The Reverse Pathway: Parameters for the Integration of Function and Aesthetics with Implants

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Abstract

Implant Dentistry has evolved dramatically since it's inception as an anchor for the fully edentulous patient population. Today, more than ever, implants are being utilized for the partially edentulous patient as segmental or single tooth replacements where long term function and esthetics are of prominent importance. The dental implant specialist must therefore attempt to work backwards from the restorative-esthetic final goal of therapy to the beginning of the case where the initial decisions are being made. Restorative driven implant based decision making by the surgeon will lead to the correct augmentation and implant selection for the specific needs of the patient. This "reverse pathway" approach is the protocol featured in this article to achieve excellent results and avoid complications.

KEY WORDS: Dental implants, treatment planning, occlusion, prosthetics

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Figure 1: Final crown on upper right central temporarily cemented. Laboratory work by Fujiki Toshi, RDT.

Figure 1a: Custom abutment torque tightened to 35 Ncm. Soft tissue emergence profile created with the provisional restoration. Laboratory work by Fujiki Toshi.

Figure 1b: Ovate pontic after 3 weeks healing time created with a provisional bonded restoration. Gingival margin is higher than adjacent central because patient refused orthodontic treatment to supraerupt hopeless tooth. Bone grafting in addition to tissue molding with the provisional prosthesis was required to create the best possible soft tissue profile.

Figure 1c: Lateral view of poor fitting crown with gingival recession on a tooth with hopeless prognosis.

INTRODUCTION

Contemporary implant dentistry is more than providing a patient with a titanium fixture and restoration. When replacing a missing tooth, patients' expectations are high from an aesthetic, functional and health perspective. Success is achieved in a reverse pathway by working from an aesthetic goal to a healthy, supportive foundation (Figures 1, 1a, 1b, 1c, 1d, 1e).

Knowledge, vision, ability, interdisciplinary treatment and technical support enable us to envision the design of the final prosthesis for patients in the midst of complex problems with sequential solutions as soon as a diagnosis is established.

Before the introduction of the osseointegrated implant, dentists often resorted to heroic measures to maintain teeth with guarded or poor prognoses because quality replace-

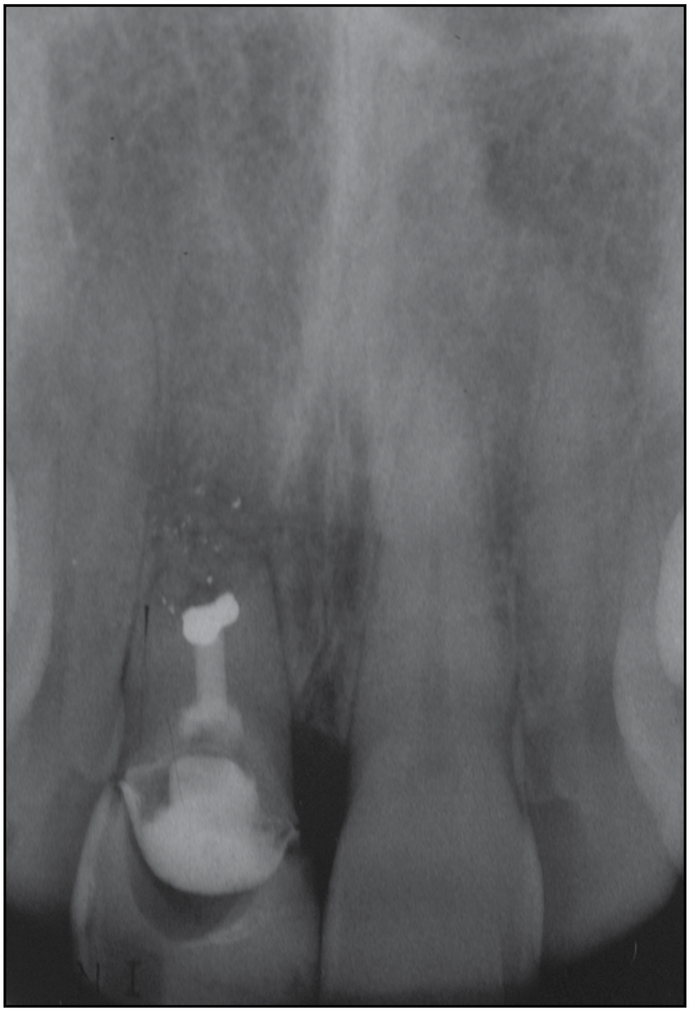

Figure 1d: Initial radiograph showing hopeless prognosis of upper right central incisor.

