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ORIGINAL ARTICLE

Oral motor dysfunction in children with adenotonsillar hypertrophy—effects of surgery

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Abstract

Adenotonsillar hypertrophy is associated with a wide range of problems. The enlargement causes obstructive symptoms and affects different functions such as chewing, swallowing, articulation, and voice. The objective of this study was to assess oral motor function in children with adenotonsillar hypertrophy using Nordic Orofacial Test-Screening (NOT-S) before and 6 months after surgery consisting of adenoidectomy combined with total or partial tonsil removal. A total of 67 children were assigned to either tonsillectomy ($n=33$) or partial tonsillectomy, 'tonsillotomy' ($n=34$); 76 controls were assessed with NOT-S and divided into a younger and older age group to match pre- and post-operated children. Most children in the study groups had oral motor problems prior to surgery including snoring, open mouth position, drooling, masticatory, and swallowing problems. Post-surgery oral motor function was equal to controls. Improvement was independent of surgery method.

Key words: *Adenotonsillar hypertrophy, children, NOT-S, oral motor function, tonsil surgery*

Introduction

During the first 4 years of life, the respiratory tract is exposed to a multitude of infections. As a result of the developing immune defence in response to these infections, most children between the ages of 3 and 5 years have a relative hypertrophy of the lymphoid tissue in the pharynx, including both the tonsils and the adenoid gland. For many children, this enlargement causes obstructive symptoms of varying degrees (1–3), and different functional aspects are affected. The decreased oropharyngeal air-space causes sleep disturbances ranging from simple snoring to obstructive sleep apnoea. The resulting day-time sleepiness has an impact on behaviour and academic performance (4). The airway obstruction leads to oral breathing which, in turn, causes postural alterations of several orofacial structures such as an open mouth, lower-anterior position of the tongue, and a lower position of the hyoid bone.

In the long run, these postural alterations may also have effects on dental occlusion and facial skeletal growth (2,3,5,6). The postural modifications may in turn affect other orofacial functions such as chewing and swallowing, as well as several aspects of speech production including nasalance (a measure of the relative amounts of oral and nasal acoustic energy exhibited by a speaker), consonant articulation, and voice characteristics (7,8). Drooling is also a prevalent symptom in children with hypertrophic tonsils (9).

The children with adenotonsillar obstruction are usually treated with adenoidectomy and tonsil surgery, which is the operation most frequently performed in children (10). The main recognized indications for surgery thus far are 'obstruction', resulting in different degrees of sleep-disturbance (heavy snoring with or without apnoea) and 'recurrent infections', primarily tonsillitis. Problems with mastication, swallowing, and speech are less often reported (11).

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Two surgical methods are currently used. Tonsillectomy (TE), whereby a total extirpation of the tonsils are made, is the most common. Tonsillotomy (TT), in which only the obstructive tissue is removed, has recently been reintroduced (12,13). Several studies have shown that TT gives lower primary morbidity with less postoperative pain and provides positive long-term effects against snoring and infections (14–17). The question is whether TT also has an equally effective impact on other functional aspects that may be affected by tonsillar hypertrophy. The aim of the present investigation is to evaluate oral motor function using the new clinical instrument NOT-S (Nordic Orofacial Test-Screening) (18) in preschool children before and after planned surgery due to obstructive problems in comparison to healthy controls assessed with NOT-S. The oral motor function is evaluated and compared after adenoidectomy plus TE and adenoidectomy plus TT.

Material and methods

The study was approved by the Medical Ethics Committee of Linköping University on 2003-11-04 (No. 03-448).

A total of 118 children with adenotonsillar hypertrophy and obstructive problems, on the waiting lists for surgery from three clinics in the south-east region of Sweden, were randomized to either TE or TT. The decision about surgery was made together with the parents after a clinical examination, with findings consistent with a case history including heavy snoring and/or recurrent tonsillitis. No sleep studies were performed. The families were invited to participate in the research project after the parents received written information about the study and the surgery their child would undergo (19). Thirty-seven families declined participation (23 TE and 14 TT). Ten children were excluded in accordance with the exclusion criteria: treated tonsillitis within 3 months prior to the planned operation, spontaneous recovery from an earlier obstruction, concomitant disease, or non-Swedish speaker. Four children were excluded due to randomization error. The process of enrolment is shown in Table I.

