

# Diameter selection of implants placed in extraction sockets: A new approach

**Abstract/Introduction:** Implant placement in extraction sockets is considered a daunting challenge due to offering risks of bone remodeling and consequent gingival alterations. **Objective:** This study aims at proposing a protocol for selecting the diameter of upper anterior osseointegrated implants placed in extraction sockets. This protocol was based on the bucco-palatal dimension of the socket and allows a 3-mm gap to form between the implant and the outer surface of the buccal bone wall. Such gap must be filled with biomaterial or autograft so as to increase the predictability of long-term results. **Keywords:** Extraction socket. Immediate implant. Implant diameter. Immediate provisionalization. Bone graft.

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## INTRODUCTION

Tooth loss associated with physiological factors implies in progressive alveolar bone tissue remodeling with reduction in buccolingual and apico-coronal dimensions.<sup>1,2,3</sup> Bone remodeling is more severe in the anterior maxilla due to having a thin buccal bone wall.<sup>3,4</sup> Reduction in buccopalatal distance may reach 50% within 6 to 12 months after extraction.<sup>5,6,7</sup> With a view to preventing bone and gingival tissue damage, immediate osseointegrated implant placement has been suggested.<sup>8</sup>

Nevertheless, predictability of bone maintenance as a result of implant placement is contradictory and has not been the focus of clinical and animal-based studies.<sup>6,9</sup> Conversely, alterations in bone and gingival tissue that hinder esthetic outcomes of immediate implant loading have been reported by recent clinical trials,<sup>10,11</sup> thereby rendering rehabilitation in edentulous esthetic zones a daunting challenge.

Thus, when an extraction is recommended, especially of anterosuperior teeth, clinical maneuvers must be planned with a view to maintaining buccal bone wall and preventing tooth sockets from collapsing.<sup>11</sup> Extraction must be as minimally invasive as possible, favoring preservation of the socket as well as of interproximal and buccal gingival contour.<sup>12,13</sup> After extracting a compromised tooth, one can see there is a discrepancy between root cross section, usually triangular-shaped, and the implant, usually round-shaped.

To completely fill the tooth socket 4.0 or 5.0-mm diameter implants are selected for central incisors and canines, whereas 3.0 or 4.0-mm diameter implants are selected for lateral incisors. As a result, small gaps are formed between the implant

surface and the alveolar walls, particularly the buccal bone wall. Some reports highlight that there is no need in filling gaps smaller than 2 mm, even though these cases offer a higher risk of gingival recession and bone remodeling with reduction in tissue volume.<sup>2,8,10</sup>

Nevertheless, recent clinical trials<sup>2,4</sup> yielded predictable and more stable results with gaps greater than 2 mm, in which case filling procedures with biomaterial or autograft are performed. Thus, selecting proper implant diameter is essential for maintenance of an ideal alveolar space and long-term stability of soft tissues.

This study presents a new protocol for selecting the diameter of immediate implants placed in extraction socket with a view to preserving buccal bone wall and favoring gingival tissue stability.

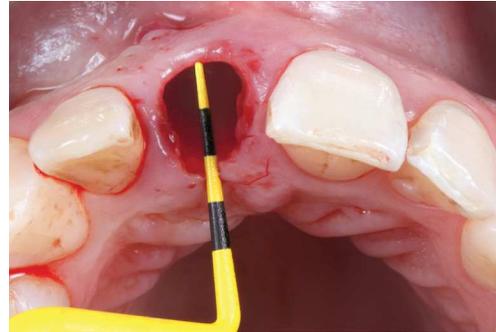
## PROTOCOL FOR SELECTING THE DIAMETER OF IMMEDIATE IMPLANTS

The mesiodistal distance from the extracted tooth is advocated as reference to select implant diameter (Fig 1). However, the new protocol proposed herein uses the bucco-palatal measurement as reference (Fig 2), aiming at a gap of 3 mm between the implant surface and the outer buccal bone wall. This 3-mm gap provides better placement and compaction of grafting used for gap filling, either biomaterial or autograft bone.