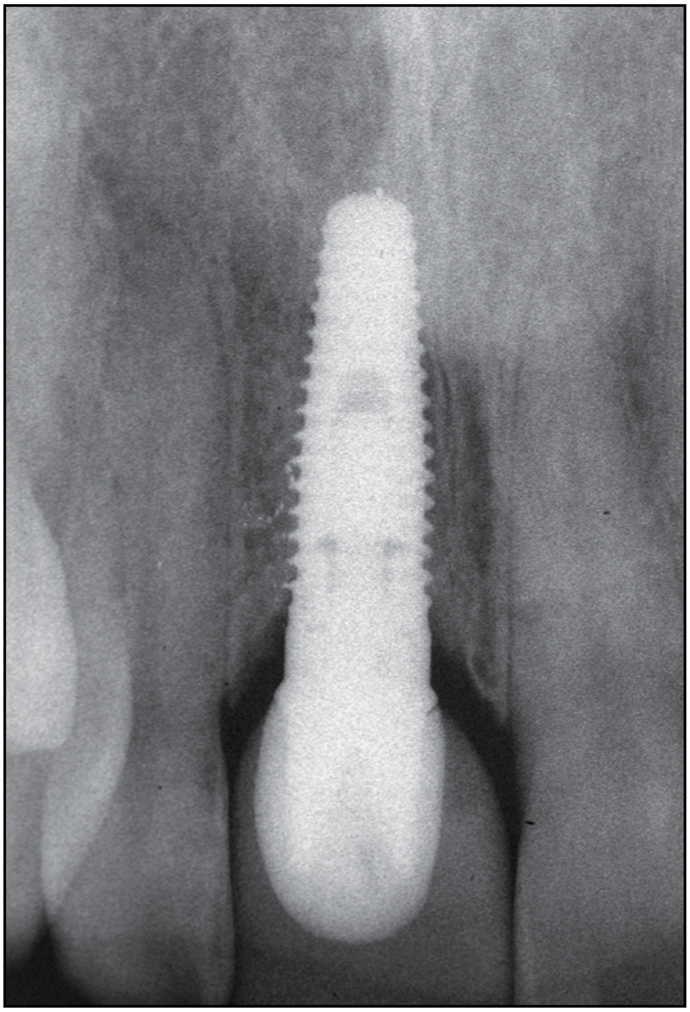

Figure 1e: Final radiograph showing Implant and final restoration. Implant placed by Dr. Maurice Salama.

ments were not available. Endodontic treatment and prosthetic and surgical techniques such as hemisection and root amputation were employed to preserve tooth function and bone support.[1-4] Today implant technology has revolutionized dentistry and improved the quality of life for patients with missing and nonviable teeth by aesthetically restoring function and providing long-term periodontal and peri-implant health.[5,6]

THE EVOLUTION OF IMPLANTS AND CASE SELECTION

Osseointegrated titanium dental implant technology has made enormous progress since its introduction in the early 1980s.[7] A common problem with older implants without anti-rotational properties and even some that used an external anti-rotation hexagon was screw loosening on the abutments, which led to instability of the overlying crown. The development of implants with external and internal anti-rotation, improvements in abutment and screw design, abutments with conical seals, and the availability of screw torque devices have enhanced the stability of abutments and prosthetic components.[8-10] Surface treatments that promote osteoblast differentiation and new bone formation have shortened the time to osseointegration.[11,12] Advances in bone grafting[13,14] used to augment supporting bone which often is thin or narrow and osteodistraction techniques used to increase bone height[15-18] have expanded prosthetic options and optimized results. In addition, the use of 3-dimensional computed tomography assists in diagnosis and treatment planning, thus reducing surprises during surgery.[19]

Appropriate case selection is critical to avoid complications and achieve successful osseointegration. Visualizing the final restoration before the treatment commence, allows the dentist to develop a treatment plan that creates the infrastructure necessary for a durable implant prosthesis. Such treatment plans may include orthodontia to supraerupt teeth in order to improve the quality and quantity of bone for the future implant bed.[16,20-25] This strategy may reduce the size of the bone graft or eliminate the need for such surgical intervention altogether.

