



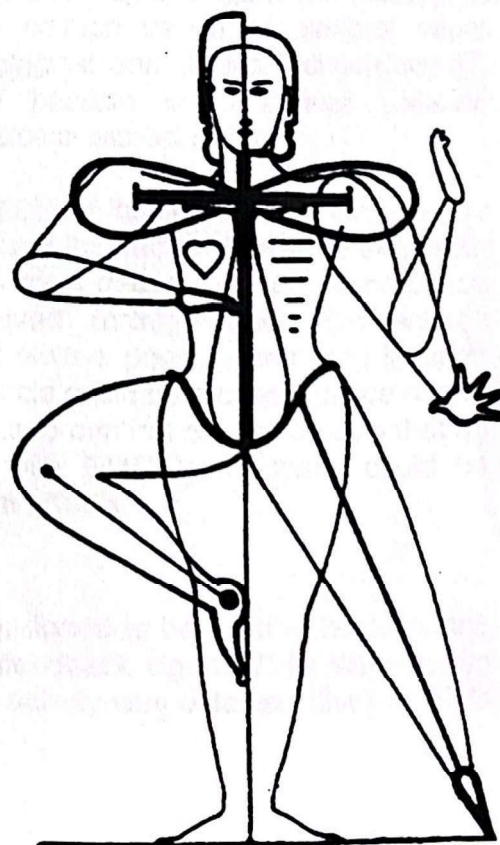
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## PROCEEDINGS

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# EMG BIOFEEDBACK DEVICE FOR DETECTION AND REDUCTION OF DESTRUCTIVE MASSETER MUSCLE FORCE IN PATIENTS WITH NOCTURNAL BRUXISM

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**Abstract** - The problem of nocturnal and diurnal bruxism expressed as clenching and grinding of teeth has been treated in 18 centric bruxers prosthetically and psychologically. For the purpose of the study an EMG biofeedback device was developed implementing electrical stimuli as a painful biofeedback signal applied through EMG detecting electrodes to the site of EMG source (m.masseter). The device was tested in a home environment. Preliminary results of combined therapy were positive in 10 patients who refrain completely from their destructive habit. In two patients the bruxistic activity was reduced in number of episodes and their frequency. Six patients terminated their biofeedback treatment after completion of their prosthetic rehabilitation. The study suggested that the successful therapy of bruxism should combine prosthetic and psychological treatment.

## INTRODUCTION

Nocturnal and diurnal bruxism is a destructive parafunctional habit expressed as rhythmic, yet forceful sustained clenching of teeth and mandibular grinding. It usually develops in stress situations or when a conscious control is reduced. Signs and symptoms of bruxism could be found in children and in the adult population.<sup>1</sup> Enormous force could be generated by masticatory muscles during nocturnal bruxism episodes being even 10 times higher than an average working force. The consequences are destruction of stomatognathic system with symptoms of permanent headache and myofascial pain (Figure 1a). Etiology of bruxism is still not yet fully understood.<sup>3,6,9</sup> In addition, it has neither been agreed upon the therapy of reasons nor rehabilitation of consequences.<sup>9</sup> It is our opinion based on several years experiences that primary reasons for bruxism are psychological and occlusal disturbances<sup>6</sup>. Timely, comprehensive and effective management of bruxism could relieve patients' psychological problems, prevent biological damage and reduce treatment costs.

The key problem in managing bruxism is that more than 80% of individuals are not aware of performing their parafunctional activities or they do not accept this fact<sup>1,6</sup>. Therefore they often start their rehabilitative treatment too late. Several studies have demonstrated that nocturnal bruxism and symptoms related to it can be relieved through EMG biofeedback therapy.<sup>2,3,4,5,8,9,10</sup> The results of such treatment were not always positive and long lasting<sup>4</sup>. Hypothetically it was assumed that the lack of long term effects could be a consequence of only partial therapeutic approach. The purpose of this study was to confirm our hypothesis that an integral prosthetic and behaviour therapy combined with EMG biofeedback could be effective in treatment of bruxism and could have long term effects.

## METHODS

An EMG biofeedback portable device (Figure 1b) was designed to be used at home during sleep<sup>4,7,9,10</sup>. Electrical stimuli were used as a painful biofeedback signal. They were strong enough to wake up a patient when an increase in EMG activity was detected. Surface EMG



electrodes (Figure 1b) were placed above m.masseter being most active muscle during bruxistic activity. EMG detecting electrodes served also as stimulating electrodes. Masticatory muscles force (Figure 2a) resulted in an increase in EMG (Figure 2b). EMG signal was processed and compared to a reference signal adequate to a threshold force level (Figure 2c). When the level was exceeded, a painful train of electrical pulses (train duration 0.5s; frequency 20Hz; pulse duration 0.3ms; current amplitudes up to 20mA) was applied through the electrodes to the detecting site. If the muscle activity was sustained, electrodes were switched periodically from detecting to stimulating part of the EMG processing electronics. The trains of pulses were repeated until increased muscle force was removed.

