

THE DIVING MOUTHPIECE AND THE CONDITIONS OF THE TEMPOROMANDIBULAR JOINTS. PRELIMINARY STUDY

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ABSTRACT

The article presents the results of research on the effects of a long-term exposure to non-physiological location of anatomical elements of the masticatory organ in the course of diving. The said exposure is connected with the utilisation of various types of diving mouthpieces.

The study was conducted on 186 professional divers manifesting various conditions occurring immediately upon diving completion and connected with the temporomandibular joints and muscles lifting the mandible. The most frequently reported pain affected the areas of cervical spine and shoulder ring, earache and reflex pain, an exhausting gritting of teeth.

Key words: masticatory dysfunctions, diving mouthpiece, bruxism.

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INTRODUCTION

The job of a professional diver has a particular effect on the occurrence of dysfunctions of the temporomandibular joints. To a large extent the factor leading to the occurrence of symptoms is a mechanical one and not psychogenic or stress-related. While holding the diving mouthpiece in the mouth, a mechanical strain is generated within the stomatognathic system. When the mouthpiece of a regulator is held by tooth rows (upper and lower teeth), the mandible automatically distances itself from the jaw and moves to an advanced position, thus maintaining a non-physiological location.

Since the mouthpiece of a typical rebreather weighs approximately 0.25-0.30 kg, it is quite obvious that it can be the cause of excessive load on the temporomandibular joints and an incorrect continuous tension of the muscles lifting the mandible.

An additional load is generated by asymmetric water resistance exerted on the LP hose of an open-circuit regulator (fig. 1) or LP hoses of closed-circuit or semi-closed circuit apparatuses – regulator (fig. 2) – here symmetrical

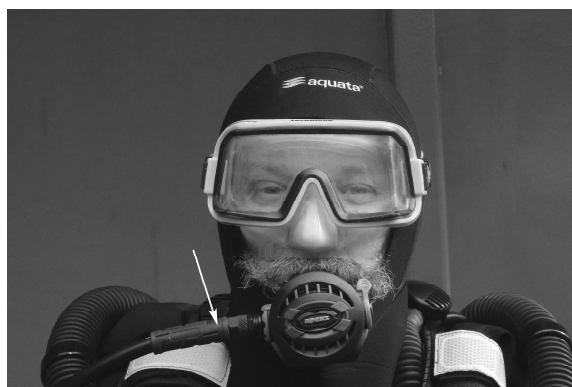


Fig. 1. Rebreather – open circuit (the authors' own photos). The arrows show the directions of additional forces during movement in water.



Fig. 2. Respiratory loop of a rebreather (the authors' own photos). The arrows show the directions of additional forces during movement in water.

Due to the described factors, many recreational divers, mainly professional or military, complain about various symptoms occurring following the performance of a dive. Of course, if dives are carried out frequently, as it is the case with professional divers, the symptoms of dysfunctions become more intense.

The ailments mainly affect the head, ears, shoulder girdle, but may also occur in distant areas of a human organism. Until the present time, disorders that occur in divers have not been considered and analysed as disorders of the temporomandibular joints and the entire masticatory system. Each of the disorders combined acute symptoms with some form of a diving illness, with no visible connection with the shape and type of a mouthpiece used with the rebreather. Utilisation of currently available mouthpieces generates incorrect myofascial tensions and, in consequence, pain in the head and neck area [1]. The areas and types of symptoms are presented in fig. 3.

A diving mouthpiece is a very significant element that imposes a non-physiological position of the mandible (lower teeth) in relation to the jaw (upper teeth). Such an improper position increases the tension in masticatory muscles, mainly the muscles lifting the mandible (masseter, temporal, medial pterygoid and lateral muscles, sternocleidomastoid and digastric muscles). An increased tension generates pain and other symptoms [5,6].

