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Incorrect patterns of swallowing and tongue resting position and the articulatory structure of phonemes realisations in adults

SUMMARY

The incorrect patterns of swallowing as well as improper resting postures of the tongue in adults seem to be insufficiently described in the literature. In theory, the problem is defined mainly as tongue-thrusting (interdental swallowing), in practice, however, several other abnormal patterns of the tongue's primary motility can be also observed. The author presents not only the descriptions of incorrect patterns of swallowing and tongue at rest postures, obtained on the basis of logopaedic study conducted among 254 adults, but also the analysis of the relationship between these primary disorders and the prevalence of non-normative realisations of phonemes. The results of the profiled study which come from a profiled research group (42 patients with an incorrect swallowing pattern and tongue at rest posture but having no coexisting anatomical disorders) reveal a resemblance between the tongue's primary motor patterns and the articulation – both in the norm as well as in a pathology. Some undesirable non-normative phonetic features of dentals and palatals such as interdentality, addentality and dorsality appear to be strictly connected with the type of an incorrect primary motoric pattern.

Key words: swallowing, tongue thrust, tongue rest position, compensatory strategies, interdentality, addentality, dorsality

INTRODUCTION

There has been a lot of articles concerning the role of primary functions disorders which may be harmful to the articulation development in children. The studies and analysis highlight mainly the abnormal swallowing process (Stecko and Hortis-Dzierzbicka 2000, Mackiewicz 1992, 2002) and to a lesser degree the wrong pattern of tongue in rest posture while breathing (Pluta-Wojciechowska 2011, Knösel et al. 2012, Malicka 2014). However, on the basis of a literature

review it might seem that the act of swallowing is hardly ever evaluated in adults speech therapy, unless the neurological disorders appear. It is, presumably, believed that swallowing disorders are a symptom of some immaturity of peripheral and/or central structures and they pass as a result of orthodontic treatment or simply when the subjects reach their adolescence. Speech therapy practice pictures that the incorrect swallowing pattern and/or tongue at rest position in adults is not a rare problem, but it is rather rarely diagnosed. These abnormalities seem to be of great importance not only in children articulation, but also in adult one (along with other factors determining the quality of phonemes realisation, such as a shortened frenulum, malocclusion or perception disorders, etc.). Different possible swallowing patterns appear not to be commonly known; there is only one model of impaired swallowing (tongue thrust) mentioned in most of the publications. The relationship between the various types of swallowing and tongue at rest postures and the occurrence of certain undesirable phonetic features has not been studied and described in detail yet.

The first part of this publication provides an overview of the Polish and foreign literature, including on the one hand the descriptions of the incorrect variants of swallowing and tongue at rest posture during breathing observed among subjects (children and adults), and on the other, the analysis of the relationship between these functional abnormalities and the motor aspects of articulation. In the second part, the author indicates, according to her own research what types of incorrect functional patterns have been observed in adults, which anatomical abnormalities coexist with functional ones; what is the overall incidence of non-standard realisations of phonemes and undesirable phonetic features – based on the comparison between a group with the incorrect swallowing pattern and a control group. In the third part, the results of a profiled research will be presented. A smaller, contoured isolated group of visceral swallowers (without any anatomical abnormalities) has been chosen in order to analyse more accurately the impact of swallowing and tongue rest position on the articulation of dentals, alveolars and palatals.

In this article the author deliberately has omitted a detailed description of the long-standing and still open discussion concerning the influence of disordered swallowing on the malocclusion formation, and vice versa. Structural conditions of reverse swallowers will be indicated and briefly elaborated in the course of discussing the results of research. Beyond the scope of this article are reflections on the development and transformation of the swallowing process in children. The literature on this topic is extensive and easily available to the Polish reader[1].

[1] Cf. a comprehensive review of the discussion on the stomatognathic structure and function relationship which can be found in the works of B. Mackiewicz (Mackiewicz 2002), L. Konopska (Konopska 2007), M. Łuszczuk (Łuszczuk 2013). A broad view of the masticatory system development model presents D. Pluta-Wojciechowska (Pluta-Wojciechowska 2011, 2013).

PATTERNS OF SWALLOWING AND TONGUE AT REST POSTURE – REVIEW

Both in Polish and in foreign literature the description of incorrect swallowing patterns typically involve tongue thrusting, which is reported in most papers in relation with an anterior open bite. This type of swallowing is being defined by the adjectives "infantile"[2], "visceral", "reverse" or "immature" as opposed to the mature swallowing type, also known as the somatic one. Some researchers also distinguish an inconstant type of swallowing, observed in children during the transition period (Proffit et al. 2009, Peng et al. 2003). The most important aspects of a differential diagnosis in the evaluation of the swallowing pattern list the location of the tip of the tongue (whether it is inside dental arches or between them), the position and tension of the perioral muscles and the presence or the lack of masseter muscle activity (Subtelny 1970, Pisulska-Otremba 1997, Tomasz et al. 2010). The incorrect tongue at rest posture is much less described in the literature and the swallowing and tongue rest position are seldom assessed together. Meanwhile, the impact of the tongue rest position on adjacent structures lasts longer (Konopska 2007, Artese et al. 2011, Pluta-Wojciechowska 2008, 2013), and the adopted posture is reflexive and involuntary, thus more difficult to automate due to the myofunctional therapy (Artese et al. 2011). Research has shown that resting position of the tongue may determine the success or failure of orthodontic treatment, meanwhile, it is a underrated and too rarely taken into account factor (Engelke et al. 2011, Artese et al. 2011, Knösel et al. 2012).

A brief overview of publications is presented below. The author has chosen such publications which show a broader aspect of the process of swallowing or include the tongue resting position assessment, and thereby can shed some new light on the problem of logopaedic diagnosis and therapy of these disorders.

The known term "tongue thrust" has been extended by Brauer and Holt, who have been classifying the different types of swallowing according to the type of associated malocclusion. The authors distinguish between thrusting not causing deformation, with the deforming anterior or anterolateral thrusts; pointing out that some other individual types of incorrect swallowing patterns may exist. Researchers enumerate muscular habits caused by improper feeding or the parafunctions, enlarged tonsils, ankyloglossia or macroglossia as the causes of impaired tongue activity in swallowing (Brauer and Holt 1965). B. Mackiewicz describes the existence of two patterns of incorrect swallowing: thrusting on the lower incisors (the tongue during swallowing is inside the oral cavity proper, while there is

[2] As emphasized by Proffit, Fields and Sarver, the term „retained, infantile type of swallowing" is irrelevant, since it occurs only in children suffering from a brain damage, which hinders the development of the proper tongue activity (Proffit and Fields, 2001).

a poor activity of masseter muscles and a slight orbicular muscle tension) and interdental arrangement of the tongue (with the lingual-labial contact, a complete lack of masseter muscle activity: Mackiewicz, 2002). The author has noted that these patterns should be differentiated because they cause different effects – not only by the diverse pressure exerted by the tongue on the teeth but also by different tongue motility during articulation. A quite different forms of incorrect swallowing has been recorded by D. Pluta-Wojciechowska; namely, she has described/ describes? the following patterns: tongue thrusting between teeth, tongue thrusting on the upper incisors, swallowing with the apex based on the lower incisors. Based on research carried out in a group of 40 children and adults, patients seeking speech therapy, the author states that the abnormal swallowing pattern of the examined has amounted to 65%, while the incorrect tongue in rest position to 67.5%. According to the author the incorrect tongue rest position during breathing has an enormous impact "on the activity of the tongue during the articulation, as it does not consolidate the 24-hour-tongue arrangement in the vertical-horizontal position" (Pluta-Wojciechowska 2013: 128).

The contemporary research, based on imaging studies using ultrasound (Peng et al. 2003; 2004) has revealed that the tongue tip movements may be inconsistent in visceral adolescent swallowers (the authors have observed the following patterns: forward apex movement without vertical movements, upward and forward movement, downward and upward apex movement in the frontal plane), while somatic swallowers presented a standardized motor pattern. More importantly, the authors have shown that the feature which differentiates the mature swallowing pattern from the mentioned atypical patterns is the genioglossus muscle activity which must be taken into account. In every case of abnormal swallowing a contraction of this muscle appeared regardless of the type of the impaired movement. The authors speculate that in subjects with a mature swallowing pattern the tongue is lifted with a higher activity of the other muscles (Peng et al. 2003).

The work of A. Artese and colleagues has shown a few different postures of the tongue at rest, observed among the examined patients. The researchers emphasize the impact of constant pressure exerted by the tongue on the hard tissues – highlighting that even very slight forces exerted for a long time may affect the occlusion stability. They also indicate that various causes will generate diverse results, therefore, some irregular variations of the tongue at rest posture can be noticed. The first of these is the "high" posture when the apex rests on the palatal surface of the upper incisors, beneath the incisive papilla (Fig. 1b). The second is called the "horizontal" – the position where the apex is positioned lower, touching both the palatal surface of the upper incisors and the incisal edges of the lower incisors (Fig. 1c). The third of the reported postures is determined as "low", with the apex positioned on the lingual surfaces of the lower incisors (it changes the traverse dimension of the upper arch and exerts forces on the mandibular incisors

– Fig. 1d). The fourth, defined as "very low" occurs when the apex lies below the base of the lower incisors, in the area of the mandibular alveolar ridge (Fig. 1e). The authors comment on the impact of the various types of the tongue at rest postures on the malocclusion, concluding simultaneously that the abnormal tongue posture may be one of the main causes of the anterior open bite development (Artese et al. 2011).

Several more other reports from the experimental and imaging studies can be found in the literature. These papers point out the other features of the process of swallowing: German researchers have conducted observations of a duration of the high resting position in the final phase of the swallowing in mouth-breathing subjects as well as in the control group (Knösel et al. 2012). The other studies have depicted the analysis of forces exerted by the tongue on the hard palate when swallowing and attaining the tongue in rest position (Engelke et al. 2009) In these studies, the importance of the underpressure produced in the oral cavity in the normal swallow is underlined. Consequently, keeping the tongue in the high rest position requires no effort and the balance is maintained between the forces affecting the dental arches and palate.

