AMERICAN COLLEGE OF PROSTHODONTISTS
Your smile. Our specialty.℠

Biological Aspects as a Rule for Single Implant Placement. The 3A-2B Rule: A Clinical Report

Fernando Rojas-Vizcaya, DDS, MS[1,2]

[1]Mediterranean Prosthodontic Institute, Castellón, Spain
[2]Department of Prosthodontics, University of North Carolina School of Dentistry, Chapel Hill, NC

The article is associated with the American College of Prosthodontists' journal-based continuing education program. It is accompanied by an online continuing education activity worth 1 credit. Please visit www.wileyhealthlearning.com/jopr to complete the activity and earn credit.

Keywords
Radiographic Biological Ruler; 3A-2B rule; biological rule; single restorations; dental implants; screw-retained single restorations; esthetics; pink esthetics; implant site development; biological width.

Correspondence
Fernando Rojas-Vizcaya, Mediterranean Prosthodontic Institute, Avenida Rey Don Jaime, 5, Entresuelo, Castellón 12001, Spain.
E-mail: frojasv@prosthodontics.es, rojasf@dentistry.unc.edu

The author denies any conflicts of interest.

Accepted January 6, 2013

doi: 10.1111/jopr.12039

Abstract

For an implant restoration to be both esthetically and functionally successful, the prosthodontist must conduct a thorough treatment plan and complete a prosthesis design. The prosthodontist must carefully calculate the space needed for the restoration and soft tissue in the restoration process. The restoration and soft tissue are affected by the three-dimensional (3D) position of the implant, as the implant's depth determines the ideal length of the crown. When determining the 3D position of the implant, the clinician must consider the biological aspects required to ensure the restoration's biological integration with the patient's hard and soft tissues. The restoration must be the first component considered in the treatment plan. In addition, the clinician must understand that the distance between the cervical contour (of the planned restoration) and the level of the bone will dictate how the surgical and prosthetic treatment plan is enacted. In this report, a novel Radiographic Biological Ruler© (with biological information) was used to help facilitate the treatment plan's analysis.

A finished restoration should physically mimic the replaced tooth by providing similar esthetics and functionality and ensuring harmonious gingival architecture.[1-3] The gingival zenith (the most apical point of the soft tissue) is located distal to the long axis of the maxillary central incisors and canines. In the maxillary lateral incisors, the zenith is located along the tooth axis.[4] The gingival zenith level of the maxillary lateral incisors is located approximately 1 mm more coronal, relative to the adjacent central incisor and canine.[3] The restoration of the single edentulous space is a viable and predictable alternative to the treatment plan when using dental implants.[5] This treatment plan could be used in several clinical scenarios, including healed ridges,[6] grafted areas,[7] extraction sockets,[8] and infected sites.[9]

The success of the treatment can be evaluated using an esthetic scoring system.[10,11] This esthetic scoring system evaluates the reproducibility of pink and white esthetics. To preserve the pink esthetic, bone needs to remain stable to support soft tissue.[12] The soft-tissue level around anterior-maxillary single-tooth implants can be affected by many factors. For example, the interproximal papilla is dependent on the interproximal bone crest level of the adjacent tooth.

The papilla is present when the distance between the contact point to the crest of the bone is less than 5 mm.[13-15] The buccal soft-tissue level can be affected by the peri-implant biotype, the buccal bone level, the angulation of the implant, the interproximal bone crest level, the depth of the implant platform, and the level of the first bone (to implant contact).[16]

Different authors offer varied guidelines for obtaining a highly esthetic result for implants. These guidelines focus on the ideal three-dimensional (3D) position of the implant, and how to best use the cervical contour of the planned restoration as a reference.[1,17,18] The first step in treatment planning is to determine the occlusal plane or incisal edge. The second step is to determine the cervical contour of the planned restoration, and the third step is to measure the distance between the cervical contour and the level of the remaining bone.[18]

The implant should be positioned 3 mm from the cervical contour of the planned crown, to achieve appropriate biological width.[19,20] To preserve 1.8 mm to 2.0 mm of buccal bone without resorption,[21] the implant should be placed 2 mm (in a palatal or lingual direction) from the cervical contour. These two biological aspects (3 mm Apical and 2 mm Buccal rule—3A-2B rule) can be used as a guideline for implant placement.[17,18]

