SHORT COMMUNICATION

Development of the pulpal floor for the upper first molar in *Suncus murinus* (Soricidae, Insectivora)

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Introduction

Study of the morphology of the tooth root of *Suncus murinus* (house musk shrew) of the family Soricidae of the order Insectivora confirmed the presence of several well-developed ridges, especially on the external surface of the pulpal floor of the upper molar¹⁾. The development of the pulpal floor for the upper first molar in *Suncus murinus* was observed from the perspective of ontogeny in order to confirm whether or not the aforementioned ridges were interradicular crista formed by the concrescence of multiple subpulpal lobes.

Subpulpal lobes were described for the first time by Jørgensen²⁾. He discovered islands of dentin independent of the crown on the ridges of the root of the upper second deciduous premolar and upper first molar in children and believed that the ridges of the root were formed not by continuous calcification from the crown, but by concrescence of the islands of dentin with the dentin of the crown. He named these islands of dentin subpulpal lobes.

We believe that it is very meaningful to clarify the relationship between the development of subpulpal lobes in the pulpal floor

and the furcal ridges of an organism belonging to the Insectivora, which is positioned at the root branch of the mammalian phylogenetic tree.

Materials and Methods

A total of 66 male and female juvenile specimens of *Suncus murinus* aged 3 to 17 days after birth were used in this study.

After affixing the specimens in 70% alcohol, their entire bodies were stained with alizarin red, and the upper first molar was extracted whose calcified regions were stained from the maxillary bone under a stereo microscope. Because the calcified regions of the pulpal floor of these molars were stained poorly in this condition, they were stained again with alizarin red and observed under a stereo microscope.

Results and Discussion

1. Subpulpal Lobe

The earliest appearance of calcified islands of dentin, *i.e.*, subpulpal lobes, in the pulpal floor of the upper first molar in *Suncus murinus* was observed on Day 5 after birth. Independent subpulpal lobes were observed in

Fig. 1 The primary subpulpal lobe of the upper first molar in *Suncus murinus* at 5 days after birth.
(B : Buccal; M : Mesial)

the lingual region of the pulpal floor in four of the ten specimens aged 5 days (Fig. 1).

Subpulpal lobes were observed in seven of the eleven specimens aged 6 days. At this age, there was much difference in the degree of calcification of the subpulpal lobes between individual specimens (Fig. 2). As seen clearly in Figure 2, some of these specimens had numerous small subpulpal lobes (which we shall call primary subpulpal lobes), whereas others had several large subpulpal lobes formed by the concrescence between the smaller subpulpal lobes (which we shall call secondary subpulpal lobes). In seven of the specimens aged 6 days, concrescence between crown dentin and one or four to five secondary subpulpal lobes had already taken place. This

finding makes it clear that the formation of the pulpal floor of the upper first molar in *Suncus murinus* begins with the appearance of primary subpulpal lobes, followed by the concrescence between several of these primary subpulpal lobes to form 4 to 5 secondary subpulpal lobes forming large islands of dentin. Finally, the concrescence of several of these secondary subpulpal lobes completely closed up the pulpal floor. The concrescence between the secondary subpulpal lobes was quicker on the lingual half than on the buccal half of the pulpal floor.

The concrescence between the secondary subpulpal lobes with the crown dentin as well as between two or more secondary subpulpal lobes was evident in seven of the nine speci-

Fig. 2 The primary (asterisks) and secondary (solid circles) subpulpal lobes of the upper first molar in *Suncus murinus* at 6 days after birth. crown dentin is shown in black.

mens aged 7 days. In two of the specimens, there were some independent secondary subpulpal lobes showing no evidence of concrescence with each other or with the crown dentin.

Observed was the concrescence between all secondary subpulpal lobes as well as between these aggregated secondary subpulpal lobes and the crown dentin in five of the six specimens aged 9 days. In the specimens aged 10 days and more, all concrescence between all secondary subpulpal lobes as well as between the secondary subpulpal lobes and the crown dentin was complete.

It is clear from the above-mentioned findings that the number of secondary subpulpal lobes corresponds to the number of roots. Thus, when there were 5 roots, 5 secondary subpulpal lobes appeared, and when there were 4 roots, 4 secondary subpulpal lobes emerged. In addition, the site at which the

Fig. 3 The crista interradicularis of a completed upper first molar in *Suncus murinus*.

primary subpulpal lobes first appeared was the trigon basin, while the site of rapid concrescence of the secondary subpulpal lobes was the lingual half. These findings are probably manifestations of the early reinforcement of the pulpal floor against double-opposing occlusion.