Patterns of swallowing and the tongue rest position – differences in terminology and methodology of examination

Some inconsistencies exist in the studies on the course of the oral phase of swallowing mainly in descriptions of the proper resting position of the tongue. They may contribute to the erroneous interpretation of the test results, and consequently, lead to the insufficient diagnosis of these primary functions. The following statements can induce doubts:

• "the ultrasound examination was started by asking the subject to place the tongue in the rest position on the floor of the mouth with the tip of the tongue contacting the lingual tooth surfaces (…) [after swallowing] the tip of the tongue moves back to the floor of the mouth, the dorsum either remains in contact with the palate or returns to its normal position with simultaneous increasing muscle relaxation*"* (Arkadani, 2006: 3). Presumably, the misunderstanding is caused by the insufficient description of the tongue movements in the saliva swallowing. The tongue may be decreased to collect the saliva from the area of salivary glands but it is not the resting position of the tongue: it is only a part of its activity during deglutition. In some studies, an active position in preparation for the adoption of food or liquid at decreased mandible is also described as a resting position (Subtelny 1970);

• in numerous analyses and methodological guidelines for diagnosticians and therapists, swallowing models are just limited to two patterns: the mature swallowing and infantile swallowing (tongue-thrust), with a simultaneous lack

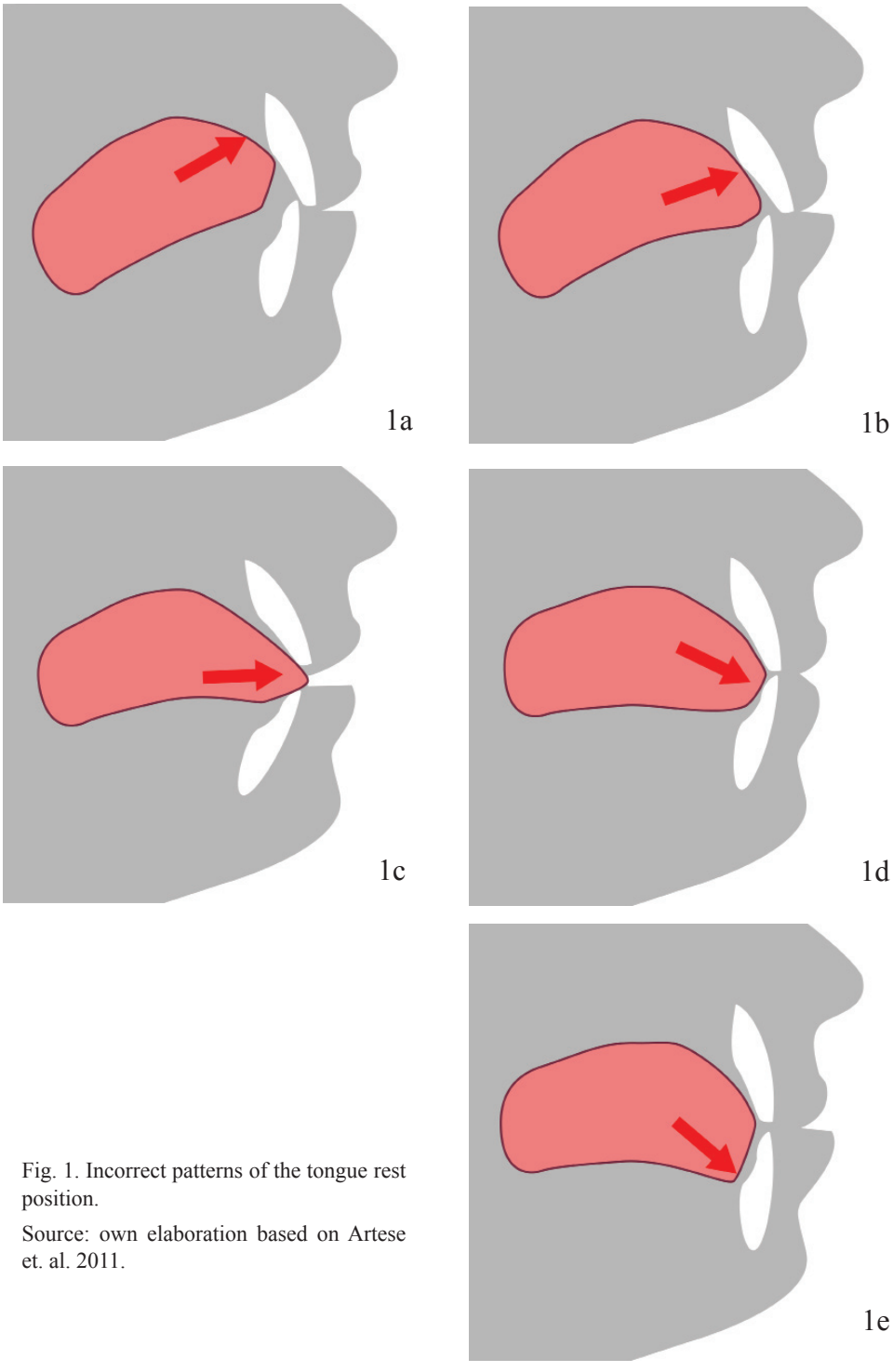

Fig. 1. Incorrect patterns of the tongue rest position.

Source: own elaboration based on Artese et. al. 2011.

of reference to the rest position of the tongue. The literature is full of statements suggesting that the diagnosis of abnormal swallowing is easy and quick – this approach is challenged by other researchers (Wędrychowska-Szulc 2001, Peng et al. 2003, Knösel et al. 2012);

• the conviction that the swallowing dysfunctions (in healthy subjects) originate from the central nervous system, without the exclusion of the other potential harmful factors, such as the coexistence of ankyloglossia: "the lack of tongue lifting in children at school age suggests disorders in the cerebral centre of tongue's movement coordination" (Skorek 2001: 61), "functional paralysis, involving the retained of infant motor stereotype, suggests that the reason lies in the functional central tongue muscles coordination disorder (...) the central origin of dysfunction is proven by the fact of hereditary prognathism and/or progenia, as exemplified by (...) the Habsburg royal family" (Mackiewicz 2002: 91) In view of the verified relationship between class III malocclusion and ankyloglossia (cf. Jang et al. 2011: 361) and the reports on genetic conditionings of ankyloglossia (see Srinivasan and Chitharajan 2013: 14), it may be assumed that ankyloglossia and malocclusion may have been inherited in mentioned lineages. A shortened frenulum may also affect the formation of malocclusion, as well as the swallowing disorders (Horton 1969, Jang et al. 2011).

On account of these discrepancies it is worth to mention the characteristics of a physiological tongue resting position:

1. The apex is arranged at incisal papilla (*papilla inciva*) behind the necks of the medial upper incisors; the tip of the tongue remains wide and does not present any symptoms of an increased muscle tension (Karłowska 2001, Pluta-Wojciechowska 2009, 2013; Artese et al. 2011)

2. Praedorsum is in contact with praepalatum, the tongue is slightly sucked (by the underpressure maintained between the anterior part of the tongue and the anterior part of the palate) but not tensed.

3. The coronal part of the tongue is arranged around the base of the premolars and molars (within the maxillary arch).

4. The convex dorsum may but need not to be in contact with the hard palate – the position of the dorsum and especially the postdorsum is lower in the rest position than during swallowing due to a lower position of the mandible (Fishman 1969, Verma et al. 2012).

The position described above keeps "the anterior teeth in balance while preserving the transverse dimension of the upper arch" (Artese et al. 2011: 143). For a full description some features should be added: the correct position of the tongue must be accompanied by a competent closure of the lips, without excessive activity of the mentalis muscle (Wędrychowska-Szulc 2001: 62) and the rest interocclusal space between the molars (Majewski 2009). A negative pressure remains between the tongue and the palate (Engelke et al. 2009, Nęcka 2011). These

features are also of fundamental importance for the articulation (Sambor 2015, in print).

Obviously, some other tongue postures can be described, eg. in decreasing the mandible, the position of the anterior part of tongue is approximately the same as in the vowel [a] (if the item is in preparation for the adoption of food, then postdorsum remains in contact with the soft palate, because the breathing still remains), the neutral position described by Chomsky and Halle is a preparation to an utterance with taking the first dynamic inspiration (Chomsky and Halle 1968) and the language-specific position of the organs of speech, taken during the pauses in an utterance ("Inter-speech Posture", see Wilson and Gick 2006; Pluta-Wojciechowska and Sambor in 2015). Nonetheless, these phenomena and their importance for the development and maintenance of normal articulation should not be confused. In this paper, the term "resting position of the tongue" refers only to the tongue posture during physiological breathing, which means that it adopts the vertical-horizontal position along the hard palate (Pluta-Wojciechowska 2009, 2013).

The co-occurrence of abnormal swallowing patterns, the tongue rest position and articulation disorders

The relationship between the movements in feeding and speech, which was being described in Poland mainly by Bogdan Mackiewicz (Mackiewicz 2001), has been confirmed in the objective imaging studies. According to the results obtained in the studies conducted by Karen Hiiemae and Jeffrey Palmer (Hiiemae and Palmer 2003), and later supported and expanded in the research of Antoine Serrurier's team (Serrurier et al. 2012), it was proved that the articulatory movements constitute a component of a feeding movements store. D. Pluta-Wojciechowska, commenting on the results of the above studies, determines biological functions as "biomechanical basis of articulation" – because the overall biomechanical prototypes of primary functions are reflected in the articulation movements. The author also shows the similarities and differences between the movements in feeding and articulation (Pluta-Wojciechowska 2011, 2013).

The typology of speech disorders published in 1997 by H. Mierzejewska and D. Emiluta-Rozya was the first in which functional disorders were taken into consideration as one of the pathomechanisms of defective realisation of phonemes (functional dyslalia). The knowledge of the relationship between motor feeding patterns, or more specifically between primary functions and the secondary function (articulation), became the basis for a new approach to the diagnosis and therapy of dyslalia. In contemporary logopaedic publications the aspect of functional determinants affecting articulatory mechanisms is widely discussed (Mackiewicz 1992, 1998, 2002; Stecko and Hortis-Dzierzbicka 2000; Pluta-Wojciechowska 2009, 2011, 2013; Lorenc 2013; Łuszczuk 2013).

In the last three decades most of the undertaken studies and analysis reveal the connection between interdental swallowing (tongue thrust) and a faulty realisation of phonemes / t, d, n / and / s, z, c, ʒ/ (also mentioned in some publications phoneme /l/) which are then realized between dental arches (Lebrun 1985, Jaruzelska-Łabiszewska 1997, Stecko and Hortis-Dzierzbicka 2000, Grabowski et al. 2007, Sahad et al. 2008, Van Lierde 2014). These reports indicate the coexistence of similar position of the apex during swallowing and during the realisation of these phonemes. However, there are few studies showing the impact of these dysfunctions on the articulatory structure of other phones and describing the relationship between other atypical patterns of swallowing and tongue rest position and articulation. The authors do not always indicate how they assessed the articulation and if all the biological conditions were taken into account (eg. a shortened frenulum).

