible explanation may be that a dummy can be used more continuously, for example simultaneously with the daily activities, resulting in longer duration of muscular activities acting on the dento-alveolar complex than when a finger is used. Another aspect is that finger/thumb sucking may start later in life than dummysucking and therefore at three years the habit has not caused detrimental changes on occlusion yet.

It was also found that the duration of the sucking habit has a significant influence on the prevalence of posterior crossbite but not on increased overjet, Class II occlusion and frontal open bite (Table 4).

The dominating malocclusion trait found in this material was anterior open bite. The prevalence of 50% is similar to earlier studies (6,3). The prevalence of posterior crossbites (19%) and increased overjet (23%) is also similar to what previous studies have reported (15,18). Also, the amount of Class II occlusion (26%) found was within the range of previous reports (18,23,27).

Sucking habits were common (80%) and comparable to Scandinavian studies presented twenty to thirty years ago (7,11,15,24). Dummy sucking was the totally dominating sucking habit and this is also in accordance to studies from 1980s (10).

It was obvious that the sucking habit had a strong association to anterior open bite, Class II occlusion, increased overjet and posterior crossbite and this have been verified by several other authors (6,7,12,15,16,19,24,25,27). Further on, a strong association between sucking habits and Class II occlusion was found but this association had previous studies shown disagreement about (7,19,27).

Evaluations of fusions/geminations and hypodontia in primary dentition have been rare. The low rate of these conditions found in this study was comparable to what have been earlier described in the literature (3,5).

Few studies have evaluated the breathing and snoring pattern among 3-year-old children. Interestingly, in our study it was found that the parents reported that 19% of the children were mouth breathers, 9% snored every night and 6% had nocturnal breathing interruptions. In a previous study (14) there were only 9,3% mouth breathers while, 6,0% snored every night and 4,3% were reported having nocturnal breathing interruptions. These differences may be explained by the fact that they are highly relied on the parents' subjective experiences.

The sample size of 457 participants gives the study the power that has often been lacking in many of the previous conducted studies in this field. As many other epidemiological studies, this study also have its limitations. First, as mentioned above, the reported amount of mouth breathing, snoring and nocturnal breathing interruptions must be interpreted with caution since these observations are highly relied on the parents' subjective experiences.

Second, even if the dropout rate was fairly acceptable, it must be considered that the children that had to be excluded because they refused the clinical examination may be more immature than expected for a normal 3 year-old child. Consequently, these children who refused examination probably to a higher extent were dummy or finger suckers than

those who was examined clinically, and this fact is important to have in mind when analyzing the results. Nevertheless, the dropout analysis revealed no differences between the final sample and dropouts regarding gender or clinical belonging, and thus, in this respect making a homogenous missing material.

Some authors claim that Class II occlusion and posterior crossbite seldom self-corrects after 4 years of age since these malocclusions are stable from this early age into the permanent dentition (6,17). On the other hand, other proclaims that posterior crossbite may be spontaneously corrected in a range between 17 and 45% (8,13,22). Overall, it has not been clearly shown to which extent and how long time it will take for spontaneous correction of different malocclusions after the sucking habit has ceased. One way to explore this is to longitudinally follow the occlusion from the early primary dentition to the mixed dentition in children with and without sucking habits. Since such studies are very few (6,7), new longitudinal studies are desirable. To supply sufficient evidence when and to which extent spontaneous corrections of malocclusion traits occur from the primary to the mixed dentition longitudinal studies have to be carried out. Therefore, the sample in this study will be followed up to 7 years of age and be presented in a future study.

Conclusion

The prevalence of malocclusion traits in 3-year-old children was high. Sucking habits was highly prevalent and dummy sucking resulted in more malocclusion traits than finger/thumb sucking did.

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Patients' experience of care and treatment outcome at the Department of Clinical Oral Physiology, Dental Public Service in Stockholm

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Abstract

◎ Chronic pain conditions in the craniofacial region are common in the adult population with a prevalence of approximately 10%. They are included in the generic term temporomandibular disorders (TMD) and accompanied by restricted mouth opening capacity, chewing difficulties, headache and neck pain. These pain conditions cause psychological suffering, impaired social relations, and recurrent sick leave, subsequently leading to frequent use of health care, medication and consequently to a decreased quality of life.