Ooë³⁾ confirmed the existence of subpulpal lobes from histological and three-dimensional observations using a reconstruction model of a germinal human lower deciduous premolar. Other mammals for which the existence of subpulpal lobes has been confirmed are pig⁴⁻⁶⁾, rat^{7,8)}, cow⁹⁾ and dog⁶⁾. On the other hand, there have been reports that subpulpal lobes are not formed in mice^{10,11)}. These differences in the formation of the pulpal floor among species are extremely interesting.

2. Crista Interradicularis

When the external surface of the pulpal floor of a completed tooth (site of bifurcation) of a *Suncus murinus* are observed, well-developed ridges running on the opposing surfaces of the roots are seen (Fig. 3). Observation of the manner in which these ridges run provides a good understanding of how the sites of concrescence of the secondary subpulpal lobes in

the formation of the pulpal floor previously described actually form the ridges. Therefore, it has been confirmed that these ridges are in fact crista interradicularis formed by the concrescence between two or more secondary subpulpal lobes. The sites of concrescence between two or more primary subpulpal lobes also manifest themselves as unclear crista.

Crista interradicularis are pronounced in the upper first molar of a *Suncus murinus*. Kondo et al.¹⁾ have suggested that this is caused by the morphological specificity of the *Suncus murinus*, that the degree of separation between their roots is large and that the area of the pulpal floor is subsequently large.

Crista interradicularis were first described by Jørgensen²⁾ using human molars. Since then, Everett et al.¹²⁾ reconfirmed the structure of crista interradicularis histologically, and called them intermediate bifurcational ridges in his report.

It has been reported that in humans, the intermediate bifurcational ridges are straight lines which run along the mesiodistal direction in the case of two roots, are Y-shaped in the case of three roots, and are covered with cement-like material and not pronounced in completed teeth¹³⁾.

There have been various reports pertaining to the crista interradicularis of organisms belonging to the Insectivora : *Suncus*¹⁾, Erinaceidae¹⁴⁾, *Nesophontes*¹⁵⁾ and *Solenodon*¹⁵⁾. In these reports, the crista interradicularis in the case of three roots were Y-shaped *Erinaceus*, *Nesophontes*, and *Solenodon*. When there were four roots, the crista interradicularis were X-shaped *Gymnura*¹⁶⁾, and when there were five roots, the crista interradicularis resembled those for four roots and were a modified X-shape (*Suncus*).

There were three roots in *Tupaia glis*, and the crista interradicularis were also Y-shaped¹⁶⁾.

As seen above, the shape of the crista interradicularis corresponded well with the number of tooth roots.

Conclusion

We observed the development of the pulpal floor of the upper first molar in *Suncus murinus* of the Soricidae, Insectivora.

1. Numerous small, primary subpulpal lobes formed initially in the pulpal floor of *Suncus murinus*, and several of these primary subpulpal lobes aggregated to form larger secondary subpulpal lobes.

2. The sites of calcification in the primary subpulpal lobes first appear on after 5 to 6 days birth. They appeared in the lingual trigon basin.

3. The concrescence between two or more secondary subpulpal lobes and/or between secondary subpulpal lobes and the crown dentin occurred on Days 6 to 7 after birth. The concrescence between two or more secondary subpulpal lobes occurred more rapidly in the lingual half than in the buccal half.

4. The reason for the appearance of the primary subpulpal lobes as well as the concrescence between two or more secondary subpulpal lobes occurring more rapidly in the lingual half is probably the manifestations of the early reinforcement of the pulpal floor against double-opposing occlusion.

5. In seven of the specimens aged 6 days, concrescence between crown dentin and one or four to five secondary subpulpal lobes had already occurred.

6. The several well-developed ridges on the external surface of the pulpal floor (site of furcation) are crista interradicularis of the sites of concrescence between two or more secondary subpulpal lobes. The sites of concrescence between two or more primary subpulpal lobes also manifest themselves as unclear crista.

7. The number of secondary subpulpal lobes and the shape of the crista interradicularis correspond well with the number of roots.

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