One of the imaging (objective) tests, the work of Japanese researchers in 1970 evaluated both the course of swallowing and the articulatory processes. Wada, Yasumoto, Ikeoka et al. conducted a cinefluorographic study of articulatory movements in patients with tongue thrusting. Although the examined group consisted of only five people, the authors managed to observe significant differences in articulation between the tongue thrusters and the control group. The results provide a clearly diverse patterns of swallowing and articulation in both groups; more importantly, the researchers have noted that the subjects with the incorrect swallowing and tongue rest position need a much greater number of articulatory movements and present a prolonged transition between particular tongue arrangements (Wada, Yasumoto, Ikeoka 1970). It can be assumed that the observed additionally and unnecessary (in terms of standard and economy of speech) inter-articulatory movements could provide some sort of compensation, related to a non-economic position of the tongue, an enlarged distance between separate places of articulation and some inefficiency of the tongue, etc. Nonetheless, in spite of the exact mode of the study, it is difficult to establish some general trends in the articulation of the visceral swallowers on the basis of such a small number of subjects.

In an analysis published in 2000, based on the observation of more than 2,200 children consulted by orthodontists and speech therapists, E. Stecko and M. Hortis-Dzierzbicka undermine the opinions of a developmental character of interdental articulation. The authors define the articulation as the result of biological activities and anatomical conditions within the stomatognathic system. The interdentality which may be conditioned by a mouth breathing habit (with low resting position of the tongue) or an abnormal course of feeding is in their opinion a pathology in every age; moreover, it does not retreat with age, but perpetuates and may cause further problems also with a phonemic differentiation (Stecko and Hortis-Dzierzbicka 2000).

In the year 2007, E. Krasnodębska-Jeżewska describes in her article the logopaedic research which she conducted among more than five hundred seven-year-old children with a peripheral dyslalia. The results showed that articulation disorders have been accompanied with swallowing disorders in nearly 88% of the examined children. The researcher distinguishes the following incorrect swallowing patterns: a flat arrangement of the tongue ("a childlike, infantile type" – 62.5% of subjects) and swallowing with an anterior seal provided by labial-lingual contact (24.9%). These disorders were connected mostly with a mouth-breathing and malocclusion; an isolated abnormal swallowing pattern (without any other anatomical and functional disorders) occurred in 48 children. The author writes, "at impaired respiratory function the tongue arranges itself / is positioned incorrectly also during swallowing (...) it is not lifted, but lays flat behind the lower teeth or falls between the teeth" (Krasnodębska-Jeżewska, 2011: 105). Simultaneously, it is worth noting that the incidence of undesirable interdentality has amounted to 91% in the entire group of subjects (Krasnodębska-Jeżewska 2011).

U. B. Dixit and R. M. Shetty have been comparing two groups of children aged 10–14: the research group included children with an interdental swallowing pattern, a control group was formed of children with a normative swallowing. Both groups consisted of 21 subjects. As many as 86% of tongue thrusters presented an interdental pronunciation (the authors use the term: lisping), while in the control group there was not a single case of such an articulatory distortion (Dixit and Shetty 2013).

K. M. Van Lierde with colleagues have stated after assessing the articulation and oromyofunctional behaviour of 56 children seeking orthodontic treatment that the test group is characterized by a high incidence of comorbidity of an anterior tongue position at rest and the addental realisations of phonemes (in comparison to the control group). The researchers distinguish two types of tongue thrusting: addental or interdental (the tongue tip is against the palatal surface of the incisors or between them) and they highlight that all children with tongue thrust presented an anterior tongue position at rest. What may be surprising is the fact that the authors describe the physiological tongue position at rest as the apex resting at the upper or the lower alveolar ridge (Van Lierde et al. 2014).

On the basis of the presented research results, one can notice that the relationship between tongue thrusting and interdental sigmatism (the so-called "lisping") has been observed in many languages (in subjects who were users of: English, German, Flemish, Hindi, Japanese and Polish). Therefore, it can be concluded that in numerous languages of the world the primary functions disorders determine the occurrence of an abnormal secondary function (the distorted articulation) in a similar way. However, the impact of the functional abnormalities on the articu-

lation may be more or less severe in an auditory assessment, depending on the requirements of a given language phonetic system.

Following the deliberations of both B. Mackiewicz and D. Pluta-Wojciechowska it can be concluded that the oral phase of swallowing and also the tongue in rest position during breathing are the prototypes for the majority of Polish consonants which articulatory structure is based on vertical-horizontal position (Pluta-Wojciechowska 2009, 2013). Some special attention should be paid to:

• praedorsum position: comparable to later place of articulation of palatal sounds, especially the sibilants (which are in fact praedorsal and praepalatal – Rocławski 1976, 2010; Ostaszewska and Tambor 2000),

• position of the apex: comparable to the place of articulation of dentals (the apex touches the incisal papilla behind the necks of the upper incisors; during the articulation of / t, d, n / it comes slightly lower, on the cingulum of the upper incisors, while the tongue remains in contact with the post-dental alveolar area);

• and finally, the location of the tongue's circuit, positioned within the upper dental arch: an approximate position can be observed in the realisations of / t, d, n /, / s, z, c, ʒ/, / r /, / š, ž, č, ǯ /, / ś, ź, ć, ʑ /, / i̯ / and / ń / (Mackiewicz 2001 Pluta-Wojciechowska 2009, 2013).

• In addition, in preparation for swallowing the bolus or liquid is lifted by the concave anterior part of the tongue which is followed by forming a peripheral (anterior, lateral and posterior) seal (Wildman, Fletcher and Cox 1964, Pluta-Wojciechowska 2009, 2013), then the dorsum becomes convex and contacts the palate (Peng et al. 2003). An essential part of this movement is reproduced during the articulation of an alveolar sibilant followed by a palatal sound (a parallel efficient movement of the tongue is required, eg. in the Polish consonant clusters like [učćivy čćićel]).

THE AUTHOR'S RESEARCH – A GENERAL APPROACH

Materials and methods

254 adults have been logopaedically examined. The group consisted of 123 women and 131 men, aged 16 to 63 years (the vast majority of the subjects were young adults between 19 and 25 years of age). The logopaedic examination has comprehensively taken into account the assessment of biological and functional determinants of the speakers, such aspects as the aural hearing, anatomic conditions (the construction of the lips, the tongue, the palate, the type of occlusion, the labial and lingual frenulum, a palpation assessment of the temporomandibular joints and masseter muscles, an indicative evaluation of the nasal cavity) and functional conditions (the efficiency of speech organs, a course of primary functions such as: breathing, biting, chewing, swallowing and the tongue at rest posture). The phonemes realisation has been analysed using the auditory, visual, sensory

and experimental paths of access, with respect to the Polish phonetic and phonological standard specified by B. Rocławski. Finally, an interview has been conducted, respecting the course of pre-, peri- and postnatal period, feeding, speech development, a history of diseases and a breathing model in childhood, the occurrence of possible parafunctions, etc. Bilinguals, neurological patients or persons having impaired physiological or aural hearing were excluded from the study.

The evaluation of swallowing and the tongue at rest position has proceeded in several stages. The first stage referred to the assessment of the activity of masseter muscles and lips during swallowing a small amount of water, as well as during an empty swallow occurring straight after it[3]. Next, some food with a light texture was used (a yogurt or a fruit mousse); the patient received a command to take the food from the spoon and swallow it with their lips slightly parted in a smile (in order to check the quality of the anterior and lateral seal within the oral cavity; however, as it will be presented further, it cannot be a distinctive method in diagnosing the incorrect swallowing pattern). Placing a wooden spatula between the premolars allowed to observe the movements of the tongue during the swallowing and the after-swallow movement which can be interpreted as an attempt to the patient's natural tongue at rest posture. Then the patients have had his/her lips slightly spread apart during the quiescent nasal breathing in rest (in the case of mouth-breathing patients the observation of the tongue position is not complicated). When the patient presents a physiological rest position of the mandible, the resting posture of the tongue is possible to be observed thorough a freeway space between the separated premolars. If the patient had remained in the maximum intercuspation, a wooden mouth spatula has been used in order to separate the dental arches – in a form of the natural interocclusal distance in rest.

The observation of the tongue during the swallowing or at the rest position with the dental arches slightly parted does not precisely reflect the process of swallowing which takes place under physiological conditions; however, (similarly as in the examination of phone's articulatory structures) by conducting this practise some tendency of the tongue to adopt certain position can be observed.

The proposed diagnostic procedure may be difficult to apply in the case of younger patients. An adult can verify or supplement the diagnosis of a speech therapist by his/her own observations, but these pieces of information should not be interpreted as decisive, but only as one of many premises gathered during the diagnostic process. It happens that the patient's initial sense of the tongue at rest posture is completely different from the real one. For instance, the majority of patients presenting the normative pattern of swallowing and tongue at rest posture

[3] An empty swallow resembles the natural saliva swallowing; during water swallowing the tongue tends to adopt retracted position and course of swallowing can then be different from the habitual (Peng et al. 2003: 455). A detailed guidance on how to study speech therapy swallowing can be found in D. Pluta-Wojciechowska (Pluta-Wojciechowska 2009: 135–136).

is surprised to discover that their tongue remains within the upper arch and along the palate while breathing, and what is more they often identify this posture as an incorrect one.

Types of swallowing and tongue rest position

The abnormal pattern of swallowing/TRP has been observed in 124 of the subjects which constitutes almost 49% of the examined. However, only two of patients presented the most frequently described swallowing type (the so-called infantile or visceral), with the arrangement of the tongue between the incisors, accompanied by the labial and buccal contraction.

Among the examined adults the following patterns of swallowing and tongue rest position have been diagnosed:

• **mature** (51% of the subjects) – the coronal part of the tongue remains within the maxillary arch, the apex exerts pressure on the incisal papilla behind the upper central incisors, the blade and dorsum are in contact with the palate;

• **addental** (28%) – the apex is positioned on the lingual surface of the upper incisors or even lower, in contact with the incisal edges of the lower incisors, with or without thrusting (forward movement in swallow). Since the assessment of the force exerted by the tongue is impossible in the logopaedic diagnosis, the term "addental swallowing pattern" seems to have a wider application;

• **dorsal** (more than 19% of the subjects) – the apex can be positioned against the mandibular incisors, below the crowns of the incisors or in the lingual surface of the lower alveolar ridge. In some patients the tongue body remains in the maxillary arch during breathing, with the dorsum positioned in contact with the hard palate (it has been the most common type of dorsal swallowing and dorsal tongue at rest posture); in others the tongue body is completely lowered (the tongue in general does not reside in the upper arch, this item most frequently co-occurs with of traverse changes of both the upper and lower dental arch);

• **interdental/tongue thrusting** (0.8%) – involves the position of the tongue between the dental arches (accompanied by the negative ovebite – anterior open bite);

• **retracted** (0.8%) – a rare, although described in the literature (Karłowska 2001) palatal swallowing pattern (high and posterior position of the tongue; the anterior seal is achieved by the apex-praepalatum cntact, behind the alveolar ridge). This pattern coexisted in with bilateral buccal crossbite (scissors bite) and with class II malocclusion.