Approximately 25 % of children have signs of TMD and girls are shown to be more affected than boys. These signs increase with age and in the adult population the prevalence is approximately 38–40 %, also here with a higher frequency in women than in men.

This study comprised 198 patients who answered an anonymous questionnaire after termination of their treatment. The study aimed to investigate the activity at the department of clinical oral physiology at the Folktandvården Eastman Institute in Stockholm, Sweden, regarding the patients and their cause of care-seeking, as well as the patients' subjective experiences of the specialist care and the treatment outcome. As a secondary aim the purpose was to investigate how/if the clinicians at the department of clinical oral physiology reached their intention of being "curious", "considerate" and "accessible".

The results from this study show that the majority of the patients (57.1 %) were referred from the dental public service in Stockholm. 71.7 % of the patients were young women between the ages of 11 and 20. The main causes of care-seeking were temporomandibular joint clickings, followed by limited jaw movement, headache and orofacial pain. Further, an immense majority of the patients (89.9 %) were very satisfied with their treatment as well as the treatment outcome. These results indicate that the clinicians at the department reached their intention of being "curious", "considerate" and "accessible", which also implies that the department clearly meets the three core principles of the Folktandvården in Stockholm.

Key words

Temporomandibular disorders, questionnaire, children/adolescents, quality of care, treatment outcome

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Beskrivning av en patientgrupp på en bettfysiologisk avdelning och deras upplevelse av erhållet omhändertagande

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Sammanfattning

◎ Kroniska smärttillstånd i ansikts- och huvudregionen är vanliga i den vuxna befolkningen med en prevalens på cirka 10 %. Dessa tillstånd placeras ofta under termen temporomandibulär dysfunktion (TMD) som dessutom inbegriper nedsatt gapförmåga, tuggsvårigheter samt huvud- och nackvärk. Personligt lidande med risk för försämrade sociala relationer, ökad sjukfrånvaro, ökat antal sjukvårdsbesök och ökad läkemedelskonsumtion medför i sin tur en nedsatt livskvalité.

Ungefär 25 % av alla barn har TMD symptom och fler flickor än pojkar drabbas. Dessa symptom ökar med stigande ålder och bland de vuxna är förekomsten närmare 38–40 %. Även bland de vuxna är det fler kvinnor än män som drabbas.

Denna studie omfattar 198 patienter, remitterade till en bettfysiologisk avdelning, som svarade på en anonym enkät. Enkäten delades ut efter avslutad behandling. Studien syftade till att undersöka aktiviteten på avdelningen för bettfysiologi på Folktandvården Eastmaninstitutet i Stockholm. Patientunderlaget, patienternas personliga orsak till sökt vård, deras subjektiva upplevelse av specialistbehandlingen och behandlingsresultatet utvärderades. Dessutom utvärderades om behandlarna på avdelningen för bettfysiologi uppnådde målet att vara nyfikna, omtänksamma och tillgängliga.

Resultaten från studien visade att en majoritet av patienterna (57.1 %) var remitterade från Folktandvården i Stockholms län AB. 71.7 % av patienterna var unga kvinnor i åldrarna mellan 11 och 20 år. De huvudsakliga orsakerna till sökt vård var käkledsknäppningar, nedsatt gapförmåga, huvudvärk och ansiktssmärta. En betydande majoritet av patienterna (89.9 %) var mycket nöjda med behandlingen och behandlingsresultatet. Dessa resultat tyder vidare på att behandlarna på avdelningen uppnår sina mål att vara nyfikna, omtänksamma och tillgängliga och därmed att avdelningen möter Folktandvårdens, i Stockholm, tre värdegrunder.