The implant can be placed at the level of the bone, if the bone is 3 mm from the cervical contour. If the bone is more than 3 mm in the apical direction from the cervical contour, a bone grafting procedure is indicated. The bone will need to be reduced to create space for biological width if the bone is less

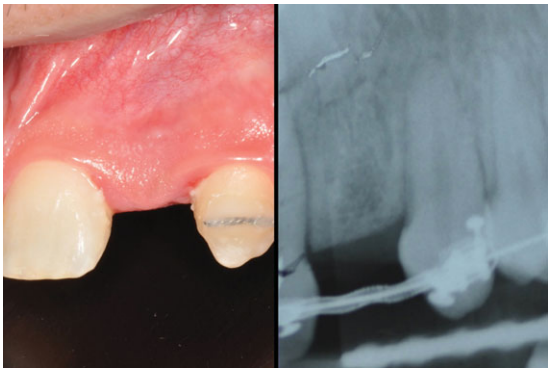

Figure 1 Edentulous space after orthodontic treatment to be restored with a dental implant.

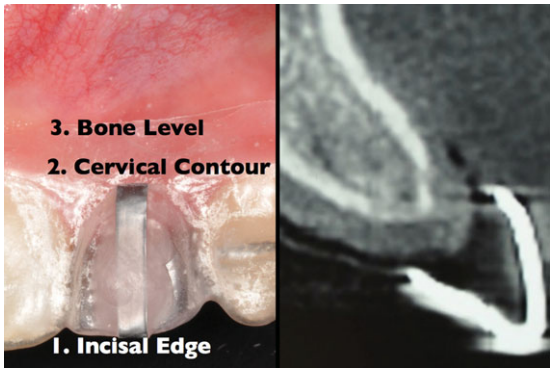

Figure 2 Sequence for treatment plan and normal image from CT with profile of planned crown.

than 3 mm. In areas of extraction sockets, where the crestal bone is less than 3 mm from the margin of the planned crown, the implant can be placed below the bone (without any reduction of the bone). In all patients, the implant should be placed 3 mm from the cervical contour, and the procedure should maintain 2 mm of buccal bone.[18]

This report details the use of a novel Radiographic Biological Ruler© (based on 3A-2B rules) to plan the treatment procedure. Protocol for restoration of the maxillary left lateral incisor is also described.

Clinical report

A 32-year-old man came to the Mediterranean Prosthodontic Institute with agenesis of the maxillary left lateral incisor. After receiving orthodontic treatment to create space for the maxillary lateral incisor (Fig 1, left), the patient wanted a fixed prosthodontic solution in the form of a dental implant.

Digital photography, periapical radiographs, and articulated casts were used to analyze the situation. The mesiodistal space for a dental implant was confirmed using a periapical radiograph (Fig 1, right). A minimum mesiodistal average space of 6.0 mm for the restoration was found using the diagnostic cast. Diagnostic waxing was performed to determine the incisal edge and the cervical contour of the planned restoration. An impression of the diagnostic waxing was made with irreversible hydrocolloid impression material (Cavex CA37; Cavex, Haarlem, The Netherlands), and a duplicate cast was made in Type IV dental stone (T.C. 15; Techim Group, Milan, Italy). A thermoplastic template (Temp Splint 0.5 mm; Denta Flux, Madrid, Spain) was created. The thermoplastic template was transformed into a radiographic template. One radiopaque marker (made of 1 mm lead strips from periapical radiograph films) was placed with sticky wax (Kerr, Orange, CA) from the buccal to the palatal cervical margin of the planned crown (Fig 2, left). The relationship between the existing bone and the cervical margin of the planned crown could then be visualized using a computerized tomography (CT) scan[22] (Fig 2, right). Analysis was completed with a radiographic ruler, based on the rule of 3 and 2 mm[18] (Radiographic Biological Ruler©; Mediterranean Prosthodontic Institute, Castellon, Spain) (Fig 3). The ruler helped calculate the crown's marginal contour level, the required space for 3 mm of biological width, the required space for 2 mm of buccal bone, and the ideal position of the implant. The ruler also displayed the prosthetic zone as a projection from the implant (Fig 4). The analysis showed that bone was in contact with the cervical margin and therefore needed to be reduced (Fig 5).

