

Restorative Considerations for the Immediate-Load Transitional Prosthesis

The predictability of successful osseointegrated implant rehabilitation of the edentulous jaw as described by P-I Brånemark introduced a new era of management for the edentulous predicament. Implant rehabilitation of the edentulous patient remains one of the most complex restorative challenges because of the number of variables that affect both the aesthetic and functional aspects of the prosthesis.¹

Complete dentures have been the most common treatment modality for edentulism.

Patients with dentures have shown only a marginal improvement in their quality of life, while patients who have undergone implant therapy have shown significant improvement in functionality. Most patients who have complete dentures complain of pain, areas of discomfort, poor denture stability and difficulty eating. When there is severe resorption lack of retention also presents.²⁻⁴

Treatment planning of edentulous patients with fixed restorations on dental implants has undergone a paradigm shift since the introduction of graftless solutions.

Today, patients have options whereby, in the right indication, complete rehabilitation can be accomplished by the use of four to six implants per arch. The huge advantage of this procedure is the reduced number of implants and the ability to bypass extensive grafting procedures. This rehabilitation not only satisfies aesthetics and function but also considerably reduces costs for the patient. This ultimately results in increased patient acceptance and an increased number of patients treated. Very few patients today are able to afford extensive implant rehabilitations on six to eight implants, and the All-on-4[®] treatment concept, or graftless protocol, is gaining popularity as being the preferred treatment for the edentulous patient.

In a world environment where the numbers of edentulous patients are increasing, there are not enough available dentists trained in these protocols to be able to treat them. Patients are not given these options because of the dentist's reluctance to offer them. Reasons for this are lack of education and the notion that these treatment protocols are not predictable. Delivering

graftless protocols requires attention to detail from a surgical, prosthodontic and laboratory perspective. Only through adequate education and training will the results compare to published data using conventional protocols.⁵

Patients who present with terminal dentition seek solutions that involve fully implant-supported fixed restorations. From prosthodontic and aesthetic standpoints, these patients present with teeth that are in unfavorable positions. Patients with missing posterior teeth are often diagnosed as having lack of posterior support. With this diagnosis, a presentation of splayed, supraerupted teeth often results. Both of these events may be physiological or pathological and coupled with dentoalveolar compensation. Dentoalveolar compensation is the process in which the housing around the tooth will undergo compensatory changes in order to maintain occlusal contact with the opposing dentition. As a result of these changes, a lack of restorative space often results. Adequate restorative space is critical, and guidelines exist depending upon the type of prosthesis being treatment planned.

For the purpose of this article, the focus will be on the implant-supported fixed denture. There must be adequate space for bulk of restorative material that also permits a prosthesis design to establish aesthetics and hygiene. If space is limited, re-establishing a patient's vertical dimension, altering the opposing occlusion or an alveolectomy should be considered.

Following are pitfalls that are often seen when restorative space is lacking.

1. Poor Emergence Profile

This occurs as a result of an implant placement that is too shallow. There is insufficient room to transition from the head of the fixture to the ideal incisal edge position. A ledge often results that may serve as an area of food entrapment. This ledge may also result in a concavity of the lip in the region of the naso-labial angle affecting overall facial aesthetics.

2. Concave Tissue Contours

A concave undersurface makes it difficult for the patient to maintain appropriate hygiene.



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The concave surface serves as a reservoir for microorganisms, which may ultimately impact the health of the peri-implant tissues.

3. Short Unaesthetic Teeth

A compromise in the aesthetics of the final restoration is very disappointing for both patient and clinician. This can be avoided if the diagnostic phase includes a thorough analysis of the vertical space required.

4. Food Entrapment/Speech Impairment

A common complaint by patients is food entrapment and impairment of speech. This occurs as a result of too much space beneath the restoration.

All the problems above arise as a result of inadequate bone reduction. Clinicians are trained to preserve teeth and bone wherever possible. In the right circumstances this is a valid stance where aesthetics, mechanics and hygiene of the prosthesis can be optimized. When treatment planning a fixed, implant-supported denture, a paradigm shift in thinking must occur. Adequate restorative space and lip support is a surgical responsibility which, if ignored, will result in myriad problems for the restorative dentist.

From a prosthodontics perspective there are five considerations.

1. Tooth Position

The incisal-edge position is determined utilizing the principles taught in complete denture fabrication. Traditional guidelines tell us when the patient makes the “F” sound, the incisal edge should touch the vermillion border of the lower lip. Once the incisal-edge position has been established, the length for the central incisors is determined. On average, the length of the central incisors is 10.5 mm; this can be more in elderly patients who exhibit gingival recession.