Introduction

Chronic pain conditions in the craniofacial region are common in the adult population with a prevalence of approximately 10% (5, 12, 14). It has further been shown that the prevalence of chronic pain conditions is higher among women and these pain conditions tend to increase in the adult population (26). All disturbances, both medical and dental conditions, associated with the function of the masticatory system, i.e. a number of clinical signs and symptoms affecting the temporomandibular joints (TMJs), and/or the masticatory muscles as well as the associated structures, are embraced in the generic term temporomandibular disorders (TMD) (19, 25, 30). Persisting pain conditions in the craniofacial region due to functional disorders of the masticatory muscles are probably the most frequent condition of TMD (19). These conditions are often accompanied by restricted mouth opening capacity, chewing difficulties, chronic fatigue symptom, headache and neck pain (23, 31). They are further accompanied by psychological suffering, impaired social relations, recurrent sick leave, subsequently leading to frequent use of health care and analgesics (17, 29), leading to a decreased quality of life (3).

According to *Thilander et al.* (25), a number of studies carried out worldwide, have shown that TMD are common amongst children and adolescents. Approximately 25 % of the children (5–17 years of age) have TMD signs, and girls are shown to be more affected than boys with a ratio of 1.5-2:1 (18, 25). TMD signs increase with age (16, 24), reach a peak around the age of 40 to level out and decrease at higher ages (11). In the adult population, the prevalence is approximately 38–40 % with a higher frequency in women than in men (2-3:1) (21).

Previous studies have shown that the most frequent TMD sign is pain, usually from the masticatory muscles, but also from the TMJ and/or the preauricular area (inflammatory diseases) as well as headache. The non-painful TMD signs are limited or asymmetric mandibular movements and joint sounds such as clicking and crepitus (2). According to *Yap et al.* (30) approximately 31 % of the Asian TMD-patients suffer from muscular disorders, 16 % have TMJ sounds and 13 % have TMJ signs such as athralgia, arthrosis and arthritis. These findings are similar to the results from a previous study comparing the signs and symptoms of TMD patients in Sweden and the United States (15), where 50 % of the Swedish and American population was shown to suffer from myofascial pain.

In Stockholm, Sweden, these patients are referred and treated at the department of clinical oral physiology at the dental public service (Folktandvården i Stockholms län AB) of Stockholm county council. The Eastman Institute, one of the specialist clinics, mainly treating children and adolescents, receives approximately 600 referrals each year, from dentists in the dental public service as well as the private care, physicians, physiotherapists and others.

In order to meet the patients´ needs all caregivers have the intention to be "curious", "considerate" and "accessible". These three principles are further the three core principles of the Folktandvården in Stockholm. The first principle "curious" refers to the caregiver taking an active interest in the patients' situation and trying to understand the cause of their treatment seeking. Further, it encourages the caregiver to follow the advancement in the field of TMD and be part of it as well as being anticipated and perceived as being modern and experienced by the patients. The purpose of the second principle "considerate" is to provide attention, safety and feeling of wellbeing to the patients. The rationale of the last of the three principles, which is "accessible", is that the patient receives the necessary information in an understandable manner. In addition, that the caregiver is easily available leading to a friendly and welcoming atmosphere.

All patients experience their condition(s) subjectively. What one patient considers as painful may not be painful for another, and what one patient considers an illness may be a natural state for another. So, with this in mind, it is of great value to let the patients describe their experiences of their condition. In order to provide the necessary treatment the caregiver has to consider the clinical findings in combination with the patient's subjective symptoms. In chronic conditions, it is of great importance to take into consideration that not only the caregiver but also the patient can influence his problem and also to let the patient himself evaluate the treatment outcome.

Therefore it is of great importance to investigate the patients' own experiences from the treatment. Hence, the primary aim of this study was to investigate the activity at the department of clinical oral physiology at the Folktandvården Eastman Institute in Stockholm, Sweden, regarding the patients and their cause of care-seeking, as well as the patients' subjective experiences of the specialist care and the treatment outcome. As a secondary aim, the purpose was to investigate how/if the clinicians in the field

of TMD reached their intention of being "curious", "considerate" and "accessible".

