

# Evaluation of Bone Thickness in the Anterior Hard Palate Relative to Midsagittal Orthodontic Implants

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**Purpose:** The Straumann Orthosystem (Institut Straumann, Waldenburg, Switzerland) describes a technique that involves placement of titanium implants (4 or 6 mm long and 3.3 mm in diameter) into the midsagittal hard palate for orthodontic anchorage. The aim of this study was to determine the quantity of bone in the midline of the anterior hard palate, and specifically the thickness inferior to the incisive canal. **Materials and Methods:** Twenty-five dry skulls were radiographed with a standardized cephalometric technique. The vertical thickness of the midsagittal palate was then measured to the nearest tenth of a millimeter. Next, gutta-percha was injected into the incisive canal, and the radiograph was repeated. The bone thicknesses were then measured from the inferior hard palate to the most inferior part of the radiopaque canal. This is defined as the actual bone available for the implant without violating the canal. **Results:** The measurements have shown that an average of  $8.6 \pm 1.3$  mm of bone is theoretically available for the implant. However, considering the canal (where only bone thickness inferior to it is utilized and measured), only  $4.3 \pm 1.6$  mm of bone exists. The canal itself averaged  $2.5 \pm 0.6$  mm in diameter. **Discussion:** Prior studies have overestimated the amount of bone available for implants in the median hard palate. The main reason for this is that the incisive canal is not well visualized on cephalometric radiographs of live patients. **Conclusion:** This study supports the continued use of implants, as approximately 50% of skulls still had the requisite minimum 4 mm of bone inferior to the incisive canal for maximum osseointegration with the 4-mm implants. However, 6-mm implants should be used with caution. (INT J ORAL MAXILLOFAC IMPLANTS 2003;18:578–581)

**Key words:** dental implants, hard palate, orthodontics, osseointegration

Dental implants are used increasingly often by orthodontists for anchorage.<sup>1–3</sup> Orthodontic treatment of some patients requires that implants be placed in sites other than an edentulous space.<sup>1,4,5</sup> One such novel location for implants is the midline of the hard palate, with the intent of removing the implant once orthodontic treatment is completed.

Temporary endosseous implants placed into the hard palate provide support for anchoring teeth in certain orthodontic treatments (Fig 1). Class II malocclusion is one of the most common conditions for

using palatal implants.<sup>5,6</sup> The palatal implant provides an alternative to extraoral anchorage with headgear, which is often rejected by patients because of social and esthetic concerns. Headgear also has the potential to cause facial injuries.<sup>7,8</sup> The Straumann Orthosystem (Institut Straumann, Waldenburg, Switzerland) is designed for placement of 4- or 6-mm-long titanium implants into the anterior median hard palate for the purpose of providing temporary anchorage.

Vertical height must be specifically evaluated in this anatomic location to determine whether sufficient bone is available for retaining implants that are 4 or 6 mm long. Lack of adequate bone at the implant site may compromise the bone-implant surface area for integration, as well as risk perforating into the incisive canal and possibly the nasal cavity. The incisive canal houses the nasopalatine nerves and the terminal branches of the nasopalatine and greater palatine vessels, all of which could be violated if an implant that is too long is placed. The

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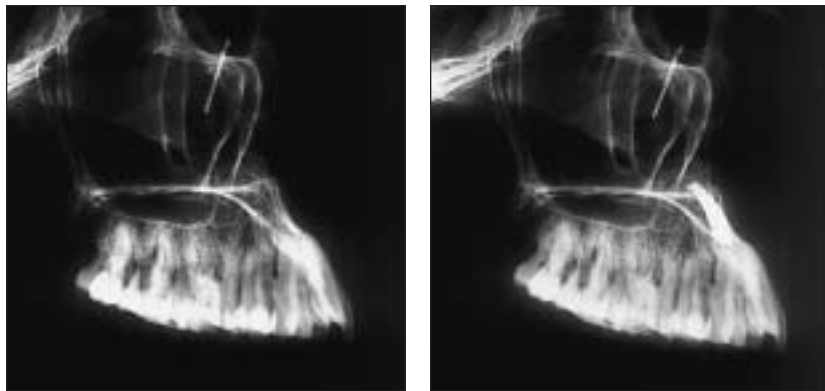


**Fig 1** Midpalatal implant placement for orthodontic anchorage.



**Fig 2** Gutta-percha is injected into the incisive canal for radiographic contrast.

**Figs 3a and 3b** Cephalograms obtained (left) before and (right) after gutta-percha injection.



long-term sequelae of damage to these structures do not seem to be of great clinical significance; however, the lack of bone in the area of the incisive canal may adversely affect osseointegration. The purpose of this study was to evaluate the quantity of bone in the midline of the anterior hard palate to determine the specific thickness of bone inferior to the incisive canal available for an implant, as well as to determine the width of the incisive canal.

