Oral splint ameliorates tic symptoms in patients with tourette syndrome

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Tourette syndrome (TS) is a neurodevelopmental and psychiatric disorder characterized by chronic multiple motor and phonic tics. Many TS patients also complain of premonitory urges and often have comorbidities, such as attention-deficit/hyperactivity disorder, obsessive-compulsive disorder, and anxiety disorder. Currently, behavioral, pharmacological, and surgical interventions are applied to TS patients.

The present study aimed to investigate whether an oral splint (Fig. 1A), commonly used for dental treatments of temporomandibular joint disorders, clenching, and bruxism, might be therapeutically effective to ameliorate TS-related tics. To this end, we examined tic scores in 22 TS patients (Supporting Information) using the Tic Symptom Self-Report, which consists of motor and phonic tic scores (0–60; higher scores indicating severer states). Mean age at TS onset was 5.9 years, and mean age at the first hospital visit was 17.2 years. Mean motor and phonic tic scores before splint application were 15.3 and 15.1, respectively. Individual scores immediately decreased to 11.0 and 8.2 at the first hospital visit while wearing the splint; average reduction rates were 30% and 43%, respectively (Fig. 1B). The accompanying videos...
clearly demonstrate the immediate effects on the motor tics of 2 patients: Both oral and ocular tics were improved. Sixteen (72.7%) of the 22 patients exhibited improvements in both motor and phonic tics; 10 of 14 children (<20 years of age) and 6 of 8 adults experienced positive dual effects. Overall, motor and phonic tic scores were significantly improved (Fig. 1B; Wilcoxon signed-rank test: \( P = 0.025 \) and \( P < 0.001 \), respectively), and the effects were long lasting (>100 days of treatment; Supporting Information). The video-based analysis showed the effectiveness in motor tics in the head/face/neck and arm/hand/pect body parts (Supporting Information). The effects of the splint on motor tics were well correlated with those on phonic tic (Fig. 1C; Spearman's correlation coefficient: \( r_s = 0.860; \ P < 0.001 \)). Both age at the first hospital visit and age at tic onset were critical: They were negatively correlated with long-term improvement (>100 days) of motor tic scores (Fig. 1D; Spearman's correlation coefficient: \( r_s = -0.635 \) and \( r_s = -0.594; \ P = 0.015 \) and \( P = 0.025 \), respectively).

**Figure 1**

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Beneficial effects of oral splint on motor and phonic tics. (A) A custom-made oral splint. The splint applied to the bilateral molar teeth can increase the occlusal vertical dimension. (B) Short-term effects of the oral splint on motor (left) and phonic (right) tic scores. Using Tic Symptom...
Self-Report, the post-treatment effects were evaluated by the patients during a week before the first hospital visit while wearing the splint. The red lines indicate patients whose tic scores decreased while wearing the splint, the blue lines indicate patients whose scores increased, and the black lines indicate patients whose scores were unchanged. (C) Positive correlation between short-term improvements in phonic and motor tic scores. (D) Negative correlations of long-term improvements (>100 days of treatment) in motor tic scores with age at the first hospital visit (left) and with age of tic onset (right).

Our results showed that biting this simple device successfully and immediately produced therapeutic effects on the motor and phonic tics in two-thirds of TS patients. We would like to suggest that the application of oral splint is worth trying to treat TS patients, especially younger patients. The oral splint might exert a placebo effect, but should serve as a sensory trick that ameliorates symptoms in tics\(^4\) as well as in dystonia. Interestingly, the effectiveness of the sensory trick in cervical dystonia is associated with neural processing of proprioception.\(^5\) The oral splint would modulate proprioceptive signals from jaw-closing muscle spindles, which are conveyed to the insular cortex\(^6\); the abnormal insular hyperactivity has also been reported in TS patients.\(^7\) Further studies are needed to reconfirm the therapeutic benefit of the oral splint and elucidate its underlying mechanism.

In conclusion, an oral splint application can be therapeutically effective to ameliorate TS-related tics.

**Legend to the Video**

**Video 1.** The first and the second video segments show TS-related tics in 2 patients (see Supporting Information, No. 8 and No. 19). In each patient, the TS-related tics before the application of an oral splint are displayed on the left of screen, whereas the amelioration of tics during the splint application is shown on the right.

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Nothing to report.

Supporting Information

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<td>mds27819-sup-0002-Supinfo.docx</td>
<td>Appendix S1: Supporting Information</td>
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References