Material and methods

The study was conducted at the department of clinical oral physiology at the Folktandvården Eastman Institute in Stockholm, Sweden. The participants were the patients referred and treated at the department. All patients treated between the 1st of October 2007 and the 31st of March 2008 received a questionnaire at their last visit, when the treatment was terminated. A six month period was chosen to achieve a sufficient amount of questionnaires.

To ensure that the answers were not affected by the treatment situation the questionnaires were handed out at the participants' last visit by an assisting dental nurse not participating in the patient treatment. The patients completed the questionnaire in the waiting room and placed it in a sealed box that was emptied at the end of the study period in order to guarantee anonymity.

Participants

The study comprised 198 patients of which 179 (90.4 %) were children/adolescents and 19 (9.6 %) were adults, i.e. over 20 years of age. The patients were referred from the dental public service in Stockholm, from private practitioners and from hospitals as well as medical care centers.

Questionnaire:

The anonymous questionnaire administrated to the participants at the end of treatment was structured comprehensibly and comprised nine questions. It captured information on gender, age, the instance referring the patient, reason for treatment seeking/referral, time at waiting list, as well as the patients' subjective experiences of the specialist care and treatment outcome. The treatment situation included if the patients were pleased with the reception at the clinic, if they were given enough and accurate information, if they were helped with their TMD problems, and if they were satisfied with the treatment received. The questionnaire used a five-point scale ranging from "very good" to "very bad". The participants had further the opportunity to comment each answer about their attitudes toward each treatment situation.

Statistics

Descriptive statistics and statistical analyses were performed with the SigmaStat software (version 3.10, Systat software Inc., San Jose, CA, USA). In order to investigate gender differences, differences between children/adolescents and adults, as well as differences between the patients depending on the instance referring them, these values were normalized. This was done to eliminate any confounding factor due to the great variability in the number of patients in each group. The two way analysis of variance (ANOVA), with the Holm-Sidak test as post-hoc test, was used to test the differences between the groups, i.e. gender, age and instance referring the patients. For all tests the level of significance was set at $P < 0.05$.

Results

Patients

The majority of the participating patients referred and treated at the department were women between the ages of 11 and 20 years. The comparison of the patient allotments referred from the different instances showed no significant variations in any gender or age variable (Table 1). 57.1 % of the patients were referred from the dental public service in Stockholm, 21.2 % from private practitioners and 21.7 % from hospitals or medical care centers.

Table 1. Comparison of patient allotments depending on the referral center. Patient grouping (%) according to gender, age and waiting time for treatment.

	Total	Dental public service	Private practitioners	Hospitals and medical care centers
Gender				
Men	20.2	16.8	19.0	30.2
Women	79.8	83.2	81.0	69.8
Age				
< 10	2.0	1.8	0.0	4.7
11–15	35.9	31.9	42.9	39.5
16–20	52.5	58.4	50.0	39.5
21–30	1.5	2.7	0.0	0.0
30–60	6.6	4.4	2.4	14.0
> 60	1.5	0.9	4.8	2.3
Acceptable waiting time for treatment				
Yes	92.9	96.5	81.0	95.4
No	7.1	3.5	19.1	4.6

There were no significant differences between the instances referring the patients.

When the genders were analyzed separately, there were no gender differences regarding the age variables. 53 % of all patients were between 16–20 years of age, and 68.4 % of the adult patients (6.6 % of all patients) were between 31–60 years of age (Table 2).

A great majority, 184 patients (92.9 %), graded the time at waiting list as reasonable (Tables 1 and 2). The vast majority had to wait less than 3 months, 13 patients (6.6 %) had a time at the waiting list between 3-6 months, and only 1 patient had a time at the waiting list that exceeded 6 months.

Cause of care-seeking

46.5 % of all patients suffered from TMJ clickings, while 34.8 % of the patients suffered from orofacial pain. 36.4 % of the patients were referred due to limited jaw movement capacity and 35.9 % due to headache.