## MATERIALS AND METHODS

Twenty-five dry skulls from adult humans of Indian descent were used; the age was unknown. All teeth anterior to the first molar were present. Each skull was placed in a cephalostat and radiographed with a standardized lateral cephalometric technique (56 kV/mA 100S). The vertical thickness at the midline of the anterior hard palate was then measured to the nearest tenth of a millimeter. The location of measurements was made based on the orientation of implants placed perpendicular to the cortical bone on the inferior surface of the hard palate, striving for the maximal available bone. The suggested

angle is 60 degrees relative to the palatal plane.<sup>9</sup> This anatomic location is best described as starting at the horizontal plane of the first premolar in the midsagittal section of the palate and ending posterior to the anterior nasal spine.

The Obtura endodontic injector (Fenton Business, Fenton, MO) was then used to fill the incisive canals with gutta-percha (Fig 2). Warm gutta-percha fills the canal completely, rendering it radiopaque. The lateral cephalometric radiographs were again taken using the same radiographic technique. The bone thicknesses were then measured from the inferior surface of the hard palate to the most inferior part of the radiopaque canal. This can be defined as the actual bone available for implant placement without violating the canal. Cephalograms obtained before and after gutta-percha injection can be seen in Figs 3a and 3b.

A posteroanterior cephalometric radiograph (62 kV/mA 100S) was also obtained on each skull to determine the average horizontal dimension (lateral width) of the incisive canal (Fig 4).

All cephalometric radiographs were measured using a Boley gauge to the nearest tenth of a millimeter. Measurements were performed by 2 investigators,



**Fig 4** Posteroanterior cephalometric radiograph for determining the horizontal dimension of the incisive canal.

**Table 1** Measurements of Cephalometric Radiographs

| Skull no. | Theoretical amount of bone available (mm) | Actual amount of bone available (mm) | Horizontal width of incisive canal (mm) |
|-----------|-------------------------------------------|--------------------------------------|-----------------------------------------|
| 1         | 7.8                                       | 4.2                                  | 3.4                                     |
| 2         | 8.3                                       | 4.8                                  | 2.8                                     |
| 3         | 8.6                                       | 4.3                                  | 2.5                                     |
| 4         | 8.1                                       | 4.9                                  | 2.8                                     |
| 5         | 8.7                                       | 4.4                                  | 2.7                                     |
| 6         | 7.1                                       | 3.7                                  | 3.0                                     |
| 7         | 9.0                                       | n/a                                  | n/a                                     |
| 8         | 7.1                                       | 3.3                                  | 2.4                                     |
| 9         | 8.2                                       | 2.5                                  | 4.0                                     |
| 10        | 8.2                                       | 3.9                                  | 3.2                                     |
| 11        | 9.7                                       | 4.6                                  | 1.2                                     |
| 12        | 8.0                                       | 4.6                                  | 3.3                                     |
| 13        | 10.3                                      | 5.3                                  | 2.0                                     |
| 14        | 8.5                                       | 3.5                                  | 2.1                                     |
| 15        | 9.5                                       | n/a                                  | n/a                                     |
| 16        | 6.8                                       | 3.4                                  | 2.9                                     |
| 17        | 7.9                                       | 3.0                                  | 3.1                                     |
| 18        | 7.3                                       | 3.6                                  | 3.9                                     |
| 19        | 8.2                                       | 3.2                                  | 2.7                                     |
| 20        | 8.5                                       | 4.2                                  | 2.8                                     |
| 21        | 7.7                                       | 3.8                                  | 2.6                                     |
| 22        | 10.3                                      | 5.1                                  | 2.4                                     |
| 23        | 11.2                                      | 9.2                                  | 2.3                                     |
| 24        | 11.0                                      | 7.0                                  | 3.4                                     |
| 25        | 9.2                                       | 3.4                                  | 2.6                                     |
| Mean      | 8.6 ± 1.3                                 | 4.3 ± 1.6                            | 2.5 ± 0.6                               |

n/a= Incisive canal calcified so gutta-percha was unable to be injected for measurement purposes. These skulls were not averaged.

As shown by relatively large standard deviations, there is much variability between individual bone thicknesses. Bernhart and coworkers also support the wide range of bone thicknesses in individuals.<sup>11</sup>

and an average reading was recorded. The measurements were corrected for the 8.5% magnification that occurs with the cephalometric radiograph machine used in this study.

## RESULTS

The vertical thickness of the midsagittal hard palate at the level of the first premolar was  $8.6 \pm 1.3$  mm. This measurement represents the thickness through the entire hard palate, including the incisive canal.

The vertical thickness of the midsagittal hard palate inferior to the incisive canal was  $4.3 \pm 1.6$  mm. This measurement represents the thickness from the inferior hard palate to the most inferior part of the incisive canal. This thickness of bone is of utmost importance, because it represents the actual bone thickness where implants can be placed in direct contact with bone.

The horizontal width of the incisive canal was found to be  $2.5 \pm 0.6$  mm. Measurements of the 25 skulls are shown in Table 1.