The radiographic template was transformed into a surgical template. The buccal flange was removed, and the cervical contour of the planned crown was underlined. A roll technique was designed.[23] The epithelium was removed by firm dissection. The pedicle was built from the palate toward the buccal angle of the crest, and the flap was elevated. After placing the surgical guide in position, bone and cervical contour at the same level were confirmed as in the CT (Fig 6, left).

The surgical guide information was used to reduce the bone in this area[18] until a 3-mm space between the cervical contour of the planned restoration and the bone was achieved (Fig 6, right). An osteotomy was performed to place the dental implant. A fluoride-modified screw-shaped implant (Fixture MT OsseoSpeed; Astra Tech AB, Mölndal, Sweden), 3.0 mm in diameter and 13 mm long, was then placed in the position of the maxillary left lateral incisor. The implant axis was aligned between the two adjacent teeth (Fig 7, left). The implant was placed 3 mm apical from the cervical margin of the planned crown (Fig 7, center), and positioned at least 2 mm from the cervical margin in the palatal direction (Fig 7, right). A healing abutment (Healing Abutment 3.0, 4 mm, Astra Tech AB) was screwed into the implant (Fig 8, left) and sutured with 3-0 silk (Silk; Stoma, Emminingen-Liptingen, Germany). The suture was inserted around the free end of the flap and in the flap's buccal base. The flap was rolled inversely into the buccal insertion and sutured (Fig 8, right).

After 8 weeks, the healing abutment was removed, and the impression coping (Implant Transfer 3.0; Astra Tech AB) was connected to the implant. An open-tray definitive-implant-level impression was made with a vinylpolysiloxane (VPS) impression material (Coltoflax; Coltène/Whaledent AG, Altstätten, Switzerland), capturing the matured soft-tissue contour. Soft tissue was reproduced in the impression by using VPS (Gingifast Rigid; Zhermack, Rovigo, Italy), and the definitive cast was poured with Type IV stone (T.C. 15; Techim Group, Milan, Italy). The ideal emergence profile and the contour of