During prosthetic-surgical planning, implant diameter may be selected by means of a study model or tomographic exam. Selecting implant diameter by means of a study model requires “extraction” of the compromised tooth from the model respecting the gingival contour. The study model must be worn up to 1 mm



**Figure 1.** Conventional implant diameter selection using the mesiodistal distance from the extracted tooth as reference.



**Figure 2.** New protocol for selecting implant diameter using the bucco-palatal distance as reference.

below the gingival level throughout the tooth circumference. The socket opening is measured in the bucco-palatal direction with the aid of a millimeter periodontal probe (Fig 3).

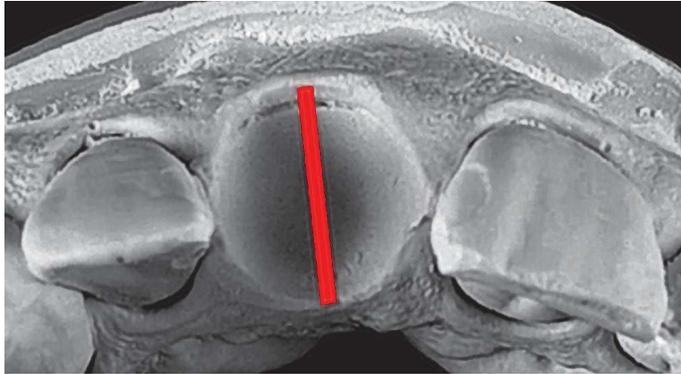
Bucco-palatal measurements must also be taken by means of tomographic exams. Cone-beam computed tomography with enhancement of soft tissues is used.<sup>12</sup> The socket opening is measured by the central sagittal section of the tooth, particularly the bucco-palatal cervical width of soft tissues (Fig 4). Measurements are taken prior to surgery and computed tomography is considered more reliable than the study model. This method aims at anticipating the diameter of the implant used and the amount of bone necessary to fill the socket.

To determine the implant diameter, a total of 3 mm must be subtracted from the bucco-palatal distance of the socket obtained by means of measurements taken with a study model or computed tomography. Such diameter must allow

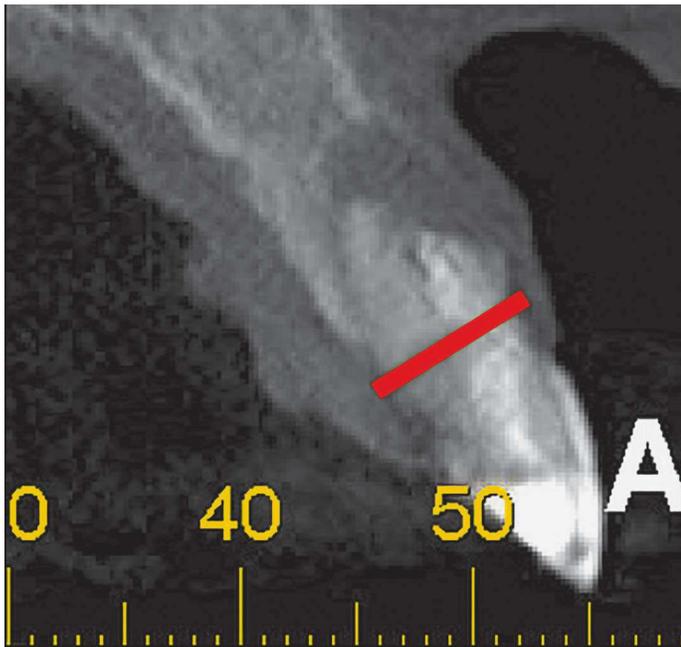
a 3-mm gap to form between the outer buccal bone wall and the implant surface. The gap must be filled with biomaterial or autograft (Fig 5). For instance, sockets with bucco-palatal distance lower than 7 mm require small-diameter implants; sockets with bucco-palatal distance of 7 mm require regular-diameter implants; and sockets with bucco-palatal distance greater than 7 mm require large-diameter implants (Fig 6).

Prosthetic-surgical planning includes selection of implant diameter and minimally invasive extraction aiming at preserving the integrity of supporting tissues, especially buccal bone wall and proximal papillae, with flapless procedures without incisions. Subsequently, the socket undergoes careful curettage for removal of granulation tissue and periodontal ligament fibers. To this end, fine curettes are used with copious irrigation.