A total of 67 children (33 TE and 34 TT) were included, 28 girls and 39 boys, aged 4;2 to 5;5 years

(mean age 4;8 years). None of the participating children were involved in any oral motor training prior to the study.

Seventy-nine controls were selected out of a cohort of preschool children, tested with NOT-S (20), 47 for comparisons before surgery, and 32 after. Possible snoring among the controls was not an exclusion criterion (Table II).

Thirty-three children received a tonsillectomy (TE) by cold knife and blunt dissection, and 34 received a tonsillotomy (TT) by high-frequency radiosurgery (Ellman 4.0 MHz Surgiton Dual Radiowave Unit, Ellman International, Oceanside, NY). The methods have been described in detail earlier by Hultcrantz and Ericsson (21). A total of 53 children, 27 in the TE group and 26 in the TT group, also had an adenoidectomy during the operation. The 14 children who did not have an adenoidectomy were evaluated at surgery to have small, not obstructive adenoids; 7 of them had earlier undergone an adenoidectomy. The children participated in an oral motor test, NOT-S (Nordic Orofacial Test-Screening) (18), and a test of phonology (22) within a month prior to surgery. Each child was assessed a second time 6 months postoperatively. The assessments took about 30 minutes. All speech material was audio-recorded using a Marantz PMD 660 Professional Recorder and an Audiotechnica mb microphone. Two of the authors (I.L. and A.M.) performed the tests of the two study groups. The controls were assessed as part of a master's thesis project within speech and language pathology. A random choice of 10% of the assessments of the operated children were videorecorded to check for interrater agreement.

The Nordic Orofacial Test-Screening, NOT-S, is a newly introduced screening instrument developed within the Nordic countries to identify individuals who need further oral motor evaluation/treatment. It has been translated into several languages including English (<http://www.mun-h-center.se/>) and has been shown to have high reliability (18). The foundation for the test development was a large survey of relevant literature and the authors' discussions on oral motor evaluation based on their collective experience and clinical knowledge. NOT-S identifies

Table I. Process of study enrolment.

Invited <i>after</i> randomization	Declining participation	Excluded due to study criteria	Excluded due to randomization error	Enrolled in the study
118 (62 TE, 56 TT)	37 (23 TE, 14 TT)	10 (4 TE, 6 TT)	4 (3 TE, 1 TT)	67 (33 TE; 34 TT)

TT = tonsillotomy; TE = tonsillectomy.

Table II. Number of boys and girls and mean age of participants and controls at the NOT-S assessments.

TE		TT		Controls	
Preop (<i>n</i> = 33)	Postop (<i>n</i> = 32)	Preop (<i>n</i> = 34)	Postop (<i>n</i> = 33)	'Preop' (<i>n</i> = 47)	'Postop' (<i>n</i> = 32)
♀11 ♂22	♀11 ♂21	♀17 ♂17	♀17 ♂16	♀21 ♂26	♀16 ♂17
4;10 years	5;6 years	4;9 years	5;5 years	4;9 years	5;6 years

TT = tonsillotomy, TE = tonsillectomy, NOT-S = Nordic Orofacial Test-Screening.

the prevalence of symptoms but not necessarily the degree of the problems.

NOT-S consists of two parts: a structured interview and a clinical examination, each consisting of six domains (Table III).

The NOT-S was expanded for this investigation in the domains 'Dryness of the mouth' and 'Speech'. These adjustments included replacement of the speech items with a more thorough speech and language assessment and three follow-up questions related to chewing and swallowing and dryness of the mouth, like excessive drinking: 'Is your child avoiding any food-texture?', 'Is he/she chewing longer than normal?', and 'Do you feel that your child is drinking a lot to be able to swallow?'. The results are presented as prevalence of symptoms in the TE and TT groups and in controls. The results of the speech and language assessment will be published later.