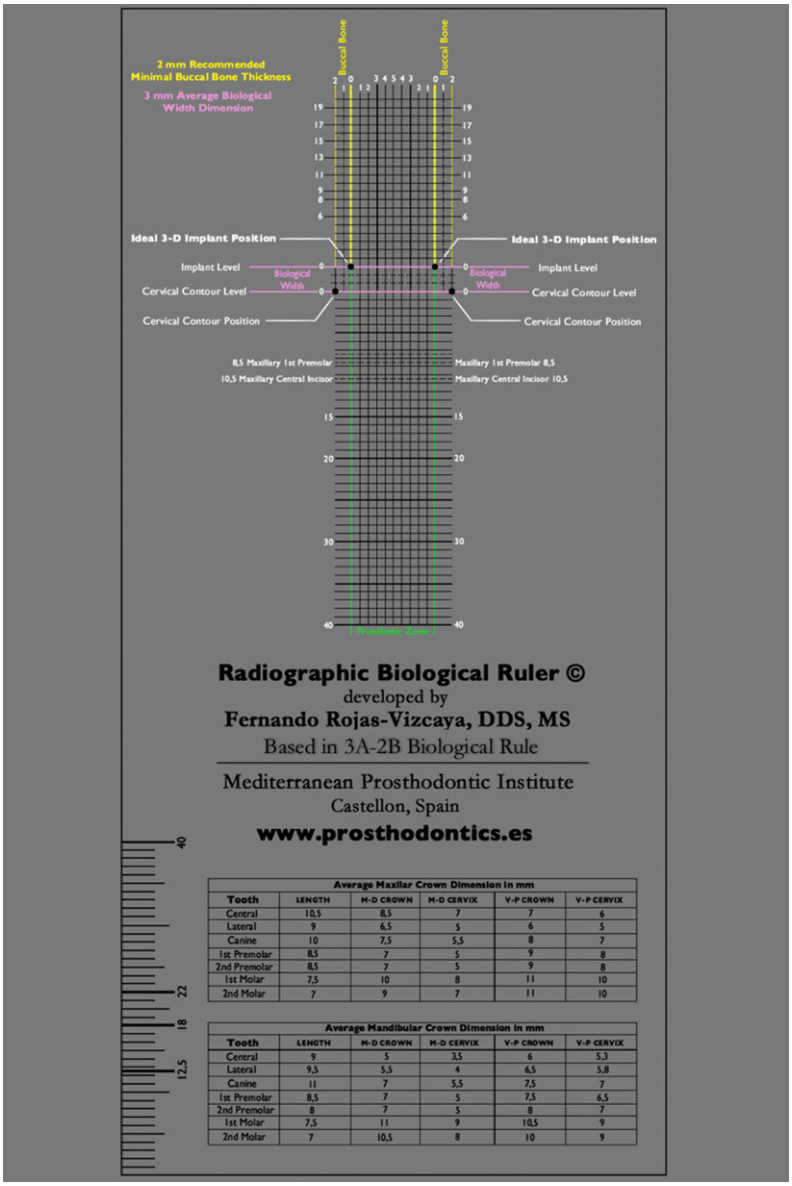

Figure 3 Radiographic Biological Ruler, based on 3A-2B rule for implant placement.

the soft tissue (at the level of the restoration) were both created by using a laboratory bur and removing the silicone until the desired shape was obtained (Fig 9, left).

An interim prosthesis was made with an autopolymerizing acrylic resin (Bosworth Trim II; Bosworth Company, Skokie, IL) using a screwed temporary abutment (Temporary Abutment 3.0; Astra Tech AB) on the master cast. After the interim prosthesis had been polished with pumice (Kerr) and a goat-hair brush (Finopolish slim polishing brush; Laboshop Spain, S.A. Barcelona, Spain), the interim prosthesis was cleaned, disinfected with chlorhexidine gluconate (0.12%) (Chlorhexidine Lacer; Lacer, S.A. Barcelona, Spain), and screwed into the implant. Palatal access was covered with hard-body silicone. A periapical radiographic was made to control the fit of the restoration into the implant (Fig 10, center). After few days, the adaptation of the soft tissue to the restoration was natural looking (Fig 9, right). The definitive cast was sent to the laboratory and scanned for virtual abutment design (VAD Atlantis; Astra Tech Dental, Waltham, MA) (Fig 11, left) and subsequent fabrication through a computer-aided design/computer-aided manufactured (CAD/CAM) abutment (Atlantis GoldHue Abutment; Astra Tech AB). A crown, manufactured from monolithic zirconia (Zirconia Prettau; Zirkonzahn, Gais, Italy), was created to include access to the abutment screw (Fig 11, right).

The abutment was screwed into the replica of the implant of the master cast, and access to the screw was then covered with cotton. The crown was cemented extraorally on the abutment with glass ionomer, and all the excess from the glass ionomer was cleaned carefully (Fig 12). The interim prosthesis was removed, and the matured new soft tissue contour was

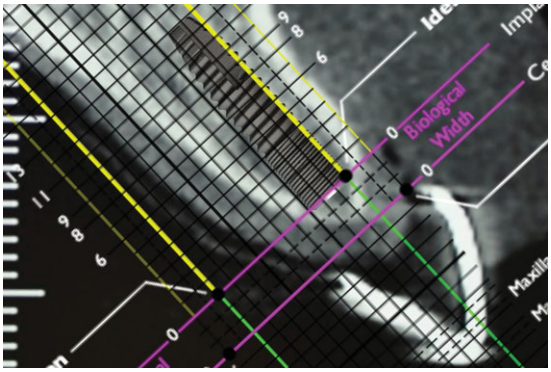

Figure 4 Radiographic Biological Ruler in position indicating bone reduction to obtain 3 mm space for biological width and showing 2 mm of remaining buccal bone.