Furthermore, in individual cases one could observe the asymmetric posture of the tongue during swallowing and at rest position, co-occuring with its low position. In one of the subjects a habitual parafunction in a form of bilateral tongue biting caused the lateral fixation of the tongue to such an extent that it has become the habitual rest position.

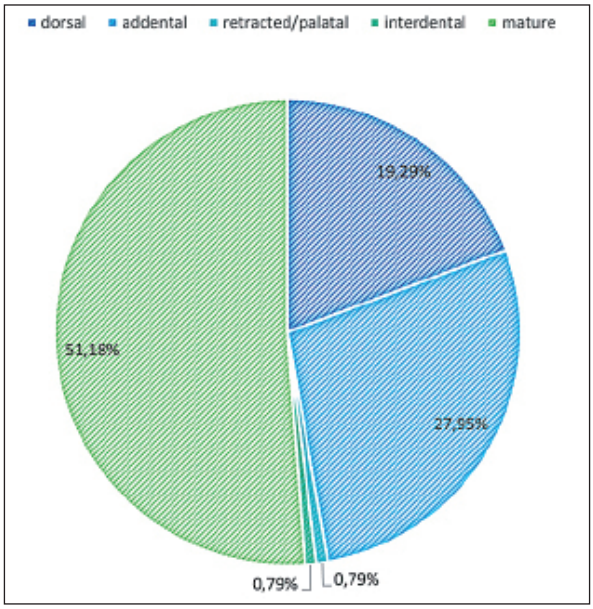

Chart no. 1. The prevalence of various types of swallowing and tongue rest position in the examined adults (n = 254)

Structural determinants of functional disorders

Table 1 presents a co-occurrence of various types of swallowing and rest positions of the tongue with malocclusion and different degrees of ankyloglossia[4] in subjects (Table 1).

The proportion of subjects with normal occlusion has been higher in the group with a mature tongue motor patterns (66%), but in groups with the addental and dorsal swallowing pattern the subjects with normal occlusion constituted more than half of the examined. It does not mean that the tongue posture cannot change the occlusal conditions or do not correlate with malocclusion; as some of the patients have had retention, stabilizing their occlusion conditions after orthodontic treatment. It is also possible that there are some patterns of tongue's movement and resting position which are abnormal in terms of physiology, but due to the intra-individual factors of subjects do not affect the occlusion. However, this issue requires an objective measurement and remains outside the field of a logopaedic analysis.

[4] The method of assessment the ankyloglossia degree has been based on the procedure proposed by B. Ostapiuk (Ostapiuk 1997).

Table 1. Anatomical conditions of the subjects with various types of swallowing and tongue at rest posture

Types of swallowing and rest position of the tongue	Degree of ankyloglossia	Occlusion
mature (n = 130)	none: 56.1%, mild: 36.9%, moderate: 6.9%, severe: 0.00%	normal: 66.9% class II malocclusion: 12.3% posterior crossbite: 10.8% deep overbite: 6.1% zero overbite: 3.8%
addental (n = 71)	none: 59.1%, mild: 35.2%, moderate: 5.6%, severe: 0.00%	normal occlusion: 56.3%, class II malocclusion: 12.7%, posterior crossbites: 9.8%, deep overbite: 5.6%, incisal protrusion: 4.2%, posterior open bite: 1.4%, anterior crossbite: 1.4%
dorsal (n = 49)	none: 42.9% mild: 36.7%, moderate: 14.3%, severe: 6.1%	normal occlusion: 55%, class III malocclusion: 16.3%, posterior crossbite: 16.3 % zero overbite: 6.1% deep overbite: 4.1%
retracted (n = 2)	none: 50.00%, mild: 50.00%	scissors bite: 50% class II malocclusion: 50%
tongue thrusting (n=2)	none: 50.00%, mild: 50.00%	anterior open bite: 100%

The profile of malocclusion incidence in normal swallowers and in addental ones is similar (considerable prevalence of class II malocclusion and posterior crossbites) but it is presented differently in the group with dorsal type of swallowing (predomination of class III malocclusion and posterior crossbites). All subjects with class III malocclusion have presented the dorsal type of swallowing and dorsal TRP, but the majority of them has also been diagnosed to have ankyloglossia (see Yang et. al. 2011). In both cases of open-bite patients tongue-thrusting has been observed, as it is described in the literature. Inordinately high and retracted tongue position has been noted in two patients and it has co-occurred with the scissors bite and class II malocclusion. Moreover, in eight of the subjects, despite the previous treatment of an open bite, tongue thrusting has remained (with a strong anterior tongue movement during swallowing and addental rest position of the tongue).

The profile of the prevalence of various degrees of ankyloglossia is similar in the groups with physiological and addental swallowing, while in the group with the dorsal type one can observe a higher incidence of abnormalities and its increased severity. Since the research group is too small in case of the other models of swallowing, the analyses have not been carried out.

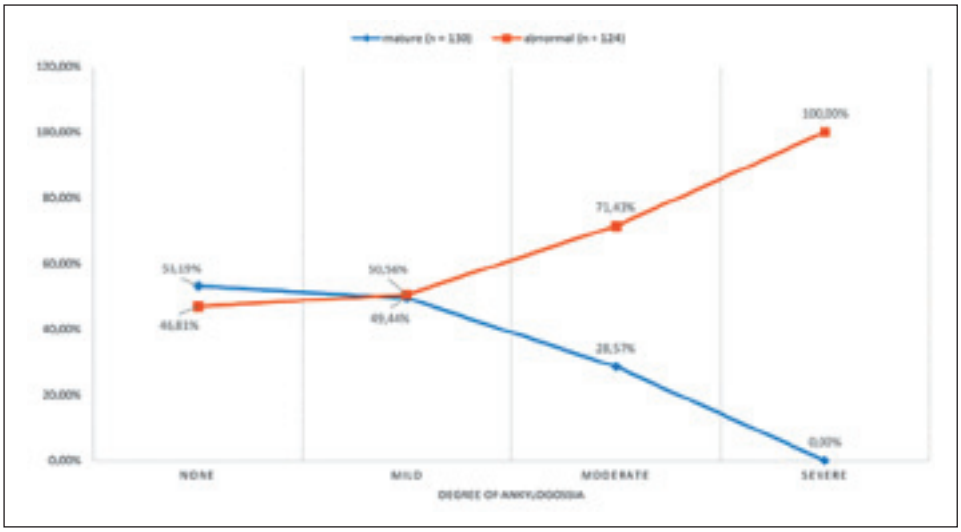

Chart no. 2. The incidence of an abnormal swallowing in subjects with various degrees of ankyloglossia[5]

Judging from the results presented in Chart no. 2, in case of medium and severe ankyloglossia degree there is a limited mobility of the tongue and a restricted possibility of its elevation which results in distortions of mastication and deglutition (cf. Ostapiuk 2013). However, in the case of a shortened frenulum in a mild degree, the occurrence of swallowing and TRP disorders may depend on the co-existence of some other, additional factors (mouth-breathing, non-nutritive suction, enlarged tonsils, etc.); therefore, a shortened frenulum can be just a factor which intensifies another pathomechanism. All conditions and interrelationships occurring in the stomatognathic system have not been completely recognized yet. For instance, such issues like: a various tension in the apex area occurring even with a slight shortening of the frenulum, changes in movement patterns under various compensatory mechanisms, ankyloglossia's impact on the tongue efficiency in the various spatial conditions of the oral cavity, etc. have not been objectively studied.

[5] It has been assumed that ankyloglossia as a conditioning previous to the swallowing development is an independent variable.

The studies of the connections between ankyloglossia and swallowing/TRP abnormalities have not been widely presented in the literature so far. In a few studies the researchers have obtained ambiguous results: from linking ankyloglossia with the suck dysfunctions and consequently the immature swallowing pattern (Wright 1995; Messner et al. 2000), to the denial of connections between these irregularities (Ruffoli et al. 2005). On the other hand, there is a lot of various descriptions of research carried out in order to clarify the relationship between the shortened lingual frenulum and the construction of the orofacial space (including Defabianis 2000, Yang et al. 2011, Srinivasan 2013). There are also works devoted to the analysis of co-occurrence of abnormal patterns swallowing and malocclusions (Görgülü et al. 2011, Yilmaz et al. 2011, Artese et al. 2011). In the long term analysis of the results will presumably help to determine the precise relationship between ankyloglossia, malocclusion and the abnormal swallowing/TRP pattern. However, the problem lies in the non-standardized methodology used by the researchers (various scales of frenulum assessment, variously defined norms of tongue at rest posture, etc.).

Types of swallowing and tongue rest position – the discussion

The findings indicating the incidence of swallowing and TRP disorders in the subjects correspond with the results obtained by E. Krasnodębska-Jeżewska and D. Pluta-Wojciechowska, and are qualitatively similar to the insights from imaging studies conducted by A. Artese et al. (Artese et al. 2011, cf. also Fig. 1 in this text).

It should also be noted that the results cannot be referred to the entire population: some of the subjects have been students of theatre academies, inherently without major structural abnormalities within the orofacial space and in assumption without significant articulation deficits (however, the incidence of an abnormal tongue resting position in this group has been equal to 40%). Other subjects have been mostly the patients seeking logopaedic help on account of speech defects; in this group the reported prevalence of the discussed disorders have already reached 62% (see Krasnodębska-Jeżewska 2007, Pluta-Wojciechowska 2013).

Usually, it is assumed that the assessment of swallowing and tongue rest position is an estimate of the zero-one type: the patient presents an absolutely normative or a completely abnormal model of the mentioned functions (commonly identified as the tongue thrusting). In practice, however, some other types of impaired swallowing (interdental, addental with or without thrusting, dorsal, retracted/palatal) may be observed, as well as some intermediate phases between them (Artese et al. 2011). In some patients the tongue resting posture has been inconstant – for example, the patient presented the correct swallowing and TRP pattern during the

examination, but then admitted that he had observed deviations from this norm in everyday functioning. It also happened that the patient properly arranged the tongue in swallowing, and then received the incorrect resting position (after a normal swallowing the tongue adopts a lower resting posture: addental or dorsal, and rises to the vertical-horizontal position again until the next swallow). Similar results were obtained in imaging studies of swallowing (Ardakani 2006). A slightly higher incidence of TRP disorders rather than the swallowing disorders has also been noted by D. Pluta-Wojciechowska (Pluta-Wojciechowska 2013). These irregular cases has been the margin of subjects; yet this is a strong indication for a separate examination of both systems: both swallowing and tongue rest position, and (if possible) for some monitoring of these activities in daily life of the patient.