PARADIGM SHIFT FOR OSSEOINTEGRATION

Minimizing Micromovement and Enhancing Occlusion

A growing trend in implant dentistry is to use an implant immediately after placement, with or without a nonfunctional provisional.[26] When immediate use of the implant is planned, the choice of components must be guided by the need to minimize micromovement between the implant and abutment[27] while creating a seal that reduces bacterial invasion.[28] When evaluating for optimum bone preservation around an implant, we cannot separate from the implant design and its surface treatment its direct correlation to the prosthetic component and connection.[29] Furthermore, there are too many variables to conclude that the prosthetic materials selected will have a more favorable or negative impact on the outcome.[30,31] Among the variables with the current restorative materials is acrylic, composite, gold, titanium, zirconia and porcelain. It must be also considered the amount of implants, implant position, location and or angulation, length and width, quantity and quality of bone. Understanding patient's existing occlusion as well as parafunctional habits could influence on the overall treatment plan and material selection.[31]

With no evidence based on the best occlusal design and restorative material to be selected for the implant supported prosthesis and due to the lack of a periodontal ligament, we must also consider factors that could negatively affect the long term success and bone preservation of the implant-prosthetic unit such as: occlusal design, occlusal forces to prevent overloading, large cantilevers, premature contacts.[32]

Preserving Bone

Postoperative bone preservation is key to implant success and must be continually evaluated both clinically (demonstrated by healthy, stable tissue) and radiographically. Contributors to bone preservation include the use of implants with external microthreads,[33-35] loading of the implant to a conical sealed abutment,[36,37] and use of a narrower abutment-crown to implant connection[38] which directs the loading forces closer to the center of the implant and away from the exter-

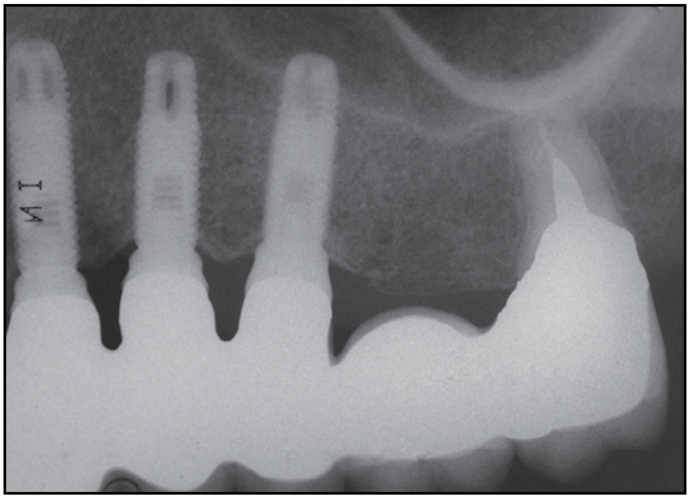

Figure 2: Implants placed with a 3 mm separation at bone level. Implants placed by Dr. Sidney Peskin.

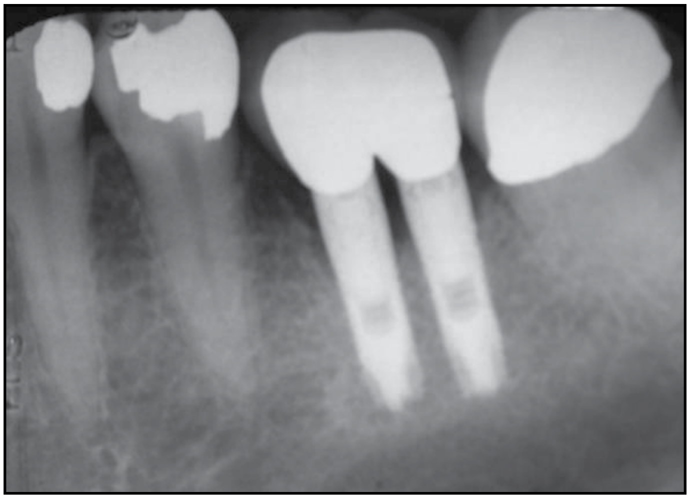

Figure 3: Implants placed too close together can lead to poor oral hygiene and bone loss.