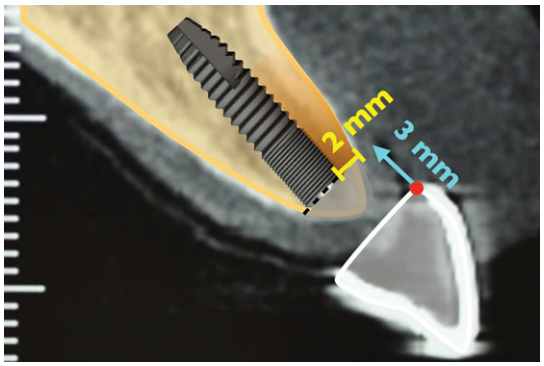

Figure 5 Implant in symmetrical and perpendicular position between adjacent teeth, after bone reduction at 3 mm from cervical contour of planned crown and with 2 mm of buccal bone.

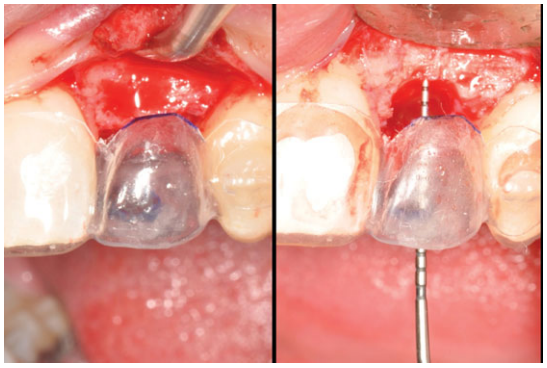

Figure 6 Bone requires reduction to create 3 mm space for biological width but without reduction of the interproximal bone.

appreciated (Fig 13, left). The crown-abutment was screwed into the implant (Fig 13, right), and access was covered with wax and composite. The fit of the restoration into the implant was verified with periapical radiographs, and the marginal bone at the level of the implant was confirmed after 1 year (Fig 10, right).

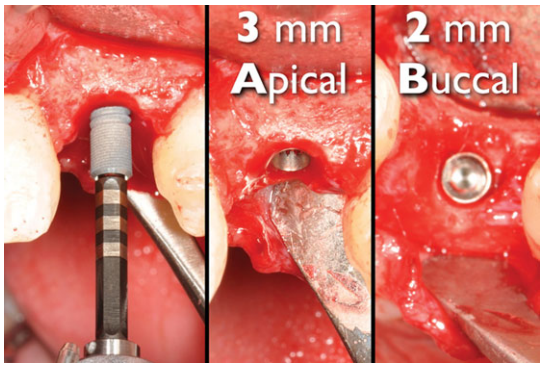

Figure 7 Implant was placed 3 mm apical from the cervical margin of the planned crown, and 2 mm of buccal bone was achieved.

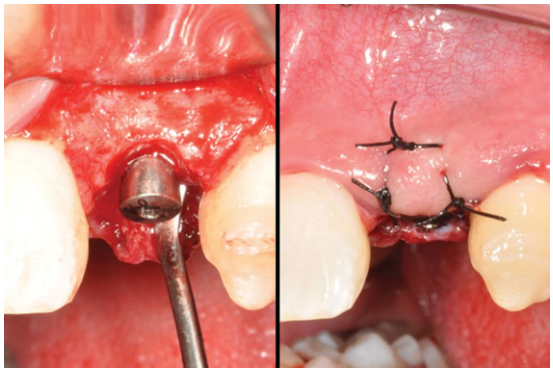

Figure 8 Contour of the buccal soft tissue was improved.

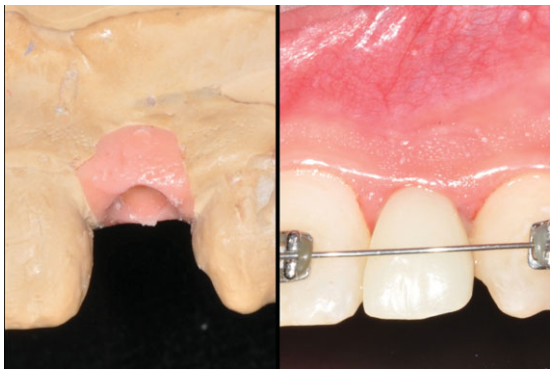

Figure 9 Desired soft tissue contour was created in the master cast using a laboratory bur and interim prosthesis modified soft tissue in patient.

Discussion

Resin-bonded fixed dental prostheses, fixed partial dentures, or a dental implant are alternative treatment options for the restoration of the single edentulous space in the esthetic area. In this instance, adjacent teeth were healthy without decay or restorations, and a dental implant was the selected option for treatment.