Importantly, the commonly recommended diagnostic procedure (with the evaluation of the lips contraction and the masseter muscle tension during swallowing) has proved to be insufficient in diagnosing adult patients (which may explain why such a large percentage of these disorders remain undiagnosed). In the examined who has presented both addental and dorsal type of swallowing, lips contraction remained imperceptible. Patients have also presented a complete oral seal because of the teeth-tongue contact, due to which they obtain sufficient underpressure during the act of swallowing. The subjects has also clenched dental arches during swallowing, so the masseter muscle activity has been palpable. Hence, these trials cannot be used as sole criterions for differentiating types of swallowing.

It seems that during the logopaedic diagnosis it is not always possible to assess the pattern of swallowing and tongue rest position with only one method of examination. For example, during an observation of the swallowing with the use of yoghurt, the patients with the dorsal swallowing pattern achieve a complete anterior seal (obtaining it by the contact of praedorsum with the incisors or the maxillary gingiva) and the expected outflow of food into the oral vestibule will not be observed by the therapist. However, it does not mean that the pattern of swallowing is correct.

All the above observations encourage to regard the problem of swallowing and the rest position of tongue in adults attentively: the nature and some subjectivity of the logopaedic examination cause that the diagnosis of these abnormalities will be dependent on the knowledge and experience of the therapist.

Relationship between the type of incorrect swallowing pattern and non-normative realizations of consonant phonemes – an overall analysis

The Chart no. 3 presents the comparison of non-standard phonemes realisation incidence between the group of mature swallowers with standard TRP (n = 130) and the group with an abnormal swallowing and TRP pattern (n = 124).

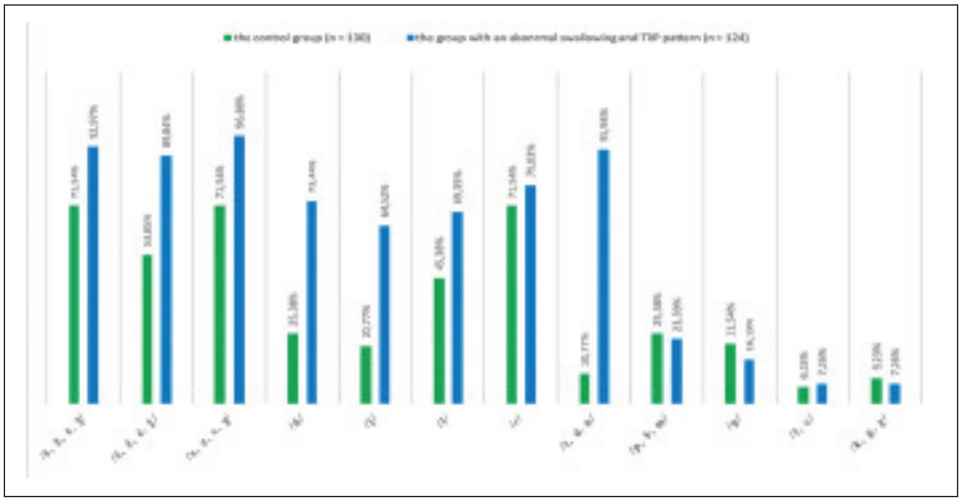

Chart no. 3. The incidence of non-standard phonemes realisation in the group of mature swallowers with standard TRP (n = 130) and in the group with an abnormal swallowing and TRP pattern (n = 124).

As it has been illustrated by the presented data, regardless of comorbid anatomical disorders, the incorrect patterns of swallowing and TRP are accompanied by an increased incidence of non-standard realisation of phonemes (the highest in the case of the group of phonemes: /t, d, n/ but also significant in the case of the palatal phonemes and all sibilants – in other words in all these phonemes, whose realisation is based on the vertical-horizontal position of the tongue). The presence of certain undesirable phonetic features is dependent on a number of factors; it should be assumed that in some cases only a combination of two or more pathomechanisms[6], which affect the speech organs, leads to significant articulation disorders. Above all, only a description of the kind of non-normative realisation type provides basic knowledge of an articulatory motor patterns of abnormal swallowers. On the basis of the author's research and analysis it is possible to say (using the terminology proposed by D. Pluta-Wojciechowska) that the subjects with different anatomical and/or functional disorders use different secondary compensatory strategies (Pluta-Wojciechowska 2013, Sambor 2014b).

The incidence of the non-normative phonetic features, which have been most frequently noted in the study group as well as in the control group (the subjects without swallowing and TRP disorders), is presented on the Chart no. 4.

As it has been shown on the Chart no. 4, the results are naturally quite general due to the fact that in both of the examined groups different anatomical disorders have co-occurred (although there has been a similar incidence of various disorders

[6] eg. ankyloglossia and malocclusion; ankyloglossia and abnormal swallowing, etc.

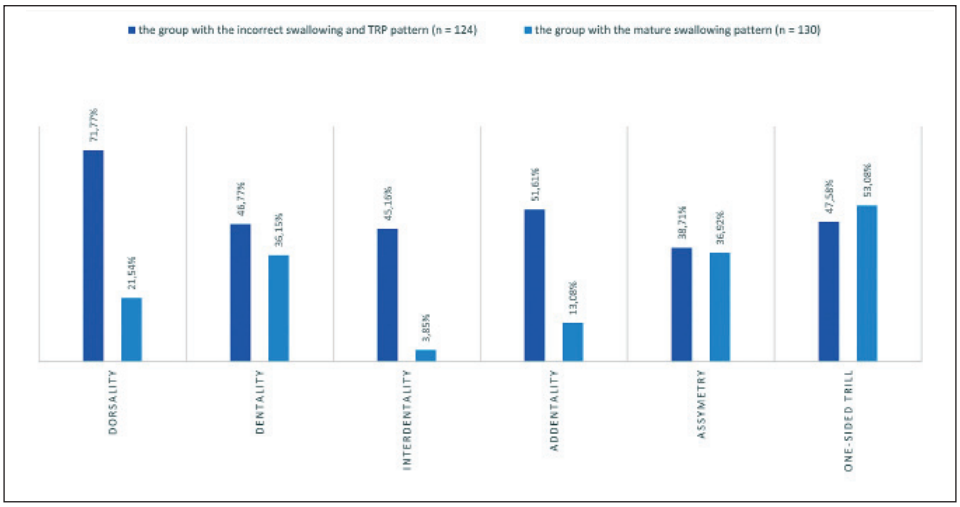

Chart no. 4. The prevalence of non-normative phonetic features in the study group (n = 124) and in the control group (n = 130).

– cf. Table no. 1). However, a certain regularity can be noticed: some undesirable phonetic features (dorsality, interdentality, addentality) appear significantly more often in the group of patients with an incorrect swallowing pattern (cf. Lorenc 2013, Pluta-Wojciechowska 2013). The assumption that there is a correlation between the type of primary compensatory strategies used by these subjects, and the type of secondary (phonetic) compensatory strategies has been thus reflected in the presented results (Pluta-Wojciechowska 2013).

However, in order to show more accurately the relationships between aberrant patterns of swallowing and TRP and the type of secondary compensatory strategies used by the subjects, some profiled results will be presented in the next part of the study. A group of patients with an isolated[7] swallowing and/or TRP abnormalities (divided in terms of diverse incorrect functional patterns) will be shown, in connection to the articulatory structure of the dental, alveolar and palatal phonemes realization.

SECONDARY COMPENSATORY STRATEGIES IN PATIENTS WITH ABNORMAL PATTERN OF SWALLOWING AND TONGUE REST POSITION DURING BREATHING

Criteria of the profiled research group selection

The profiled research group has finally amounted to 42 subjects with an isolated incorrect swallowing/ TRP pattern with a simultaneous absence of comorbid

[7] Without any comorbid anatomical and functional disorders like malocclusion or ankyloglossia.

anatomical and functional disorders (such as: ankyloglossia, malocclusion, palate defects, enlarged tonsils or nasal obstruction). The examined represented two of the described types of swallowing pattern and tongue in rest posture: addental (28 subjects) and dorsal (14 subjects). Some patients have undergone a previous orthodontic treatment, carried out due to the teeth relationship disorders: tooth rotation, spacing, crowding or diastema; at present they have a normal occlusion (which has been confirmed in an orthodontic examination). Those subjects, who had been provided with the previous treatment of class II, class III or transverse malocclusion, were excluded as well as those who had previously undergone frenotomy (a surgical undercut of the lingual frenulum). In the analysed 42 cases neither swallowing nor a TRP therapy has been conducted. The control group has consisted of 29 subjects devoid of any anatomical and functional disorders (in this group several subjects have also undergone previous orthodontic treatment, but under the same conditions as mentioned above).

As it has been presented, the profiled group is relatively small in comparison with not only the number of all subjects and also with the total number of persons with swallowing pattern and TRP disorders (42 individuals out of 124). It is a consequence of the fact that functional disorders frequently co-occur with anatomical abnormalities (Brauer and Holt 1965, Primozic et al. 2013). Obviously, there can be no assurance that some occlusion irregularities, which are not identifiable in the logopaedic procedure, had not occurred within the selected group (eg. a slight asymmetry of the occlusal plane). It refers also to some of the lingual frenulums, which may have been so slightly shortened so that they could have been classified as normative.

The analysis of the articulatory structure of the realisations of consonant phonemes (dentals, palatals and alveolars) depending on the type of swallowing and TRP will be presented below. These results do not include realisations of vowel phonemes, although it seems that a non-normative pattern of swallowing can coexist with an impaired vowel phonemes realization (cf. Sambor 2015b). This theme will be the subject of a separate study.

Incorrect models of swallowing and tongue at rest posture and the articulatory structure of dentals

The following Chart (no. 5) shows types of realisation of a group of phonemes / t, d, n / in patients with different patterns of swallowing and tongue at rest posture during breathing.

