was located beneath the loading point of both models. But, the m9 element on the lingual side of the Connected model showed an upward stress, although the upward stress does not occur in clinical situations. The upward stress was not observed in the Separated model.

Strain on the Mucosa

The principal strain in the horizontal and vertical directions on the mucosa elements (m1 - m9) are shown in Fig. 6. Differences were found between the Connected model and the Separated model. In the horizontal direction, m5 and m8 elements of the Connected model had reversed directions for the lingualward and buccalward strain. Element m9 showed abnormal lingualward strain. On the other hand, element m9 on the Separated model showed no lingualward strain, while the mucosa elements, m1 - m8, showed lingualward strain. In the vertical direction, element m9 on the Connected model also showed an abnormal upward strain.

Displacement of the Occlusion Rim and Friction

Displacement of nodes 1, 2, and 3 on the occlusion rim in the Separated model is shown in Fig. 7. In the horizontal direction, displacement of the occlusion rim increased as the friction of gap elements decreased. Although friction was designed to be 0.005, the displacement would not be out of control. The model was still sufficiently stable for analysis.

In the vertical direction, node 1 showed the highest value of displacement. However friction did not significantly affect the vertical displacement.

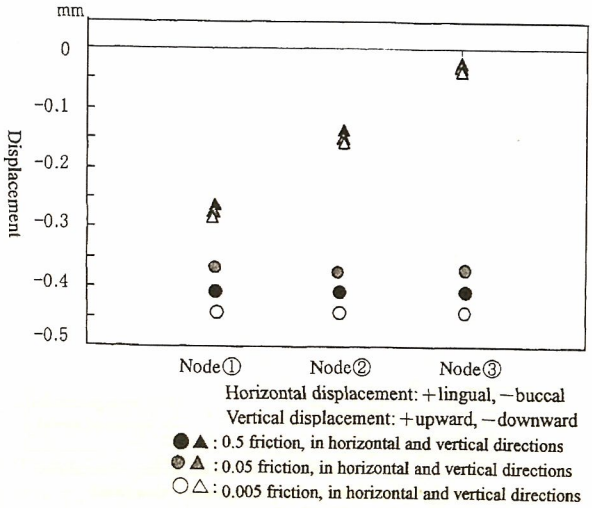

Fig. 7. Displacements of nodes on the occlusal surface for three different frictions in the Separated model.

DISCUSSION AND CONCLUSIONS

Analytical Method

Stress distribution and the dynamic behavior of various dental materials, teeth, and dentures have been studied by photoelastic and electronic strain gauge techniques. Recently, however, the finite element method has been successfully used in dental research. No matter the shape of the evaluated material, the stress, strain, and displacement can be precisely calculated. But, almost all of the analytical models of the finite element method used to evaluate dynamic behavior are designed as a block with several connected parts. Two different materials contact one interface, and use the same node for connecting to each other. Thus, when evaluating the dynamic behavior of removable dentures, the connected relation between the denture base and supporting tissues does not allow prediction of actual values of stress distribution, strain, and displacement. In this study, the author designed a finite element model with a reasonable contact relation to evaluate these items.

Finite Element Model

In this study, a 2-dimensional model was constructed which simulates a frontal section at the first molar area on the edentulous mandible with an occlusion rim. The resorption situation was designed to be at a moderate level based on the research of Kamizyo[11] and Cawood.[12] The thickness of the cortical bone and the mucosa was based on related studies.[13-18] The thickness of the cortical bone was 2.0 mm, and that of the mucosa was 1.5 mm.

Influence of Contact Relation

The contact relation between the tissue surfaces of the occlusion rim and the mucosa is defined by the