Graft-less solutions in implant dentistry: Part 1

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Diagnosis, treatment planning and delivery of the immediate load prosthesis

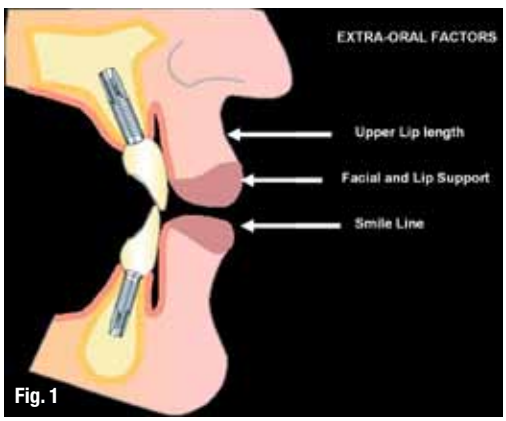
The predictability of successful osseointegrated implant rehabilitation of the edentulous jaw as described by Branemark et al[1], introduced a new era of management for the edentulous predicament. Implant rehabilitation of the edentulous patient remains one of the most complex restorative challenges because of the number of variables that affect both the esthetic and functional aspect of the prosthesis.

The routine treatment for edentulism has been complete dentures. Epidemiological data has reported that the adult population in need of 1 or 2 dentures would increase from 35.4 million adults to in 2000 to 37.0 million adults in 2020[2]; and the researchers warn that their estimates may be "significantly conservative." Clinical studies have reported that patients with dentures have shown only a marginal improvement in the quality of life when compared with implant therapy.[3] The common reasons for dissatisfaction in patients using dentures are pain, areas of discomfort, poor denture stability and difficulty eating as well as lack of or compromised retention capability.[4]

A review of the literature noted that prostheses supported by osseointegrated implants significantly improved the life of edentulous patients when compared with conventional dentures.[5]

Many patients tolerate complete dentures despite the dissatisfaction. Reasons for this could be:

- Anatomic. They have been told they are not



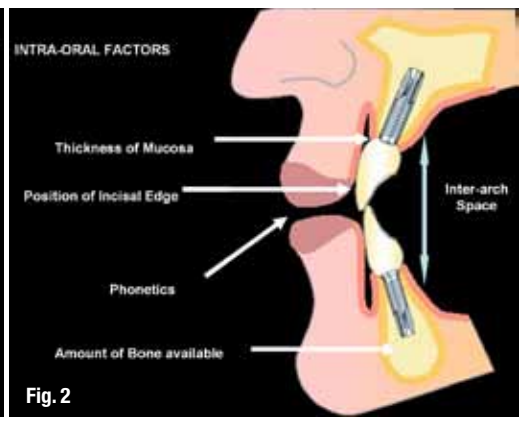


Fig. 1_Extra-oral factors in diagnosing the edentulous patient.
Fig. 2_Intra-oral factors in diagnosing the edentulous patient.


Fig. 3


Fig. 4


Fig. 5

implant candidates because of pneumatized sinuses and severe resorption of the posterior mandible.

- Cost.
- Lack of education. They have not been educated about dental implants and do not visit a dentist because they feel nothing can be done for them.

Restoration of the edentulous patients with dental implants is costly whichever method is used to restore the patient. Fixed reconstructions require more laboratory assistance and implant parts, and, thus, are a lot more expensive.

Due to economic factors, many patients have been provided with implant- and mucosa-supported overdentures.

However, cost needs to be considered not only during fabrication of the prosthesis but also during maintenance. Overdentures seem to have more post-insertion maintenance than their fixed counterparts. If this is consistent, it could be questioned whether an economic indication for choosing an overdenture could be justified when there is sufficient bone to support implants for a fixed prosthesis. The patient must be made aware that maintenance costs for removable prostheses on implants will be higher than that of a fixed prosthesis.

Today, clinicians are seeing an increasing number of dentate patients where the dentition is terminal. These patients would have been edentulous a long time ago if it had not been for the efforts of skilled restorative dentists. Clinical treatments have involved maintaining non-restorable teeth for as long as possible to avoid a removable appliance. Patients understand that maintaining a terminal dentition has consequences on the bone. However, the fear of edentulism forces them to ignore failing oral conditions.

In spite of the increasing numbers of edentulous or soon-to-be edentulous patients, there still appears to be many reasons why patients avoid treatment with dental implants. These reasons could include:

- The fear of wearing a removable appliance in the transitional phase.
- The notion that the proposed treatment is time-consuming and unpredictable.
- The number of visits involved and the fear of pain.
- Cost.

