Anatomic landmarks and availability of bone for placement of orthodontic mini-implants for normal and short maxillary body lengths

Jan Hourfar,[a] Dirk Bister,[b] Christopher J. Lux,[c] Bouthayna Al-Tamimi,[d] and Björn Ludwig[e]
Reinheim, Homburg, Heidelberg, and Traben-Trarbach, Germany, and London, United Kingdom

Introduction: Increasing numbers of orthodontic mini-implants are placed in the anterior maxilla. To our knowledge, bone levels and root proximity of patients with cephalometrically short maxillae have not been investigated before. The first, second, and third rugae were used as clinical reference lines, and the aim of this study was to measure bone availability in that area by comparing patients with short and normal maxillary body lengths. **Methods:** The sample consisted of 21 patients in each group: short maxillary body length and normal maxillary body length. The patients' study models were bisected, and the outline of the palatal contour was marked on the surface. The models were scanned, and the palatal contours were superimposed on the palatal structures of their respective initial cephalometric headfilms, and the vertical and oblique bone levels of the sagittal plane were compared using the Student *t* test. The level of significance was set at $P < 0.05$. **Results:** Compared with maxillae of normal maxillary body length, less bone was available in maxillae of short maxillary body length. However, the differences did not reach clinical or statistical significance ($P > 0.05$) at the third rugae. **Conclusions:** Almost equivalent average bone depth at the third rugae in patients with normal and short maxillary body lengths suggests that this site can be used for 8-mm long obliquely inserted orthodontic mini-implants. (Am J Orthod Dentofacial Orthop 2017;151:878-86)

Orthodontic mini-implants (OMIs) offer inexpensive support for anchorage-demanding orthodontic biomechanics.[1] They are generally accepted by patients and are used routinely in practice.[2] The parasagittal insertion site for OMIs in the anterior palate has one of the highest success rates,[1] most likely because of the good osseous anatomy.[3] Bone availability in the palate for the insertion of OMIs has been investigated before[4-17]; most of these studies, however, measured bone availability in relation to structures that are not visible clinically, such as the incisive foramen.[4-15] One study, based on dry skulls, used interproximal contact points of teeth as anatomic reference points.[16] In a recent investigation, the cementoenamel junction of the maxillary central incisors was used as a clinically visible anatomic reference point to measure bone thickness.[17] Both the position of anatomic contact points and the cementoenamel junctions of the maxillary central incisors may be influenced by the underlying malocclusion and are therefore not always reliable landmarks for placing OMIs. As an alternative, the palatal rugae, also called "plicae palatinae transversae" and "rugae palatina," can be used as clinically visible reference structures for the insertion of OMIs.[18] These are ridges in the anterior part of the palatal mucosa on each side of the median palatal raphe.[19] The third palatal ruga can be used as a stable[18,20] and clinically visible anatomic reference structure.[20] The authors of 2 recent studies found suitable amounts of bone in that area for OMI insertion.[21,22] These investigations evaluated bone availability in

[a]Private Practice, Reinheim, Germany; Department of Orthodontics, University of Saarland, Homburg, Germany.
[b]Department of Orthodontics, Guy's and St Thomas' NHS Foundation Trust, London, United Kingdom.
[c]Department of Orthodontics, University of Heidelberg, Heidelberg, Germany.
[d]Dental and Maxillofacial Surgery Department, Great Ormond Street Hospital, NHS Foundation Trust, London, United Kingdom.
[e]Private Practice, Traben-Trarbach, Germany; Department of Orthodontics, University of Saarland, Homburg, Germany.
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Address correspondence to: Björn Ludwig, Private Practice, Am Bahnhof 54, 56841 Traben-Trarbach, Germany; e-mail, bludwig@kieferorthopaedie-mosel.de.
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relation to the palatal rugae on lateral cephalometric radiographs[22] and using cone-beam computed tomography (CBCT)[21]; both studies showed almost equivalent bone quantities, sufficient for OMI placement. CBCT is not used for routine orthodontic examinations because of the comparatively high radiation burden,[23] and most clinicians place OMIs without a 3-dimensional radiographic assessment.[24] A recent study used lateral cephalometric radiographs and plaster models that were part of the initial routine orthodontic examination for assessment of bone availability, using a simple reproducible methodology.[22] Studies measuring the availability of bone in the anterior maxilla, to our knowledge, did not consider patients with shorter maxillary body lengths.[17,18] It is perceivable that patients with a shorter maxillary length have less bone available for implant insertion in the anterior maxilla, and studies investigating Class III patients have shown that maxillary body length is usually reduced.[25-28] In addition to shorter maxillary body lengths, the topographic relationships between teeth and adjacent maxillary structures were found to be different compared with patients with normal occlusions.[29,30] Bone availability for possible OMI placement in patients with short maxillae may be different. Individual maxillary body length can be easily measured on lateral cephalometric radiographs and compared with a calculated individual norm value[31,32]; the maxillary length can then be classified as "normal" or "short," and this methodology was used in our study.[32]

