Correlation between functional disorders of the masticatory system and speech sound disorders in children aged 7–10 years

Zależność pomiędzy zaburzeniami czynnościowymi narządu żucia a nieprawidłowościami wymowy u dzieci w wieku od 7 do 10 lat

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Abstract

Background. Masticatory system and speech sound disorders concur, have the same causes and similar consequences – both increase the risk of dental and periodontal diseases.

Objectives. The study was conducted to establish the correlation between functional disorders of the masticatory system and speech sound disorders.

Material and methods. Three hundred patients aged 7–10 years were examined to detect functional disorders of the masticatory system and speech sound disorders. Functional disorders were assessed in patients with and without speech sound disorders.

Results. According to the study results, functional disorders of the masticatory system concur more often with speech sound disorders than with correct articulation and lead to speech sound disorders. There is a strong correlation between:

- any dysfunction and errors in the /p/, /b/, /m/, /s/, /z/, /ʃ/, /dʒ/, /ɸ/, /ʒ/, /tʃ/, and /dʒ/ sounds,
- mouth breathing and errors in the /p/, /b/, /m/, /s/, /z/, /ʃ/, /dʒ/, /ɸ/, /ʒ/, /tʃ/, and /dʒ/ sounds,
- persistent tongue thrust and errors in the /s/, /z/, /ʃ/, /dʒ/, /ɸ/, /ʒ/, /tʃ/, /dʒ/, /ɸ/, /ʒ/, /tʃ/, and /dʒ/ sounds,
- and
- parafunctional sucking and errors in the /s/, /z/, /ʃ/, /dʒ/, /ɸ/, /ʒ/, /tʃ/, /dʒ/, /ɸ/, /ʒ/, /tʃ/, and /dʒ/ sounds.

Conclusions. To implement effective and early prevention and treatment, it is crucial to know the correlation between the masticatory system and speech sound disorders, as it reduces treatment duration and minimizes relapses of not only communication disorders, but also of concurrent masticatory system disorders.

Key words: prevention, malocclusion, speech sound disorders, dental care in children

Słowa kluczowe: profilaktyka, wada zgryzu, wady wymowy, opieka stomatologiczna dzieci

Early orthodontic intervention and logopedic follow-up include all preventive, diagnostic, therapeutic, tutorial, and promoting steps aimed at preventing, limiting or eliminating speech sound and communication disorders, and attenuating their consequences. Orthodontic and logopedic prevention also includes the assessment of biological characteristics, defined as morphology and functioning appropriate for a given age.

Masticatory system and speech sound disorders occur, have common causes and similar consequences for the teeth, increasing the risk of dental and periodontal diseases. Both are featured together in many dental, orthodontic, laryngological, phoniatric, and logopedic studies. These studies cover various functional disorders, such as improper swallowing or oral breathing, and speech sound disorders.¹ However, there have been no studies simultaneously featuring the many parafunctional habits and dysfunctions of the masticatory system, in the broad meaning of the terms, and correlating them to respective speech sound disorders.^{2,3} With such studies, dentists would be able to take part in the debate on the risk factors of speech sound disorders and on the impact of the latter on the oral cavity.

The aim of the present study was to define the correlations between functional disorders of the masticatory system and respective speech sound disorders in children aged 7–10 years.

Material and methods

Children aged 7–10 years attending primary schools in Warszawa, Poland, were qualified for the study. The inclusion criteria were as follows: children born between 2001 and 2004, with a written consent of their legal guardian to participate in the study. The exclusion criteria, aimed to increase the statistical significance of the results, included: cleft lip or palate, congenital anomalies with dysmorphic features within the facial bones of the skull, neurological disorders, mental diseases, intellectual disability, psychomotor retardation, delayed speech development, and hearing loss. Parents or legal guardians were informed verbally and in writing about the objective and scope of the study, techniques employed and data use, and were asked to sign a consent form regarding their child's participation. Children's caregivers were also given a medical interview questionnaire on dysfunctions and parafunctional habits. Dental and logopedic examination was performed between 2010 and 2012 by 1 dentist who was also a speech therapist. Examination was conducted at the school premises.

Dental and logopedic examination assessed the dysfunctions of the masticatory system, occlusal and non-occlusal parafunctional habits, dental and medical treat-

ments underway, and potential logopedic treatment. Masticatory system examination encompassed:

- functional status of the masticatory system,
- dysfunctions such as oral breathing, persistent tongue thrust and lazy chewing,
- occlusal parafunctional habits (teeth grinding and clenching), and
- non-occlusal parafunctional habits (prolonged pacifier use, prolonged bottle feeding, sucking habits, nail biting, and lip or mucosa biting).