Most patients will look toward an implant rehabilitation hoping to acquire a fixed prosthesis. Treatment planning of edentulous patients with fixed restorations on dental implants has undergone a paradigm shift since the introduction of graft-less solutions. In particular, the All on 4 method™.

Today, patients have options whereby in the *right indication* complete rehabilitation can be accomplished by the use of four implants per arch. The huge advantage of this procedure is reduced number of implants and the ability to bypass extensive grafting procedures. This rehabilitation not only satisfies esthetics and function but also considerably reduces costs for the patient. This ultimately results in in-

Fig. 3: Lip support with denture in place.
Fig. 4: Lip support without denture in place.
Fig. 5: Lip support with denture in place.


Fig. 6

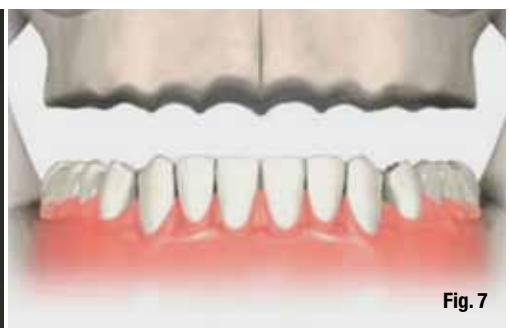


Fig. 7

Fig. 6: Lip support without denture in place look at collapsed facial architecture.
Fig. 7: Minimal resorption. Patient is missing teeth and minimal bone

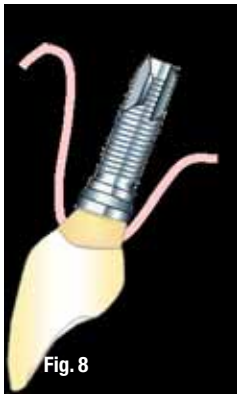
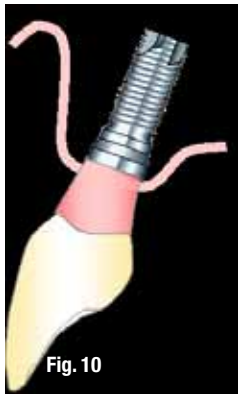


Fig. 8


Fig. 9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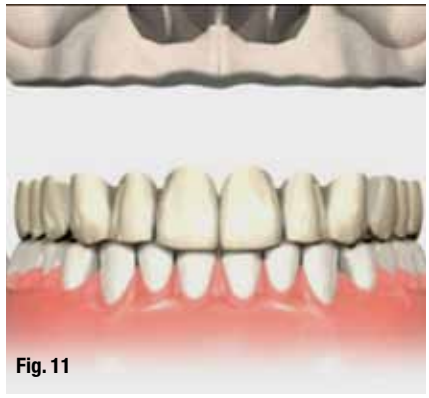


Fig. 11

Fig. 8: With minimal bone resorption, conventional crown and bridgework on implants is feasible.
Fig. 9: With moderate resorption, the patient is missing tooth, hard and soft tissue.
Fig. 10: For patients with moderate bone resorption, the prosthetic replacement may involve pink acrylic or pink ceramic.
Fig. 11: Patient with severe resoption missing tooth soft and a lot of hard tissue.

Fig. 12: Patients with severe bone resorption may require a prosthesis with a flange for lip support.
Fig. 13: A large horizontal discrepancy between the implant position and the position of the teeth for lip support results in prosthesis contours that are not conducive to good hygiene.
Fig. 14: To re-create physiologic contours, alveolectomy is required and placement of the implants more apical.

creased 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 or graft-less protocol is gaining popularity as being the treatment of choice 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.

It is imperative that clinicians gain the available hands-on training and work with other experienced practitioners treating patients in a clinical setting to be able to implement graft-less options for patients in their practices. It is the authors' opinion that weekend courses without a practical hands-on component for the practitioner will not prepare the clinician adequately to treat patients. These protocols, although simplified, require meticulous attention to each detail to provide a successful outcome.

There are many options for the edentulous patient, ranging from fixed crown and bridgework on six to eight implants, implant-supported fixed dentures on four to six implants and implant-supported overdentures. Each type of restoration requires unique dimensional tolerances for biomechanical integrity. Adequate restorative space must be provided to ensure a robust prosthesis, which will provide longevity of service

In this article, the focus will be on the fixed implant denture on four to six implants.

