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Changes of myelinated nerve and myelin basic protein expression in rats' periodontal ligaments after experimental tooth movement

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Introduction: Information about the effect of tooth movement on the myelinated nerve in the periodontal ligament is limited. In this study, we aimed to investigate what responses of the periodontal myelinated nerve can be evoked during experimental tooth movement. **Methods:** In experimental-I group, the maxillary left and mandibular right third molars were moved distally. In experimental-II group, the maxillary left third molar but not the right one was moved, and the bilateral mandibular third molars were extracted. The ultrastructures of the myelinated nerve in the periodontal ligament of the bilateral maxillary third molars were observed under a transmission electron microscope. The expression of myelin basic protein was evaluated by immunohistochemistry. **Results:** Degenerative ultrastructural changes of the myelinated nerve in the periodontal ligament were noticed mainly in the myelin sheath; these were observed earlier and were recoverable in the experimental-I group. In contrast, the ultrastructural changes of the myelinated nerve occurred mainly in the axons, were observed later, and were unrecoverable in the experimental-II group. A concomitant decrease of myelin basic protein expression was observed in both groups. **Conclusions:** Both experimental tooth movement and occlusal changes accompanying it caused changes of the myelinated nerve in the periodontal ligament. (Am J Orthod Dentofacial Orthop 2012;142:814-24)

The innervation of the periodontal ligament plays an important role in regulating masticatory movement.[1] The myelinated nerve in the periodontal ligament is in charge of transmitting signals to the central nervous system. Tooth movement alters the mechanical microenvironment of the periodontal ligament; this causes a series of biologic reactions[2-4]: apoptosis of periodontal ligament cells[5,6]; remodeling of the ligament, blood vessels, and alveolar bone[7,8]; and expression of various regulative factors.[9-13] In addition, it has been reported that experimental tooth movement can induce ultrastructural or morphologic changes, as well as functional changes of periodontal Ruffini endings, such as decreased mechanical thresholds, discharge frequencies, and conduction velocities.[14-16] However, little information is available about the effect of tooth movement on the myelinated nerve in the periodontal ligament.

Myelin basic protein is a major component of myelin in the peripheral nervous system and plays a critical role in myelin maintenance and remyelination.[17] It has been shown that shear stress could down-regulate the myelin basic protein level in Schwann cells and induce demyelination and remyelination of injured sciatic nerves in a model of chronic nerve compression injury.[18] It is well known that the mechanical microenvironment in the periodontal ligament can be changed by tooth movement or occlusal changes. However, the influence of the mechanical microenvironment changes induced by experimental tooth movement on the myelinated

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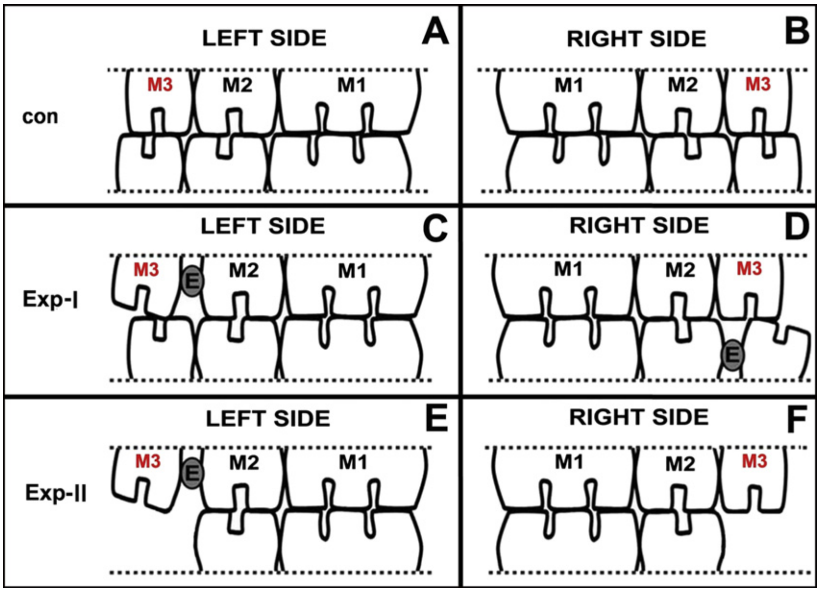

Fig 1. A and **B,** Conceptual diagrams of experimental tooth-moving procedures in the 2 animal models. **C** and **D**, In experimental-I group, the crowns of the maxillary left third molar and the mandibular right third molar were moved distally by an elastic band, causing an unmatched occlusion with their opposing molars. **E** and **F**, In experimental-II group, the left and right mandibular third molars were extracted, and the crowns of the maxillary left third molars were pushed distally by an elastic band. *M1*, *M2*, and *M3* indicate the first, second, and third molars, respectively; the *E* in the circle indicates the elastic band.

nerve and myelin basic protein expression in the periodontal ligament has never been investigated before.

Thus far, several animal models of tooth movement have been proposed to study the periodontal changes after tooth movement. Previously, orthodontic elastic bands were used to push the first molars mesially to develop an animal model of experimental tooth movement and to investigate the histologic changes of the periodontal ligament after tooth movement.[19,20] In another study, this model of experimental tooth movement was also used to study the effect of inferior alveolar nerve transection on osteoclast numbers in periodontal ligaments during tooth movement.[21] In our previous studies, we found an unmatched occlusa contact pattern between the maxillary and mandibular molars in the same animal model.[22-25] Therefore, in this study, we adopted this animal model to investigate the influence of experimental tooth movement and occlusal changes on the myelinated nerve in the periodontal ligament.

MATERIAL AND METHODS

All experimental procedures involving animals were conducted according to the Institutional Animal Care guidelines and were approved by the Administration Committee of Experimental Animals in the Fourth Military Medical University, Xi'an, China. Seventy-two female Sprague-Dawley rats, 8 weeks of age, weighing 200 to 220 g, were provided by the Laboratory Animal Center of the university. All animals received a standardized diet, and their body weights were recorded throughout the study. The rats were divided into 2 main groups, experimental-I and experimental-II (Fig 1, *A* and *B*). Each subgroup was redivided into 3 time subgroups and a control group for immunohistochemistry (n = 5) and electron microscopic (n = 4) analysis, respectively. The detailed animal numbers are given in Table I. These rats were sexually mature at about 7 weeks of age,[26] and their functional occlusion was established at about 5 weeks.[27] Therefore, these rats were young adults with a stable functional occlusion.

For the rats in the experimental-I group, 2 third molars were orthodontically moved distally as described previously.[25] In brief, the rats were anesthetized with intraperitoneal injection of 1% pentobarbital (40 mg/kg). An elastic rubber band (3/16#, 1 mm in diameter, 2 mm in length; 3M Unitek, Monrovia, Calif) was stretched and inserted between the crowns of the maxillary left second and third molars, and also between the