

Functional disorders of the masticatory organ: etiology and symptoms

Zaburzenia czynnościowe układu ruchowego narządu żucia – etiologia i objawy

Grzegorz Kogut, Andrzej Kwolek

Key words

facial pain, headache, mandibular dysfunction, parafunctions, temporomandibular joint, TMJ disc displacement

Summary

The paper presents a review of the literature on the functional system disorders of the masticatory organ. Anatomical structures and physiological functional mechanisms of the system were described. General and regional factors responsible for functional disorders as well as pathological structural changes of the temporomandibular joint were discussed. The current findings show that the changes are accompanied by both objective and subjective symptoms which can occur not only in the masticatory organ but also in the area of face, head hearing and sight organs, neck, nape, acromial belt as well as in some remote regions of the motor system. The specific character of disturbances results from jaw functions, i.e. a system of jaw movements in three dimensions, jaw joints with ligaments, muscles and occlusion. In many patients disturbances within this organ may occur without clinical symptoms. Very often the organism reaches the so-called limits of adaptation but further negative impact may put the whole system out of order. The patient with acute symptoms of the chewing organ disturbances diagnostics and therapy may become a real problem for a medical team. Untreated or ignored functional disturbance may develop into mioarthropathy with exaggerated pain. One third of teenagers and over half of adults show the first symptoms of the discussed disturbances. They include crackles in jaw joints, deflection of jaw in central line while opening the mouth, pain during palpation examination of joints and muscles of the chewing organ. The main cause of disturbances is, first of all, a traumatizing occlusion, but also malfunctions and parafunctions of the chewing organ. The lack of balance in the load of muscular system, especially for a longer period of time, causes asymmetrical structural changes in joints. There is a rule supported by the research: the fewer teeth, the bigger disturbance. Therefore, an exact functional analysis is necessary to make a correct diagnosis.

Słowa kluczowe

ból twarzy, ból głowy, dysfunkcja narządu żucia, parafunkcje, staw skroniowo-żuchwowy, przemieszczenie krążka stawu skroniowo-żuchwowego

Streszczenie

Na podstawie aktualnej literatury przedstawiono problemy zaburzeń czynnościowych układu ruchowego narządu żucia. Opisano struktury anatomiczne i fizjologiczne mechanizmy czynnościowe tego układu. Wskazano czynniki ogólne i miejscowe wywołujące zaburzenia czynnościowe oraz zmiany patologiczne struktur stawu skroniowo-żuchwowego. Aktualny stan wiedzy wskazuje, że zmianom tym towarzyszą objawy obiektywne jak i subiektywne, które mogą być umiejscowione nie tylko w narządzie żucia, ale również w obrębie twarzy, głowy, narządu słuchu, wzroku, okolicy szyi, karku, pasa barkowego, jak również w odległych okolicach układu ruchowego. Szczególny charakter zaburzeń wynika z czynności żuchwy, tj. istnienia systemu powiązanego z jej ruchami w trzech kierunkach, stawu skroniowo-żuchwowego z więzadłami, mięśni i zwarcia. Zaburzenia w obrębie tego narządu u wielu pacjentów mogą przebiegać bez objawów klinicznych. Często organizm osiąga tzw. granice przystosowania, ale dalszy negatywny wpływ może prowadzić do rozregulowania całego systemu. Pacjent z ostrymi objawami zaburzeń narządu żucia może stanowić duży problem dla zespołu leczącego. Nie leczone lub zbagatelizowane zaburzenie czynnościowe może rozwinąć się w mioartropatię z uciążliwymi objawami bólowymi. Jedna trzecia nastolatków i ponad połowa dorosłych wykazuje pierwsze objawy omawianych zaburzeń. Należą do nich trzaski w stawach skroniowo-żuchwowych, zbaczanie żuchwy w linii pośrodkowej podczas otwierania ust, ból przy badaniu palpacyjnym stawów i mięśni narządu żucia. Główną przyczyną zaburzeń jest przede wszystkim traumatyzująca okluzja, ale również dysfunkcje i parafunkcje narządu żucia. Brak równowagi w obciążeniu układu mięśniowego, szczególnie przez dłuższy czas, powoduje asymetryczne zmiany strukturalne w stawach. Istnieje poparta badaniami reguła: im mniej zębów tym większe zaburzenie. Celem postawienia właściwej diagnozy niezbędna jest więc dokładna analiza czynnościowa.