Statistical analyses

The data are expressed with descriptive statistics for demographics, postoperative morbidity, and the prevalence of affected items in NOT-S. Differences between the groups with respect to non-parametric data are analysed with the Mann-Whitney *U*-test. The interrater agreement is expressed in per cent. Changes in oral motor function before and after surgery within the study groups are analysed using the Wilcoxon signed rank test. *P*-values < 0.05 are considered statistically significant. The statistical analyses were performed using SPSS© Windows version 15.0.

Table III. The Nordic Orofacial Test-Screening (NOT-S). Domains included in the structured interview and the clinical examination.

Structured interview:	Clinical examination:
Sensory function	Face at rest
Breathing	Nose breathing
Habits	Facial expression
Chewing and swallowing	Masticatory muscles and jaw function
Drooling	Oral motor function
Dryness of the mouth	Speech

Results and analyses

At the pre-surgical assessment, all 67 'tonsil children' (mean age of 4;8 years) and 47 controls participated (mean age of 4;9 years). All operated children except two (one in each study group) attended a follow-up visit after approximately 6 months (mean age 5;5 years). Another group of 32 children, aged 5;6 years, served as controls (Table II).

All children received their surgery in accordance with the randomization, and none experienced complications.

In the *structured interview* part of NOT-S at the preoperative assessment, the TE group differed from the TT group only with respect to drooling, with fewer children drooling in the TE group ($P < 0.05$). Compared to the controls, both study groups differed in all domains of the structured interview: snoring and/or sleep apnoea (Breathing), gag reflex elicited when brushing their teeth (Sensory function), teeth-grinding (Habits), trouble eating solid foods and excessive time spent eating (Chewing and swallowing), having to drink in order to be able to swallow (Dryness of the mouth), and saliva on the lip or chin (Drooling) ($P \leq 0.001$) (Figure 1). The item 'Coughing during meals' and 'Biting/sucking on fingers or objects' also differed compared to controls ($P < 0.01$). The item 'Swallowing too large bites' was more common in both study groups as compared to the controls ($P < 0.05$). Teeth-grinding and drooling were more common among boys in both study groups ($P < 0.05$), otherwise no gender differences were observed.

In the *clinical examination* portion of NOT-S, there was no difference between the TE and TT groups before surgery and no gender differences. Both the study groups differed from the controls on two items: 'Deviant lip position' (Face at rest) and 'Cannot keep the mouth closed and take five deep breaths' (Nose breathing) ($P < 0.0001$), which means that they assumed an open mouth position. Problems with pouting and rounding the lips differed from the controls as well as use of the tip of the tongue (Oral motor function) ($P < 0.01$) (see Figure 2). No differences were seen regarding other items in the clinical examination.

Figure 1. NOT-S interview results before and after surgery for operated children and corresponding controls. Only items where differences to controls existed before surgery are presented. TT = tonsillotomy; TE = tonsillectomy; NOT-S = Nordic Orofacial Test-Screening.

The outcome of surgery as assessed by the structured interview and the clinical examination in NOT-S was the same for both study groups: Postoperative improvements for both groups were recorded in the domains 'Sensory function', 'Breathing', 'Chewing and swallowing', 'Drooling', and 'Dryness of the mouth' ($P < 0.0001$). In the *clinical examination*, postoperative improvements were seen regarding 'Deviant lip position' (Face at rest), 'Deviant tongue position' (Face at rest) ($P < 0.01$), and 'Cannot keep mouth closed and take five deep breaths' (Nose breathing) ($P \leq 0.001$).

At the postoperative assessment the study groups did not differ from the controls in any domain of the structured interview. In the clinical examination, an open mouth position remained in a few children

both in the TE (4/32) and TT (4/33) groups. Corresponding figures before surgery were 18/33 in the TE group and 22/34 in the TT group. There were no gender differences on any item in either of the study groups after surgery or in the controls.

The interrater agreement of the videorecorded assessments was 100% between the two speech and language pathologists - SLPs and 88% between the SPLs and trained master students.

Discussion

This investigation has shown that snoring 4–5-year-old children with adenotonsillar hypertrophy in almost all cases also have other oral motor problems in addition to breathing obstruction. The results

Figure 2. NOT-S examination results before and after surgery for operated children and corresponding controls. Only items where differences to controls existed before surgery are presented.

from NOT-S clarify that many aspects of oral motor function are affected, such as mastication, swallowing, and drooling, apart from the expected domain 'breathing' (snoring was the primary indication for surgery). These problems not only impact on the affected child; often the whole family is suffering.