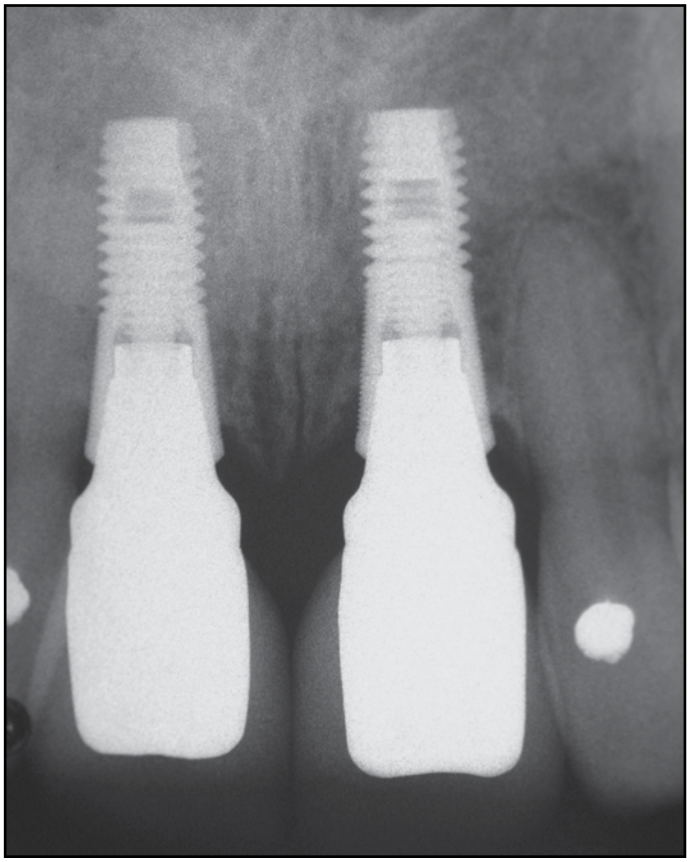

Figure 4: Implants placed more than 3 mm apart, which requires over-contouring of the crowns to provide soft tissue support.

nal and most coronal threads, thereby helping to reduce implant-abutment micromovement.[27]

Implant Spacing: 3 mm versus 2 mm

Since the introduction of the Branemark implant,[7] bone loss at the uppermost coronal threads has been the norm, particularly for implants with flat-to-flat connections versus those with internal conical seals.[37] To address one variable in this problem, there has been consensus in the literature that the recommended distance between 2 implants is 3 mm (Figure 2). This distance is sufficient to prevent implant encroachment and subsequent bone loss at the top threads (Figure 3).[37] In addition, the 3 mm distance provides sufficient subgingival tissue support for the creation of papillae[39-41] regardless of the gingival biotype (thick or thin) surrounding the implants.[42,43] When implants are placed more than 3 mm apart, over-contouring of the crowns is necessary to provide papillae support (Figure 4). Even with such contouring, the resultant papillae will have a flatter architecture and will be in a more gingival location. On

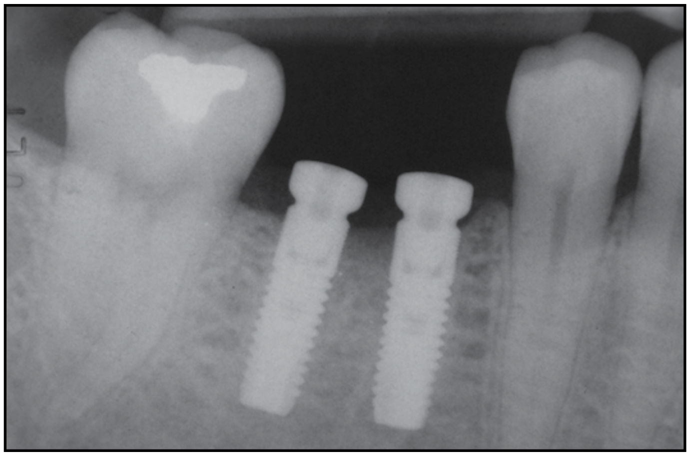

Figure 5: Radiograph showing implants replacing the mesial and distal roots on a first molar. While the interproximal placement is ideal, the implants could have been positioned an additional 1-2 mm subgingival. Implants placed by Dr. Nolen L. Levine.

