

## TELEMETRIC DIAGNOSIS SYSTEM FOR BRUXISM AND SLEEP DISEASES

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**Abstract:** A telemetric, sensor enhanced tooth splint allows to measure bite force during bruxism events comfortably and in real-time for the first time. The appliance offers a comfortable measurement and recording of the forces during bruxism events during night and day. The measured data is transmitted wireless to a common mobile phone and forwarded to an internet database where it can be accessed by the responsible dentist or psychologist. Real time biofeedback over the mobile phone is possible during daytime. Due to the long time recording during night, therapies for bruxism can be evaluated and individualized. The system will be extended with several sensors for the observation of other sleep parameters.

### Introduction

Often neglected, the medical phenomenon of bruxism is rapidly increasing. Today, 5% to 10 % of the adult population is suffering from bruxism [1,2]. It is responsible for a variety of pain in the orofacial region and causes serious damage of the involved teeth. The main symptoms are a strong wear of the teeth and a tension, not only in the musculature of the face, but in the musculature of the neck and even in the back. A disturbance of the partner and even a tinnitus can be the consequence of bruxism as well. Although there have been more than thirty years of research in this field, there is still no specific treatment for sleep bruxism.

Bruxism is often related to mental causes. The clenching and grinding at night- and as well at daytime is a type of decomposition of stress, fear and frustration. Each subject has to be individually evaluated and treated [3].

The present treatment is done mainly with oral appliances. The patient receives a tooth splint to protect the teeth from severe damage. Pharmacological

treatment is done in some cases as well. Psycho behavioral treatment such as relaxation training is widespread.

Measurement today is mainly made using EMG adhesive electrodes in face, as seen in Fig.1. This is done at a sleep laboratory or with home recording systems. This method, due to the electrodes and cables, is very unpleasant for the patient and affects the sleep quality of the patient. Furthermore about 40 % of the EMG recorded events may not be specific to bruxism [4,5].



Figure 1: Measurement with EMG Electrodes in daily life [6]

As mentioned above, the majority of the bruxism patients have to wear a tooth splint to protect their teeth. The integration of a measurement device into a usual tooth splint is of great value, to provide long time measurement without affecting the quality of life of the patient and to give the patients who suffer from bruxism an instrument to take control over the disease.

## Methods and Materials

A piezoelectric film was placed into the chewing surface of a tooth splint for the measurement of bite force. The film is only 50 micrometer thin. This allows designing a splint which is not thicker than a usual tooth splint. The data amplifying, analog-to-digital converting and digital processing is done by a microprocessor inside the splint. Data are transmitted wireless through a RF-Link at 868 MHz to a so called "sleepwatcher-box", a receiver that can be placed anywhere in the sleeping room or due to miniaturization even in the pocket of the patient. From the sleepwatcher-box the data are transmitted via Bluetooth to a common mobile phone, where the data can be displayed to give a feedback to the patient. Software for the mobile Phone is done in C++ programming language on a Symbian operating system. The data are forwarded automatically via GPRS or UMTS to an internet database. Via a web interface the physicians, these could either be a dentist or a psychologist, can analyze it.

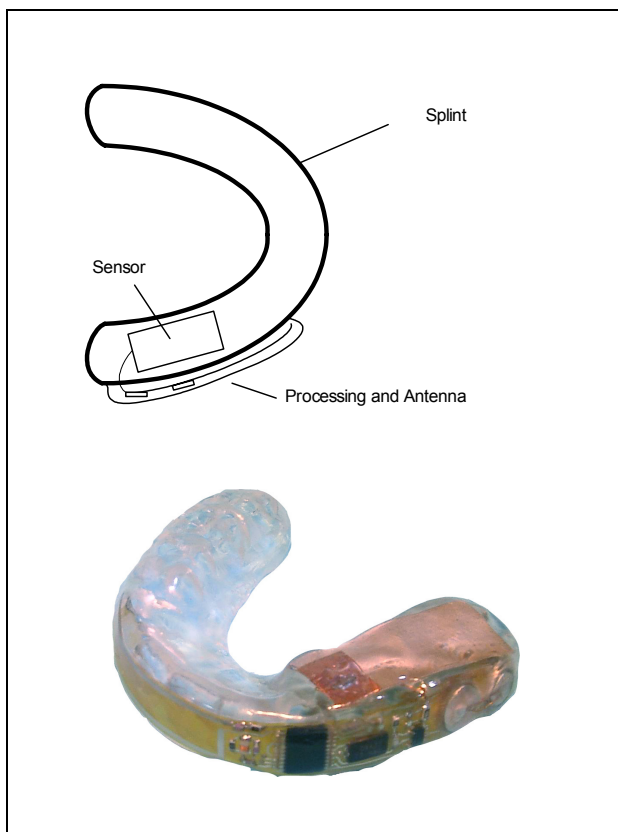


Figure 2: The telemetric tooth splint

The diagnosis system, from the data processing and wireless data transmission to the storage in the internet database is designed and realized fully digital.

Figure 2 shows the design of the telemetric tooth splint and the integration of prototype electronics in a dental tooth splint.

## Results

A complete, telemetric, sensor enhanced tooth splint was developed and tested on humans. It allows the measurement of bite forces during bruxism events comfortably and in real-time without inconvenient cables or electrodes in the face of the patient. The forces are measured directly where they occur: between the teeth. Sensors and fully flexible designed electronics including the antenna are housed inside a common tooth splint. These splints today are prescribed to people who are suffering from bruxism for conserving their teeth and musculature. The developed electronics are miniaturized and can be placed easily in the tooth splint by a trained dental technician, individually for every patient. It offers a high reliability and excellent wearing comfort with the same convenience as a normal tooth splint. The power consumption of the transmitter is extremely low thanks to a power management system. The lifetime of a tooth splint is about two month with only 13mAh of battery capacity. The transmitter records the data to enhance the readout of the data via a USB-interface to a computer. Alternatively the data are transmitted via Bluetooth or a direct connection to a mobile phone. Due to the fully digital design of the system it can easily be extended with other sensors for sleep diseases.

In Figure 3 the complete bruxism diagnosis and therapy system is shown with the telemetric tooth splint, the sleepwatcher-box and a commercially available mobile phone. The full transmission line from the sensor inside the telemetric tooth splint via RF-Link over the sleepwatcher-box, via Bluetooth over the mobile phone and via GSM/UMTS to the internet was realized and tested on humans.



Figure 3: The telemetric bruxism diagnosis System

### Conclusion

Devoid of electrodes in the face of the patient and thus without interfering sleep quality of the patient and consequently altering the result, the measurement for both diagnosis and therapy control can be performed under normal living conditions at patients home. During the night a comfortable recording of the bruxism events is possible. Diagnosis, therapy control and personal entrainment can be performed by the dentist or, in case, the psychologist. Studies with much more subjects, under normal living conditions, are now possible. With the experience of the collected data from a wide base of patients, new therapies for bruxism can be evaluated and individualized.

Another promising approach to help bruxism patients is the method of biofeedback [7,8]. Worn at daytime or at night the device can give real time biofeedback to the patient, for example by vibrating the mobile phone in the pocket of the patient.

More sensors, for example physiological parameters like temperature or vibration sensing, can be integrated into the system to allow measurements

for other sleep diseases like snoring and sleep apnea or the monitoring of the state of health.

Future research concentrates on pattern recognition and analysis of bruxism events and the realization of broader clinical tests.

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