The axial inclination of the central incisor should be placed so as to provide adequate support for the upper lip. Once the crown length, angulation and coronal form have been determined, the distance between the cervical crown margin and residual bone crest can be assessed.⁸

A clinician needs to make the determination if the maxillary incisal edge is indeed in the right position. If repositioning of the incisal edge is required more apically, this will have

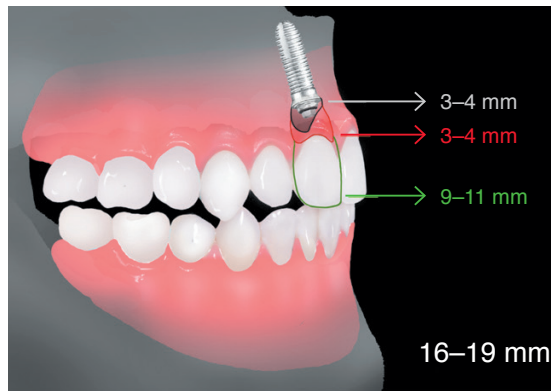


Figure 1. Restorative requirements for an implant-supported fixed denture.

an impact on implant placement and ultimately on the bone reduction required prior to implant placement.

2. Restorative Space

To accommodate adequate designs, different types of restorations require different dimensional tolerances. Accurately mounted casts are critical in assessing prosthetic space limitations. Spatial constraints must be considered as a matter of practicality. The limiting factor in edentulous patients is the available inter-arch space.

Adequate restorative space is critical, and guidelines exist depending upon the type of prosthesis being treatment planned. Guidelines for space requirements are between 16–19 mm (Fig. 1). Heat-processed resin requires 2–3 mm to provide adequate strength as a denture base material. Space is also required for the prosthetic tooth and the titanium framework. If restoring both arches, a minimal space requirement of 32 mm is needed from the head of the fixture in one jaw to the head of the fixture in another.

3. Aesthetics

The movement of the upper lip during speech and smiling should be evaluated. Authors have described the average smile as having the position of the upper lip such that 75 to 100 percent of the maxillary incisors and interproximal gingiva are displayed.⁹ In a high smile line, additional gingiva is exposed, and in a low smile line, less than 75 percent of the maxillary anterior teeth are displayed.

Lip length should also be evaluated because it influences the position of the maxillary anterior teeth. In a patient with a short upper lip,



Figure 2. When an edentulous patient smiles without his denture, the ridge should not be visible.



Figure 3. A visible ridge will cause aesthetic problems.

the maxillary anterior teeth will be exposed in repose; whereas in patients with a long upper lip, the anterior teeth will usually be covered. A long upper lip is a more favorable situation for the restorative dentist.

Patients should be asked to smile with and without the denture in place. If the soft tissue of the edentulous ridge cannot be seen, the transition between an implant-supported prosthesis and the residual ridge crest will not be visible, resulting in flexibility for color matching and the contour change of the prosthesis at the junction of the soft tissue (Fig. 2).

If the alveolar ridge crest is displayed during smiling, the aesthetics can be very challenging because the horizontal transition zone between the restoration and the gingival complex will be visible and have aesthetic consequences (Fig. 3).

In situations like this, alveolectomy as part of a proactive protocol must be considered prior to implant placement. If alveolectomy is not performed, the restorative outcome will display the transition zone, which, ultimately, is very difficult to re-treat. If the patient refuses alveolectomy, a removable appliance with a flange that overlaps the gingival junction must be planned. This prosthesis can be removed by the patient so oral hygiene is not compromised.

In the mandible, similar pretreatment evaluations exist.

Two types of patients present:

- a. Edentulous.
- b. Dentate patients with terminal dentition who would prefer not to wear a removable appliance.

For edentulous patients, the amount of bone resorption will dictate which type of prosthesis

is to be fabricated. If the treatment plan is for a fixed implant-supported denture (hybrid), then an evaluation must be made to determine if sufficient restorative space exists to fabricate a biomechanically robust prosthesis. Alveolectomy may be required to satisfy the unique dimensional tolerances of the prosthesis design. The transition line is not an issue in the mandible as the drape of the lip will make the final aesthetics of the mandibular prosthesis acceptable for most patients.

For dentate patients who are to become edentulous, additional considerations are required.

When a patient presents with a maxillary denture and mandibular anterior dentition, a thorough evaluation must be made of the existing mandibular incisal-edge position. In most instances, the mandibular incisal edge is in the incorrect position and the correct position must be planned.