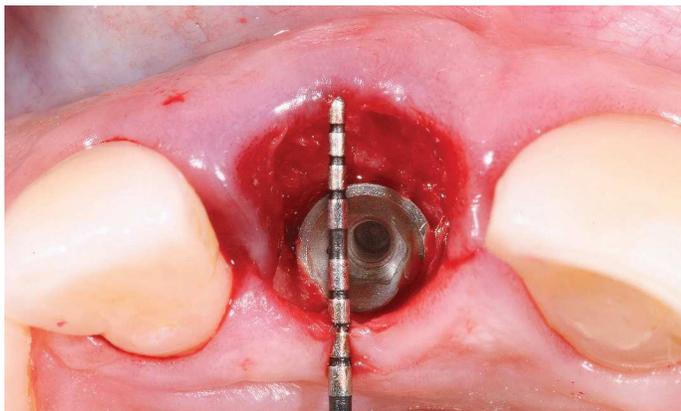
The integrity of the socket is examined for potential dehiscences and/or fenestrations. Examination may be visually



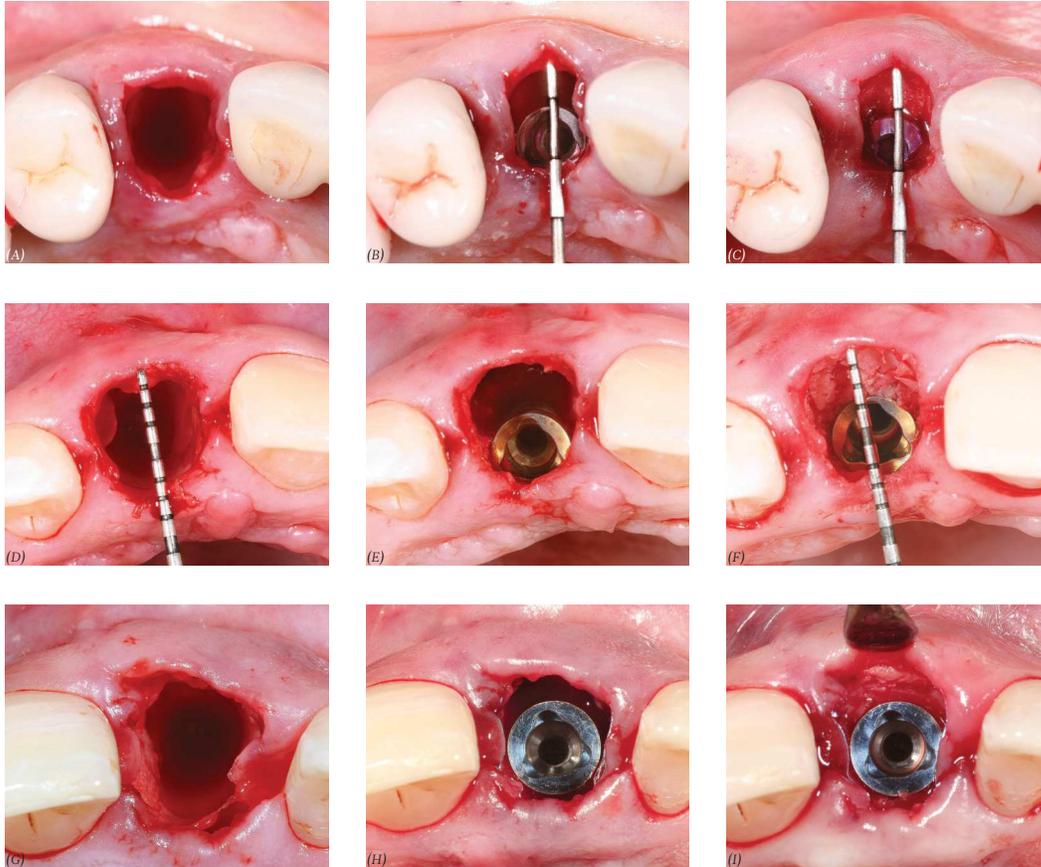
**Figure 3.** Selecting implant diameter using a study model before surgery.



