Quantitative Evaluation of Isolated Buccal and Marginal Facial Nerve Branch Transections in the Rat Model: The Importance of Both Branches in Whisking Function

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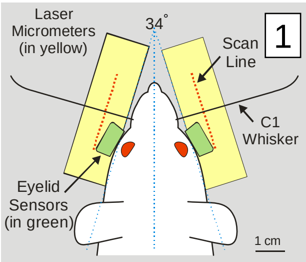
Introduction

The whisker pad musculature in rats is innervated by the buccal and marginal mandibular branches of the facial nerve. Electrophysiologic recordings have proven that overlap between the buccal and mandibular braches exists (Mattox and Felix, 1987). In addition, transection studies have shown that both the buccal branch and the marginal mandibular branch must be transected to block vibrissal movement (Semba and Egger, 1986). Our objective in this small study was to quantitatively determine the individual importance of the buccal and the marginal mandibular nerves in rodent whisking, by examining the effect of isolated branch transections on whisking function.

Methods



Methods for monitoring eyelid and whisker movements

The monitoring system is described in detail in Heaton et al., 2008 and included two pairs of photoelectric sensors (for bilaterally tracking eyelid and whisker movements), three pneumatic mechanisms (for delivery of stimuli intended to elicit such movements) and recording equipment (for sensor and video data) **(Fig.1)**

Subjects and head fixation

Subjects were 8 female Wistar-Hannover rats. For head fixation rats were fitted with a light-weight titanium head implant. The body restraint device was a half-pipe with Velcro straps. The head was fixed by lowering the titanium head implant onto four threaded rods, followed by nuts. **(Fig. 2)**

Whisker tracking apparatus and methods

The hardware and software used for monitoring whisker movements was adapted from that described by Bermejo and colleagues (Bermejo, et al. 1998, 2002). Briefly, movement of a single whisker (C-1) on each side of the head, marked to increase its detectability by the monitoring system, was independently tracked on the horizontal plane using two sets of commercial laser micrometers. **(Fig. 2)**

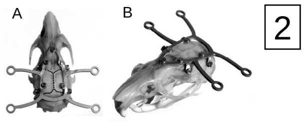
Generation of stimuli eliciting whisking

Computer-controlled air valves were used to deliver air puffs directed at the cornea to elicit eye blink and sustained flows of scented air towards the snout to elicit whisking behavior. The timing of stimulus delivery was on a pseudo-random schedule within the 5 minute testing session for each animal on each testing day. Ten-second air flows were delivered at random time points for a total of 3 air flows per testing period.

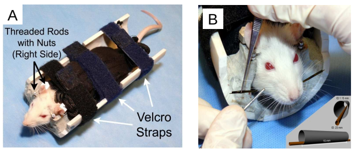
Analysis of whisking

Whisking was analyzed in an automated fashion using software adapted from Bermejo et al (1998, 2002). The average amplitude and velocity of the C1 whisks from onset to peak protraction was calculated for the largest three whisks recorded on each day from each side of the face.

Head/Body Restraint System and Whisker Marking



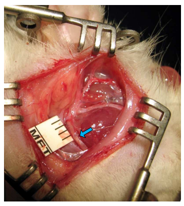
The titanium head implant is shown in superior (A) and lateral views (B) secured to an adult female Wistar rat skull using 9 screws.

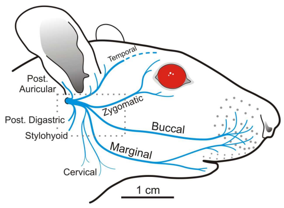


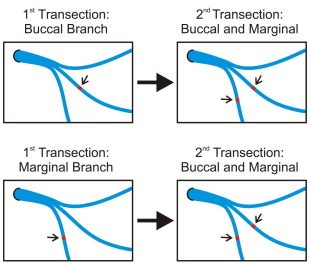
A) Rat in rigid restraint apparatus containing an interface for the titanium head implant to mate with threaded rods and nuts, as well as three Velcro strap locations at the limbs and across the mid back.
B) Application of polyimide tubes used to enhance the detectability of the C1 whiskers. The insert shows enlarged schematic views of the marking tube eccentric configuration.

Facial Nerve Injury Patterns

Photo on the right is an intraoperative view showing a transection location (blue arrow) on the marginal branch approximately 5 mm from the main facial nerve trunk.

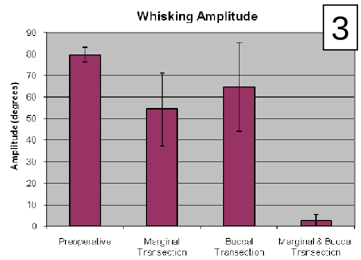






The right facial nerve was cut. The initial Injury was made at either approximately 5 mm distal from the main trunk along the buccal branch (Buccal group; top) or the marginal branch (Marginal group, bottom). The second injury was made to the previously uninjured branch. The contralateral intact nerve served as a control in each rat.

Whisker Movements after Facial Nerve Injury



Results

Pre-operatively, the buccal branch group had an average amplitude of 79.5 (SD 3.50) and the marginal branch group had an average amplitude of 77.4 (SD 6.51). All animals demonstrated normal to near-normal whisking after isolated branch transection, according to amplitude, velocity, and acceleration parameters of whisks. The buccal transection group average whisk amplitude was 54.4 (SD 17.0) and the marginal group average whisk amplitude 64.8 (SD 20.5). There was a statistically significant difference in amplitude in the marginal transection group between pre-operative testing and after transection of the marginal mandibular branch ($p<.05$, paired one tailed t-test). However, there was not a statistically significant difference between pre-operative testing and after transection of the buccal branch ($p>.05$, paired one tailed t-test) or between the buccal branch transected group and the marginal mandibular transection group ($p>.05$, two-tailed t-test).

After transection of both the buccal and the marginal mandibular branches whisking was eliminated in all animals. The buccal transection group had an average whisk amplitude of 1.56 (SD 3.13) and the marginal mandibular transection group had an average whisk amplitude of 2.46 (SD 2.86). **(Fig. 3)**

Summary & Conclusions

•This study quantitatively demonstrates the importance of both the buccal and marginal mandibular branch contributions of the facial nerve in the whisking function of rodents.

•Transection of the buccal and marginal mandibular nerve branches is required for cessation of whisking function.

Acknowledgements

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References

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