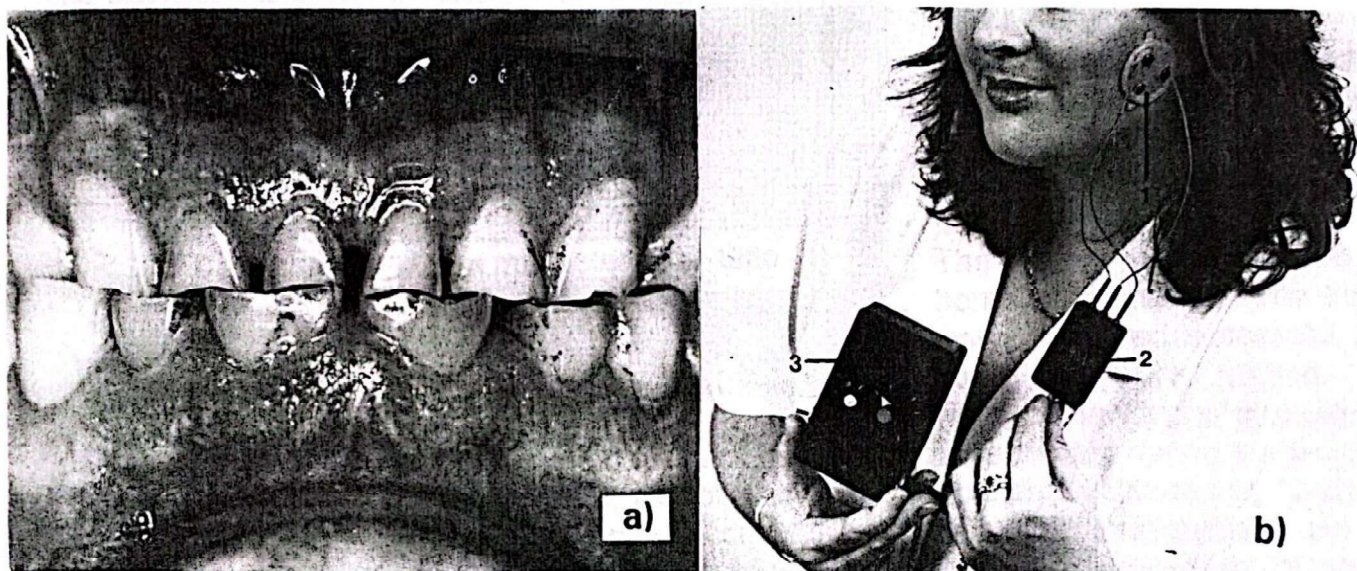


Figure 1: a) Consequences of a destructive bruxism activity - horizontal abrasion with vertical loss of bite height. b) Portable EMG biofeedback device with combined detecting/stimulating electrodes (1) applied to m.masseter; preamplifier (2) and the signal processing unit (3) with a built-in stimulator.

The device was evaluated with a group of 18 centric bruxers who were aware of their bruxism. Before entering the therapeutic programme with the biofeedback device, the patients were treated stomatoprosthetically. Their habits were treated psychologically in their roots and consequences and a true reason for their parafunctional activity was identified. Capabilities to produce bite forces were measured in a clinical environment at the beginning of the rehabilitation programme. Maximum bite force in the region of the first incisor were assessed by a bite force measuring brace based on strain gauge transducers. Additionally, endurance time was measured during a fatigue test.

EMG feedback device was then used at home during sleep until even single nocturnal bruxism episode was detected. The threshold level as well as the level of painful stimulation were individually adjusted. Number of episodes per night, the threshold level and the stimulation amplitude were registered by the patients. In the period from one to twelve months after completion of the rehabilitation programme each patient underwent two consequent night tests using biofeedback device. The therapy was considered successful if two conditions were fulfilled: there were no new signs of bruxism on patients dental system and that the biofeedback device was not activated during the two nights test.

## RESULTS

Average maximum bite force measured in the region of the first incisor was  $507\text{N} \pm 192\text{SD}$ . Endurance was measured at approx. 34% of the maximum ( $151\text{N} \pm 32\text{SD}$ ). The force was



measured until its value dropped to 50% of its initial value or the patient was unable to maintain it. An average sustained force lasted  $386s \pm 275SD$ .