26.3 % of the adults sought treatment due to attrition, while only 11.7 % of the children/adolescents were referred because of this. 15 children (8.4 %) with juvenile idiopathic arthritis were referred for either treatment, control or follow ups of the TMJs. Other reasons for referral were obstructive sleep apnea, tinnitus, otalgia, chewing difficulties, tooth ache, jaw muscle tension as well as consultation before orthodontic treatment and implant surgery. In Table 3, the cause of care-seeking is shown.

Treatments given

During this time period all patients received general counseling information. The treatments provided to the patients were interocclusal appliances, occlusal adjustments, oral appliances for snoring, intra-arti-

Table 2. Comparison of the patient allotments divided by gender, results are shown in percentage. The patient spread is divided according to age and waiting time for treatment.

	Total	Men	Women
Age			
< 10	2.0	5.0	1.3
11–15	35.9	37.5	35.4
16–20	52.5	45.0	54.4
21–30	1.5	2.5	1.3
30–60	6.6	7.5	6.3
> 60	1.5	2.5	1.3
Acceptable waiting time for treatment			
Yes	92.9	97.5	91.8
No	7.1	2.5	8.2

There were no significant differences between genders.

Table 3. Illustration of the participating patients' cause of care-seeking, in percentage. The table is divided into four parts. The first part shows the total amount of the referred patients' cause of care-seeking. The second part handles the differences in patient allotments among the instances referring the patients. The third part handles the differences in patient allotments regarding gender and the fourth part illustrates the differences in patient allotments between age-groups.

	Pain	Clickings	Headache	Attrition	Limited jaw movement	JIA[a]	Other[b]
Total	34.8	46.5	35.4	13.1	36.4	7.6	8.1
Instance referring							
Dental public service	38.1	47.8	40.7	12.4	28.3	4.4	8.0
Private practitioners	28.6	40.5	42.9	23.8[d]	31.0	0.0	9.5
Hospitals and medical care centers	32.6	48.8	16.3[c]	4.7[c]	39.5	23.3[d]	11.6
Gender							
Men	22.5	32.5[e]	35.0	22.5[e]	22.5	12.5[e]	5.1[e]
Women	38.0	50.0	36.1	10.8	33.5	6.3	20.0
Age-group							
Children/adolescents	33.5[f]	46.9	36.3	11.7[f]	31.3	8.4[f]	6.7[f]
Adults	47.4	42.1	31.6	26.3	31.6	0.0	21.1

[a] = juvenile idiopathic arthritis.
[b] = such as consultation before orthodontic treatment and implant surgery, obstructive sleep apnea, tinnitus, otalgia, chewing difficulties, tooth ache, tensions.
[c] = significantly less amount of referred patients compared to the other instances and to the total amount of patients.
[d] = significantly larger amount of referred patients compared to the other instances and to the total amount of patients.
[e] = significant difference between genders.
[f] = significant difference between age-groups.

cular corticosteroid injections, intra-muscular corticosteroid injections, jaw exercises, transcutaneous electrical nerve stimulation (TENS), diagnostic nerve blockades or a combination of the above mentioned treatments. According to the answers from the questionnaires 25 patients received only general counseling information and 11 patients were referred only for consultation.

Subjective experiences of the specialist care and treatment outcome

In general the patients were very pleased with the treatment situation, and there were no significant differences between the genders or the age groups, neither between the patient allotments from the different instances referring the patients (Table 4).

89.9 % of the patients graded the reception at the clinic with the highest grade "very good", and they also provided a lot of positive comments but no negative ones. A few examples of the comments are as following: "Pleasant reception and nice personnel", "Very pleasant and accommodating", "A visit here makes you happy", "It feels safe and not hard at all to visit you".

At the inquiry if the participants were given enough and accurate information, 87.9 % answered "very good". Notable is that the participants provided only positive comments: "Good help", "The caregiver spent a lot of time explaining in an understandable way", "Clearly and in an understandable language", "I got answers to my questions".