Logopedic examination assessed the articulation of Polish phonemes in 3 positions: initial, medial and final. All Polish phonemes were expressed according to the International Phonetic Alphabet.

Three hundred children participated in the study. Two groups were created after the logopedic examination:

1. treatment group – with speech sound disorders (161 patients, mean age ± 8.26 years), and
2. control group – without speech sound disorders (139 patients, mean age ± 8.89 years).

Statistical analysis was performed using SPSS v. 14.0 PL for Windows (IBM Corp., Armonk, USA). Pearson's χ^2 test compared the sample distribution of variables to their theoretical distribution. Cramér's V measured the correlation between 2 assessed nominal variables. Statistical significances were expressed quantitatively and set at $p \leq 0.05$.

Results

The prevalence of functional disorders was different in the treatment group (with speech sound disorders) and the control group (without speech sound disorders). Among the 10 functional disorders (6 parafunctional habits and 4 dysfunctions) assessed, the results referring to nail biting, prolonged bottle feeding, teeth clenching, and lazy chewing were found statistically insignificant. The remaining disorders occurred more often in the treatment group, and those results met the criteria for statistical significance.

The correlation between speech sound disorders and any parafunctional habits was weak, but statistically significant. It was slightly higher for occlusal than non-occlusal parafunctional habits.

The coexistence of occlusal parafunctional habits and speech sound disorders was also statistically significant. Occlusal parafunctional habits were exhibited 2 times more often in the treatment group than in the control group and their correlation with speech sound disorders was moderately strong.

A strong correlation exists between the prevalence of speech sound disorders and non-occlusal parafunctions: prolonged pacifier use, sucking habits and lip or mucosa biting. However, such a correlation was not observed for speech sound disorders and nail biting – their χ^2 test results indicated a considerable risk of being random.

The correlation between speech sound disorders and any type of dysfunction was much stronger than with any parafunctional habit (Cramér's V at 0.405 vs 0.188).

Oral breathing and persistent tongue thrust were common dysfunctions in the treatment group; persistent tongue thrust (Cramér's V at 0.387) and mouth breathing (Cramér's V at 0.378) had the strongest correlations with speech sound disorders.

Table 1 presents the prevalence of functional disorders and their correlation with speech sound disorders measured with Cramér's V.

The correlations between functional disorders and speech sound disorders, measured with Cramér's V, for persistent tongue thrust, oral breathing and sucking habits were strong. Lip or mucosa biting, prolonged pacifier use and tooth grinding ranked next according to the strength of their correlation with speech sound disorders.

The present study revealed 72 correlations between anatomical abnormalities and errors in the articulation of respective sound groups, of which 52 were statistically significant ($p \leq 0.05$) (Table 2).

There were strong correlations (Cramér's V 0.3–0.5) between the prevalence of:

1. Oral breathing and errors in /p/, /b/ and /m/ sounds;
2. Any dysfunction and errors in /p/, /b/ and /m/ sounds;
3. Persistent tongue thrust and errors in /s/, /z/, /tʃ/, and /dʒ/ sounds;
4. Oral breathing and errors in /s/, /z/, /tʃ/, and /dʒ/ sounds;
5. Any dysfunction and errors in /s/, /z/, /tʃ/, and /dʒ/ sounds;
6. Sucking habits and errors in /s/, /z/, /tʃ/, and /dʒ/ sounds;
7. Persistent tongue thrust and errors in /ʃ/, /ʒ/, /tʃ/, and /dʒ/ sounds;
8. Sucking habits and errors in /ʃ/, /ʒ/, /tʃ/, and /dʒ/ sounds;

9. Persistent tongue thrust and errors in /ʃ/, /ʒ/, /tʃ/, and /dʒ/ sounds;

10. Oral breathing and errors in /ʃ/, /ʒ/, /tʃ/, and /dʒ/ sounds;

11. Any dysfunction and errors in /ʃ/, /ʒ/, /tʃ/, and /dʒ/ sounds; and

12. Sucking habits and errors in /ʃ/, /ʒ/, /tʃ/, and /dʒ/ sounds.

Discussion

There have been no comprehensive studies on parafunctional habits and dysfunctions of the masticatory system, and their correlation with speech sound disorders. Existing studies were focused on specific disorders of the masticatory system and their coexistence with speech sound disorders. They were also not aimed at assessing the strength of this relation in a quantitative manner. However, their results may be compared to partial findings of the present study.

