Short Communication

Can the location of tooth agenesis and the location of initial bone loss seen in juvenile periodontitis be explained by neural developmental fields in the jaws?

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Recent studies on prenatal innervation of the jaws have shown that three separate main innervation paths, constituting three bilateral neural developmental fields (incisor field, canine/premolar field, molar field) exist in each jaw. In this communication the sequences in which the fields are innervated are indicated. These correspond to the sequences of formation of teeth and jawbone. The normal pattern of tooth agenesis is closely related to the neural fields, as the region within a single field where innervation occurs last is always the area most often affected by tooth agenesis. The initial manifestations of juvenile periodontitis also appear at the sites within the different fields where innervation occurs last. It is suggested that the pubertal growth of the alveolar process does not occur in these regions due to deficient innervation, and that the infection in juvenile periodontitis might be secondary to this regional lack of bone apposition. □ *Alveolar bone; embryology; growth; human; innervation*

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A developmental field is an embryologic area with a well-defined common developmental origin. Previous studies have shown the existence of different developmental fields along the axial skeleton (1, 2). These fields have been related to the course of the notochord, which induce the development of the central nervous system and the formation of skeletal tissue (3).

In the jaws the peripheral nervous system has been shown to be present close to the initial bone formation (4). It has also been shown that nervous tissue is present from the early stages of tooth formation (5, 6) and is seemingly of importance for the ongoing tooth development.

With regard to jaw formation and the course of peripheral nerve tissue, it has been shown that three main nerve paths are important for the osseous formation of the upper jaw. These are the nasopalatine nerve, the infraorbital nerve, and the palatine nerve (7). A recent study has pointed out that in the lower jaw three originally separate main innervation paths in prenatal life form the later alveolar inferior nerve (8).

The purpose of this presentation is to draw attention to neural developmental fields in the jaws and dentition and to elucidate how these different fields, defined by their individual relation to the different branches of the peripheral nervous system, may possibly explain the location of tooth agenesis and juvenile periodontitis.

The scientific hypothesis underlying this presentation is that deviations in nerve tissue proliferation in a field might in early childhood result in the absence of hard tissue formation, such as tooth formation, and later in childhood arrest alveolar bone formation. From craniofacial implant studies it has been shown that the rate of eruption during puberty is closely associated with general growth in height (9, 10). This means that the growth of the alveolar process is also associated with general growth in height.

Developmental fields in the jaws

On the basis of embryologic investigations of upper jaw innervation (7) and lower jaw innervation (8) the following three bilateral fields are defined in each jaw: incisor field, canine/premolar field, and molar field (Fig. 1). In the figure the sequences in which the fields are innervated from the main nerve branch are indicated. These sequences are those in which the bony jaws and the toothbuds are formed. Previous studies (11, 12) have shown that tooth formation occurs in close association with the surrounding bone development.