Further, 86.4 % of the patients awarded a top score on the query if they were helped with their troubles. Even here the participating patients gave only positive comments, such as: "Very good", "My pain is gone", "It is much better now", Super improvement", "My doctor was very good".

Finally, 89.9 % of the participants were very satisfied with the treatment and gave it the highest grade. The treatment satisfaction was presented by the patients with comments such as: "Everything is very well now", "I feel much better now", "All visits have really helped and I am very grateful, thank you!", "The best thing I have done", "100% satisfied, I feel safe!".

Discussion

The main results from this study show that the majority of the patients at the department were young women between the ages of 11 and 20 referred from the dental public service in Stockholm. The main cause of care-seeking was TMJ clickings, followed by limited jaw movement, headache and orofacial pain. Furthermore, an immense majority of the patients were very satisfied with their treatment as well as the treatment outcome.

Activity at the department of clinical oral physiology

During the six-month time period, when this study was made, approximately 300 patients were referred to the department. 198 patients terminated their treatment and all of these patients answered the anonymous questionnaire. Due to the anonymity we are not able to exactly describe the distribution of the given treatments. One reason to that all patients participated might be that the structure of the questionnaire was clear, with just a few short questions that were easy to complete. The disparity between the amount of referrals and the patients that terminated their treatment can be explained by the fact that some patient groups are followed up during their childhood and adolescence, such as the juvenile idiopathic arthritis patients. The amount of participating patients is sufficient to provide an adequate picture of the activity at the department since they represent a normal distribution of patients during a six-month period at the clinic. During the year 2006, an amount of 376 patients terminated their treatment while during the year 2007, 468 patients terminated their treatment.

The department has a unique patient distribution since the majority of the referred patients are children and adolescents in contrast to other clinics where the bulk of patients are middle aged women. As expected, the results indicate that the bulk of patients were children/adolescents which also represent the normal distribution at the department with approximately 15 % adults per year. When analyzing the age groups, the majority of the patients were between the ages of 11–20 years and with a higher concentration at the ages of 16–20 years, which is in accordance with previous studies of Swedish adolescents with symptoms and signs of TMD (18). The patient distribution in terms of gender showed a significant majority of women, which is in agreement with one previous study with self-reported TMD in children/adolescents (18), as well as with a study including a clinical examination (10) and another including long-term follow-up (4).

The patients' cause of care-seeking

The primary outcome for this study was to evaluate the patients' subjective view of their condition and

their own cause of care-seeking, as well as their experienced treatment outcome. To be able to evaluate the treatment outcome from a patient perspective, i.e. if the patients were helped with their subjectively perceived problems, a self reported questionnaire was used. Hence, the clinical findings and diagnoses were therefore not controlled for, nor the written cause on the referral. The purpose was to evaluate the treatment outcome or treatment success from a patient perspective, and for this it is important to know the patient's subjective cause of care-seeking and the patient's subjective treatment satisfaction. Consequently, the clinical findings and diagnoses are of minor importance in this study.

Most of the patients had more than one symptom, i.e. the results from this study can illustrate the patient allotment but not arrange or grade the severity of the symptoms. In order to keep the answers from the participating patients completely anonymous and to avoid any kind of influence from the care-giver, the questionnaires were handed out after the last visit at the department by an assisting nurse not participating in the patient treatment.

In this patient allotment the main cause of care-seeking was TMJ clickings, which is in concordance with two previous studies on children/adolescents (13, 22). This complaint was followed by limited jaw movement. The above mentioned results, where TMJ clickings and/or limited jaw movement are the main causes of care-seeking, are supported by some studies (13, 27, 28) while in other studies this complaint was less frequent (6, 8, 22). This divergence might be due to the fact that the cause of care-seeking in this study is the patient's self-perceived experience and not the result from a clinical examination or the reason for referral, since a clinical examination would violate the anonymity. Further, the discrepancy from previous findings that persisting pain conditions in the craniofacial region are the most

Table 4. Summary of the participating patients' experiences of the specialist care and the treatment outcome (%). The table is divided into four parts. The first part shows the total amount of the referred patients' attitudes. The second part handles the differences in patient allotments among the instances referring the patients. The third part handles the differences in patient allotments regarding gender and the fourth part illustrates the differences in patient allotments between age-groups.

