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Original article

Evaluation of sleep bruxism with a novel designed occlusal splint

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ABSTRACT

Purpose: This report presents our evaluation system that assesses sleep bruxism. The characteristics and fabrication process of our novel designed splint, and the analysis process of our system are presented.
Methods: The subjects were 17 volunteers. The splint was fabricated with a self-curing resin compounded with an amino-acid powder for easy wear on the semi-adjustable articulator, and adjusted for a full-balanced occlusion. An impression of the splint, located on the cast, was taken before and after it was worn. The analytical casts were made and scanned via a dental 3D scanner. The datasets were superimposed using two kinds of regions of interest (palate and occlusal surface). The differences between the two datasets were quantitatively presented with pseudo-color mapping. The maximum differences in coronal and apical directions were calculated on the selected area in the occlusal surface when the occlusal surface was used as a region of interest for registration. The relationship between the EMG activities and the change of occlusal surface of the splint were investigated.
Results: In all subjects, deformation and wear facets on the splint were observed. The differences in the apical direction, which indicate wear depth, were correlated with the maximum muscle activity during sleep ($p=0.036$).
Conclusion: From our results, it is suggested that we are not able to eliminate the influence of parafunction for the prosthesis only by designing the surface of occlusal splint using the semi-adjustable articulator. Our splint may have the potential to detect specific facets due to parafunctions as nocturnal bruxism.

1. Introduction

Occlusal overload during sleep bruxism is a significant negative factor that affects prosthetic treatment plans, maintenance of teeth, and the longevity of dental prostheses [1–3]. Clinically, the grinding contact of the upper and lower teeth in powerful bruxism is quite important because post occlusal reconstruction stability depends upon the effect of cranio-mandibular function, such as parafunctional activity.

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Therefore, it is extremely important to reconstruct occlusion based on strong grinding movement [3]. Furthermore, after prosthodontic treatment, the occlusal splint should be applied to avoid overloading of the abutment teeth and the prosthesis. After wearing an occlusal splint, the bruxism pattern is reflected on the surface of the occlusal splint as wear facets. A splint can be an important diagnostic tool to determine wear patterns, bruxism severity, and temporomandibular disorder status. Examination of the grinding pattern during bruxism is necessary and should be incorporated in the diagnosis of occlusion in order to make a proper treatment plan for each patient [3].

Commonly, the grinding pattern is evaluated by observing wear facets on the occlusal splint [3,4]. Information gained from wear patterns on the splints helps determine occlusal configurations, material choice, cusp heights and shapes, guidance angulations, axial loads, and the envelope of function [5]. However, it is difficult in a dental setting to accurately diagnose sleep bruxism and to objectively assess the severity, frequency or natural history of this condition in an individual patient [6].

We proposed an evaluation system of wear facets on the surface of the occlusal splint. This system includes a novel designed occlusal splint that can show grinding patterns, and an analysis technique using a 3D scanner with dedicated software. The system can analyze the location and direction of wear facets and surface loss of an occlusal splint created by the grinding of the teeth during sleep.

The pattern of wear facets depends on the adjusting method and the prearranged occlusal guidance of the splint. A previous study reported that the range of mandibular movements with nocturnal bruxism extended beyond functional movements during daytime [7]. In addition, complications from long-term use (more than four to six weeks) of splints can be severe and irreversible [8]. For this reason, the occlusal splint employed in our system is a full-coverage type with full-balanced occlusion, and designed to be easily worn in short-term use.

In this report, we introduce our evaluation system that assesses sleep bruxism. The characteristics and fabrication process of our novel designed splint, and the analysis process of our system are also presented.

2. Materials and methods

2.1. Participants

In this current report, the subjects were 17 volunteers (male: 6, female: 11, 46.4±14.2 years). The dentulous adults, with all teeth existing except their second and third molars, were recruited. The experiment procedures were explained to all participants before obtaining consent. This research was approved by the Ethical Committee at Tsurumi University Dental Hospital (Approval No. 1416).

2.2. Fabrication of the occlusal splint

The impressions of upper and lower dentitions were taken using ready-made trays and an alginate impression material. The casts were made by a high strength dental stone (GC FUJIROCK, GC, Tokyo, Japan). These casts were mounted on a semi-adjustable articulator with a face-bow (ProArch III, Shofu Inc., Kyoto, Japan). In addition, the condylar path angles were adjusted with protrusion and lateral check-bites, and a custom-fabricated incisal table. After mounting, the interocclusal space was set approximately 2 mm in the molar region for fabrication of the occlusal splint. To obtain an adequate retentive force, and avoid a severe deformation of the splint, a polyester sheet with a 0.75 mm thickness (DURAN, Scheu Dental Technology, Iserlohn, Germany) was chosen as a base material (Hereinafter referred to as base splint). The design of the base splint followed that of the cap clasp [9], where the undercut at the buccal side was utilized. However, if there was no available undercut on the buccal side, the undercut at the palatal side was utilized. The undercut was set at 0.25 mm. The sheet was pressed to the upper cast via a pressure molding machine (Ministar S, Great Lakes Orthodontics, LTD, NY, USA), and trimmed along the design line mentioned above.

This base splint was located on the mounted upper cast on the articulator. The incisal guide pin of the articulator was adjusted to secure a clearance of at least 1 mm in the molar region for a self-curing resin (Facet resin, GC, Tokyo, Japan). The self-curing resin, which compounded with an amino-acid powder (airflow powder, Shofu Inc., Kyoto, Japan) for easy wearing, was built-up on the occlusal surface of the base splint (resin powder: amino-acid powder=1:1). The upper cast was moved through the right, left, and protrusive movement while the soft resin was setting. Finally, the occlusal guidance of the splint was adjusted for a full-balanced occlusion. Therefore, the subject's mandibular movement was impressed on the occlusal surface of our splint. Fig. 1 shows our adjusted splint. The occlusal surface was not as flat as the stabilization splint, and presents an individual subject's functionally-generated pathway which was simulated on the articulator. Occlusal guidance of each subject resulted in different characteristics.

2.3. System description

The splint, located on the cast, was taken an impression with a duplicating silicone (Duplicone, Shofu Inc., Kyoto, Japan) before and after it was worn by the participant. The analytical casts were made of a high strength dental stone (New FUJIROCK, GC, Tokyo, Japan) and were scanned via a dental 3D scanner (D900, 3Shape, Denmark). The scanned data was analyzed via 3D image analysis software (Rapidform 2006, INUS Technology, Korea). The location and direction of the wear facets, and the surface loss of the occlusal splint created by teeth grinding during sleep were investigated.

Surface EMG of the masseter muscle was also recorded for 14 nights with a portable EMG recorder with a sampling rate of 10 Hz and 10 bit resolution (Chewing recorder BR-1000, Nishizawa Electric Meters Manufacturing Co., Nagano, Japan). Disposable bipolar self-adhesive pre-gelled surface Ag/AgCl electrodes (RectLoad, Nishizawa Electric Meters Manufacturing Co., Nagano, Japan) were applied over the thickest portion of the right masseter muscle belly. A reference electrode was placed on the center of the forehead. Recorded EMG signals