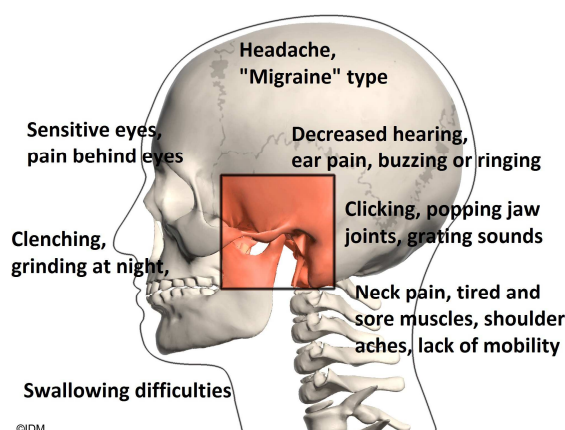


Fig. 3. The most common symptoms of dysfunctions of the masticatory system.

The image of symptoms in the temporomandibular joints is highly complex with their intensity increasing and becoming more and more diversified along with the improper functioning of the masticatory system. The adaptive capabilities of an organism to certain irregularities depends on numerous factors. They tend to be greater in younger individuals, hence in the age group of 20-30 years the subjects did not usually report any symptoms [2,7].

MATERIAL AND METHODS

The study was participated by 186 professional divers at the age between 20-60 years, 3 females and 183 males. 33 subjects belonged to an age group of between 20-30 years. These individuals reported relatively mild symptoms, as they are characterised by high adaptation capabilities to such irregularities.

The research was performed on active divers with many years of experience. The patients took part in a survey – they were asked to fill in a questionnaire prepared by the authors and answer the provided questions.

186 subjects were divided into 2 groups:

- group that described the mouthpiece as comfortable
- group that described the mouthpiece as uncomfortable

Among 186 participants 32 reported that the mouthpiece they utilised was uncomfortable (23%), 10 of them used an anatomical mouthpiece and 22 a standard one. 154 subjects assessed the mouthpiece as comfortable (77%) – 7 mouthpieces were anatomical and 147 were standard. One person among those researched reported that the mouthpiece was custom-made on the basis of jaw models, nonetheless the subject noted that he bit the mouthpiece tightly and experienced pain in the face and a limited capacity of opening the mouth upon diving completion.

Another person reported chronic maxillary sinusitis – a condition that may lead to recurring headaches. The said condition constitutes a contraindication to performing diving activities, as it may lead to sinus barotrauma.

In the survey prepared by the authors the respondents were asked to specify their conditions – their character, time and place of occurrence. The analysed

questions were concerned with headaches, ear conditions, cervical spine and shoulder girdle pain, restricted mouth opening, gritting of teeth on the mouthpiece, biting off of appendices, crackling noises in the temporomandibular joints and the use of analgesics.

It was decided to omit in the analyses pain in lumbar spine noted in several questionnaires, as it could have been caused by the use of the diver's weight belt. Moreover, the literature mentions it as a condition resulting from an incorrect work of the temporomandibular joints.

The most commonly experienced symptom reported in the questionnaire was pain. The participants described pain of various areas of the head, as well as a strong earache and tinnitus, pain in facial muscles, cervical spine and upper limbs. The second quite significant symptom consisted in ear conditions, not only pain but also tinnitus, impaired hearing, squealing, rumbling and crackling noises.

Moreover, the divers reported ophtalmic symptoms – pain, sensation of an eye being pushed out of the eye socket. Another common symptom involved a hindered ability to open the mouth which lasted for a period of time following dive completion. Besides the listed symptoms there were also non-specific ones, such as difficulties in swallowing. The frequency of reporting particular symptoms in the groups describing the mouthpiece as comfortable and uncomfortable is presented in tables 1, 2 and 3.

An important aspect of the studies remained in the fact that the described conditions appeared in the subjects after a performed dive, hence we can assume that holding a mouthpiece between upper and lower teeth constituted the inducing factor.

Tab. 1.

Frequency of an occurrence of temporomandibular joint disorders (TMJ) in all subjects.		
SYMPTOMS	Number of subjects – UNCOMFORTABLE MOUTHPIECE (32)	% share in the group
Headaches	43	23%
Otologic symptoms, earache	60	33%
Tinnitus, screeches, noises in the ears	39	21%
Pain in cervical spine and shoulder girdle	67	36%
Limited ability to open mouth	27	14.5%
Gritting of teeth on the mouthpiece	47	25%
Crackling and cracking symptoms in both tmjs	18	10%
Limited ability to open mouth	27	14.5%
Necessity to administer analgesics	23	12%
Symptoms occurring upon diving completion	41	22%

Tab. 2.

