Snoring and sleep related breathing disorders

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Abstract *— In group I an individually shaped mouth floor electrode (IME) and in group II an also individually adaptable silicon electrode (MPE) were used for electromyostimulation therapy in patients (n = 12) with obstructive sleep apnea. The treatment was carried out two times daily for thirty minutes per session during daytime hours only. All patients were registered previously and after 8 weeks by 3D-ultrasound. After 8 weeks stimulation an increase of volume of the geniohyoid muscle could be proved in median of 27.6 % in group I and of 24 % in group II. Additionally also in both groups a shortening (contraction) of the muscle in length of 4.7 % in median was measurable, which is important for the opening of the posterior airway. The EMS enables a physiological non-invasive therapy.*

Keywords *— electromyostimulation, individual mouth floor electrode, OSAS, snoring, 3D-ultrasound*

Introduction

Many people suffer from an untreated sleeping disorder. They do not know that in most cases they are snoring and have undiagnosed breathing stops also known as sleep apnea. At the age of 30 years 10 percent of men and 5 percent of women are snoring; at the age of 60 years even 60 % of men and 40 % of women are affected. There exists a significant increase of snoring with age. Due to the noise they disturb others and put their own health in danger: peak values reach 87.5 dB (Guinness book of records 1990) - so the noise is louder than a pneumatic hammer (75 dB). Normally, by breathing through nose or mouth a sufficient oxygen saturation can be achieved, but 2 percent of women and 4 percent of men over 35 years suffer from the dangerous form of snoring with breathing stops (obstructive sleep apnea). Snoring has the origin in the nose or throat due to an obstruction of the airway. The obstruction is caused in the nose (5 % of the cases), by a relaxation of the soft palate (15 %) or in 80 % in a relaxation of the tongue muscles and muscles of the mouth floor. The relaxation of the tongue muscles and muscles of the mouth floor can lead to a complete occlusion of the rear airway with resulting breathing stops. Through the restriction during breathing the inhaled air is accelerated and vibration of the throat soft tissue develops so that the snoring noise occurs. The breathing stops can last longer than a minute, before the person awakes for a short time. Because these breathing stops may occur hundreds of times during one night, no deep sleep phase better known as REM-phase is achieved and the oxygen saturation is not sufficient. For therapy of OSAS next to preventive methods, also medicine therapy is applied, whereas in severe obstructive sleep apnea cases, the nasal continuous positive airway pressure (N-CPAP) is inevitable for treatment. During the last years, also innovative muscle stimulation techniques have became alternatives for therapy of OSAS breathing disorders. In the procedure of electromyostimulation (EMS) the indirect and direct muscle stimulation have to be differentiated. The stimulation efficiency is assumed to have influence on sleeping parameters. In this study It therefore was of interest whether optimized intraoral electrodes had influence on efficiency of the EMS-therapy.

Material and Methods

In a first group of OSAS patients an individually shaped mouth floor electrode (IME) was used for electromyostimulation of the tongue and mouth floor muscles. For producing the intraoral electrode first a pattern of the lower jaw was produced with special casting of the mouth floor. On the basis of this a negative form of the mouth floor was built. On both sides of the geniohyoid and genioglossus muscle a golden electrode was integrated and a feed line was led to the extraoral area [1]. The lingual frenum was excluded from the electrode surface (s. figure 1).

Figure 1: Individual mouth floor electrode (IME)

Figure 2: I-Pulse-stimulation apparatus

The negative form with the attached electrode was additionally stabilized by a biteguard splint. A small self-adhesive electrode in all cases was fixed extraorally in the submental area. The EMS apparatus I-pulse (s. figure 2) was connected with the electrodes.

In a second patient group an also individually adaptable mouth floor electrode (MPE) made of silicon was applied for EMS-therapy by using the same stimulation parameters as in group I. The enoral-cutaneous EMS was carried out with the low frequency stimulation apparatus I-pulse over a period of eight weeks, two times daily for thirty minutes during daytime hours, only. The stimulation intensity in both groups could individually be influenced by the patient himself. For achievement of an efficient recruitment of the muscles, patients were instructed to choose treatment with maximum intensity. Before and after stimulation treatment 3D-volumetric sonographical measurement of the geniohyoid muscle was carried out by B-scan sonography in combination with a 3D-workstation.

Results

All patients (n = 12, average age 50.1 years) totally applied the EMS-therapy. In all patients the geniohyoid muscle could sonographically be identified and three-dimensionally and in volume be demonstrated. As well under IME as under MPE after four weeks EMS-therapy a volume increase in median of 19.6 % (minimum 9.5 %, maximum 27.6 %) was registered, the median after eight weeks IME was 27.6 % and in MPE 24 %. Through the visualization of the muscles in 3D-models the concentric volume increase could be proved which was mainly due to the contraction of the muscles. In both groups, a reduction of the muscles in length of 4.7 % was proved. Due to this fact, an opening of the posterior airway was enabled, so that snoring and breathing stops simultaneously were reduced. The main difference between both electrodes was to be seen in the comfort of application because the IME was fixed like a denture and the MPE electrode had to be fixed by closing the teeth during the 30 minutes stimulation time. The IME could be cleaned like a denture and therefore is especially recommendable for a long time therapy.

Discussion

The EMS enables a non-invasive therapy of OSAS and snoring whereby this form of therapy should regularly be carried out over a period of 8 weeks. In opposite to so far established extraoral stimulation techniques [2], combined intraoral and extraoral electrode techniques and stimulation parameters [3, 4, 5] with this technique an threefold effectiveness enhancement could be verified by using both individually adaptable electrodes (IME as well as MPE). The optimal fixation, adaptation and size of surface of the intraoral electrode therefore occurred to be essential parameters for an effective EMS-therapy in obstructive sleep related breathing disorders. The so far observed reduction of in mean 59% $\pm$ 30% [6, 7] as well as reduction of breathing stops [5] could be improved through the optimized electrodes, because the contraction of the genioglossus and geniohyoid muscle lead to a greater reduction of the oropharyngeal and naso-pharyngeal collapsibility [8]. The proved contraction of the geniohyoid muscle which resulted from this treatment study also explains the reduction of the collapsibility of the posterior airway. The EMS-therapy with optimized individually adaptable electrodes therefore has the potential of a causal physiologically effective and non-invasive therapy of obstructive sleep related breathing disorders.

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