Conventional prosthodontic guidelines will place the mandibular incisal edge just at the level of the lower lip with 0.5-1.0mm of the incisal edge visible. Guidelines in relation to the lower mandibular occlusal plane can also be sought from anatomical landmarks such as the retromolar pad. If the mandibular incisal edge is excessively visible and if the height of the mandibular incisal edge is significantly above the level of the retromolar pad, the clinician must reposition it.

If the clinician is planning a fixed implant-supported denture (hybrid), adequate restorative space must be provided. The over-eruption of teeth brings with it an excess of bone, which must be reduced prior to the implants being placed.

4. Emergence and Contours

One of the best diagnostic tools is the patient's existing maxillary denture. The clinician can evaluate the patient's denture to determine what likes and dislikes there are regarding aesthetics, speech and function. Each point should be noted for improvements in the new restoration.

There is always a tendency for patients to prefer fixed over removable prostheses. It is the restorative dentist's responsibility to determine if this is feasible.

Facial support is an important decision in this regard. Assessments of the patient's facial support with and without the denture in place, with the patient facing forward and in profile, need to be made so the clinician can determine which type of prostheses would be more suitable.

Facial support, if inadequate, is obtained mainly by the buccal flange of a removable restoration. Lip support is derived from the alveolar ridge shape and cervical crown contours of the anterior teeth. Resorption of the edentulous maxilla proceeds cranially and medially, and this often results in a retruded position of the anterior maxilla.

When evaluating a diagnostic setup with the anterior teeth in proper relation to the lip, the position of the anterior teeth is often anterior to the alveolar ridge.

Depending on the severity of the resorption, there can be a discrepancy between the ideal location of the teeth and the ridge. This in turn leads to a discrepancy of the anticipated position of the implants in relation to the teeth. This discrepancy must be taken into consideration to achieve a prosthesis that satisfies the parameters of adequate speech, lip support, hygiene, sufficient tongue space and patient acceptance.

If the anticipated position of the teeth and implant results in a large horizontal discrepancy, a number of options must be considered before finalizing implant placement.

If the horizontal discrepancy is quite large, options include bone reduction and a deeper implant placement to allow the contours of the restoration to satisfy the parameters of lip support and hygiene. Without bone reduction, undesirable contours in the restoration are developed, which make it very difficult for the patient to maintain hygiene.

When deemed too large, the discrepancy can be managed only with the flange of a removable prosthesis.



Figure 4. Undersurface of the prosthesis should be convex and highly polished.

5. Appropriate Tissue Contact

After initial healing, the immediate-load transitional restorations must be designed to satisfy the following requirements:^{6,7}

- a. Provide positive tissue contact.
- b. Be contoured so that the patient is able to maintain hygiene.
- c. Avoid food entrapment.
- d. Avoid speech impediments.
- e. Be used to develop tissue contours.

To do that, the undersurface must be convex and highly polished and put sufficient compression on the tissue to be able to sculpt it. The clinician's goal is to develop a concave tissue profile so that the restoration will have a convex undersurface (Fig. 4).

Communicating Alveolectomy

Adequate restorative space often requires the surgeon to perform an alveolectomy. In most situations, this is decided through clinical judgment. There are no specific objective guidelines to dictate the necessity of an alveolectomy, but information can be gained from a number of techniques.

CT Guided and Measured

In this technique, a CT scan is taken with the patient wearing a duplicate acrylic appliance with radiographic markers at the correct vertical dimension of occlusion. The patient is asked to smile so the lip position is visible in the CT image. Software is required to allow the soft tissue to be visible in the image. With software manipulation, the inter-arch distance can be accurately measured and the amount of reduction calculated, so as to hide the transition zone below the highest smile line.



Figure 5. Window in duplicate of denture with correct incisal-edge position.

Window Technique

A second technique is to create a window in a clear resin duplicate denture 5–6 mm from the position of the prosthetic-free gingival margin.¹⁰ The duplicate denture is placed intraorally and, following anesthesia, the surgeon scores the bone in the region of the window. On raising the flap, this marking serves as an indication of the amount of alveolectomy required (Fig. 5).

Highest Smile Determination

A third technique is intra-operative determination. In a patient with excessive display of the residual ridge crest, the surgeon may ask the patient to smile and then perform the alveolectomy 5 mm above the highest smile line.

Bone Reduction Guide

The above techniques work well in the edentulous patient. When a patient presents with a terminal dentition a bone reduction guide is required.

The bone reduction guide must satisfy the following requirements:

- a. Must be stable.
- b. Must be easy to use.
- c. Must have a reference point from which the surgeon can measure.