## DISCUSSION

The incisive canal is not well visualized on cephalometric radiographs of live patients. One could use computerized tomography to completely visualize and understand the anatomy of the incisive canal, but this is expensive and exposes patients to unnecessary radiation. When the incisive canal is injected with gutta-percha on dry skulls, the incisive canal can be seen on cephalometric radiographs. In this way, bone inferior to the incisive canal can be specifically measured.

Wehrbein and coworkers have shown that bone height in the midsagittal area is 1 to 2 mm greater than what a cephalogram shows.<sup>10</sup> This is an optimistic finding, as it does not take into account the incisive canal when determining bone levels in the midsagittal anterior hard palate. However, the present investigation does support continued use of the implant, such as with the Orthosystem, where 4 mm are required for maximal osseointegrating potential. On average,  $4.3 \pm 1.6$  mm of bone was found inferior to the incisive canal. In fact, this study showed that 50% of the anterior hard palate thickness is located inferior to the incisive canal. It must be reinforced that this latter measurement is significant, because the incisive canal lacks retentive action for implants and therefore should not be considered when calculating implant length. This would seem to anatomically validate the excellent clinical success rate of this implant.

On the other hand, this study demonstrates that some patients will have less than 4 mm of bone available for midsagittal palatal implants and therefore may not achieve maximum osseointegration with 4-mm implants. Approximately 48% of the skulls in this study had less than 4 mm available inferior to the incisive canal, and 1 skull had only 2.5 mm of bone available. It is uncertain how many implants will fail because of the lack of osseointegration, but it is definitely a variable to consider when investigating failed implants. For instance, if a 4-mm implant needs 4 mm of bone contact to completely osseointegrate, then only 12 of the measurable 23 skulls in this study qualified. These results suggest that the 6-mm version of this implant be used with caution.

Bernhart and coworkers<sup>11</sup> have suggested an alternative location for implants in the hard palate. The suggested site was 3 to 6 mm paramedian, which avoids the midpalatal suture and incisive canal.<sup>11</sup> The present study supports these data, in which the incisive canal was found to be  $2.5 \pm 0.6$  mm in horizontal diameter. Thus, if the incisive canal were placed perfectly symmetrically in the midline, it would be approximately 1.25 mm lateral to the midline. Even the widest incisive canal in this study (4.0 mm) would not extend 3 mm from the midline, further verifying the data of Bernhart and coworkers. However, paramedian implants do have other anatomic and functional distractions, such as the roots of anterior teeth and the difficult anchorage vectors created for orthodontics.

The present study considered adult Indian skulls only. More research is needed in adolescents and other races. Male/female idiosyncrasies should also be examined. Longitudinal studies of growing children could also be studied with palatal implants to visualize the growth of the anterior hard palate and incisive canal and to determine whether lack of fusion of the midpalatal suture affects the success of these novel implants.

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## REFERENCES

1. Wehrbein H, Glatzmaier J, Mundwiler U, Diedrich P. The Orthosystem—A new implant system for orthodontic anchorage in the palate. *J Orofac Orthop* 1996;57(3):142–153.
2. Odman J, Lekholm U, Jemt T, Brånemark P-I, Thilander B. Osseointegrated titanium implants: A new approach in orthodontic treatment. *Eur J Orthod* 1988;10:98–105.
3. Roberts WE, Helm FR, Marshall KJ, Gonglof RK. Rigid endosseous implants for orthodontic and orthopedic anchorage. *Angle Orthod* 1989;59:247–256.
4. Wehrbein H, Merz BR. Aspects of the use of endosseous palatal implants in orthodontic therapy. *J Esthet Dent* 1998;10(6):315–324.
5. Tosun T, Keles A, Erverdi N. Method for the placement of palatal implants. *Int J Oral Maxillofac Implants* 2002;17:95–100.
6. Wehrbein H, Feifel H, Diedrich P. Palatal implant anchorage reinforcement of posterior teeth: A prospective study. *Am J Orthod Dentofac Orthop* 1999;116(6):678–686.
7. Egolf RJ, Begole EA, Upshaw HS. Factors associated with orthodontic patient compliance with intraoral elastic and headgear wear. *Am J Orthod Dentofac Orthop* 1990;97:336–348.
8. American Association of Orthodontists. Special bulletin on extra-oral appliance care. *Am J Orthod Dentofac Orthop* 1975;75:457.
9. Wehrbein H, Merz BR, Diedrich P, Glatzmaier J. The use of palatal implants for orthodontic anchorage. Design and clinical application of the orthosystem. *Clin Oral Implants Res* 1996;7:410–416.
10. Wehrbein H, Merz BR, Diedrich P. Palatal bone support for orthodontic implant anchorage—A clinical and radiological study. *Eur J Orthod* 1999 Feb;21(1):65–70.
11. Bernhart T, Vollgruber A, Gahleitner A, Dortbudak O, Haas R. Alternative to the median region of the palate for placement of an orthodontic implant. *Clin Oral Implants Res* 2000;11(6):595–601.