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RESEARCH ARTICLE

A quantitative anatomical study on posterior mandibular interradicular safe zones for miniscrew implantation in the beagle

Zhiqiang Wang[a,b], Yu Li[a,b], Feng Deng[c], Jinlin Song[c], Zhihe Zhao[a,b,*]

[a]Department of Orthodontics, West China College of Stomatology, Sichuan University, Chengdu, PR China
[b]State Key Laboratory of Oral Diseases, Sichuan University, Chengdu, PR China
[c]Department of Orthodontics, College of Stomatology, Chongqing University of Medical Sciences, Chongqing, PR China

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Summary

With the increasing expansion of miniscrew anchorage use in orthodontic treatment, more and more studies have been and will be carried out on the biochemistry, biomechanics and side effects of miniscrews *in vivo*. In such studies, a beagle has been the most commonly used animal model and its mandibular interradicular zones have been the greatest focus of interest. However, interradicular miniscrews risk failure by being loosened due to collision with adjacent roots. Therefore, it is necessary for the surgeon to be familiar with the anatomy of a beagle's mandible, especially that of the interradicular zones. This study has been performed to investigate the beagle's mandibular interradicular safe zones for miniscrew implantation to provide an anatomical guide for this type of study. Twenty-four beagle corpses were collected. Their mandible specimens were ground parallel to the respective buccal alveolar surface using a model trimmer until a horizontal plane was obtained, which was then sectioned on the line passing each tooth's central groove. In the image of this plane, cut at 2, 4, 6, 8 and 10 mm beneath the top of the alveolar crest, the mesiodistal width between the roots of P2 and P3, P3 and P4, P4 and M1 and the mesial and distal roots of M1were measured, respectively. Zones of mesiodistal width measurement larger than 3.2 mm were found between P4 and M1, below the 8 mm cut and between the mesial and distal roots of M1, below the 4 mm cut. In addition, between P2 and P3, below the 8 mm cut and between P3 and P4, below the10 mm cut, the mesiodistal width measurement was larger than 2.2 mm. The mandibular interradicular safe zones for miniscrew implantation in the dog were located between the mesial and distal roots of M1 and between the roots of P4 and

*Corresponding author at: Department of Orthodontics, West China College of Stomatology, Sichuan University, Chengdu, 14#, 3rd section, Renmin South Road, Chengdu 610041, PR China. Tel.: +86 28 85503347; fax: +86 28 85582167.
E-mail address: zhaozhihe1963@yahoo.com.cn (Z. Zhao).

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M1, where there was enough mesiodistal width. Alveolar bone was relatively narrow between P2 and P3, P3 and P4, where care must be taken during implanting.

Introduction

If asked to name the most important issue in orthodontics, the majority of orthodontists might well answer *anchorage*, defined as the resistance to unwanted tooth movement. Anchorage control is critical in orthodontics. Uncountable methods and apparatuses have been developed to enhance it (Melsen and Verna, 1999). In a sense, the history of orthodontics is actually that of the improvement of anchorage control. In recent years, new means of anchorage, known as temporary anchorage devices (TAD), have been utilized for absolute anchorage in orthodontic treatment and have been paid an increasing amount of attention (Freudenthaler et al., 2001; Lee et al., 2001; Kuroda et al., 2004; Giancotti et al., 2004; Motoyoshi et al., 2007). Compared with other types of TAD, miniscrews bear some unique advantages: minimal anatomic limitation for placement, lower medical cost, simpler placement and removal surgery, less discomfort after implantation and the possibility of immediate or early loading (Deguchi et al., 2003). Because of the small screw size, the miniscrews can often be placed in interradicular locations. Buccal insertion into interradicular sites has been the most common usage of miniscrews in orthodontic clinical practice. However, one of the potential side effects is trauma to adjacent dental roots (Kravitza and Kusnotob, 2007). Quite a few studies have been focused on the human being's interradicular safe zones for miniscrew insertion using volumetric tomography (Poggio et al., 2006), panoramic radiographs (Schnelle et al., 2004), cadaver specimens (Kim et al., 2006) and reconstructed three-dimensional computed tomographic images (Deguchi et al., 2006). In animal experiments, dogs, especially beagles, have most commonly been used for insertion of miniscrews in the interradicular spaces (Ohmae et al., 2001; Deguchi et al., 2003; Asscherickx et al., 2005). Asscherickx et al. (2005) implanted 20 miniscrews between the dental roots of beagles' lower jaws, three of which collided with the roots of neighboring teeth and six of which were very close to the roots of neighboring teeth. Needless to say, the most reliable way to guide the implantation of miniscrew is to take an X-ray film before each insertion and that is what is done for patients. However, it is impossible to apply this rationale on beagles for the simple reason that they will not cooperate. A beagle must be subjected to general anesthesia before accepting X-ray. This means, we would have to anaesthetize the beagle in the animal laboratory, transport it to the X-ray room of the hospital, take the X-rays, wait for the film and transport it back to the laboratory before insertion of the miniscrew. Obviously, the extended period of anesthesia would increase danger to the beagle and we would also be unable to save the beagle should an accident occur on the way. Actually, in such experiments (Ohmae et al., 2001; Deguchi et al., 2003), X-ray guiding was usually omitted and the surgeon performed the implantation largely by his limited knowledge of a beagle's anatomy. In order to increase the success rate of implantation, avoiding unnecessary waste of animals and trauma to the dental roots of the beagles, necessary both for the success of the experiment and ethics of animal experiments, it is necessary to study a beagle's mandibular interradicular space. Thus, we designed and performed this study to investigate the beagle's posterior mandibular interradicular safe zones for miniscrew implantation, to provide an anatomical guide for this type of study in the future.

Material and methods

Twenty-four adult male beagle corpses were collected. The beagles were 14–16 months old and weighed 11–12.5 kg. They were supplied by the Experimental Animal Center of the Sichuan University and had also been used in other experiments. Our study was approved by the Bioethics Committee of Sichuan University.

The veterinary records indicated that the dogs were healthy with no malocclusion and periodontal diseases. A beagle has 42 teeth with the dental formula as follows:

$$2\left(\mathrm{I}\frac{3}{3}\mathrm{C}\frac{1}{1}\mathrm{P}\frac{4}{4}\mathrm{M}\frac{2}{3}\right) = 42$$

There are three incisors (I), one canine (C) and four premolars (P) in each quadrant, two molars (M) in each maxillary quadrant and three molars (M) in each mandibular quadrant. In the maxillary