In a double-arch case, a minimum of 32 mm of inter-arch space is required (Fig. 6).

Impressions are made and duplicate diagnostic casts are cross-mounted. On one set of casts, the midline, vertical and horizontal overlap of the teeth and desired restorative space is marked (Fig. 7). The gingival margins of the teeth are marked and the anterior teeth are removed from



Figure 6. 32 mm of space is required for upper and lower arches.

the cast (Fig. 8). The model reduction is done and a diagnostic denture tooth set of the anterior teeth is completed (Fig. 9). A duplicate of the diagnostic setup is made in clear acrylic resin. The flange portion of the guide is removed. The surgeon can use the gingival margin of the tooth as a reference from which to measure the bone reduction (Fig. 10).

At the time of surgery, the anterior teeth are removed (Fig. 11) and the guide is placed and indexed on the posterior teeth. With the use of a periodontal probe, the surgeon measures from the gingival margin of the guide to the existing bone (Fig. 12). If inadequate space exists, bone reduction is completed to create restorative space prior to implant placement (Figs. 13–15).

With precision in planning, adequate restorative space is created, which allows the restorative dentist to provide a restoration that satisfies the requirements of aesthetics, mechanics and hygiene.

Discussion

This article addresses a relevant topic that is commonly overlooked in full-mouth supported implant reconstructions. Detailed attention to the sagittal plane for restorative space is required. There are many implant protocols available on the market today that encourage clinicians to perform full-mouth implant reconstructions. In these protocols, surgical considerations and implant placement are discussed in depth. Many of these protocols either bypass or do not place enough emphasis on certain potential prosthetic pitfalls. It has been shown that restorative space is a relevant parameter that must be evaluated

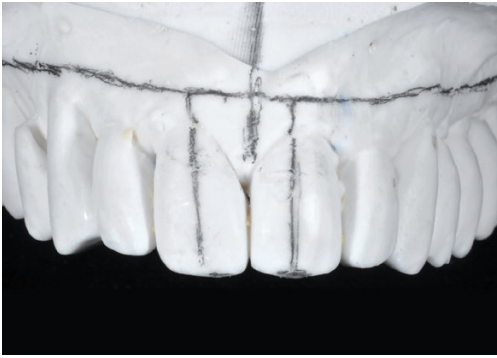


Figure 7. Vertical and horizontal reference lines are marked on the diagnostic cast.

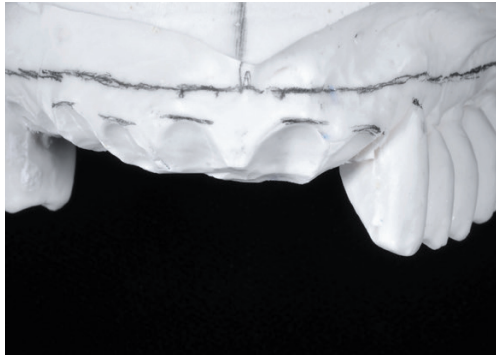


Figure 8. Teeth are removed and amount of restorative space desired is marked.



Figure 9. Anterior teeth are set; posterior teeth will be used as a reference.

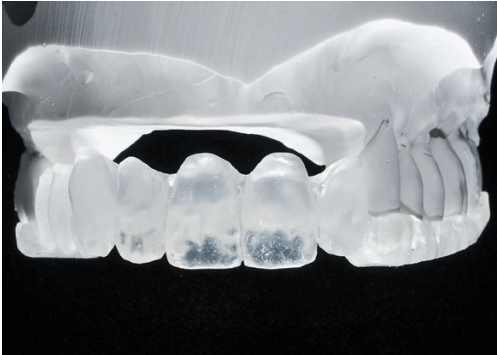


Figure 10. Setup is duplicated in clear acrylic resin; acrylic beyond gingival margin is removed.

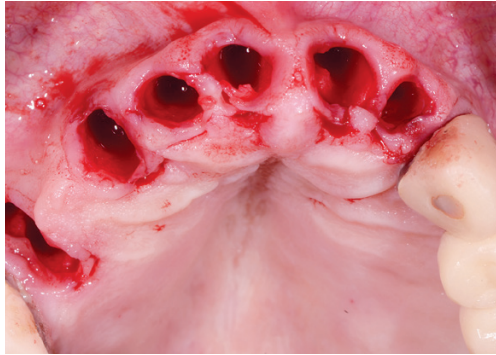


Figure 11. Anterior teeth are removed; posterior teeth will be kept as a positive stop for the reduction guide.