Figure 5a: Initial occlusal view of a lower right first molar with a vertical fracture.

Figure 5b: Initial periapical radiograph.

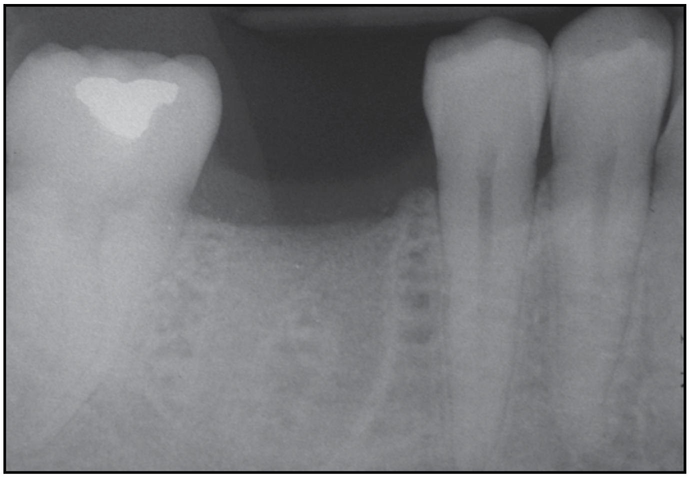

Figure 5c: Radiograph showing extraction of the first molar due to a vertical fracture. Note the anatomic landmark of the original roots in the bone.

the other hand, spacing implants closer than 3 mm may be advantageous in some scenarios.

When the implants used provide optimal bone preservation at the upper threads and, thus, achieve an excellent soft tissue response, a 2mm distance between implants may be acceptable (Figure 5).[44-46] Short-term results suggest that 2 mm spacing does not compromise papillae formation and offers excellent function and aesthetics. The 2 mm distance is also recommended when replacing missing anterior teeth. Considering the options of restoring two missing

Figure 5d: Lateral view of the healing caps.

Figure 5e: Occlusal view showing the abutment in place on the implant replacing the mesial root. The emergent soft tissue profile from the implant replacing the distal root has been created by the healing cap.

Figure 5f: Both abutments in place on each implant.

Figure 5g: Occlusal view of metal try-in procedure. Only one screw is used to verify a passive fit.

anterior teeth with two implants and two crowns versus one implant and two crowns, avoiding the cantilevered crown will enhance support without compromising the aesthetic result. When one implant is supporting two crowns and one is cantilevered, following guidelines for proper papillae support will yield a more predictable result.[39]

Retaining or Removing Molars

The decision to retain or remove a molar is based on several factors: anatomy, periodontal, endodontic, and occlusal status, tooth position, quality

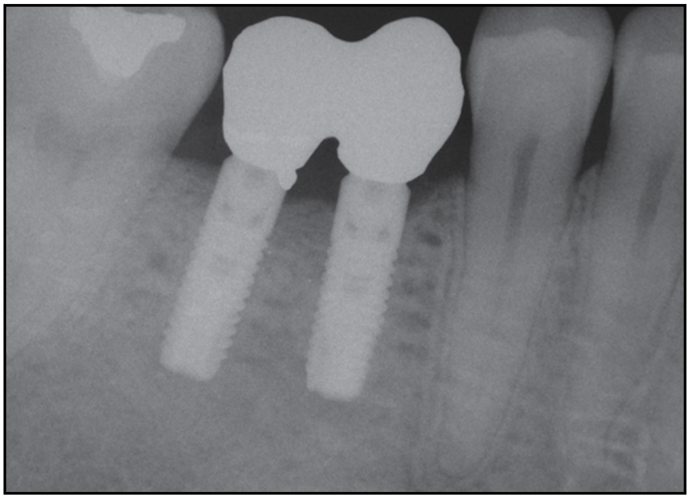

Figure 5h: Radiograph showing proper fit during metal try-in.