Introduction

Effective prophylaxis and modern treatment methods in dental practice

have led to the achievement of good control of acute odontogenic pain. Despite this, there have been an in-

creasing number of patients with facial pain and headache caused by organic as well as functional and psy-

chomastic factors. Interdisciplinary management of pain in these patients involves, first of all, the diagnosis of functional disturbances and disorders in the oral cavity and the face, i.e. in the stomatognathic system.

The functioning of this system may occur under physiological and pathological conditions. Biological reaction of the tissues participating in this function can occur within clinically acceptable limits or lead to pathological symptoms. This refers both to the tissue structure and the functions, which these tissues participate in. The physiological state is asymptomatic. A transition from the physiological into the pathological state is smooth. Practically, occurrence of symptoms may be considered a demarcation line. Pathological state can be recognised by an impaired harmony between the form and the function in given tissues. However, the development of symptomatic pathological state depends on many factors, including tissue reaction, time and force of biomechanical effects, as well as patient's personality. Adaptation properties of the stomatognathic system are also important. Their importance becomes evident when considering a well preserved chewing function of the masticatory system in patients, in whom conditions of dental arcs occlusion are far from acceptable physiological patterns. Concurrently, there are patients, who seek orthopaedic or physiotherapeutic help due to a lack of or improper stomatologic treatment.

Anatomy and physiology of the masticatory motor system

The masticatory motor system consists of anatomical elements that distinguish it from other parts of human motor system. The first, specifically structured, element is the temporomandibular joint (TMJ); further parts include the muscles, the teeth and the parodontium.

The temporomandibular joints are the only articulations coupled not only functionally, but also anatomically, because of their permanent connection by the mandibular body and ramus. The following structures form this

joint: articular surfaces of the temporal bone and the mandibular condyle, the meniscus, the articular capsule and ligaments. The articular surface of the temporal bone is formed by the anterior segment of the mandibular fossa and the articular tubercle located anteriorly to this segment. Of the mandibular fossa, lying anteriorly to the external auditory meatus, only the anterior segment (the articular fovea) forms the articular surface, which is lined by fibrous cartilage. The posterior segment contains connective tissue, adipose tissue, and – sometimes – a part of the parotid gland can penetrate into it. On the mandible, the articular surface is formed by the ellipsoidal mandibular condyle, and is directed upwards and anteriorly thus facing the articular tubercle. The meniscus, built of fibrous cartilage, has a form of an oval plate, thin inside and thicker peripherally (3–4 mm), crescent round with the articular capsule. The meniscus divides the articular cavity into two completely separate spaces located one over the other. It constitutes a mobile acetabulum that, together with the mandibular condyle, is shifted during mouth opening by the lateral pterygoid muscle out of the articular fovea onto the tubercle. The articular capsule forms a funnel-shaped sac with its tip directed downwards; it encompasses the articular tubercle and fovea on the top, and the mandibular neck at the bottom. It is a loose envelope and thus enables protrusion of the mandibular condyle from the articular fovea forwards onto the articular tubercle during mouth opening. The temporomandibular joint is consolidated by three ligaments. The lateral ligament originates on the zygomatic process of the temporal bone, narrows and attaches to the lateral and posterior side of the mandibular neck. The stylomandibular ligament runs from the styloid process to the posterior rim of the mandibular ramus. The sphenomandibular ligament, located on the medial side, spreads from the sphenoid bone to the internal surface of the mandibular ramus and the lingula of mandible. Four pairs of muscles, called muscles of mastication, involved in moving the mandible to bite,

cut and crush the food, are directly associated with the TMJ. These muscles constitute not only a functional, but also a common phylogenetic group, because they stem from the muscular coat of 1st branchial arch and are supplied by the nerve of this arch – the third branch of the trigeminal nerve. The temporal muscle is the largest and the strongest muscle of this group. It originates on the temporal bone, on the medial wall of the temporal fossa, temporal fascia and the zygomatic arch. Its fibres converge to form a flat, strong tendon, terminating on the coronoid process and encompassing it bilaterally. The masseter muscle is a short, thick muscle located on the lateral aspect of the mandibular ramus. The medial pterygoid muscle is located inferiorly from the mandibular ramus, is a thick, quadrangular muscle, originates in the pterygoid fossa of the palatine bone and the maxilla, and attaches to the medial surface of the mandibular angle. The lateral pterygoid muscle is situated in the subtemporal fossa. It starts on the sphenoid bone, the pterygoid process and the subtemporal surface of the maxilla. Its fibres travel posteriorly and laterally and terminate on the condyloid process of the mandible, while fibres of the upper head attach to the anterior aspect of the articular capsule and the meniscus. The actions of both heads of the distal attachment of this muscle are strictly coupled; disturbances of this coupling are considered one of the causes of sounds occurring in these joints. The temporal, masseter and medial pterygoid muscles occlude the jaws, whereas the lateral pterygoid muscle protrudes and slightly retracts the mandible. Apart from this muscle, also oral cavity floor muscles open the jaw; mandible's weight contributes to this process as well^{1,2,3,4}.

