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Supporting Material

Force transmission in the organ of Corti micromachine

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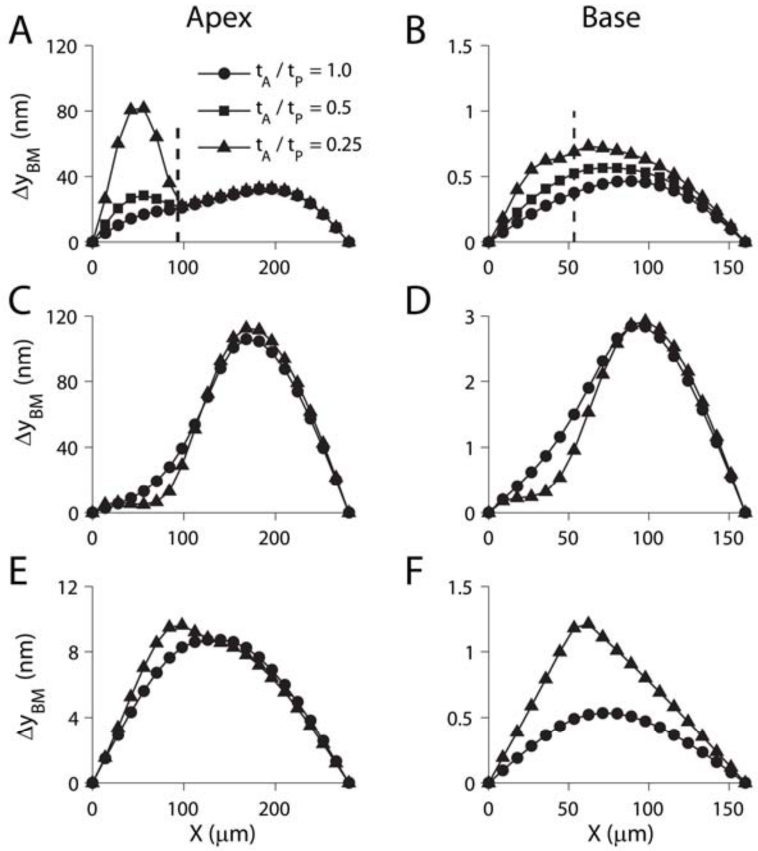
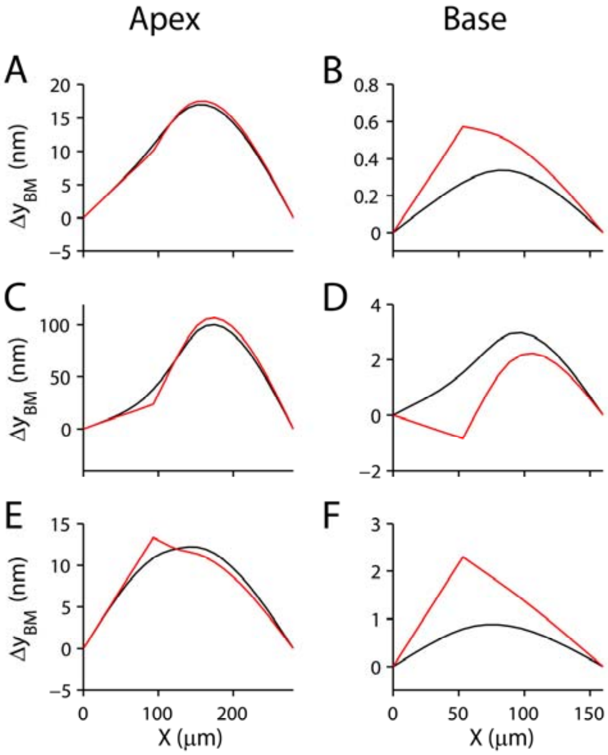


Supplementary Figure 1. Radial deformation patterns of basilar membrane depends on thickness of basilar membrane arcuate zone. **A**, **B**: Uniform pressure was distributed along the radial direction of the basilar membrane. With thickness (t_P) of the more abneural pectinate zone, BM_P , fixed, three different thicknesses (t_A) of the arcuate zone, BM_A, beneath the tunnel of Corti were simulated: t_A/ t_P =1.0, 0.5 and 0.25. Location of outer pillar cell (1/3 BM-width from the spiral limbus) marked with broken line. A four-fold reduction in BM_A thickness had little effect on the overall stiffness of the cochlear partition at the apex but roughly halved it at the base. **C**, **D**. Application of OHC somatic force f_{OHC} for t_A/ t_P =1.0 (circles) and 0.25 (triangles). When OHC contracts, the outer pillar cell pushes down the basilar membrane, while the Deiters' cell pulls up basilar membrane. **E**, **F**: Application of hair bundle force, f_{MET} for t_A/ t_P =1.0 and 0.25. The effect of thickness change was most prominent at base. Because f_{MET} was delivered to the basilar membrane primarily through the outer pillar cell, the peak displacement occurred near OPC, a trend that became more obvious with a thinner arcuate zone. The radial displacement of the basilar membrane in response to a uniform pressure (as may occur during *in vivo* sound stimulation) was unimodal in the control case but, on reducing BM_A thickness, became bimodal at the apex but not the base (Supplementary Fig. 1A, B) agreeing with the most detailed experimental study (1).

1. Cooper, N.P. 1999. Radial variation in the vibrations of the cochlear partition, in *Recent Developments in Auditory Mechanics*, edited by H.Wada, T. Takasaka, K. Ikeda, K. Ohyama, and T. Koike. World Scientific, Singapore, pp. 109–115.



Supplementary Figure 2. Joint conditions between basilar membrane arcuate and pectinate zones. The joint between the arcuate zone beneath the tunnel of Corti and the more abneural pectinate zone was rigid (black lines) and pinned (red lines). **A**, **B**: Point force was applied at the center of basilar membrane. Because the arcuate zone has no external force between the two pinned ends, it remains linear. **C**, **D**: Application of somatic force, f_{OHC} . Force was transmitted through outer pillar cell and Deiters' cell. The consequence of these two forces is more apparent with the pinned joint case. **E**, **F**: hair bundle force, f_{MET}, was applied. Force delivery to the basilar membrane was mostly through the outer pillar cell. The difference between the two joint conditions is less pronounced at the apex compared with the base because the organ of Corti dictates the overall deformation over the basilar membrane.

Supplementary Table 1. Volume compliance due to the somatic and hair bundle motors

Parameter	Apex			Base		
TM stiffness	standard	less stiff	No TM	standard	less stiff	No TM
Volume compliance (passive)	121	189	333	0.31	0.36	0.39
Volume compliance (somatic motor)	7	1	-13	0.18	0.02	-0.06
Volume compliance (hair bundle motor)	253	161	0	0.77	0.27	0

Properties at the apex and base of the cochlea, all values in mm^4N^{-1}
Volume compliance (passive) = displaced volume of BM/applied pressure at BM
Volume compliance (active) = displaced volume of BM/applied pressure by OHC motor
Tectorial membrane (TM) stiffness: in the ‘standard’ case, values for Young’s moduli were those given in Table 1 for each location; in ‘less stiff’ case, Young’s moduli were reduced ten-fold. Note that with both tectorial membrane (TM) stiffnesses, the hair bundle motor is more effective than the somatic force, motor. With the stiffest tectorial membrane, hair bundle force is even more effective in deforming the basilar membrane (BM) than a force applied directly to its center.