Figure 5i: Occlusal view of final crowns splinted and screw access covered with composite.

Figure 5j: Buccal view of the final crowns screw-retained. Laboratory work by Fujiki Toshi, RDT.

and quantity of the remaining tooth structure including existing microfractures, the ability to create a ferrule effect during tooth preparation, the crown-to-root ratio, cost, and the anticipated longevity of the tooth compared with that of an implant (Figures 5a, 5b, 5c). When a molar is missing or must be extracted, anatomical differences between the implant and the natural tooth influence treatment planning. The design of all implants resembles a single root, whereas upper and lower molars generally have multiple roots. Furthermore, the burs used to prepare the implant bed typically produce cylindrical shapes with parallel or tapered walls. Consequently, in some instances a missing lower molar is best replaced with 2 implants to better fit the extracted mesial and distal roots (Figure 5). The mesial-distal dimensions of the lower molar require that the size of each implant be sufficiently thick to withstand occlusal forces while respecting the distance from the implant to a natural tooth and from implant to implant.[41,42]

Creating a Tissue Profile

The tissue profile emerging from the implant is often created with a healing cap (Figure 5d) or an abutment (Figures 5e and 5f). Modification of the profile with a provisional may be necessary, and the final impression should not be taken until the correct soft tissue profile is created.

Figure 6: A tooth with a telescopic crown has intruded and pulled away from the prosthesis.

Figure 7: Occlusal view showing implants with abutments in place. A milled and tapped telescopic crown is permanently cemented to a natural tooth.

Figure 7a: Occlusal view with the prosthesis in place screw retained on the implant abutments and telescopic crown of the molar to prevent intrusion and separation of the molar from the prosthesis. Figure 2 is the radiograph showing excellent fit and bone preservation around the tooth and implants.

Impression Accuracy

Impression techniques and proper material selection are critical in order to accurately reproduce on a model the position of the osseointegrated implant(s). While no significant differences are described between polyether and vinyl polysiloxane materials[47,48] the polyether material provides superior detail reproduction in the presence of moisture,[49] the direct impression technique is preferable to the indirect one as well as the polyether impression material being the most precise with the direct impression technique.[50]

Connecting Implants

The decision to connect implants prosthetically is determined by the quality of the bone, the characteristics of the implant, the patient's occlusion, occlusal habits, existing restorations, and oral hygiene.[31] When implants are connected prosthetically, it is essential that a passive fit be verified clinically and in the laboratory.[51-53] This is more easily accomplished if only one screw is used[54] (Figures 5g and 5h). The assessment can be done clinically unless the crowns have subgingival margins, in which case radiographic verification is necessary.[55,56] Figures 5i and 5j show the completed treatment, with the two premolars of the implant restoration replacing one natural molar.

Whether to connect implants and natural teeth is controversial.[57,58] Such connection can be accomplished by using attachments, cementation or screws. Connecting natural teeth to an implant-supported fixed partial denture with a cemented restoration or semi-precision attachments may result in separation and intrusion from the tooth (Figure 6).[59] To avoid these complications, the natural tooth can have a crown accepting a lingual screw[60] or must have a milled telescopic crown permanently cemented (Figure 7), and the fixed partial denture should be screw-retained onto the telescopic crown and onto the implant abutments (Figure 7a, Figure 2). By retaining the implant supported prosthesis with a screw, the need for using a cementation technique is eliminated, thus sustaining evaluation for over 14 years the hypothesis that such prosthetic designs can prevent intrusion of the natural tooth/teeth.[58]

CONCLUSION

Osseointegrated dental implants have dramatically advanced dental care by aesthetically restoring function in patients with missing and nonviable teeth. Implant success is influenced by appropriate case selection, visualizing the final result before the treatment begins, and adherence to established parameters designed to reduce complications, maximize bone preservation, and achieve durable restorations. As experience accumulates and implant technology evolves, paradigms are shifting. ●

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Disclosure

The authors report no conflicts of interest with anything mentioned in this article.

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