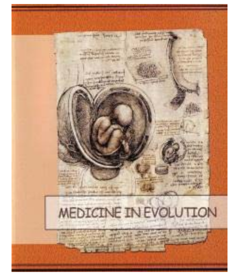
The correlation between soft tissue biotype and cortical bone thickness as succes factors in mini-implant placement – Pilot study



Popa A.[1], Câlniceanu H.[2], Brad S.[3], Popa C.S.[4], Szuhanek C.[1]

[1]2nd. Department/Orthodontics, Faculty of Dental Medicine, Victor Babes University of Medicine and Pharmacy, Timisoara
[2]1st. Department/Periodontology, Faculty of Dental Medicine, Victor Babes University of Medicine and Pharmacy, Timisoara
[3]2nd. Department/Radiology, Faculty of Dental Medicine, Victor Babes University of Medicine and Pharmacy, Timisoara
[4]PAN Dental X RAY, Arad, Romania

Correspondence to:
Name: Câlniceanu Horia
Address: Department/Periodontology, Faculty of Dental Medicine, 9, BulevardulRevoluţiei din 1989, Timisoara, Romania
Phone: +40 725910656
E-mail address: horia_calniceanu@yahoo.com

Abstract

The aim of this study is to correlate two of the factors that influence the success rate of orthodontic mini-implants and establish the correlation between soft tissue biotype and the underlying cortical bone thickness. Material and methods: 2 patients (one with a thick and one with a thin biotype, according to TRAN technique) were selected. Clinical and radiological measurements were performed in order to determine the soft tissue and cortical bone thickness. The soft tissue thickness was measured using a periodontal probe with an endodontic stopper, and the cortical bone thickness was measured using a CBCT scan. Results: The thin biotype was correlated with thin cortical bone, while the thick biotype was correlated with a thicker cortical bone. Conclusion: The correlation between the gingival biotype and cortical bone thickness would allow the clinician to select the optimal mini-implant design and to ensure a more predictable outcome.

Keywords: tissue biotype, cortical bone thickness, mini-implants, cbct.

INTRODUCTION

Orthodontic mini-implants have gained popularity among orthodontist due to their multiple advantages: they provide absolute anchorage, easy to insert, low cost. The failure rates for orthodontic mini-implants are less than 20%, which means that the success rate is high. [1,2,3,4] The research area in this field is mainly focused on the factors that influence the success rate and reduce failure.

Orthodontic mini-implant's stability is mainly mechanical, by the interlocking of the mini-implant's threads with the cortical bone. [5] Primary stability is determined by mechanical retention due to the tension–compression state generated at the bone–screw interface. This retention, is affected by the characteristics of the insertion site, the proximity to the root, the geometric design of the screw, the soft tissue, the operator technique, and magnitude and loading time of the orthodontic force, which is particularly dependent on the thickness of the cortical bone [6,7,28].

The focus of this study will be on only two factors that influence primary stability, trying to establish a correlation between them: cortical bone thickness and soft tissue biotype. The cortical bone thickness is considered to be a decisive factor in the overall success/failure rate of the mini-implant. The increase in cortical bone thickness in the alveolar bone of maxilla and mandible has been shown to significantly increases the primary stability of the mini-implant.[8,9].Similary, Marquezan et al, the meta-analysis showed positive correlation between the stability of the mini-implant and the amount of cortical bone.[10] Meta-analysis data indicate that higher failure rates (2.5 times more failures) were observed at insertion sites with a cortical bone thickness less than 1 mm (21.3%;8,3%; for ≥1 mm) concluding that cortex thickness is an important factor in ensuring primary stability, with a thickness of at lest 1 mm being required.[11,12]

For the soft-tissue stability component, Cheng et al. reported that the absence of keratinized mucosa around mini-implants significantly increased the risk of infection and failure (71% failure rate). [13] It is therefore recommended that the mini-implant be placed in the attached gingiva, adjacent to the muco-gingival junction of the upper and lower arches. Kim HJ et al reported that different areas of the buccal attached gingiva had different soft-tissue thicknesses. If orthodontic mini-implants with the same length are used in areas with different soft tissue thickness, the length of the implants inserted in the bone will be different. Therefore, soft tissue might be one of the key factors for successful implantation [14]

Fu JH et al reported a moderate association between the thickness of the labial gingiva and the underlying bone radiologically. [15]. Claffey and Shanleydefined the thin tissue biotype as a gingival thickness of <1.5 mm, and the thick tissue biotype was referred to as having a tissue thickness ≥ 2 mm. [16]

Studies have reported several methods used to measure the soft-tissue thickness of the oral mucosa. These include direct measurement using a needle or periodontal probe, [17], probe transparency (TRAN)[18]or an ultrasonic device such as ultrasonic gingival thickness meter.[19] Other methods are indirect, using computed tomography(CT), [19,20] or cone beam computed tomography (CBCT) [21].