The questions in the domain of 'chewing and swallowing' were of central importance to the parents. For many of them, meal-times had been a struggle with a child not wanting to eat and, in particular, not wanting to swallow solid food. The parents often volunteered information that the whole family had grown tired of waiting for the child to finish their meal. Shared meal-times offer great opportunities for interaction and communication. When a meal-time is interactive, the child learns social skills connected with family and communication (23). These skills had been more difficult to obtain in the families where the children were affected by adenotonsillar hypertrophy. At the post-surgical assessment, many parents spontaneously reported that meal-times had become a pleasure compared to pre-surgery. It is noteworthy that many parents had not realized the magnitude of this problem until it was solved. No difference between the two surgical options tonsillotomy and tonsillectomy was noted in the domain 'chewing and swallowing'.

Another oral motor problem that was relieved equally by the two surgeries was drooling. Only two of the children in the study groups (both in the TE group) were still drooling at the postoperative assessment. In a child's normal development, the control of drooling gradually increases during the first 2 years. By the age of 24 months, most children are able to engage in advanced fine motor tasks such as manipulation of small objects in play or speaking two-word sentences without drooling (23). When drooling persists in children aged 4 years and older, psycho-social and physical well-being is negatively affected (24).

The sex differences found in the preoperative assessment of the study group (teeth-grinding and drooling) are consistent with findings from tests with NOT-S in normal children of lower age, with maturation being somewhat slower in boys (20). The present results for children with obstructive sleep-disordered breathing indicate that adenotonsillar hypertrophy may interfere with normal development towards mature oral motor control. This is also corroborated by the higher prevalence of such habits as 'sucking on objects and biting finger-nails' in the study groups.

The NOT-S has been developed for use in individuals from 3 years and older (18). It has not previously been used in clinical research. The

experience from the present investigation is that NOT-S is easy and convenient to perform with young children. Preferably, the evaluations would have been double-blinded. However, in conjunction with tonsillar problems, a complete blinded assessment is not possible since the NOT-S requires visualization of the oral cavity including the tonsil area. Regarding further analysis of the data obtained, a blinded assessment of speech production will be possible through a listening evaluation.

The different oral motor symptoms were equally improved after TE and TT. The deviant lip position with an open mouth indicating an oral breathing habit was almost the rule before surgery in the study groups. Why the respiration in some cases (8/65) did not change after surgery, when the 'obstacle' (adenoid and tonsil tissue) was removed, is at present not completely clear but the effects of an established habit is evident. Löfstrand-Tideström and Hultcrantz (2) demonstrated in a cohort study that the prevalence of children who breathe orally increases between 4 and 6 years and that oral breathing is strongly related to snoring. Residual oral breathing may thus be regarded as a risk for later recurrence of snoring and for further deviant dento-facial development (25). Children who fail to adopt a nasal breathing pattern could benefit from postoperative behavioural intervention with training of nose breathing. This could be conducted on a daily basis by the parents at home. A training programme and a training aid (an oral screen) can be supplied by speech and language pathologists. It is important to stress to the parents the necessity of establishing nasal respiration in order to avoid a negative orthodontic and facial development (26,27).

Out of the 118 invited families 37 declined enrolment in the study, which is to be expected when the randomization is performed prior to the invitation to the study (28). Since the number of children who did not get enrolled was about the same for TE and TT, no extra analysis of them as a group was regarded as necessary. However, the proportion of children with oral motor disturbances might have been slightly higher among the participants than among the children who were not enrolled, reflecting a greater interest in the study for families experiencing the problems to be investigated (28).

Conclusions

Preschool children, scheduled for tonsil surgery due to snoring, have oral motor dysfunction to a higher degree than controls as measured by NOT-S. Both tonsil removal (tonsillectomy) and tonsil reduction

(tonsillotomy) result in an oral motor function improvement with almost complete normalization at a 6-month follow-up.

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