Frequency of TMJ dysfunctions in the group with an uncomfortable mouthpiece.		
SYMPTOMS	Number of subjects – UNCOMFORTABLE MOUTHPIECE (32)	% share in the group
Headaches	21	66%
Otologic symptoms, earache	26	81%
Tinnitus, screeches, noises in the ears	24	75%
Pain in cervical spine and shoulder girdle	20	62.5%
Limited ability to open mouth	20	62.5%
Gritting of teeth on the mouthpiece	18	56.2%
Crackling and cracking symptoms in both tmjs	11	34%
Limited ability to open mouth	20	62.5%
Necessity to administer analgesics	20	62.5%
Symptoms occurring upon diving completion	15	46%

Tab. 3.

Frequency of TMJ dysfunctions in the group with a comfortable mouthpiece.		
SYMPTOMS	Number of subjects – COMFORTABLE MOUTHPIECE (154)	% share in the group
Headaches	22	14%
Otologic symptoms, earache	34	22%
Tinnitus, screeches, noises in the ears	19	12%
Pain in cervical spine and shoulder girdle	43	28%
Limited ability to open mouth	7	5%
Gritting of teeth on the mouthpiece	27	18%
Crackling and cracking symptoms in both tmjs	22	15%
Limited ability to open mouth	7	5%
Necessity to administer analgesics	21	14%
Symptoms occurring upon diving completion	8	5%

On the basis of the analysed questionnaires, it was confirmed that in those subjects whose mouthpieces were identified as being uncomfortable, all of the symptoms were much more intense and concerned a greater percentage of participants within the group. In the group that described the mouthpiece as comfortable, the symptoms also occurred, however they were less bothersome and concerned a lesser number of participants.

DISCUSSION OF RESULTS

The market offers a wide variety of diving mouthpieces, which can be divided into anatomical (adjustable) and standard [4]. Both these categories generate burdensome conditions. Therefore it is required to reflect on the design of an ergonomic mouthpiece that will not cause such irregularities as an increased tension of masticatory muscles or significantly change the spatial positioning of the temporomandibular joints.

On the basis of research, observations and clinical experience, the authors propose a list of features characterising a fully ergonomic diving mouthpiece:

- Ensures a stable support of upper and lower teeth.
- The occlusal plane of lower teeth should be slightly withdrawn (to prevent the diver from

moving the mandible forward while gritting the teeth for the purpose of holding the mouthpiece).

- A triangular, supporting occlusal surface in lateral sections, if after biting on the mouthpiece the obtained position is with the mandible pushed forward.

Mouthpieces placed in the oral cavity should eliminate the Christensen phenomenon presented in fig. 4. If during mandibular advancement the lateral teeth are supported, the masticatory muscles will not be subject to an increased tension.

While designing the mouthpiece it is necessary to pay attention to the shape and height of its outer edges in order to prevent irritation or cutting of the periodontal tissues (periodontium). One of the participants particularly emphasised such ailments in his questionnaire, also the authors had similar problems in the utilisation of mouthpieces.

In designing a mouthpiece, it is essential to observe point 2, which mentions the necessity of withdrawing the mandible (lower jaw) to the physiological position. The advancement of the mandible for the purpose of holding the mouthpiece causes an incorrect tension in the masticatory muscles and, in consequence, pain [3].

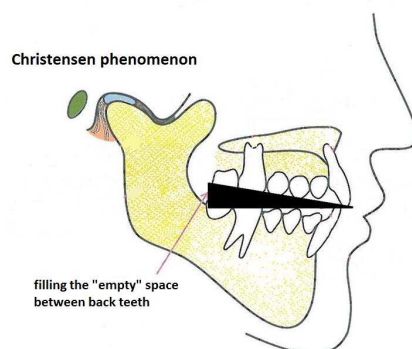


Fig. 2. The elimination of the Christensen phenomenon – provision of a stable support for the lateral teeth (as marked) with an advanced mandible.

Many divers suffer from bothersome symptoms without knowing that they are connected with the dysfunctions of the masticatory system. For this reason the authors believe that it is necessary to conduct further research similar to the presented study.

An improper choice of a mouthpiece may lead to severe conditions, in particular, persistent and chronic pain due to irregularities in the functioning of the temporomandibular joints.

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