	Reception					Adequate information					Help with troubles					Satisfaction with treatment				
	Very good	Good	Neutral	Bad	Very bad	Very good	Good	Neutral	Bad	Very bad	Very good	Good	Neutral	Bad	Very bad	Very good	Good	Neutral	Bad	Very bad
Total	89.9	8.6	1.5	0.0	0.0	87.9	11.1	0.0	1.0	0.0	86.4	11.1	2.0	0.5	0.0	89.9	8.6	1.0	0.5	0.0
Instance referring																				
Dental public service	88.5	9.7	1.8	0.0	0.0	85.8	13.3	0.0	0.9	0.0	84.9	12.4	1.8	0.9	0.0	88.5	9.7	1.8	0.0	0.0
Private practitioners	92.9	7.1	0.0	0.0	0.0	92.9	7.1	0.0	0.0	0.0	88.1	11.9	0.0	0.0	0.0	92.9	7.1	0.0	0.0	0.0
Hospitals and medical care centers	90.7	7.0	2.3	0.0	0.0	88.4	9.3	0.0	2.3	0.0	88.4	7.0	4.6	0.0	0.0	90.7	7.0	0.0	2.3	0.0
Gender																				
Men	95.0	2.5	2.5	0.0	0.0	90.0	7.5	0.0	2.5	0.0	85.0	12.5	2.5	0.0	0.0	87.5	10.0	0.0	2.5	0.0
Women	88.6	10.1	1.3	0.0	0.0	87.3	12.0	0.0	0.7	0.0	86.7	10.8	1.9	0.6	0.0	90.5	8.2	1.3	0.0	0.0
Age-group																				
Children/adolescents	88.8	9.5	1.7	0.0	0.0	87.2	11.7	0.0	1.1	0.0	85.5	10.6	3.3	0.6	0.0	90.0	8.4	1.1	0.5	0.0
Adults	100	0.0	0.0	0.0	0.0	89.5	10.5	0.0	0.0	0.0	94.7	5.3	0.0	0.0	0.0	84.2	15.8	0.0	0.0	0.0

There were no significant differences between any of the patient allotments.

frequent condition of TMD (19) can be explained by the low mean age of the present patients and due to this, they have not yet experienced chronic pain. Headache and orofacial pain, as the main cause of care-seeking, have similar frequency in this study compared to some other studies, although they were mainly focused on adults (1, 20, 28, 30) but in one other study a higher amount of patients suffered from headache (4). The comparison with these studies might not be completely appropriate due to the different age-allotments in the studies. However, this is due to the unique patient allotment at this department, consisting mainly of children and adolescents.

The patients´ subjective experiences

With this anonymous questionnaire it was possible to evaluate the patients' actual experiences. The patients answered the questions without restraint since the caregiver was not present and since their answers could not influence the treatment situation due to the fact that the treatment was terminated.

It can be discussed whether a child can provide reliable answers to a questionnaire. In this study, the majority of the participants were between the ages of 16-20 years. In a recent study measuring oral health-related quality of life among children aged from 8 to 13 years the results suggested that a questionnaire is a valid instrument and that the answers are reliable (7). Similar results have also been shown in a study of eosinophilic esophagitis among children aged from 8 to 17 (9).

The purpose of the department is to meet all patients in the same manner regardless of their age, gender and/or ethnicity, which the results from this questionnaire confirm, i.e. that all patients were handled equally. No significant differences were found between the children/adolescents and the adults, neither between genders, nor between the different instances referring the patients, i.e. the dental public service, the private practitioners and the hospitals as well as the medical care centers.

Reception at the clinic

The treatment starts already at the reception, as this is the first contact the patient has with the treatment situation. The whole treatment situation is of great importance for the treatment outcome. It is of great importance to make the patient feel relaxed and in safe hands, but also to be able to provide information, to be flexible and to meet the patients' requests. The participating patients found the reception at the clinic as being very good and expressed it with a lot of positive comments.