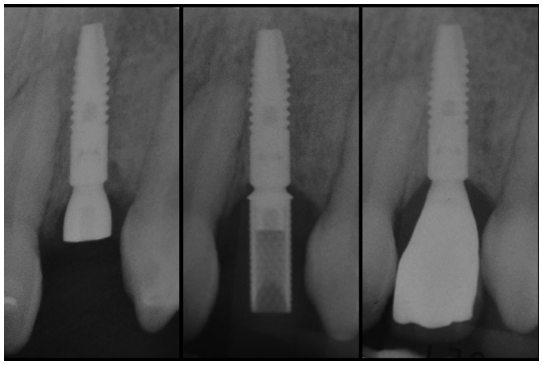

Figure 10 Periapical radiographs showing implant with healing abutment, with interim prosthesis and with definitive restoration.

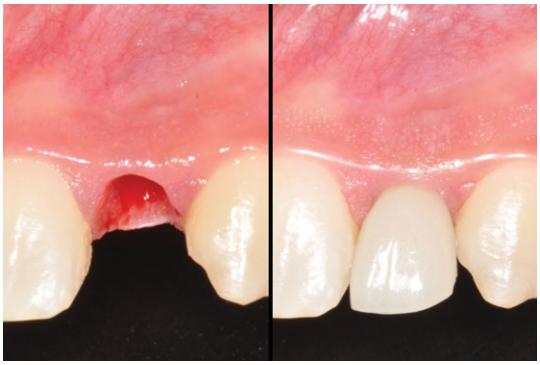

Figure 13 Definitive screw-retained restoration with adequate gingival contour and interproximal papillae.

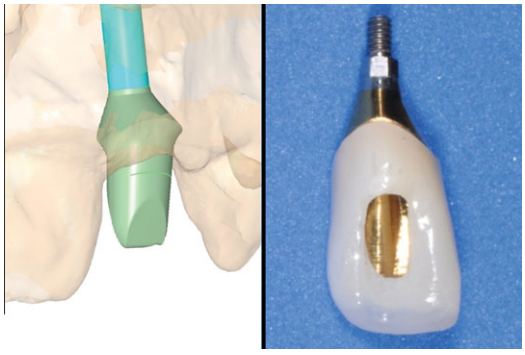

Figure 11 Abutment was designed virtually from scan of master cast, and a crown was designed to cement extraorally.

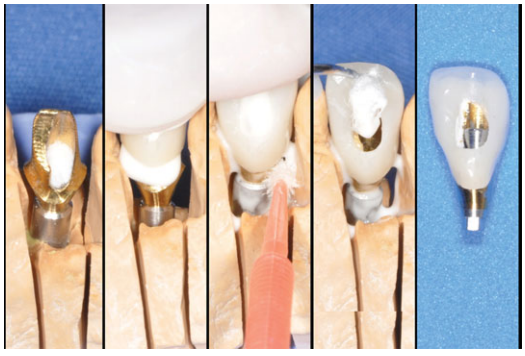

Figure 12 Sequence of extraoral cementation to avoid cover retention screw access.

Several clinical reports and studies on single-implant restorations have been completed in the past. In 2001, Cooper et al reported a high success rate with tissue response for maxillary anterior unsplinted single-tooth implants placed during one-stage surgery (and restored at 3 weeks).[6] In 1996, Raghoebar et al concluded that the augmentation of local alveolar defects in the maxilla, with intraorally harversted autogenous bone grafts, appeared to be a reliable method to enable insertion of implants for a single-tooth replacement.[7] In 2010, van Kesteren et al, in a prospective randomized clinical study, did not see any differences between patients treated with immediate or delayed approaches for midbuccal or interproximal soft tissue margins.[8] In 2011, Corbella et al showed that an immediate implant insertion in endodontically infected sites was a predictable and viable technique.[9]

In the anterior maxilla, peri-implant soft tissue recession is a major esthetic complication, and this recession can be caused by different factors. In 2000, Hermann et al concluded that a stable biological width is formed at the dental implant,[19] and according to Kan et al in 2003, the average dimension is 3 mm.[20] In the same article, Kan et al concluded that the interproximal papilla of the implants is related to the bone level next to the adjacent teeth.[20] In 2008, Evans and Chen recommended keeping 1.8 to 2.0 mm of buccal bone to preserve the bone for its resorption.[21] In the scenario presented in this report, bone was reduced to place the implant 3 mm from the cervical contour of the planned crown and to obtain the same dimension for the biological width. The interproximal bone was maintained next to the adjacent teeth to support the interproximal papilla.