In the course of the proper realisation of dental plosives and the sonorant/n/ the apex is placed around the upper incisors necks, overlapping about 1/3 or 1/2 on the crown of the upper incisors (touching the incisal cingulum). At the same time, the anterior part of the tongue is in contact with the upper gum (Wierzchowska 1971; Rocławski 1976, 2010; Dłuska 1986). The obtained results indicate

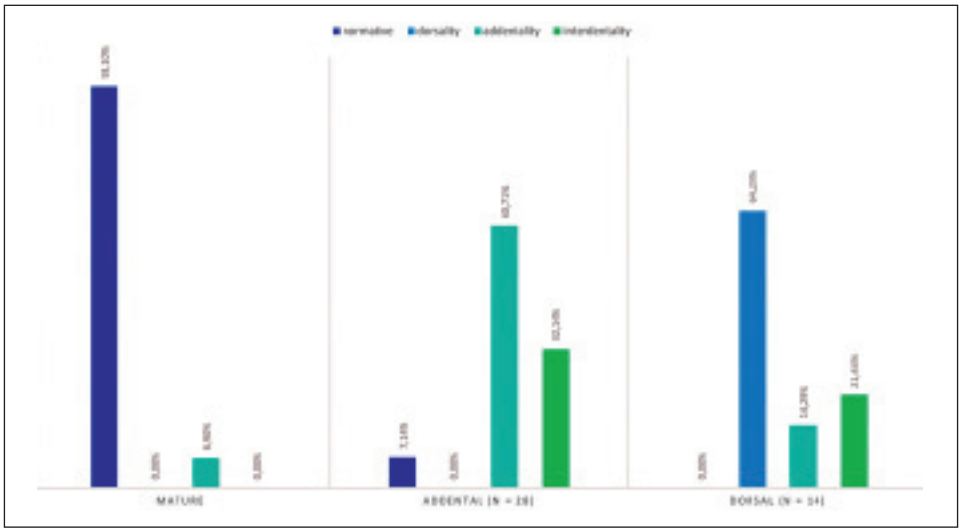

Chart no. 5. The phonetic features of realisations of phonemes /t, d, n/ depending on the type of swallowing and/or tongue at rest posture

a similar position of the apex during the articulation of dentals and the apex position during swallowing and resting position – both in norm and in pathology. In case of excessively low, addental positioning of the tongue during the realisation of the dental plosives and nasal /n/, interdental or addental realisations occur (the term "addentality" is most often reserved for dental sibilants; it is in fact an "on-dental" position: when starting the articulation the apex is based on the upper incisors edge or even simultaneously on the edges of the upper and lower incisors, not being in contact with the upper gum. The place of articulation is, therefore, similar to the English interdental phonemes /Θ/ and /ð/). The lowest, dorsal articulation of dental stops (with a praedorsum activity instead of the apex) has been observed mostly in those subjects whose primary patterns also include low, dorsal positioning of the tongue.

Abnormal realisations of /t/, /d/, /n/ are actually impossible to identify in the auditory analysis; some of them, especially those low, addental or "on-dental" ones are almost imperceptible in the fast-paced speech. The interdental and addental realisations have often occurred in the subjects interchangeably, depending on the phonetic context (eg. addental realisation of /t/ in the word-initial position and interdental realisation of /t/ in the word-final position in the same subject).

Following I. Nowakowska-Kempna and D. Pluta-Wojciechowska, the phoneme /t/ is a prototype for the entire Polish phonetic and phonological system (Nowakowska-Kempna 2000; Pluta-Wojciechowska 2002). Thus, the distortions of its realisation are of particular importance. Among patients who have presented

interdental, addental or dorsal way of the /t/ realisation, the vast majority demonstrated also an abnormal articulation of the dental and palatal sibilants. Due to the similarity of the position of the apex during swallowing to the position of the phoneme /t/ realisation, it appears that when its realisation is distorted, it may become some kind of a "warning light": an indicator that the patient (for various reasons) may have difficulties with obtaining the mature swallowing pattern or the proper posture of tongue at rest.

Types of realisation of dental sibilants are presented on the next Chart (no. 6).

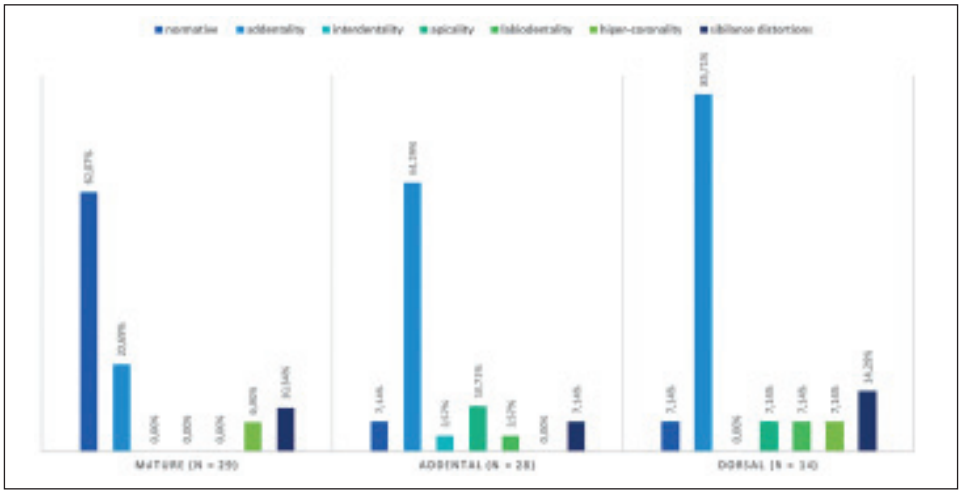

Chart no. 6. The phonetic features of realisations of phonemes /s, z, c, ʒ/ depending on the type of swallowing and/or tongue at rest posture

In adults interdental realizations of / s, z, c, ʒ/ have been fairly rare; it has emerged that in most of the subjects the tongue has remained hidden behind the incisors, even despite of its anterior position. Addental realizations of dental sibilants (see. Toczyska 2003, Kamińska 2012, Sambor 2015b) arise by the same token as incorrect realisations of dental plosives. In fact, this kind of sibilants distortion can be divided into two subtypes, correlating with a specific type of swallowing and rest position of the tongue. The first one corresponds to the addental swallowing pattern and addental TRP: the phonetic realisation of /s, z/ and /c, ʒ/ takes place by forcing the apex against lingual surfaces of the incisors and the interproximal area; it can be named the apical addentality. In the second subtype a lower tongue posture can be observed, with the apex pointing downwards and based firmly behind the lower incisors, at the lower alveolar ridge. Dental fricatives or affricates will be formed by the praedorsum contact and/or strong closeness with the inner side of the upper incisors. In both cases, the effect of changes in the shape of the articulatory gap results in an unpleasant sound of the

strident: sharp in the addental-apical realizations, stringy in addental-praedorsal ones.

An incorrect model of swallowing and tongue at rest posture and the articulatory structure of palatals

As it has been already mentioned, the articulatory structure of the i-shaped phones (the whole tongue body raised and convex[8]) may reflect one of the swallowing phases and requires special efficiency of the tongue, especially of the blade (in other words, the praedorsal part of the tongue). These skills are shaped to a great extent by a natural tongue muscle training that occurs during primary functions (assuming that the tongue has a correct mobility and an ability to move in a properly shaped upper dental arch and palate).

In a situation where the patient does not have the capacity to perform such movement correctly, he/she uses substitute movements; both in the course of primary functions and during the articulation. D. Pluta-Wojciechowska has defined this phenomenon as the primary and secondary compensatory strategies. The relationships between the occurrence of primary compensatory strategies (during swallowing and TRP) and the type of the secondary (phonetic) strategies can be observed on the Charts no. 7, 8 and 9: in the case of i-shaped phones the dorsal model of swallowing coincides with an undesirable dorsality in 78%–92% of the examined.

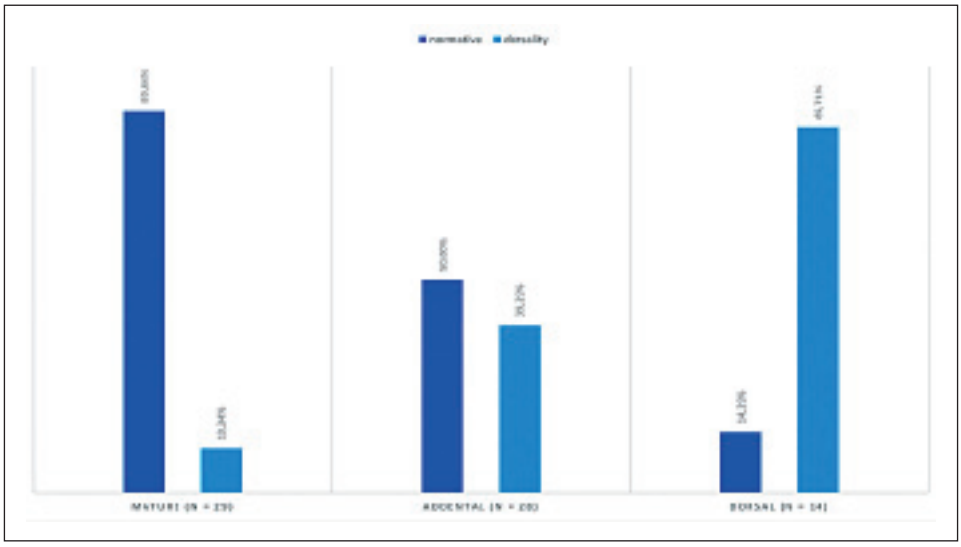

Chart no. 7. The phonetic features of realisations of the phoneme /i/depending on the type of swallowing and/or tongue at rest posture

[8] cf. Rocławski 2010.