In this study, occlusal parafunctional habits prevailed 2 times more often in the treatment group than in the control group and their correlation with speech sound disorders was moderately strong. The chi-squared test results confirmed that the correlation between occlusal parafunctional habits and errors in /t/, /d/ and /n/ sounds were statistically significant. Pizzolato et al. concluded that occlusal alterations concurred with errors of alveolar /s/, /z/, /t/, /d/, and /n/ and postalveolar /l/.³

Speech and sound disorders were observed more often in cases of prolonged pacifier use. Precisely 47% of children with speech sound disorders and 30% of those without speech sound disorders were found to have used the pacifier over longer periods of time. In a study on improp-

Table 1. Prevalence of functional disorders of the masticatory system and their correlation with speech sound disorders

Type of functional disorder (% in treatment and control group)	Prevalence – % of children in:		Correlation between the prevalence of parafunctional habits, dysfunctions and speech sound disorders (Cramér's V)
	group with articulation disorders (treatment group) n = 161	group without speech sound disorders (control group) n = 139	
Parafunctional habits in general	87.6	72.7	0.188
Occlusal parafunctional habits, including	46.0	23.7	0.231
teeth clenching*	15.5	7.2	0.129
teeth grinding	30.4	16.5	0.162
Non-occlusal parafunctional habits, including*	78.9	66.2	0.143
prolonged pacifier use	47.2	29.5	0.181
sucking habits	34.2	7.2	0.326
nail biting*	36.6	35.3	0.014
lip or mucosa biting	16.1	2.2	0.236
Dysfunctions in general	59.0	15.1	0.405
oral breathing	45.3	10.8	0.378
persistent tongue thrust	29.2	0.7	0.387
prolonged bottle feeding*	18.6	13.7	0.105
lazy chewing*	6.2	12.2	0.120

* result statistically insignificant ($p \leq 0.05$).

Table 2. Prevalence of incorrect pronunciation of groups of speech sounds and its correlation with given functional disorders of the masticatory system

Groups of speech sounds	Alveolar		Postalveolar		Pre-palatal		Bilabial	Labiodental
Type of functional disorder (number of patients in both treatment and control groups, Cramér's V)	/s/, /z/, /ʃ/, /ʒ/	/t/, /d/, /n/	/ʃ/, /z/, /ʃ/, /ʒ/	/r/, /l/	/ɲ/, /j/	/ɛ/, /ɛ/, /ʃ/, /ʒ/	/p/, /b/, /m/	/v/, /f/
Any parafunctional habit (parafunctional habits in general) n = 242	38.8% (0.165)	25.2% (0.176)	31.4% (0.187)	*	*	38.8% (0.179)	*	*
Teeth grinding n = 72	48.6% (0.160)	36.1% (0.197)	*	38.9% (0.165) (only /r/)	*	51.4% (0.197)	*	*
Prolonged pacifier use n = 117	51.3% (0.273)	33.3% (0.226)	37.6% (0.184)	*	*	48.7% (0.236)	*	2.7% (0.220)
Sucking habits n = 6	73.8% (0.428)	55.4% (0.430)	56.9% (0.349)	46.2% (0.242) (only /r/)	20% (0.167) (only /ɲ/)	67.5% (0.382)	18.5% (0.276)	10.8% (0.240)
Lip or mucosa biting n = 29	75.9% (0.280)	58.6% (0.293)	62.1% (0.255)	*	27.6% (0.185) (only /ɲ/)	69.0% (0.236)	*	*
Any type of dysfunction (dysfunctions in general) n = 116	60.3% (0.442)	42.2% (0.397)	44% (0.296)	36.2% (0.185) (only /r/)	17.2% (0.180)	58.6% (0.400)	15.5% (0.318)	6.9% (0.181)
Persistent tongue thrust n = 48	83.3% (0.442)	54.2% (0.344)	58.3% (0.304)	25% (0.239)	22.9% (0.180) (only /ɲ/)	77.1% (0.389)	18.8% (0.234)	*
Oral breathing n = 88	61.4% (0.356)	45.5% (0.372)	46.6% (0.278)	*	18.2% (0.176)	58.0% (0.315)	20.5% (0.392)	8% (0.187)

* result statistically insignificant ($p \leq 0.05$).

er function of the tongue, also in the context of speech, Straub established a statistically significant correlation between pacifier use and speech sound disorders.⁴ However, a study by Shotts et al. did not suggest that there were significant differences in articulation related to prolonged pacifier use.⁵

Sucking habits (finger, thumb or lip) and speech sound disorders were strongly correlated. Van Norman and Tarvade et al. observed that children who persist in non-nutritive sucking of the thumb or finger beyond early childhood are more likely to develop speech difficulties.^{6,7} It has been also confirmed that sucking habits are correlated with malocclusions, and malocclusions co-occur with speech sound disorders.^{8–11} There were no studies on the correlation between sucking habits and specific speech sound disorders.