Patients referred from private practitioners and hospitals appeared to show better results, which might be due to the smaller amount of participants in these groups (Table 4). This difficulty to draw conclusions is also found when comprising genders as well as for the comparison between adults and children/adolescents.

Given information

For TMD patients, an important part of the treatment is the information (19). In some conditions, such as TMJ clickings, information is often an essential part of the treatment. In other conditions information is of great value in order to help the patient to find and understand the reason or reasons for their condition, to be able to reduce or diminish the cause of the symptoms and not only for treatment of the symptoms.

As previously mentioned, it seems that the patients referred from private practitioners, hospitals and medical care centers show better results, but again there was no statistically significant difference.

The specialist care

One question addressed if the given therapy alleviated the patients' subjective symptoms of TMD. In order to assess treatment success it is not enough only to use the evaluation from the caregiver, but it is necessary also to take the patient view of the treatment outcome in consideration. Hence, one measure of a successful treatment is when the patient is satisfied. In order to maintain anonymity, only the patient's view of the treatment success was assessed in this study. Yet again the patient allotment showed a high degree of treatment success, 86.4 % were very satisfied (graded 5 out of 5). When the two highest grades (4 and 5 out of 5) were used the results showed that an immense majority of the participating patients (97.5 %) achieved a successful treatment. Further, there were no significant differences between any of the patient groups. These results are in agreement with another recent study in Sweden (4) where a 18-20 year follow-up was performed on TMD patients.

Treatment satisfaction

In concordance with another study (4) the patients were very pleased with their treatment in general. A larger amount of the patients graded their treatment satisfaction as very high compared to if the provi-

ded therapy helped them with their complaints. One explanation can be that some of the patients were satisfied just by the information given about their condition and the accurate answers to their worries, consequently leading to a treatment satisfaction without any actual clinical treatment. Another reason can be that some of the patients were referred just for consultation only, and they were pleased with the adequate information and answers to their questions. Further, the caregivers spent a lot of time answering questions and providing information during the examination, also letting the patient express their complaints, which made the patients feel that they had been taken care of.

Do the specialists reach their intention of being "curious", "considerate" and "accessible"?

The results of the questionnaire and the comments from the participating patients illustrate that the specialists at the department reached their intention of being "curious", "considerate" and "accessible" in the treatment situation. Consequently, the specialists at the department follow the three core-principles of the Folktandvården in Stockholm.

In order to be able to provide the best available therapy, the caregiver has to be curious. It is not enough to follow the technical advancement in the field, or to achieve more knowledge by attending courses and seminars, but it is also necessary to be sensitive to what the patient has to say. The caregiver has to consider both the results from the clinical examination, to take an active interest in the patient situation and to the patient history, to understand the cause of treatment seeking and to be curious in order to meet the patients' requests. With the high quality reception at the clinic, the proper and adequate information as well as the sensitivity provided by the caregiver, the participating patients found the department "curious".

By the comments from the participants, we can conclude that the department provided a feeling of safety and wellbeing, which was the purpose of the second principle "considerate". Comments as: "A visit here makes you happy", "It feels safe and not hard at all to visit you", "You are angels" illustrate this. These and other comments such as: "The personnel are always very pleasant, positive and interested in my problems", "Minimal waiting time and very polite reception", "Clearly and in an understandable language" reflect that the department also meets the third principle which is "accessible".

Conclusion

In conclusion, this study shows that the majority of the patients at the department of clinical oral physiology, at the Eastman Institute, are young women between the ages of 11 and 20 years, referred from the dental public service in Stockholm. The main reason for care-seeking was clickings, followed by limited jaw movement, headache and orofacial pain. An immense majority of the patients were very satisfied with their treatment as well as the treatment outcome. Conclusively, this indicates that the personnel at the department reach their intention of being "curious", "considerate" and "accessible", which also implies that the department clearly meets the three core principles of the Folktandvården in Stockholm.

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