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Pediatric Dental Journal

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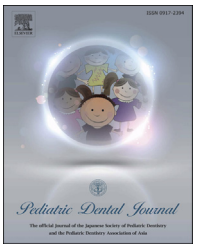

Original Article

Analysis of the calcification caused by rapid expansion of interpremaxillary suture in growing rats

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ARTICLE INFO

Article history:
Received 28 January 2013
Accepted 18 March 2013
Available online 11 February 2014

Keywords:
Rat
Rapid expansion
Calcein
Calcification
Peripheral quantitative computed tomography

ABSTRACT

Changes in the bone mineral density and the speed of mineralization were evaluated when the interpremaxillary suture received a physiological or orthodontic force in rats' growth period. Wistar rats ($N = 30$), 6 weeks of age at the beginning of the experiment, were used for this study. A rapid expansion appliance was set on the maxillary incisors of the rats in the experimental groups (1.5 mm expansion and 2.0 mm expansion groups), while the same appliance without activation was placed in the control group animals. The three groups were additionally divided into the following subgroups (five rats in each subgroup): the fed for 10 days subgroup and the fed for 24 days subgroup.

Evaluation of bone mineral density by peripheral quantitative computed tomography (pQCT) in rats' transverse and frontal sections which include the interpremaxillary suture showed that bone mineral density in the 1.5 mm expansion group and in the 2.0 mm expansion group did not recover to the level in the control group. Bone formation seemed to be accelerated in the 2.0 mm expansion group among the rats fed for 24 days, though bone mineral density did not recover to the level in the control group. These results suggest that it is essential to observe retrace and bone formation enough after expansion.

However, in the observation using calcein staining, the speed of calcification in the interpremaxillary suture in the 2.0 mm expansion group was more rapid than in the control and the 1.5 mm expansion groups, which indicated the effectiveness of rapid expansion in puberty.

1. Introduction

The purposes of dentition guidance during the growth stage are to obtain space for the eruption of future permanent teeth and prevent malocclusion caused by crowding. Methods used to prevent malocclusion include expansion of the palatal suture, as well as distal movement of the first molar, with the former method shown to play an important role and to

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0917-2394/$ – see front matter
http://dx.doi.org/10.1016/j.pdj.2013.11.001

provide an easy means of dentition guidance. Rapid expansion is the technique of choice to correct skeletal maxillary transverse deficiency [1,2]. Many studies of the rapid expansion method have been performed with animal experiments [3–8], including studies on rats [9,10]. Furthermore, there are a few reports of palatal expansion using interrupted power adjustments [11,12] and only a small number that have assessed the results of bone remodelling related to interpremaxillary the suture when using rapid expansion. Therefore, we considered it important to study the effects of bone remodelling caused by orthodontic adjustment.

In the present study, the bone density and rate of calcification were determined in rats during the growth period and following measured expansion of the interpremaxillary suture. In addition, we also evaluated changes in the suture caused by rapid expansion.

2. Materials and methods

A total of 30 Wistar male rats, each 6 weeks of age at the beginning of the experiment, were used for the study, and divided into six equal groups. All rats were given standard food and tap water. Food was obtained from Oriental Yeast (Tokyo, Japan). Rapid expansion appliances were fit onto the maxillary incisors of the rats at the beginning of the experiment. Thereafter, a new appliance was prepared, which consisted of a T-band (Sankin Co, Ltd.) and a square wire for orthodontic use (0.018 × 0.022) (Fig. 1), and it was attached to the maxillary incisors. Different-sized plugs were placed into the appliance for interrupted expansion of the interpremaxillary suture.

The expansion appliance was set into place under general anaesthesia after injection of Nembutal into the abdominal cavity, after softly grinding the maxillary incisors in order to fix the appliance more securely with adhesive resin and to provide mechanical interlocking force. The incisor surface was processed using AQ Bond® (Sunmedical Co, Ltd., Moriyama City, Shiga, Japan) and the expansion appliance was fixed to the maxillary incisors, with the space between the appliance and the incisor filled with light-cured resin (Metafil Flo; Sunmedical Co, Ltd.), and cured with a light-irradiation device. Plates made from stainless steel, with the thickness confirmed using a micrometre calliper, were used as plugs and placed into the appliance as follows.