In 2003, Kan and Rungcharassaeng concluded that papilla is lost after an extraction, and the interproximal dentogingival complex dimension is reduced to approximately 3 mm (a similar result found with an unsupported facial dentogingival complex).[24] In 2005, Ryser et al concluded that the papilla will be present in immediate provisionalization and delayed single-tooth implant restoration.[14] In this present report, the papillae were obtained in a delayed single-implant interim prosthesis. According to Choquet et al, Ryser et al, and Palmer et al, the papilla is present when the distance between the contact point to the crest of bone is <5 mm.[13-15] One factor for buccal soft tissue recession is buccal bone loss. In 1997, Palmer et al reported 0.00 mm bone level changes in a 2-year prospective study of single-tooth implants.[25] In 2000, the same authors reported seeing $+0.12$ mm of bone level change (over a 5-year prospective study) in single-tooth implants.[26] In 2001, Cooper et al reported (from a 1-year multicenter study) a bone level change of –0.40 mm,[6] the same bone level change reported by Norton in 2004.[27] In 2005, Wennström et al reported –0.11 mm of bone level change in a 5-year prospective study of implant-supported single-tooth restorations.[28] The implants used in

these studies were screw-shaped and have a conical relation to the abutments. This connection influences the positive results of bone level changes. The same implant-abutment connection was used in this report.

Conclusion

In single-implant restorations, the restoration design needs to be the first step in treatment planning. The cervical contour of this new restoration will be the point of reference to place the implant in a correct 3D position. The implant needs to be 3 mm in the apical direction from the cervical contour and placed 2 mm in the palatal direction. After implant placement, 2 mm of buccal bone should remain to avoid its resorption. If bone is 3 mm from the cervical contour, the implant can be placed at the level of the bone. If the bone is more than 3 mm from the cervical contour, the patient will need guided bone regeneration. If the bone is less than 3 mm from the cervical contour, the patient will require a bone reduction. In areas of extraction sockets, if the bone is less than 3 mm from the cervical contour, the implant can be placed below the bone (without any reduction of the bone). An implant with a conical connection can maintain the level of the bone at the level of the implant, consequently extending the longevity of the implant.

Acknowledgments

The author would like to acknowledge Dominika Prochal, DT, Warsaw, Poland, for the definitive restoration and Jorge Cid Yañez, DT, from the laboratory of the Mediterranean Prosthodontic Institute (MPI) in Castellon, Spain for the interim prosthesis.