**Figure 4.** Selecting implant diameter before surgery using cone-beam computed tomography sagittal section with enhancement of soft tissues revealing details in thickness of soft and hard tissues.



**Figure 5.** Implant diameter may be clinically assessed by measuring the bucco-palatal distance from the socket opening after extraction. The aim is to keep a gap of approximately 3 mm between the buccal implant surface and the outer buccal bone wall. In this case, the gap was filled with particulate autograft harvested from the tuberosity.



**Figure 6.** Small-diameter implant selected for socket opening lower than 7 mm (**A, B, C**). regular-diameter implant selected for bucco-palatal distance equal to 7 mm (**D, E, F**) and large-diameter implant selected for bucco-palatal distance greater than 7 mm (**G, H, I**).

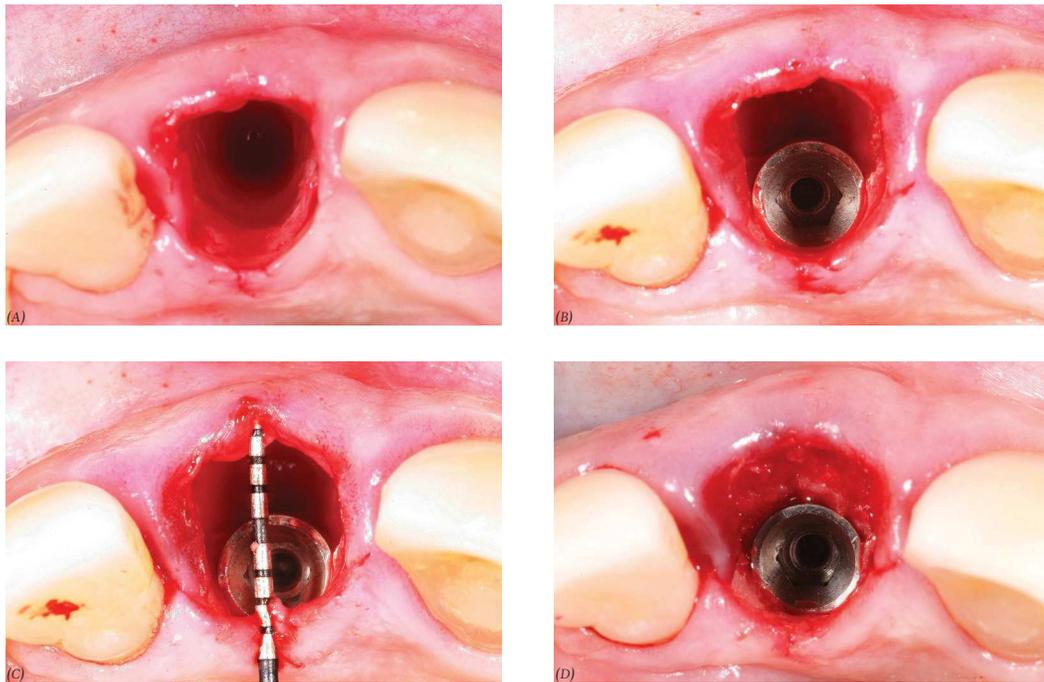
conducted or with the aid of a periodontal probe. Should one or more than one bone wall be damaged, reconstruction is performed during the same surgical procedure, thereby allowing immediate implant loading.

With a view to keeping a gap of 3 mm between the implant surface and the outer buccal bone wall, which provides greater long-term stability of peri-implant tissues, one may examine the bucco-palatal measurements obtained for the socket opening. This procedure allows the clinician to confirm the diameter of the implant, keeping the gap which will be later filled with bio-material or autograft (Fig 7).