The TMJ movements depend on joint's structure, cooperation of the muscles and on both dental arches. The movements in the right and left articulation always occur simultaneously, where articular spaces of both joints form a single, closed articular chain. In humans, three movement directions can be distinguished:

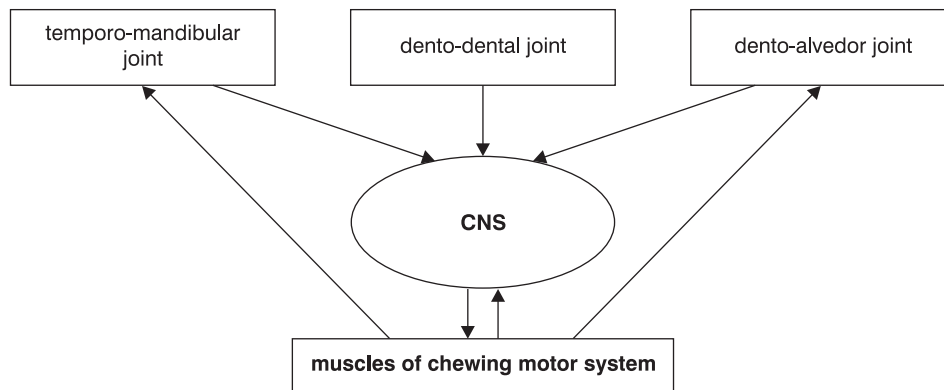


Figure 1
The influence of disturbances in three „joints” of chewing motor system on the functions of muscles

- 1) protrusion or retraction of the mandible – sleigh-like or sliding movements,
- 2) lowering and elevating the mandible – opening and closing movements,
- 3) lateral movements (transtrusion), i.e. masticatory movements.

The TMJ formation varies individually and is associated with dentition structure and type of dental occlusion. The teeth have a limited capability of adjustment, thus this role falls to the temporomandibular joint, which constitutes this most plastic part of the system, adjusting to the conditions by remodelling. It is, however, still controversial if and to what degree the TMJ undergoes marked adaptive processes or pathological morphologic changes, particularly in the adults³.

The function of masticatory system muscles is influenced not only by stimuli arising from these muscles and the temporomandibular joints, but also by the teeth and the parodontium via parodontal proprioceptors. This phenomenon is a basis of the concept postulating existence of “three joints”, introduced by Held; this concept allows an easier understanding of the physiology and pathology of the system (Figure 1). According to this concept, “three joints” can be distinguished in the motor system of the masticatory apparatus: the temporomandibular joint, the dento-alveolar joint, and the dento-dental (interdental) joint. Yet, only the temporomandibular articulation corresponds with the current definition of a joint. Despite this fact, defining the two remaining joints is physiologically justi-

fied. Stimuli acting on the dento-dental as well as the dento-alveolar joint induce, via proprioceptors, activation of appropriate muscles, similarly to stimuli acting on articular surfaces of the temporomandibular joints. Disturbances within these three joints affect the function of the masticatory system muscles via the central nervous system. There is a strict functional coupling among these joints. Its disturbance plays a crucial role in inducing masticatory apparatus dysfunction⁴⁻¹¹.

The temporomandibular joint is situated in a close proximity of structures of the external, middle and internal ear. Many authors have indicated a relationship between objective and subjective disturbances of the organ of hearing and pathological processes occurring within the TMJ. This interrelationship is caused by their close proximity, common innervation and blood supply. As a result of chronic injury or during an inflammatory state, narrowing of the space separating the articulation from the external ear can occur. In this space, there are vessels and nerves penetrating through the petrotympanic fissure and the posterior wall of the articular capsule. Therefore, otic symptoms – hearing loss, tinnitus, clicks, radiating earache – are frequently reported in patients with changes in the temporomandibular joints. An inflammatory state within the joint induced by a single major injury or repeated minor injuries can be a direct cause of these symptoms^{1,9,10,12}.