References

1. Kois JC, Kan JY: Predictable peri-implant gingival aesthetics: surgical and prosthodontic rationales. Pract Proced Aesthet Dent 2001;13:691-698; quiz 700, 721-722
2. Kois JC: Predictable single-tooth peri-implant esthetics: five diagnostic keys. Compend Contin Educ Dent 2004;25:895-896, 898, 900 passim; quiz 906-907
3. Chu SJ, Tan JH, Stappert CF, et al: Gingival zenith positions and levels of the maxillary anterior dentition. J Esthet Restor Dent 2009;21:113-120
4. Rufenacht CR: Fundamentals of Esthetics. Chicago, Quintessence, 1992, p. 127
5. Salinas TJ, Block MS, Sadan A: Fixed partial denture or single-tooth implant restoration? Statistical considerations for sequencing and treatment. J Oral Maxillofac Surg 2004;62:2-16
6. Cooper L, Felton DA, Kugelberg CF, et al: A multicenter 12-month evaluation of single-tooth implants restored 3 weeks after 1-stage surgery. Int J Oral Maxillofac Implants 2001;16:182-192
7. Raghoebar GM, Batenburg RH, Vissink A, et al: Augmentation of localized defects of the anterior maxillary ridge with autogenous bone before insertion of implants. J Oral Maxillofac Surg 1996;54:1180-1185; discussion 1185-1186
8. van Kesteren CJ, Schoolfield J, West J, et al: A prospective randomized clinical study of changes in soft tissue position following immediate and delayed implant placement. Int J Oral Maxillofac Implants 2010;25:562-570
9. Corbella S, Taschieri S, Del Fabbro M, et al: Immediate implant placement in endodontically infected sites: an alternative treatment for compromised teeth. Refuat Hapeh Vehashinayim 2011;28:25-29, 36, Review
10. Fürhauser R, Florescu D, Benesch T, et al: Evaluation of soft tissue around single-tooth implant crowns: the pink esthetic score. Clin Oral Implants Res 2005;16:639-644
11. Meijer HJ, Stellingsma K, Meijndert L, et al: A new index for rating aesthetics of implant-supported single crowns and adjacent soft tissues–the Implant Crown Aesthetic Index. Clin Oral Implants Res 2005;16:645-649
12. Cosyn J, Eghbali A, Hanselaer L, et al: Four modalities of single implant treatment in the Anterior maxilla: a clinical, radiographic, and aesthetic evaluation. Clin Implant Dent Relat Res. doi: 10.1111/j.1708-8208.2011.00417.x
13. Choquet V, Hermans M, Adriaenssens P, et al: Clinical and radiographic evaluation of the papilla level adjacent to single-tooth dental implants. A retrospective study in the maxillary anterior region. J Periodontol 2001;72:1364-1371
14. Ryser MR, Block MS, Mercante DE: Correlation of papilla to crestal bone levels around single tooth implants in immediate or delayed crown protocols. J Oral Maxillofac Surg 2005;63:1184-1195
15. Palmer RM, Farkondeh N, Palmer PJ, et al: Astra Tech single-tooth implants: an audit of patient satisfaction and soft tissue form. J Clin Periodontol 2007;34:633-638
16. Nisapakultorn K, Suphanantachat S, Silkosessak O, et al: Factors affecting soft tissue level around anterior maxillary single-tooth implants. Clin Oral Implants Res 2010;21:662-670
17. Cooper LF: Objective criteria: guiding and evaluating dental implant esthetics. J Esthet Restor Dent 2008;20:195-205
18. Rojas-Vizcaya F: Rehabilitation of the maxillary arch with implant-supported fixed restorations guided by the most apical buccal bone level in the esthetic zone: a clinical report. J Prosthet Dent 2012;107:213-220
19. Hermann JS, Buser D, Schenk RK, et al: Biologic width around titanium implants. A physiologically formed and stable dimension over time. Clin Oral Implants Res 2000;11:1-11
20. Kan JY, Rungcharassaeng K, Umezu K, et al: Dimensions of peri-implant mucosa: an evaluation of maxillary anterior single implants in humans. J Periodontol 2003;74:557-562
21. Evans CD, Chen ST: Esthetic outcomes of immediate implant placements. Clin Oral Implants Res 2008;19:73-80
22. Cooper L, De Kok IJ, Reside GJ, et al: Immediate fixed restoration of the edentulous maxilla after implant placement. J Oral Maxillofac Surg 2005;63(Suppl 2):97-110
23. Abrams L: Augmentation of the deformed residual edentulous ridge for fixed prosthesis. Compend Contin Educ Gen Dent 1980;1:205-213
24. Kan JY, Rungcharassaeng K: Interimplant papilla preservation in the esthetic zone: a report of six consecutive cases. Int J Periodontics Restorative Dent 2003;23:249-259
25. Palmer RM, Smith BJ, Palmer PJ, et al: A prospective study of Astra single tooth implants. Clin Oral Implants Res 1997;8:173-179
26. Palmer RM, Palmer PJ, Smith BJ: A 5-year prospective study of Astra single tooth implants. Clin Oral Implants Res 2000;11:179-182
27. Norton MR: A short-term clinical evaluation of immediately restored maxillary TiOblast single-tooth implants. Int J Oral Maxillofac Implants 2004;19:274-281
28. Wennström JL, Ekestubbe A, Gröndahl K, et al: Implant-supported single-tooth restorations: a 5-year prospective study. J Clin Periodontol 2005;32:567-574