There has been no branch of dentistry that has undergone such a significant change during the last 30 years. Implant dentistry has undergone a transformation from the time when implants were buried, a healing time of four to six months elapsed, and then they were uncovered and loaded. Today, we have immediate placement, immediate loading, different surfaces, a host of implant designs and CAD/CAM. Although many things have changed in the field of implant dentistry, two things have remained the same from the patient's perspective:

- Patients do not want to wear dentures at the end of treatment.
- Patients do not want to wear dentures during treatment.

The fear of becoming edentulous and wearing a removable appliance has resulted in clinicians pushing the envelope and seeking solutions, which result in patients having teeth removed, dental implants placed and receiving fixed implant supported restorations the same day. This option ultimately results in

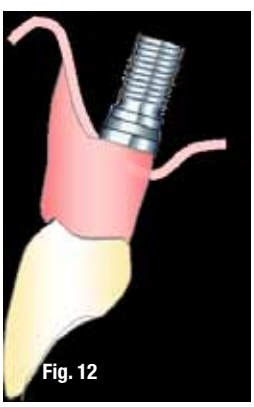


Fig. 12

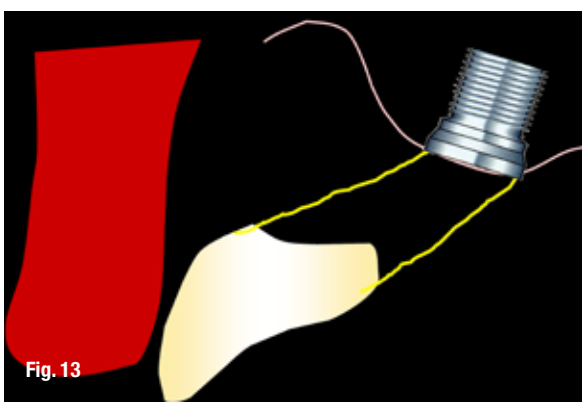


Fig. 13

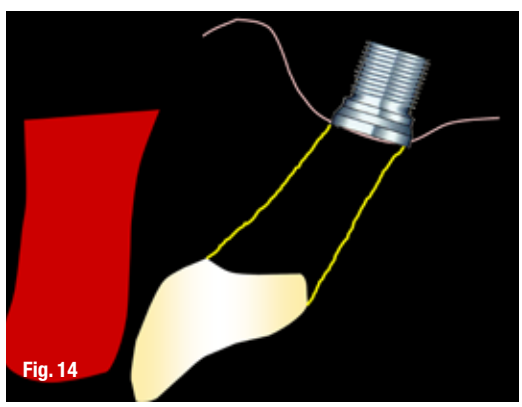


Fig. 14


Fig. 15


Fig. 16


Fig. 17

increased patient acceptance and an increase in the number of patients treated.

As in all phases of dentistry, diagnosis is critical in obtaining a predictable outcome. An incomplete or erroneous diagnosis can yield unsatisfactory results for both the patient and treating clinician.

The decision-making parameters when rehabilitating patients requires the clinician to make a decision as to whether a fixed or a removable prosthesis would be more suitable.

Zitzmann and Marinello[6] and Jivraj et al[7] described in detail parameters that need to be evaluated. A fixed restoration should not be promised to a patient until all diagnostic criteria are evaluated. These criteria must include quality and quantity of bone available to support implants, lip line, lip support and esthetic demands. Implants should not be placed until a definitive treatment plan has been established as implant positions may vary depending on type of prostheses to be delivered (Figs. 1 and 2).

_Extra-oral examination

Facial and lip support

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 esthetics, 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 dentists' responsibility to determine if this is feasible. Facial support is an important decision in this regard. Assessment of the patient's facial support with and without the denture in place, with the patient facing forward and in profile, needs to be made so the clinician can determine which type of prostheses would be more suitable (Figs. 3 and 4).

Facial support, if inadequate, is obtained mainly by the buccal flange of a removable restoration. (Figs. 5, 6) 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.[8]

When evaluating a diagnostic set up with the anterior teeth in proper relation to the lip, the position of the anterior teeth are 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 result in a large horizontal discrepancy, a number of options must be considered before finalizing implant placement (Figs. 7-12).

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 pa-

Fig. 15: An example of a prosthesis with undesirable contours. Prosthesis illustrates horizontal discrepancy between implant position and incisal-edge position.
Fig. 16: Horizontal discrepancy between implant position and incisal-edge position.
Fig. 17: Severe lack of lip support requires the patient to wear a prosthesis with a flange.