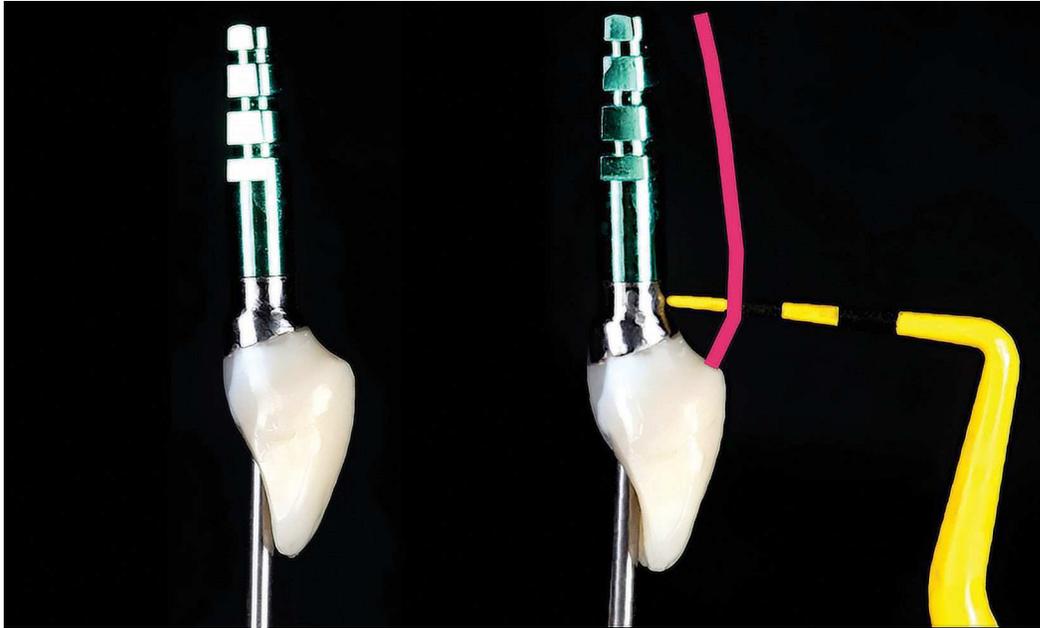
Proper tridimensional implant positioning is essential. Correct apico-coronal

positioning requires a gap of 3 mm between the implant platform and the gingival margin in the apical direction. In the bucco-palatal direction, however, the implant must be anchored in the socket palatal bone wall, thereby favoring primary stability and a buccal distance of 3 mm. Gap filling is performed after preparation of immediate provisional crown.

A correct emergence profile of the provisional crown is also essential to achieve volume stability in peri-implant tissues. The subgingival profile must be slightly concave in the buccal and proximal surfaces of the cervical region, which allows proper fitting of tissues, especially with regard to buccal volume and stability of gingival margin and papillae (Fig 8).



**Figure 7.** Post-extraction socket (A), after implant placement (B), 3-mm buccal distance (C), and after filling with autograft (D).



**Figure 8.** Slightly concave prosthetic emergence profile favoring proper space for fitting of tissues (on the left). On the right, soft tissue is simulated. It must be 3 mm distant from the implant surface in the bucco-palatal direction.

## DISCUSSION

Implant placement in extraction sockets has been exhaustively reported and discussed.<sup>2,4,5,6,9,15,16</sup> Clinical trials have been conducted and the literature has reached a consensus regarding the best treatment options.<sup>8,13,14</sup> However, esthetics remain a challenge. The present study aims at predictability of results and proposes a protocol for selecting proper implant diameter – a determining factor to yield excellent esthetic outcomes.

Immediate implant loading requires the following: good health conditions, posterior occlusal stability, absence of deep overbite and presence of residual bone apically to the socket, thereby ensuring implant primary stability. Alveolar and

gingival dimensional alterations may occur and, as a result, hinder esthetics.<sup>15</sup>

The protocol proposed herein corroborates the clinical research conducted by Capelli et al<sup>4</sup> who concluded that the experimental group with alveolar gap greater than 3 mm had increased vertical and horizontal dimensional stability in comparison to the experimental group with gap smaller than 3 mm.