Nail biting was a statistically insignificant parafunctional habit. Only 1 more child bit its nails in the treatment group than in the control group. However, Straub came to completely different conclusions – he established that nail biting led to an improper function of the tongue, including speech sound disorders.⁴

The correlation between speech sound disorders and persistent tongue thrust was strong. Zadurska et al. established the same – 61% of children with persistent tongue thrust had speech sound disorders. In the present study, this percentage was much higher – 98%. Therefore, per-

sistent tongue thrust seems to lead to speech sound disorders. Straub, Tarvade et al., Rehak et al., Hopkin and Mackiewicz confirmed this theory.^{7,12–14}

Subtelny and Subtelny often observed, when assessing the impact of tongue thrust on speech sound disorders, adapted patients with malocclusions and normal speech; however, all patients with an improper function of the tongue had speech sound disorders.¹⁵ In later studies, Subtelny first established that 72% of patients with normal swallowing and 40% of patients with tongue thrust did not have speech sound disorders, and then subsequently that 63% of patients with normal swallowing and 1% of patients with tongue thrust did not have speech sound disorders.¹⁶

Fieux (citing Szlachetko) published the results of cinematoradiographic studies on swallowing and speech.¹⁷ Children with persistent tongue thrust touched their lower lip with the tip of their tongue when articulating most speech sounds, although it was not always audible, i.e., either the produced sound or the position of speech organs was improper. Rix and Cleall, who took cineradiographic images of the swallowing process, focused not only on improper tongue posture, but also on other structures, and came to similar conclusions.^{18,19} Cleall established that persistent tongue thrust impacted the anatomy and motility of the stomatognathic system.¹⁹ Horn et al., who studied improper swallowing with electromagnetic articulography, came to similar conclusions.²⁰

In the present study, persistent tongue thrust occurred with errors in bilabial (/p/, /b/, /m/), alveolar (/t/, /d/, /n/, /s/, /z/, /ʃs/, /dʒ/), postalveolar (/ʃ/, /ʒ/, /tʃ/, /dʒ/, /r/, /l/), and pre-palatal (/ɛ/, /z/, /tɛ/, /dʒ/, /j/) sounds. Straub, Subtelny as well as Clausnitzer and Clausnitzer described concurrent improper swallowing and errors in the /s/ sound.^{4,16,21}

Oral breathing occurred 5 times more frequently in children with speech sound disorders than in children without speech sound disorders. This correlation was strong and statistically significant. Hitos et al. concluded that mouth breathing can affect speech development.²² Zadurska et al. also established a correlation between mouth breathing and speech sound disorders.¹¹ However, the percentage of mouth breathing children with speech sound disorders was lower (59%) in the quoted studies than in the present study (82%).

The correlation between speech sound disorders and prolonged bottle feeding was statistically insignificant. Significance was much higher than 0.05 (0.246). This outcome is contrary to Straub's results, who established that artificial feeding (bottle with the wrong nipple) or prolonged bottle feeding in early childhood led to improper swallowing, improper tongue posture and speech sound disorders.⁴ Subtelny obtained results similar to Straub's.¹⁶ Also, Barbosa et al. suggested that extended use of bottle feeding and other sucking behaviors may have detrimental effects on speech.²³

Conclusions

Functional disorders of the masticatory system, apart from teeth clenching, nail biting, prolonged bottle feeding, and lazy chewing, concur more often with speech sound disorders than with proper articulation, and are a material cause of speech sound disorders.

There is a strong correlation between: any type of dysfunction and errors in /p/, /b/, /m/, /s/, /z/, /ʃs/, /dʒ/, /ɛ/, /z/, /tɛ/, and /dʒ/ sounds; oral breathing and errors in /p/, /b/, /m/, /s/, /z/, /ʃs/, /dʒ/, /ɛ/, /z/, /tɛ/, and /dʒ/ sounds; persistent tongue thrust and errors in /s/, /z/, /ʃs/, /dʒ/, /ʃ/, /ʒ/, /tʃ/, /dʒ/, /ɛ/, /z/, /tɛ/, and /dʒ/ sounds; and sucking habits and errors in /s/, /z/, /ʃs/, /dʒ/, /ʃ/, /ʒ/, /tʃ/, and /dʒ/ sounds.

Knowledge on functional correlations between the masticatory system and speech sound disorders makes it possible to introduce effective prevention and treatment at the right moment. Dentists and speech therapists could work together, understanding the correlation between the structure and the function of the stomatognathic system, and focusing on the causes of speech sound disorders and concurrent dental disorders. It could shorten treatment duration and minimize the risk of relapse after the treatment's conclusion.

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