Systemic and local factors inducing functional disturbances of the masticatory apparatus

Disturbances in functioning of one of the three joints induce a dysfunction of the other ones. This leads to a disturbance of function of the masticatory apparatus muscles, mediated by the central nervous system. This disturbance may also result from an increased muscle tone of central origin. The impaired muscular activity is followed by disturbances of functioning of particular joint. Long-term functional disturbances lead to organic changes in particular parts of the masticatory apparatus motor system. Micro- and macro-injuries induce cellular response of the tissues. Remodelling and/or degenerative changes occur. Remodelling is defined as a change in the shape of articular surfaces without interruption of their continuity and without bone denudation, whereas degeneration involves cases, where damage of the articular surface and bone exposure are present. Remodelling of the TMJ meniscus involves a change of its shape (thinning, enlargement or adhesions), while perforation is considered to be a sign of degenerative changes^{3,6,13-16} (Figures 2 and 3).

In the last years, there have been an increasing number of patients (approx. 50% of the adult population) with functional disturbances of the masticatory apparatus^{5,17-22}. Factors inducing these disturbances are divided into systemic and local. Among systemic factors, the key role is attributed to the psychogenic factor. Civili-

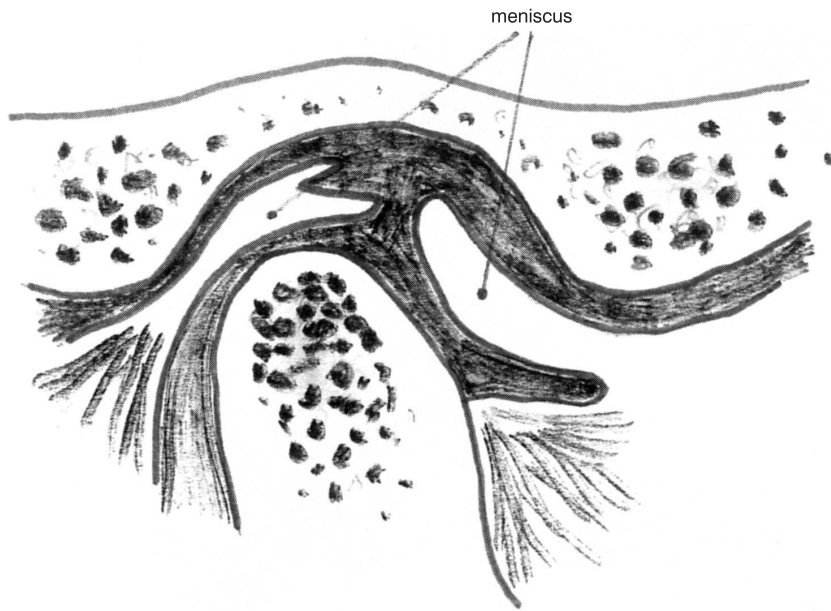


Figure 2
Perforation of disk

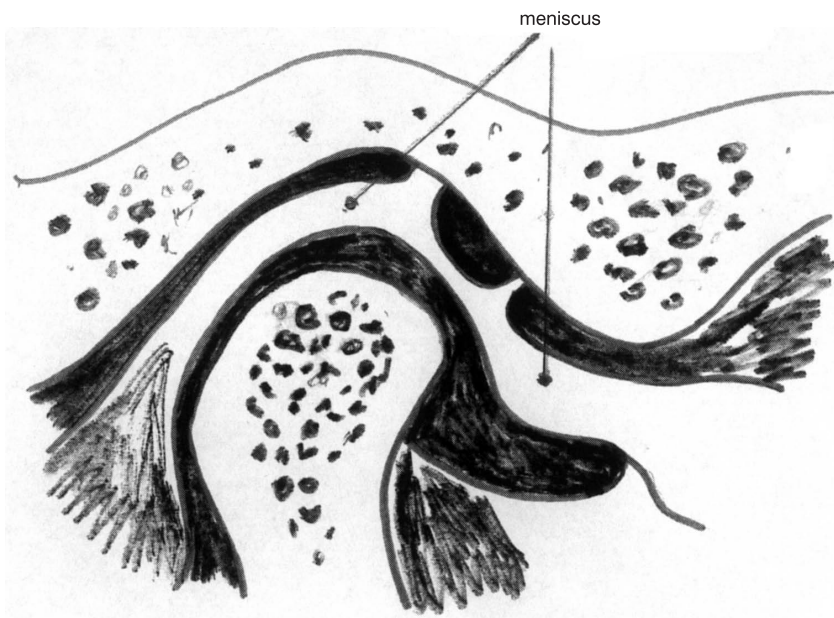


Figure 3
Disk adhesions

zation stress and emotional states increase muscle tone. Adaptation possibilities of the masticatory motor system are also altered in these situations (Figure 4), and the frequency of parafunctions (movement habits) development simultaneously increases. Therefore, the widely known sayings of jaw clenching or grinding teeth of anger become clear^{5,15}.