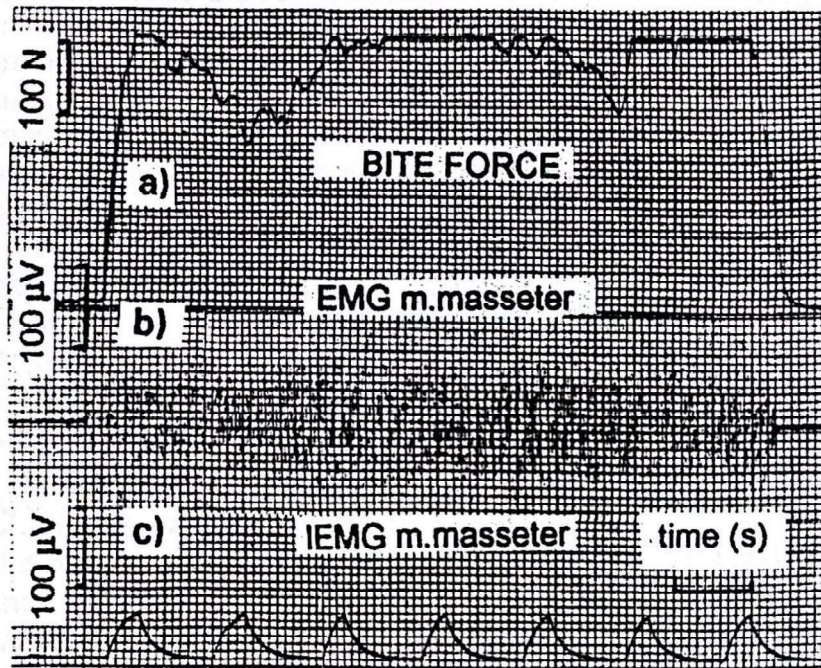


Figure 3. a) Force generated during a sustained bite - b) EMG of m.masseter. - c) Integrated EMG - when a threshold is reached, EMG detecting electrodes become stimulating electrodes. The threshold level is adjusted to a patient's bite force level.

Twelve patients completed the therapy successfully (66.6%) in less than 14 days, six (33.3%) terminated the programme after three to seven days.

The device was evaluated in a home environment. The therapy was considered successful if two conditions were fulfilled: there were no new signs of bruxism on

patients dental system and that the biofeedback device was not activated during the two nights test. According to the dentist's criteria, rehabilitation was completely successful in 10 patients (55.6%). They assessed their therapy successful as they refrain completely from their destructive habits. With two patients the bruxistic activity was reduced in number of episodes and their frequency. Six patients terminated their biofeedback treatment after completion of their prosthetic rehabilitation. On average the device was used for 8.9 nights. All but three patients expressed their positive attitude and experience with the biofeedback device therapy.

The endurance of bruxers was assessed to be far above the values reached by non-bruxers. It was concluded that a biofeedback therapy could be effective in interrupting nocturnal bruxism activity and thus shortening the duration of destructive activity.

## DISCUSSION

Our clinical experiences and the results of this study confirmed that a combined prosthetic and behaviour therapy have to be implemented in a successful therapy of bruxism. We are aware that primary cause should be identified and that biofeedback therapy can remove only parafunctional component of difficulties and not their main cause.<sup>6,10</sup> It is our strong belief that bruxism has to be recognised by the patient and that the therapy becomes his/her conscious decision.<sup>6</sup> The patient's motivation is another crucial element in the rehabilitation which includes changes of his/her behaviour pattern.

Basic principle in the implemented biofeedback therapy was »punishment« in the moment when a non-functional bite force exceeded a predetermined level. Painful electrical stimuli are applied to the site where the forces were generated that is to the masseter muscle. When nocturnal bruxistic activity slowly increases in its intensity it should be at least interrupted if not terminated before destructive forces are fully developed. Biofeedback signal must wake-up and warn the patient to stop the activity consciously. A fear against unpleasant warning should permanently modify his/her behavioural pattern.



myofacial pain and headache. The endurance of bruxers was assessed to be far above the values reached by non-bruxers. It was clinically noticed and confirmed by force measurements that bite forces are lowered after a successful therapy. This is achieved by prosthetic and/or orthodontic corrections of malocclusion (reocclusion) and reduced physical conditions in previously hyperactive masticatory muscles of a rehabilitated patient. The study showed that the biofeedback device could identify and confirm the presence of nocturnal bruxism with patients who are not aware or deny such activity to his/her dentist or even himself. The device was effective also in assessing long term effects. It was easily re-used by the patients in tests after several months. According to our expectation and patients' opinion painful stimulation is negligible, compared to permanent and sometimes unbearable pain in mandibular region, dentition and mandibular joints.

Original solution implemented in the EMG biofeedback device design reduced number of electrodes to three and thus simplified the device application. For a broader use in a clinical practice the device should be additionally miniaturised.

## CONCLUSIONS

Our clinical experiences and the results of this study confirm that patients suffering from bruxism and its consequences should undergo a complete prosthetic and psychological treatment. It is crucial for the success in rehabilitation that this parafunctional habit is transformed from unconscious to conscious action. EMG biofeedback therapy with a painful biofeedback signal can significantly contribute to the success by modifying the patient's behaviour pattern. The designed EMG biofeedback device when triggered by the m.masseter EMG activity during sleep wakes-up the patient and warns him/her on his/her hyperactivity of chewing muscles. The device was easy to apply due to reduced number of electrodes and proved to be effective also in assessing long term effects of the therapy. For the use in a clinical practice the device should be additionally miniaturised.

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