For the control group, no plate placed was placed into the appliance.

For 1.5 mm of expansion, three plates, each 0.5 mm thick, were placed into the appliance once a day for 3 days (1.5 mm group).

For 2.0 mm of expansion, the same protocol as used in the 1.5 mm group was followed for the first two days, while a 1.0-mm-thick plate was placed on the third day (2.0 mm group).

When the expansion reached 1.5 mm or 2.0 mm in the respective experimental groups, the whole appliance was fixed using light-cured resin. Expansion was started from the beginning of breeding, with five rats in each group undergoing expansion for 10 days and the others for 24 days. In addition, the process of expansion caused by interrupted force was carefully observed.

In the 10 day expansion experiment, five rats of the control group and five rats in each experimental group were injected with calcein (8 mg/kg) immediately after beginning the experiment, with another calcein injection (8 mg/kg) given 1 week later. At the end of 10 days, the rats were injected with thiamylal sodium (Isozol®) and euthanised under deep anaesthesia. After the heads were surgically removed, each head was dehydrated in a graded series of ethanol. The maxillary bone containing the premaxillary suture was then extirpated and trimmed.

In the 24 day expansion experiment, five rats of the control group and five rats in each experimental group were injected with calcein (8 mg/kg) immediately after beginning the expansion. Thereafter, calcein injections (8 mg/kg) were given once per week, for a total of 4 weeks. At the end of 24 days, the rats were injected with thiamylal sodium (Isozol®) and euthanised under deep anaesthesia (Fig. 2). After surgical decapitation, each head was dehydrated in a graded series of ethanol. The maxillary bone containing the premaxillary suture was then extirpated and trimmed.

All procedures were approved by the Committee for the Use of Laboratory Animals of Kyushu Dental University, Japan.

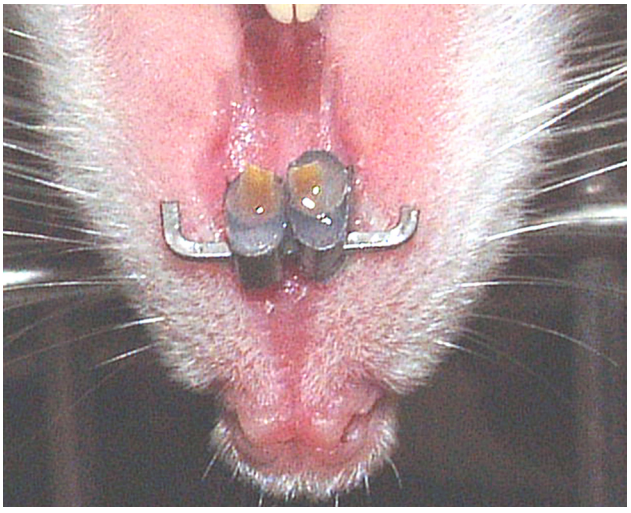

Fig. 1 – Image of rapid expansion appliance set on rat maxillary incisors.

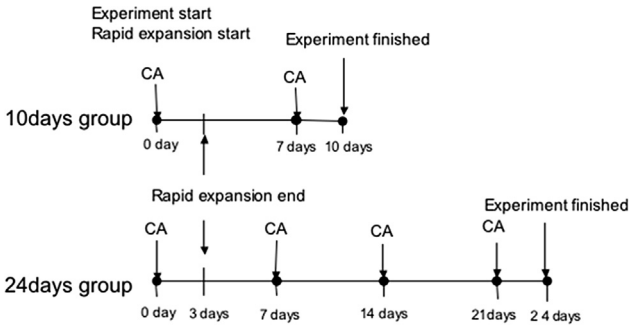

Fig. 2 – Experimental schedule in each group. CA: Calcein injected to the rats.