During prolonged stress, painful or painless dysfunction of the masticato-

ry motor system can occur. Patients often accept occlusion disturbances for years, and painful symptoms of the disturbances can become evident not earlier than by significant stressful situations (exams, misfortunes at work and in private affairs).

Systemic diseases with symptoms of masticatory apparatus dysfunction include neurological disorders, endocrine disorders, osteoporosis, infectious diseases as well as

genetic factors and developmental malformations^{3,4,23}.

Local factors are:

1. Occlusion disturbances, i.e. disturbances in the dento-dental joint. They are caused by a loss of adjacent points between the teeth, erupting wisdom teeth, and – primarily – partial loss of teeth. Disturbances in this joint are also observed in cases of malocclusion and may also be iatrogenic, resulting from orthodontic or prosthetic malpractice^{24–26}.
2. Changes in the TMJ – disturbances of mandibular condyles position or compromised function of the meniscus⁴. The following factors may be considered as causing uneven loading of the TMJ: prolonged, habitual chewing on one side, fixed position during sleep with translocation of the mandible sideways or forwards (e.g. a habit of sleeping on the abdomen), external head trauma causing damage of osseous elements (fundus of the articular fossa is very thin and sensitive to trauma) as well as of the menisci^{27–30}.
3. Local factors favouring occurrence of occlusal and non-occlusal parafunctions. Occlusal parafunctions, i.e. habitual jaw clenching and grinding teeth (referred to as bruxism) lead to chronic micro-injury and pathological attrition of teeth. They may be aggravated by stress and nervousness³⁰. Non-occlusal parafunctions are movement habits that do not involve contact of the opposing teeth. These include tongue parafunctions, biting the lips and buccal mucosa, biting one's nails, prolonged gum chewing on one side. Both cases (occlusal and non-occlusal parafunctions) involve psychogenic as well as specific local factors^{5,15}. Diagnosis of a parafunction is based on the history and determination of effects of this parafunction within the oral cavity. Parafunctions are frequently performed unconsciously; thus periodic self-control or observation of the patient by his relatives (e.g. grinding teeth during sleep) is necessary. Diagnosing parafunctions and informing the patient about

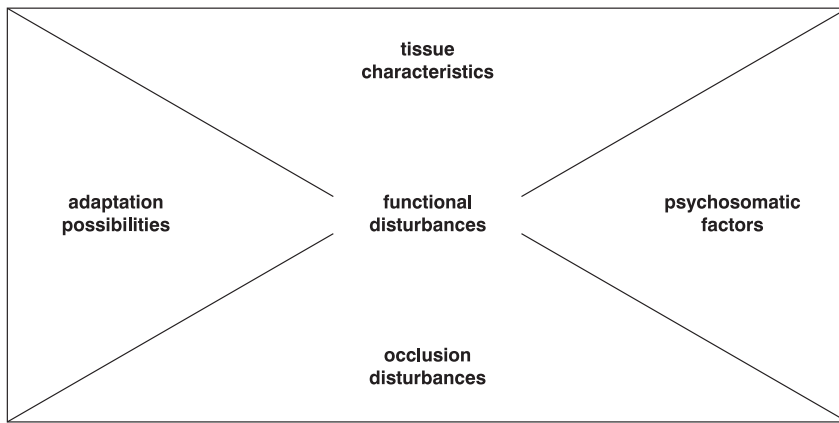


Figure 4
Problems in functional disturbances of chewing system

the fact of their existence are required for the therapy of masticatory apparatus dysfunction.

Symptoms of the dysfunction

Symptoms of functional disturbances of the masticatory apparatus may be localised in particular “joints” of the stomatognathic system as well as in the muscles associated with this apparatus and located in its closest proximity (muscles of the head, neck, shoulder, back)¹⁵ (Figure 5). Pathological attrition of teeth and positive results of grinding teeth tests are very frequently observed in the “dento-dental” joint. It is also difficult to unequivocally determine changes in the dento-alveolar joint in cases of functional disturbances; however, it is known that they favour the occurrence of the following symptoms:

- loosening of a group or single tooth,
 - translocation of teeth,
 - denudation of necks of the teeth and occurrence of wedge defects,
 - alveolar bones hypertrophy.
- Dysfunction of the temporomandibular joints may result in the following changes:
- disturbances of mandibular condyles mobility without joint sounds,
 - pathological joint sounds, i.e. cracks, clicks,
 - pain on pressure,
 - intraarticular disturbances.