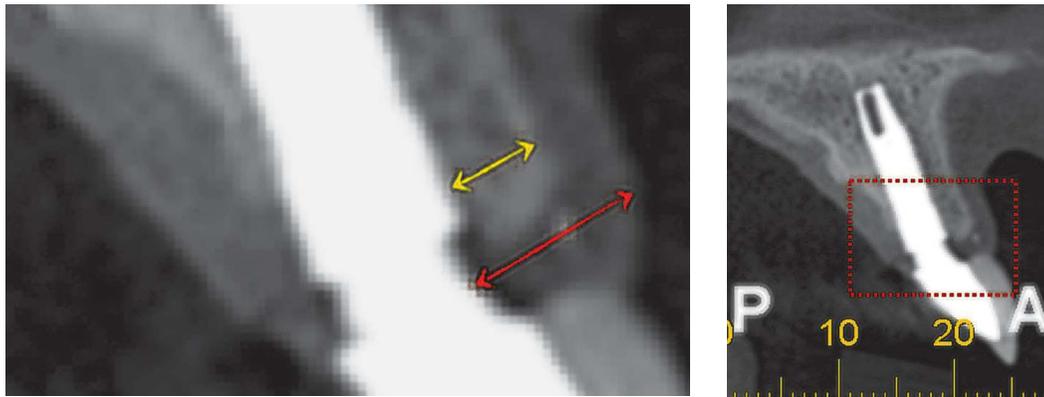
Nevertheless, the implant-socket gap varies according to the extracted tooth. Selection of implant diameter, therefore, depends on the bucco-palatal distance from the socket opening, keeping a 3-mm gap between the implant surface and the outer bucco-palatal distance. This gap must be filled with bio-material or autograft. The literature renders

unnecessary to fill gaps smaller than 2 mm. However, gaps greater than 2 mm pose difficulties with bone formation due to distance osteogenesis. For this reason and to avoid migration of soft tissues, which may hinder osseointegration, socket filling is necessary.<sup>17</sup>

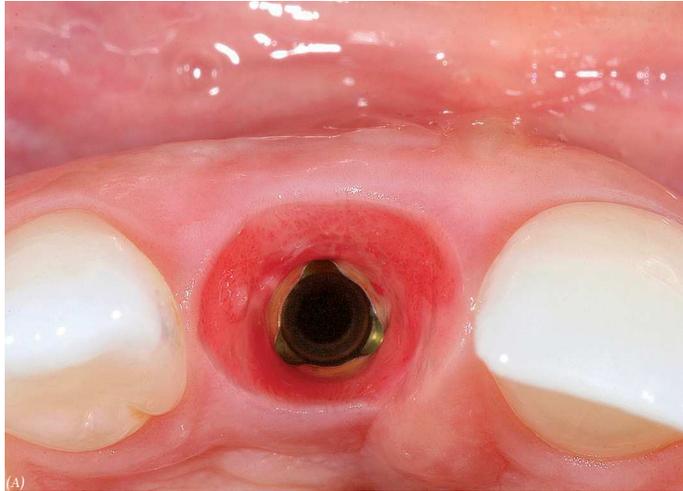
The use of small-diameter implants has also been the focus of an animal-based study revealing that these implants allow a greater gap between the implant and the buccal bone wall to form, thereby providing improved bone formation and bone-implant contact.<sup>1</sup> Better gingival stability achieved by this protocol may be explained by the

thicker buccal bone wall formed after bone regeneration. This finding was confirmed by Ferrus et al<sup>18</sup> who conducted a clinical trial with 93 patients and associated buccal bone wall thickness with the risk of gingival recession. Nevins et al<sup>19</sup> confirmed the higher risk of gingival recession in thinner buccal bone walls.

Thus, the protocol for selecting the diameter of osseointegrated implants placed in extraction sockets aims at allowing formation of thicker buccal bone walls (Fig 9) and, as a result, providing greater esthetic predictability (Fig 10).



**Figure 9.** Cone-beam computed tomography with enhancement of soft tissues taken two years after the procedure evinces 3-mm-thick buccal bone wall, totaling 4 mm with inclusion of soft tissues.



**Figure 10.** Post-operative control after 12 months (A, B) and 3 years (C).

## CONCLUSION

The new protocol for selecting the diameter of implants placed in esthetic zones uses the bucco-palatal distance from the socket opening as reference. Regardless of the tooth to be replaced, a gap of approximately 3 mm between the buccal implant surface and the outer buccal bone wall is expected. After gap filling, peri-implant tissue remains stable. This new surgical protocol has yielded satisfactory as well as predictable esthetic outcomes.

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