Fig. 18


Fig. 19

Fig. 18: Prosthesis with a flange without palatal coverage.
Fig. 19: Patient smiling with denture in place.

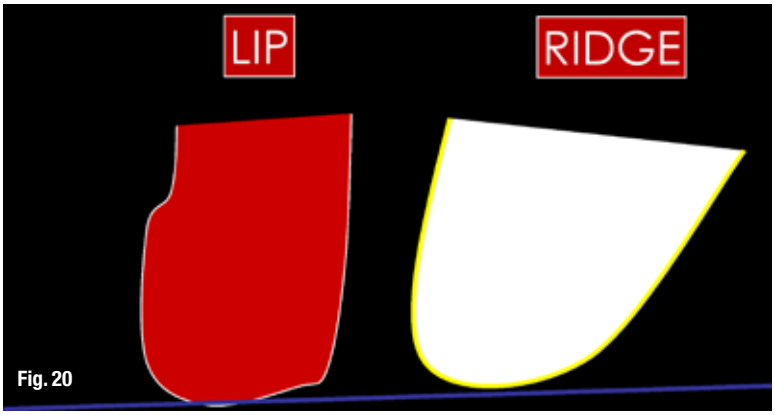


Fig. 20


Fig. 21

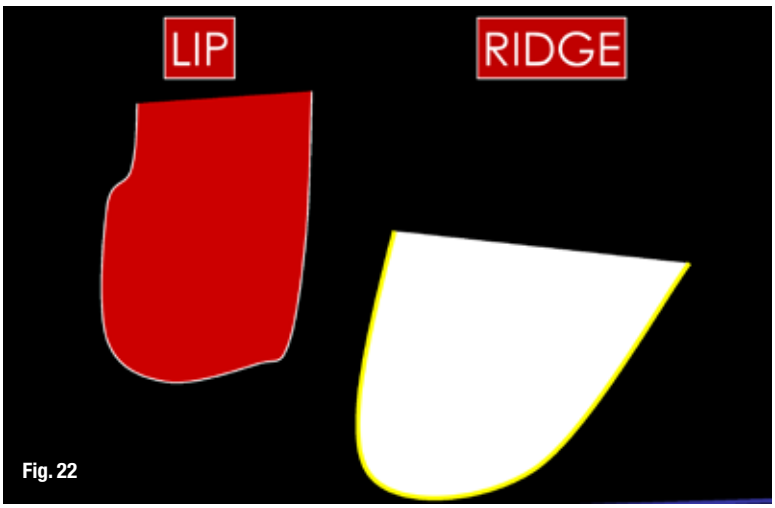


Fig. 22


Fig. 23

Fig. 20: When the patient smiles without the denture in place, the ridge should not be visible.
Fig. 21: Clinical picture illustrating patient smiling without denture. No ridge is visible.
Fig. 22: If patient smiles without a denture and ridge is visible, the transition zone will be visible.
Fig. 23: Clinical picture of patient smiling without denture with ridge display.

rameters of lip support and hygiene (Figs. 13 and 14). Without bone reduction, undesirable contours in the restoration are developed, which make it very difficult for the patient to maintain hygiene (Figs. 15 and 16).

When deemed too large, the discrepancy can only be managed with the flange of a removable prosthesis (Figs. 17 and 18).

_Smile line and lip length

The movement of the upper lip during speech and smiling should be evaluated. Tjan et al[9] described the average smile as having the position of the upper lip such that 75 percent to 100 percent of the maxillary incisors and interproximal gingival are displayed. In a high smile line, additional gingival was 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, 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 (Figs. 19-23).

If the alveolar ridge crest is displayed during smiling, the esthetics can be very challenging because the junction between the restoration and the gingival complex will be visible and bear esthetic consequences.

If the patient has minimal resorption, conventional metal ceramic restorations supported by implants can be planned and the existing soft tissue can be developed to enhance esthetics. However, if an implant-supported denture (hybrid/profile prosthesis) is being planned, the alveolar ridge display will detract from the esthetics.

In situations like this, alveolectomy as part of a pro-active 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 retreat (Fig. 24). 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 pre-treatment evaluations exist.