Pattern of tooth agenesis

The pattern of tooth agenesis in the primary dentition

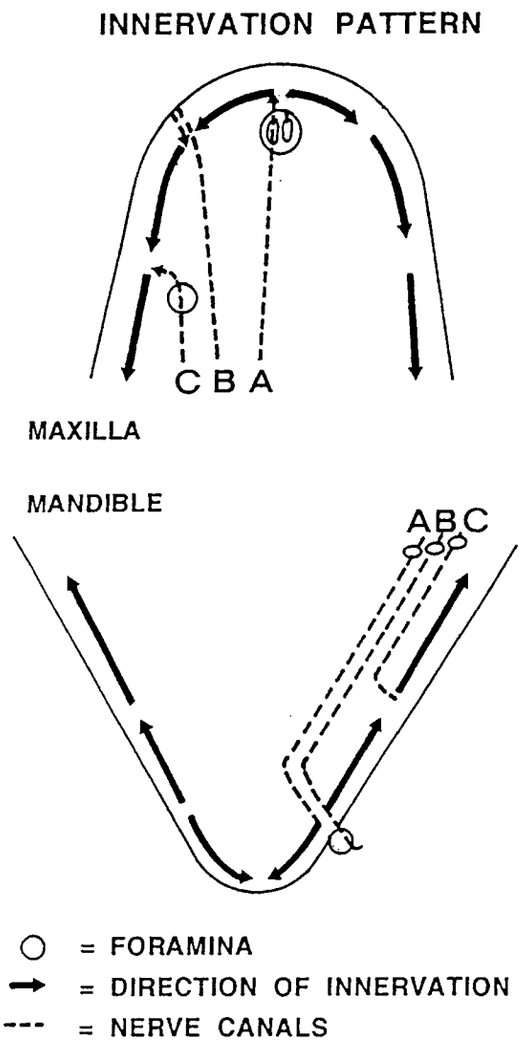

Fig. 1. The neural developmental fields in the maxilla (upper drawing) and in the mandible (lower drawing). A, B, and C indicate in the maxilla and in the mandible the innervation paths to the incisor fields, to the canine/premolar fields, and to the molar fields, respectively. The developmental fields are marked with broad arrows. The direction of innervation within the fields is indicated by the orientation of the arrows. The figure shows that the sites of entrance of the main nerve branch into a developmental field are those where tooth agenesis occurs most seldom, whereas the heads of the arrows furthest away from the entrance of the main nerve branch indicate the sites where nerve tissue-dependent agenesis occurs most frequently. The sites of initial bone loss in juvenile periodontitis correspond to the location of the heads of the arrows.

differs from the pattern registered in the permanent dentition (13).

Incisor field

For both dentitions the lateral incisors in the upper jaw and the central incisor in the lower jaw are the teeth most frequently missing (13–15).

Canine/premolar field

In the primary dentition tooth agenesis is very rare in the canine/premolar field (13). This might be due to the close relationship between tooth buds and peripheral nerve branches innervating the teeth in both jaws. In the permanent dentition the second premolars are the teeth in this field most often affected by agenesis. These teeth develop in the regions furthest away from the sites where the main nerve branches enter the developmental field, whereas the canines are close to these sites and therefore stable in occurrence.

Molar field

The presence of the first molars closest to the main nerve branch innervating the molars is extremely constant, while the third molars furthest away from the main nerve branch innervating the molar field have an unstable occurrence.

It is presumed that there are different etiologic factors behind tooth agenesis (16). Among these are lack of or deficient innervation resulting in agenesis with locations corresponding to neural developmental fields in the jaws. The pattern of location of agenesis in Down syndrome was found to be in agreement with the developmental fields, although the occurrence of agenesis was about 10 times greater than in the general population (17).

Pattern of initial bone loss in juvenile periodontitis

The pattern of initial bone loss in juvenile periodontitis could, instead of a pattern of loss, be a pattern of sites of arrested bone growth of the alveolar process. For growth of alveolar bone the presence of nerve tissue is considered essential. In the regions furthest away from the main nerve branch it is suggested that innervation of alveolar bone from the nerve endings can be absent or reduced. In these regions the rapid alveolar bone growth occurring during puberty (9, 10) does not take place. The locations exposed to this absence in alveolar bone growth are the ones in the developmental fields where innervation occurs last. These locations are the same as those described for initial bone loss in juvenile periodontitis, which are the sites between the second premolars and the first molars, the lateral incisor regions in the upper jaw, and the alveolar bone between the central incisors in the lower jaw (18).

The manifestations of juvenile periodontitis in puberty are considered to occur before and simultaneous with the growth at puberty, accelerating at the pubertal maximum and ceasing when the general growth in height ceases. It is furthermore suggested that the infection might be secondary to the growth deviation. Initial infections thus occur in the initial

'bone loss' regions. The condition can be localized, or the infection can spread from these sites to the neighboring regions. This spreading of infection is believed to be a process that camouflages and confuses the initial symptoms of juvenile periodontitis.

This hypothesis is difficult to substantiate, but previous anthropologic studies of malformed jaws (19–21) have shown the decisive role of nerve tissue, not only for tooth formation but also for alveolar bone formation.

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