In the direct method, the thickness of tissue was measured using a periodontal probe. [22] When the thickness was≥ 1.5 mm, it was categorized as a thick biotype. When the thickness was <1.5 mm, it was considered a thin tissue biotype. In the TRAN technique, the gingival biotype was considered to be thin when the outline of the periodontal probe was shown through the gingival margin from inside the sulcus. [23] The biotype was considered to be thick if the probe did not show through the gingival margin.

Aim and objectives

This study aims to correlate two of the factors that influence the success rate of orthodontic mini-implants and establish the link between soft tissue biotype and the underlying cortical bone thickness.

MATERIAL AND METHODS

Two different patients were chosen: one with a thick and one with a thin biotype, according to TRAN technique. (Fig.1) If the outline of the underlying periodontal probe could be visualized through the gingival margin, it was classified as a thin biotype; if the outline of the underlying periodontal probe could not be visualized through the gingival margin, it would be classified as a thick biotype. [23].

The study area selected was the lateral maxillary region, on the buccal side, at the most common mini-implant site placement: first and second premolar, second premolar and first molar and between first and second molar. Measurements were taken at the same level both at the muco-gingival junction (MGJ) and the buccal bone plate (BBP).

Clinical measurements: the soft tissue thickness was evaluated, using a direct method with the periodontal probe and an endodontic stopper. (Fig.2). After local anesthesia, the periodontal probe struck the soft tissue perpendicular to the cortical bone. The endodontic stopper is in contact with soft tissues. After removal of the periodontal probe, the thickness of the soft tissue shall be indicated by the stopper position. (Fig 3). Measurement were made at the muco-gingival junction, being already stated that keratinized gingiva presents a lower risk of developing hypertrophic tissues and inflammation.

CBCT measurements: Cone Beam Computed Tomography scans using Cranex Sordex were carried out, in order to obtain radiographic measurements of the thickness of the cortical bone. CBCT scans have been imported into 3-dimensional analysis software as digital imaging. (On Demand 3D dental app).Cortical bone thickness was measured at the same spots like the soft tissues (Fig.4)

Figure 1. TRAN technique

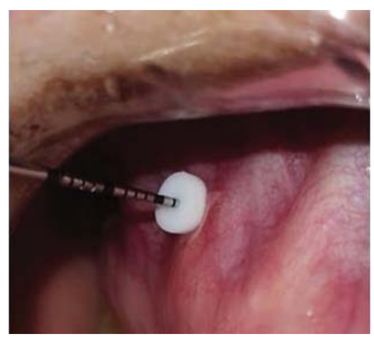


Figure 2. Soft tissue measurement

Figure 3. Soft tissue thickness

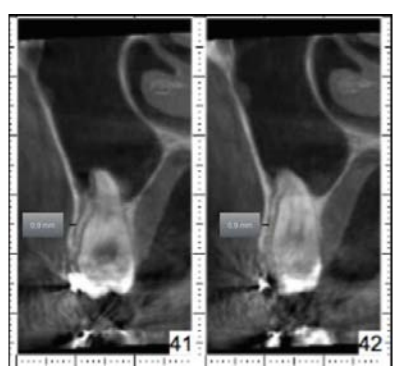


Figure 4. Cortical thickness measurement

RESULTS

The thin biotype characterized by thin soft tissue was correlated with a thin cortical bone and the thick biotype, was correlated with a cortical bone. The thickness of soft tissue at the insertion site should be taken into account when selecting the appropriate length of mini-implants and consideration should be given to individual patient variations in soft tissue and cortical bone prior to insertion of any mini-implants [24,25]. Placement within the attached gingiva, where proper soft tissue sealing can occur, has been associated with fewer soft tissue complications and failure risks compared to placement in the movable mucosa [26].

DISCUSSIONS

The stability of the mini-implants depends on the quality and quantity of the cortical bone. The main objective of an orthodontic mini-implant is to achieve maximum stability by placing it in areas with a thick cortical bone (for mechanical retention) and a thin, keratinized soft tissue (to avoid inflammation).

Before selecting the mini-implant, the soft tissue thickness at the insertion site should be measured and this procedure requires local anesthesia, delaying the selection until just before the mini-implant insertions procedure. The design of the mini-implants varies depending on the thickness of the soft tissue, therefore it implies for the orthodontist to have a wide range of mini-implants.

Kim HJ et al. reported that cortical bone had the same pattern as the soft tissue. [14] Similarly, Jia-Hui Fu et al. concluded that the gingival biotype had a moderate association with the underlying bone radiologically. [27]

CONCLUSIONS

The correlation between gingival biotype and the cortical bone thickness would allow the clinician to select the optimal mini-implant design, to ensure a more predictable outcome.

This study is the first step in future research that seeks to correlate these parameters in a greater number of patients in order to provide more reliable data.

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