The aim of this investigation was to quantitatively evaluate bone availability in maxillae with a short body length and compare it with maxillae of normal length using plaster models and lateral cephalometric radiographs. We hypothesized that there is more palatal bone depth in subjects with normal maxillary body length compared with subjects with short maxillae.

MATERIAL AND METHODS

Anonymized patient files of pretreatment plaster models and digital lateral cephalograms (Orthophos; Sirona, Bensheim, Germany) were screened for suitability. Only white patients were included. Exclusion criteria were previous orthodontic treatment, loss or extraction of permanent teeth, developmental absence of permanent teeth, craniofacial syndromes, systemic diseases, previous trauma including trauma to the maxillary front teeth, and not permanent dentition (excluding the second and third molars).

Norm values for the proportionality of the maxillary length have been published,[33-35] and the ratio was determined as 7/10 of the length of the nasion-sella distance.[25] The calculations used in this study were based on this ratio. Maxillary body length was measured on the lateral cephalometric radiograph as previously described by Schopf,[32] illustrated in Figure 1. The maxillary body length was measured as the distance between the posterior nasal spine and A-point, which represents the intersection of the perpendicular from A-point with the maxillary plane.

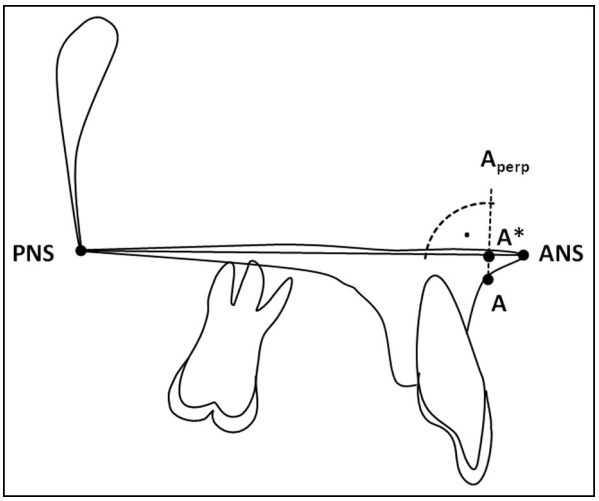

Fig 1. Measurement of maxillary body length on lateral headfilm: A_{perp}, Perpendicular from Point A to the maxillary plane (ANS-PNS). *Point A** represents the intersection of A_{perp} with the maxillary plane (*ANS-PNS*). Maxillary body length is then measured as the distance from *PNS* to *A**.

The average or norm value for maxillary body length was calculated using the method of Schopf,[32] where the distance between sella and nasion is multiplied by 0.7 for each patient. The difference between the measured maxillary body length and norm value was calculated, and the maxilla was classified as short if the difference was smaller than 0.

According to this definition for normal and short maxillary body lengths, patients were allocated to 1 of the following groups: group 1 (short maxillary body length) or group 2 (normal maxillary body length).

We used the methodology for preparation of the plaster models and cephalometric analysis that was described previously by Hourfar et al[22] as follows.

1. Bisection of the plaster study models along the maxillary midline using the midline suture as reference. The bisection was performed with a commercially available plaster trimmer. The right half of the plaster was trimmed.