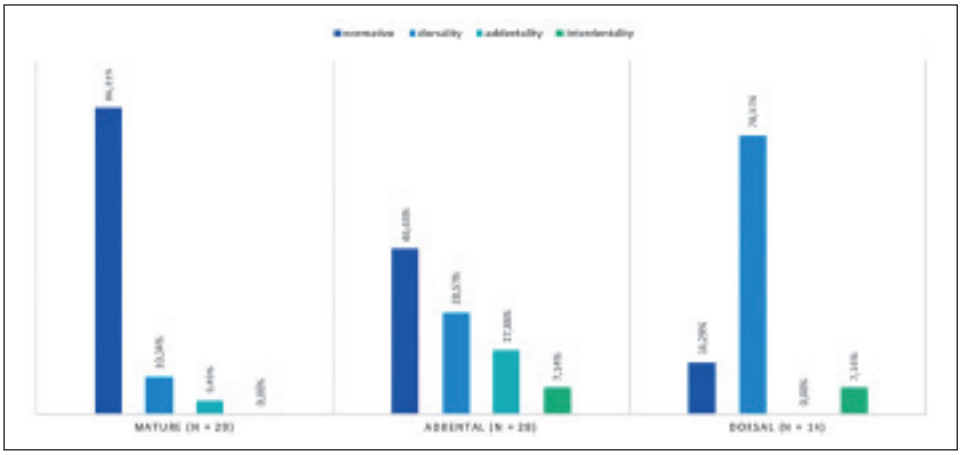

Chart no. 8. The phonetic features of realisations of the phoneme /ń/depending on the type of swallowing and/or tongue at rest posture

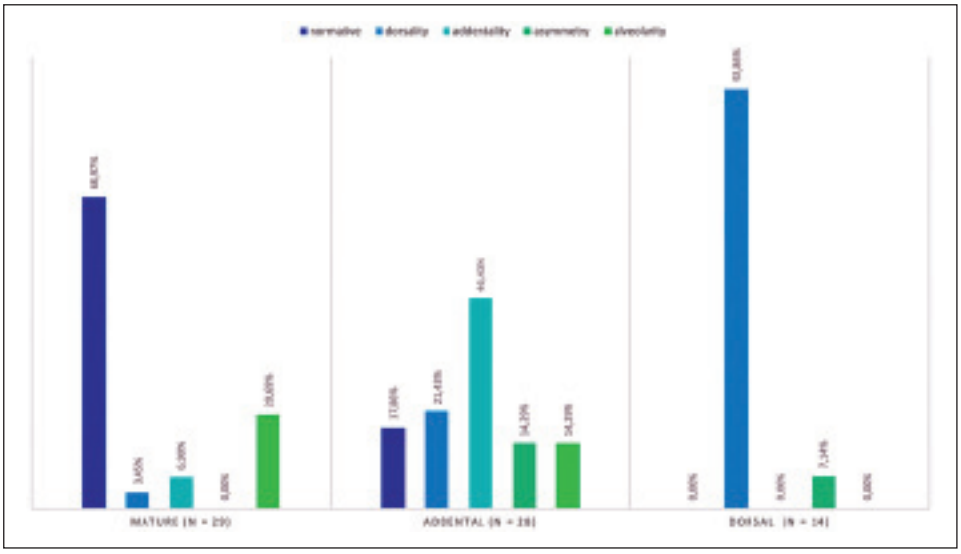

Chart no. 9. The phonetic features of realisations of phonemes /ś, ź, ć, ʒ́/depending on the type of swallowing and/or tongue at rest posture

In accordance with the phonetic and phonological system described by B. Rocławski, and together with the findings of other researchers (Wierzchowska 1971, Dłuska 1986), the palatal sibilants have the longest air-flow but the greatest constriction is formed at the point of laminal approximation of the praedorsum to the praepalatum, with the convex tongue body. In subjects with an impaired swallowing and TRP these sounds are articulated in two ways: with an undesirable

dorsality or addentality. The dorsality (approximating the dorsum to praepalatum, or the praedorsum to the postdental area) has been frequently noted in the case of a dorsal swallowing and dorsal TRP; the addentality (sometimes even a dental-apical articulation of palatal sibilants) has manifested more frequently in subjects with an addental pattern of swallowing and TRP. For this latter group the following compensation type has been often observed: the lack of praedorsum elevation has been replaced by a strong rounding of the tongue's corona, which can be specified in an additional term: hiper-coronality.

It is worth noting that the undesirable dorsality applies not only to the realisation of sibilant phonemes /ś, ź, ć, ʒ́/ (though it becomes audible then), but as it has been shown in the Charts no. 7 and 8 it also concerns the tongue posture in /i̯/ and /ń/ realisation, on which the speech therapy of palatal sibilants is often based (Ostapiuk i Konopska 2006; Toczyska 2010). Therefore, these non-audible palatals distortions should be diagnosed carefully.

An incorrect model of swallowing and tongue rest position and the articulatory structure of alveolars

The various realizations of the phoneme /r/ depending on the kind of the swallowing pattern and tongue rest position are presented on the Chart no. 10.

All subjects have realised this phoneme as an apical trill. The differences between the groups concerning the distribution of prevalence of non-normative phonetic features are not large, but the occurrence of undesirable dentality in groups

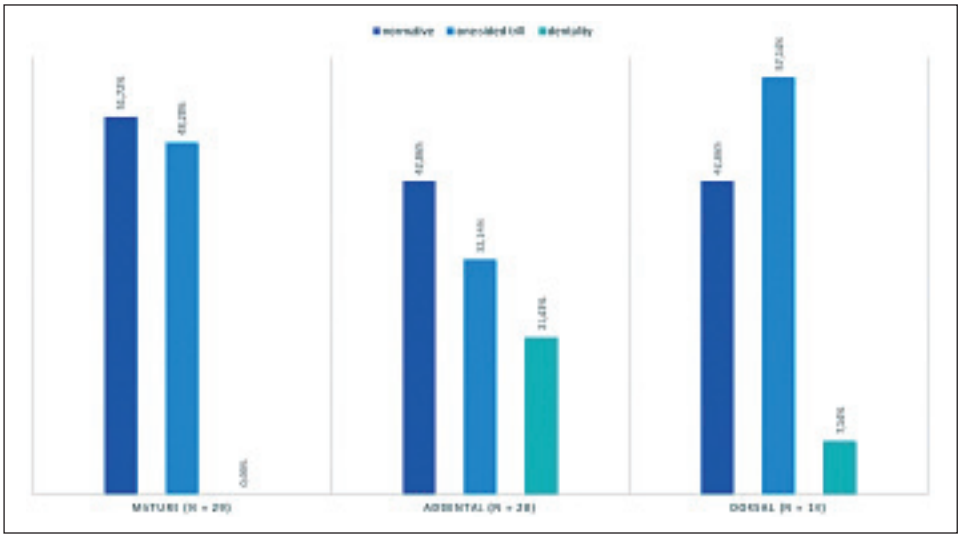

Chart no. 10. The phonetic features of realisations of the phoneme /r/depending on the type of swallowing and/or tongue at rest posture

with an abnormal swallowing and TRP may draw some attention. Nonetheless, it seems that this is not characteristic only for the subjects with an addental swallowing and TRP – a dental articulation of the alveolar trill is a common compensatory strategy in patients with ankyloglossia (Ostapiuk 2002, 2013b, Sambor 2014b).

One-sided trill (a situation when only half of the apex vibrates, with a sagittal or non-sagittal tongue body setting) is more than twice as frequent in the group with the lowest, dorsal tongue posture, which may suggest that some difficulty in obtaining the vertical-horizontal position and the full vibration at the low primary posture of the tongue. Nevertheless, the frequency of this phonetic feature is also high in subjects without the biological impediments.

It is worth noting that in all 42 patients with an impaired swallowing pattern and TRP the phoneme /r/ was realised apically and vibrationally; presumably, these functional disorders do not prevent to obtain a vibration (differently than in the case of ankyloglossia – cf. Ostapiuk 2002, 2013a).

The research has shown a higher incidence of non-standard realisation of the phoneme /l/ among patients with an abnormal pattern of swallowing and TRP (see Chart no. 11). Most of defective realisations has been recorded in the group with the lowest, dorsal tongue posture; only in this group the dorsal realizations occurred and also a significantly higher percentage of non-sagittal (asymmetric) realisations has been noticed. The interdentality of /l/, listed by the researchers as one of the phonetic features, associated with an abnormal swallowing pattern occurred only in one person (in a group of an addental swallowing and TRP); the dentality, which has been more often reported, coexisted with addental and dorsal swallowing pattern and TRP respectively two- and three times more frequently than in the control group.

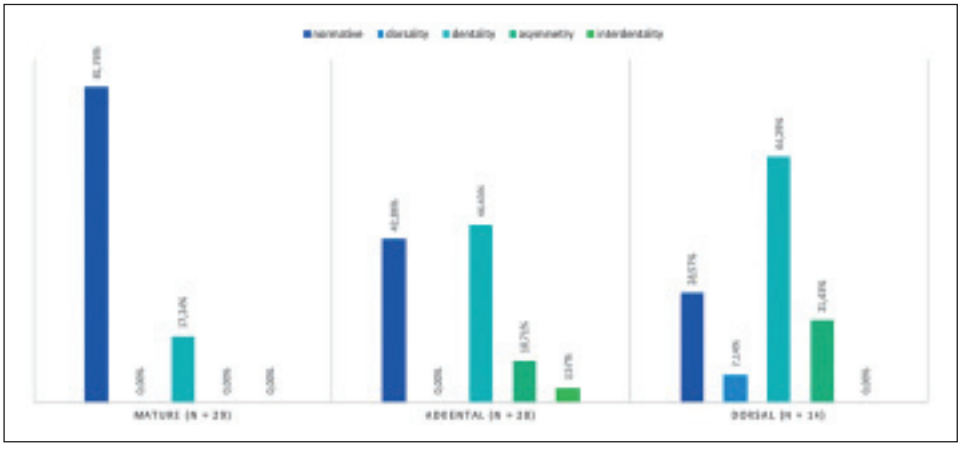

Chart no. 11. The phonetic features of realisations of the phoneme /l/depending on the type of swallowing and/or tongue at rest posture

Polish alveolar sibilants are described in the literature as articulatory complex: the tongue body achieves the vertical-horizontal position, the anterior part of the tongue is concaved when its sides are slightly raised. The apex is directed toward the alveolar ridge (or just behind the alveolar ridge – see Żygis 2004) and the sound of the phone will depend on obtaining a an even slit between the apex and the back part of the alveolar ridge.

In the analysis of the types of non-standard realisations of alveolar sibilant phonemes in groups with an impaired model of swallowing and TRP, it has occurred that the incidence of non-standard phonetic features, namely: dorsality, dentality and postalveolarity (retraction) significantly increases. The last feature is mostly an additional one connected with the other undesirable features (eg. dorsality or asymmetry). In fact, the excessive retraction of the tongue during the articulation of sounds [š, ž, č, ǯ] seems to be a way to eliminate unpleasant auditive impressions associated with the other distortions (Sambor 2015b).

An undesirable dorsality of alveolar sibilants can take different forms, diversely perceived in an auditory assessment. Within the term "dorsality" concerning these coronals two kinds of realisations can be distinguished at least: with the apex fixed on the lower alveolar ridge (Konopska 2007), or the disapical when the apex is near the alveolar area, but it is articulatorily inactive (cf. Ostapiuk 1997; 2013a; Trochymiuk and Święciński 2009; Sambor 2015b). None of the individuals in the control group has presented the dorsal articulation of alveolar sibilants – compared to more than 64% in the group with a dorsal pattern of swallowing and dorsal TRP.

The asymmetry observed in the subjects (a non-sagittal air flow and asymmetrically arranged speech organs) has been of slight intensity, in comparison with the asymmetry in patients with ankyloglossia and / or malocclusion (Ostapiuk 2013, Konopska 2007, Sambor 2014b).