Intraarticular disturbances comprise biomechanical disturbances of sliding movements associated with damage to

the meniscus, the articular capsule and articular surfaces of the mandibular condyle or tubercle. They may be accompanied by distention, disruption, adhesions or synovitis. Translocation of the meniscus occurs most frequently forwards or forwards and medially with or without its blockade. Presence or absence of joint sounds in the TMJ neither confirms nor excludes its disorders. Cracking in the joint is an unpleasant acoustic symptom; it is often observed as late as in advanced stages of degenerative osteoarthritis. Click is present at the time of jaw opening as a result of slipping of the meniscus anteriorly onto the mandibular condyle. Clicks present during jaw closing occur, when the meniscus re-translocates. If the meniscus remains translocated and does not return onto the condyle, jaw protraction is limited and the clicks subside^{31–37}.

In the muscles of masticatory apparatus and the surrounding muscles, such symptoms as the following can occur:

- sensation of fatigue and so-called early-morning muscle stiffness (predominantly of the masseters), observed in patients with jaw clenching and grinding teeth habits,
- muscular hypertonia,
- myalgia on pressure,
- muscular hypertrophy (quadrangular face),
- muscle tension headache^{15,38}.

Symptoms of masticatory apparatus dysfunction are accompanied, according to various authors in approx. 40–60%, by chronic headache. In 96% of these patients, pathological joint

sounds in the TMJ and disturbances in normal mobility of the mandible are observed. Headache is always accompanied by more or less pronounced attrition of teeth resulting from occlusal parafunctions. The pain may be located in the temporal, frontal, parietal or suboccipital region^{39–43}. It is a localised muscular pain characterised by the presence of so-called trigger points in the muscles. Stiff, hypersensitive bundles of muscular fibres correspond to these points. Pathomechanism of trigger points is not completely known. It is suggested that some nerve endings in the muscles may become sensitive in response to allo-genic substances and form a demarcated zone of hypersensitivity. Trigger point is a very restricted area, where several motor units seem to undergo a process of contraction, which, however, does not induce a contraction of the whole muscle. A characteristic feature of trigger point is that it is a source of deep pain and may induce secondary stimulation of neurones mediating the process of pain sensation. If a trigger point stimulates centrally a group of converging sensory interneurons, this stimulation may result in referred pain. This pain is frequently described by the patients as tension-type headache. Although palpation of trigger points elicits pain, this sensitivity is not the most frequent complaint reported by the patients, who mainly complain of altered autonomic sys-

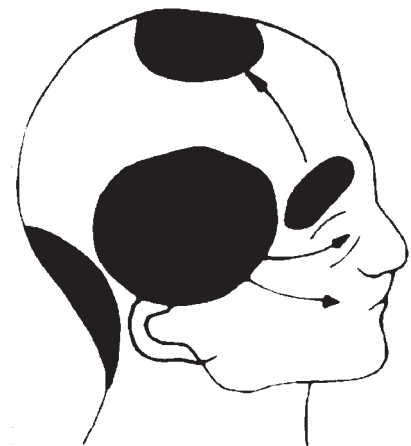


Figure 5
Localization (black areas) and radiation (arrows) of headache connected with malfunction of motor system of chewing organ (Kleinrok 2004)
 (With permission of WARSAW VOICE S.A.)

tem reactions induced by central activation of this system by the impulses arising from trigger points. Frequently, patients are not aware of the presence of trigger points; however, they do experience referred pain.

Trigger points can induce disturbances of the autonomic system function not only in a form of referred pain, but also as secondary hyperalgesia, protective muscular co-contraction, or even pathological autonomic reactions (vascular changes, lacrimation disturbances – most often unilateral). In cases of secondary hyperalgesia, sensitivity to touch is observed on the scalp⁴⁴.

In patients with functional disturbances of the masticatory motor system, difficulties with breathing, paroxysmal palpitations and gastrointestinal disturbances also occur¹⁰.

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Address for correspondence

Grzegorz Kogut, MD, PhD
Institute of Physiotherapy, Rzeszów University
ul. Warszawska 26A, 35–205 Rzeszów, Poland

*Translated from Polish
to English language:
Marcin Tutaj, MD*