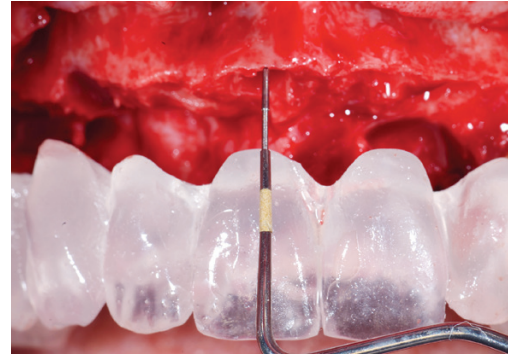


Figure 12. Surgeon measures from gingival margin to bone. If reduction is required, it is completed before implant placement.

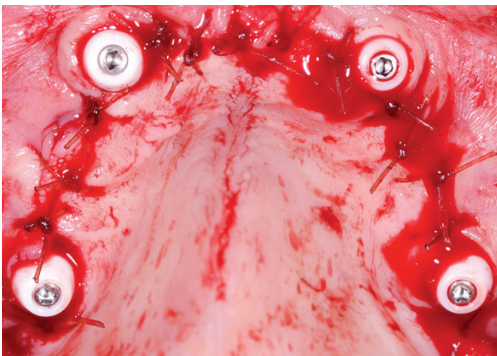


Figure 13. Implants are placed after alveolectomy has been performed.

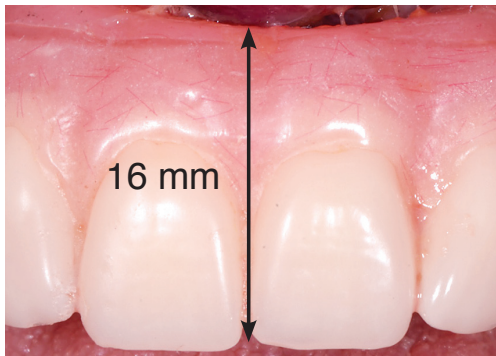


Figure 14. Adequate restorative space has been created.



Figure 15. Appropriate emergence profile developed and tissue contours achieved.

prior to any irreversible treatment. Incorporating a thorough evaluation of the sagittal plane into the diagnosis will reduce the risk of poor prosthetic contours, poor aesthetic results and an unhygienic pontic design.

It is prudent to be familiar with all aspects of restorative and surgical therapy when considering the restoration of a jaw with an implant-supported prosthesis.

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References

1. Brånemark P-I, Hansson BO, Adell R, Breine U, Lindstrom J, Hallen O, et al; Osseointegrated implants in the treatment of the edentulous jaw. Experience from a 10-year period; Scand J Plast Reconstr Surg Suppl. 1977;16:1-132.
2. US Bureau of the Census; Statistical Abstract of the United States: 1996. 116th ed. Washington DC: US Bureau of the Census 1996: p 15, Table II, No. 16; p 17, Table II, No. 17.
3. Allen PF, McMillan AS; A review of the functional and psychosocial outcomes of edentulousness treated with complete replacement dentures; J Can Dent Assoc. 2003 Nov;69(10):662.
4. Heath MR; The effect of maximum biting force and bone loss upon masticatory function and dietary selection of the elderly; Int Dent J. 1982 Dec;32(4):345-356.
5. Turkyilmaz I, Company AM, McGlumphy EA; Should edentulous patients be constrained to removable complete dentures? The use of dental implants to improve the quality of life for edentulous patients; Gerodontology 2010 Mar;27(1):3-10.
6. Zitzmann NU, Marinello CP; Treatment plan for restoring the edentulous maxilla with implant supported restorations: Removable overdenture versus fixed partial denture design; J Prosthet Dent. 1999 Aug;82(2):188-196.
7. Jivraj S, Chee W, Corrado P; Treatment planning of the edentulous maxilla; Br Dent J; 2006 Sep 9;201(5):261-279.
8. Tallgren A; The reduction in face height of edentulous and partially edentulous subjects during long-term denture wear: A longitudinal roentgenographic cephalometric study; Acta Odontol Scand 1966 Sep;24(2):195-239.
9. Tjan AH, Miller GD, The JG; Some aesthetic factors in a smile; J Prosthet Dent 1984;51(1):24-28.
10. Bedrossian E; Implant treatment planning for the edentulous patient; Mosby Elsevier 2008.
11. Misch CE, Goodacre CJ, Finley JM, Misch CM, Marinbach M, Dabrowsky T, English CE, Kois JC, Cronin, RJ; Consensus Conference Panel Report: Crown-Height Space Guidelines for Implant Dentistry – Part 1; Implant Dent. 2005 Dec;14(4):312-318.

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