As it can be seen in the Chart no. 12, in the case of functional disorders there has been also a marked increase in the number of different kinds of compensatory strategies used by the subjects; in both study groups they have been found over two times more often than in the control group.

Discussion

The quality of the realisation of phonemes in the described 42 subjects (adults characterized by an aberrant pattern of swallowing and TRP without comorbid anatomical and functional disorders) depends on many factors. The fact of a previous orthodontic treatment in subjects is certainly not without any significance. Presumably, the examined differ in motor and compensation abilities and may have various levels of determination in achieving the correct sound, etc. (Pluta-Wojciechowska 2013). Presumably, the swallowing / TRP disorders can be graded

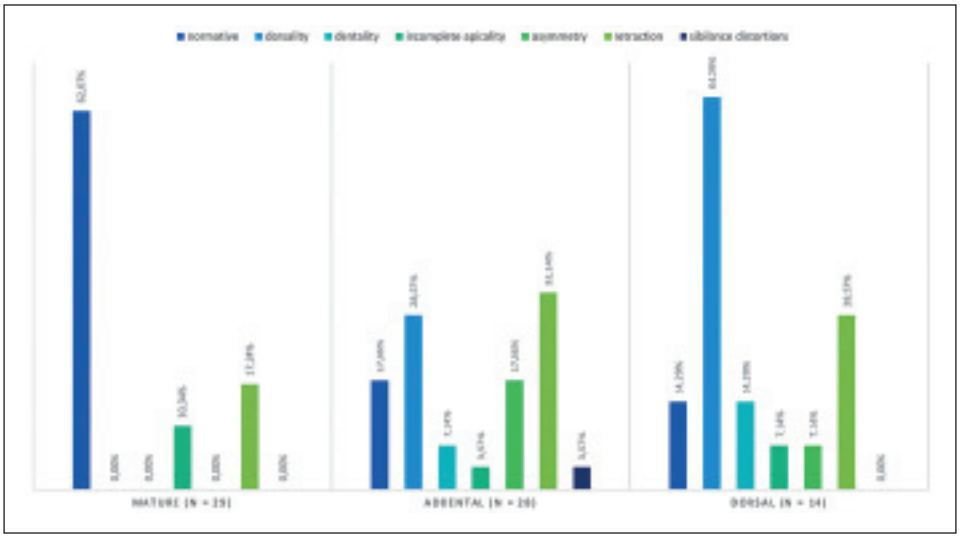

Chart no. 12. The phonetic features of realisations of the phonemes /š, ž, č, ǯ/ depending on the type of swallowing and/or tongue at rest posture

not only in terms of the observed tongue posture, but also of the strength and duration of the pathological factor's influence on the organs. For instance, one can recall two extreme cases of articulation disorders: there are two patients – A and B, both aged 20, of seemingly identical anatomical, functional and perceptual conditions (the correct construction of the orofacial space, no parafunctions, normative aural hearing, dorsal model of swallowing and tongue rest position). The patient A. presents only a dorsal realisation of palatal phonemes, rather slight in an auditory reception, the other phonemes are realised normatively. In patient B. an undesirable dorsality occurs in the articulatory structure of all phonemes, including the vowels (see Ostapiuk 1997, 2013a, Trochymiuk and Święciński 2009; Sambor 2015b). The only differences in patomechanisms occurring in patients have been found out during an interview: it has turned out that the patient A as a child had been sucking a pacifier to 23 months of age, the patient B had been bottle-fed until the age of 7 – which means that the period of an adverse impact of the negative factor overlapped with the period of formation of his whole phonetic and phonological system. There is a need for a broader study[9] to explain the specific impact of each factor on the formation of defective sounds.

[9] Cf. the study of Chilean and American researchers, in which they have analysed the impact of the duration of pacifier or thumb sucking on the condition of articulation in children (Barbosa et al., 2009) In Poland interesting studies on this topic are conducted currently by I. Malicka and A. Sowa – under the direction of D. Pluta-Wojciechowska.

However, in light of the presented data one can assume that some undesirable phonetic features coexist with an incorrect swallowing and TRP pattern, and may be their reflection in articulation (cf. Mackiewicz 2002, Hiiemae 2003, Pluta-Wojciechowska 2013). It can be seen that some certain realisations of phonemes exists which are particularly more susceptible to deformation under the influence of the described functional disorders (similarly to the alveolars distortions which are the most common articulatory disorders in the case of ankyloglossia). One can enumerate here the interdental, addental and dorsal realisations of dental phonemes, which co-occur with an abnormal swallowing pattern in most subjects. The undesirable dorsality of palatals, as well as their addental realisations (described as "baby-talk") also correlate with the described disorders. The similarity of articulatory structure of dentals and palatals to the primary motor patterns can be observed in norm as well as in pathology.

In the selected group of 42 subjects with an isolated impaired swallowing and tongue rest position there has been actually low incidence of undesirable phonetic features such as the asymmetry in the sibilants, sibilance and disorders, the lack of vibration. These features co-occur rather with ankyloglossia (the lack of vibration, an asymmetry, sibilance disorders caused by anterior jaw movements, see. Ostapiuk 2002, 2010/2011, 2013b) or malocclusions (anatomically conditioned sibilance disorders and an asymmetry – Konopska 2007, Sambor 2014). In only a few subjects The overlapping disorders of phonetic features (eg. retracted and asymmetrical dorsality) have been noticed in only a few subjects. Undoubtedly, the incidence and the intensity of such severe articulatory problems increase when abnormal conditions are superimposed on the functional anatomical abnormalities – which is the most common issue observed in the logopaedic consulting room (Pluta-Wojciechowska 2013). Detailed description of the relationship between the incidence of particular anatomical or functional disorders and articulation defects requires further in-depth research.

CONCLUSION

Summing up, an immature swallowing pattern which is the most frequently described in the literature is characterized by a triad of symptoms:

1. the anterior part of the tongue is located between the incisors, separating the dental arches,
2. a pathological activity of the lips (lip contraction) and cheeks occur,
3. the absence of perceptible mastication muscle activity (since there is no activation of these muscles due to the lack of intercuspation between the molars during the act of swallowing).

The obtained in this research results are discordant with a common procedure of the examination of swallowing since none of the aforementioned features can

be a criterion for excluding abnormal swallowing pattern or incorrect tongue at rest posture in adults in a logopaedic diagnosis.

On the basis of presented analyses it can be assumed that for the quality of articulation it is not only important whether the swallowing/TRP abnormalities are present, but what are the exact characteristics of non-normative tongue motility in the course of primary functions. For instance, in the case of addental swallowing pattern a different articulatory structure of dentals emerges than it does in dorsal or asymmetric swallowing model. Accordingly, the changes in the articulatory patterns may also occur depending on the strength and direction of the tongue's force and the produced type of oral underpressure or tongue-palate contact patterns (Shaker et al. 1988; Engelke et al. 2011; Knösel et al. 2011). The motor articulatory patterns of the tongue are different in various primary functional patterns. It supports the hypothesis by D. Pluta-Wojciechowska of the existence of primary and secondary compensatory strategies – various for sundry disorders (Pluta-Wojciechowska 2013).

A careful diagnosis followed by the training of proper swallowing and tongue at rest position during breathing (in case of such need) is, therefore, a basis for a speech therapy procedure, especially one involving non-standard realisations of phonemes which characterised by interdentality, addentality and dorsality – apart from other actions aimed at improving the articulation. However, the lack of intervention in primary functions disorders will result in a longer and not fully satisfactory course of therapy, focused rather on withdrawing the symptoms than on pathogenesis itself. Presumably, there are no speech therapy exercises, the performance of which could overcome the impact of such a strong training of articulators, which primary functions have[10].

Swallowing disorders are described much more often than the incorrect rest position of the tongue – meanwhile, the rest position in most cases has accompanied the abnormal swallowing pattern (as seen from the observation of patients, in minor percentage of them these disorders can occur separately but it is an issue that requires further research). The correct TRP influences the stability of all the structures and functions of the entire stomatognathic system (Takahashi et al. 2005; Nęcka 2006; Artese et al. 2011; Kleinrok 2012; Sambor 2015a). The importance of promoting knowledge of proper resting posture of tongue is shown not only by a high incidence of these disorders observed among adults, but also by frequent discrepancies in terminology concerning the resting position (understood mistakenly as a neutral position: the tongue lying behind the lower incisors). In

[10] By various authors the swallowing action takes place from 800 to 3,000 times per day (Proffit and Fields 2001, Mackiewicz 2002). It is also possible to calculate the estimated time that the tongue is in the rest position about 20–22 hours per day.

the conducted study several patients (with a normal swallowing and TRP pattern) admitted that they intentionally strive to keep the tongue at the floor of their mouth, since they were advised (by teachers, trainers or even, which may raise amazement, by a speech therapist!) to perform such a posture in order to obtain a correct articulation.

The results presented in this article, provoke further questions to be asked, which are relevant to the conduction of the speech therapy. For example, whether there is a critical age for the treatment of a disturbed pattern of swallowing and tongue rest position? Naturally, a therapy should be undertaken as soon as possible, before the formation of the dental arches on the one hand, and the development of the phonetic-phonological system of the child on the other hand. Speech therapists' practical experience shows that the change of functional patterns is possible at any age, as long as the patient's anatomical structures and an overall condition permit (presumably, the myofunctional therapy will be accompanied by the need to perform a surgical frenotomy and/or undergo an orthodontic treatment). A functional therapy is a prerequisite for the success of the articulation therapy; however, there is no evidence that improving functional conditions of an adult patient would thus improve his/her articulation insofar as required (similarly as it happens after frenetomy or after surgical prognathism treatment: patient does not receive standard articulation immediately and spontaneously, despite the change in anatomical structures; persisted motor patterns of speech in fact will not become changed without speech therapy; see Gommerman and Hodge 1995). Both therapeutic paths, the myofunctional and the articulatory one, are necessary to obtain normative speech in a patient with the functional dyslalia.

Taking all these consideration into account, further discussion about the logopaedic practice could be put forward, posing the following questions: whether a speech therapist and a patient always need a specific set of exercises or some technical support in the training of the speech organs? Do exercises involving the tongue muscles in a different way than the one used during primary functions and the speech can improve articulation? Finally, in the light of contemporary studies, should we examine the speech organs motility using some arrangements (eg. "scroll" or "pin"[11]), which do not appear in the physiology of mastication, swallowing, breathing and speech?

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[11] Cf. comments of D. Pluta-Wojciechowska on the exercises involving ejecting a narrow tongue outside the mouth: Pluta-Wojciechowska 2009, 2011b, 2013).

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