Two types of patient present:


Fig. 24

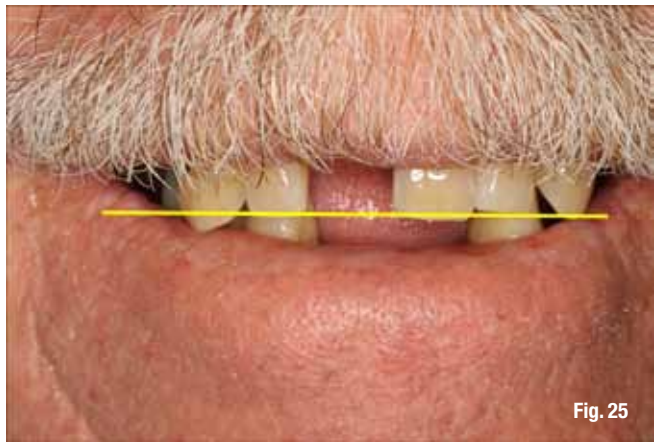


Fig. 25


Fig. 26


Fig. 27

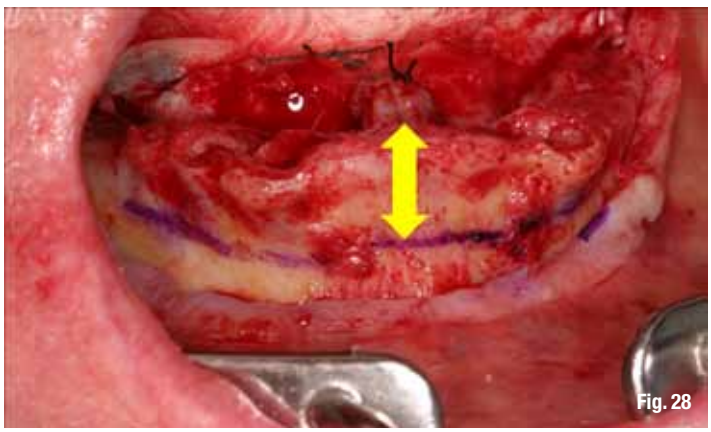


Fig. 28


Fig. 29

• Edentulous.

• Dentate patients with a 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 there is minimal bone resorption, then conventional crown and bridgework on implants must be considered. 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 esthetics of the mandibular prosthesis acceptable for most patients.

For dentate patients who are to become edentulous, additional considerations are required. In most situations, dentate patients present with:

Anterior teeth (maxillary and mandibular) present and posterior teeth missing. In these situations, a diagnosis of lack of posterior support is often made and the teeth are usually splayed forward and over-erupted (Figs. 25, 26).

Mandibular anterior teeth and an opposing maxillary denture. Over-eruption of the mandibular anterior teeth is also present in these types of patients.

Fig. 24: Restoration showing transition zone. Esthetic failure.
Fig. 25: Over-eruption of mandibular anterior teeth. Abobe level of occlusal plane.
Fig. 26: Excess bone as a result of over-eruption of mandibular anterior teeth.
Fig. 27: Level of incisal edges is above the level of the intended occlusal plane. Anatomic guidelines serve as references to position occlusal plane.
Fig. 28: Marking on ridge displaying amount of alveolectomy required to provide adequate restorative space.
Fig. 29: Alveolectomy completed.

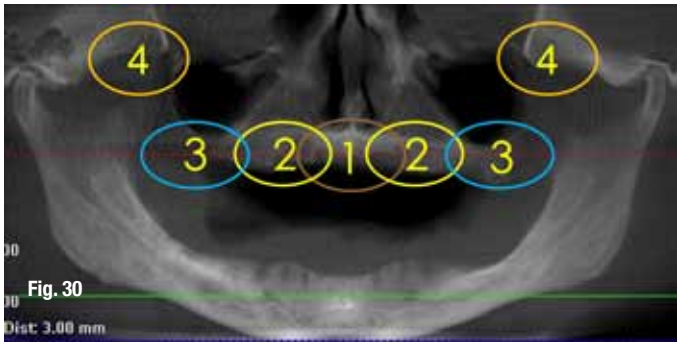


Fig. 30

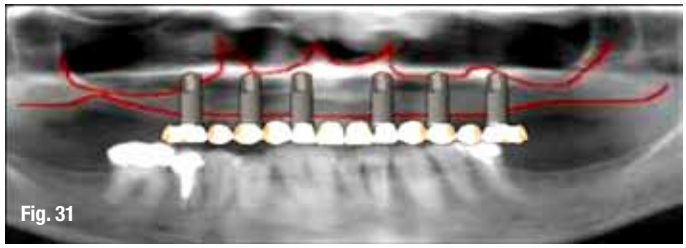
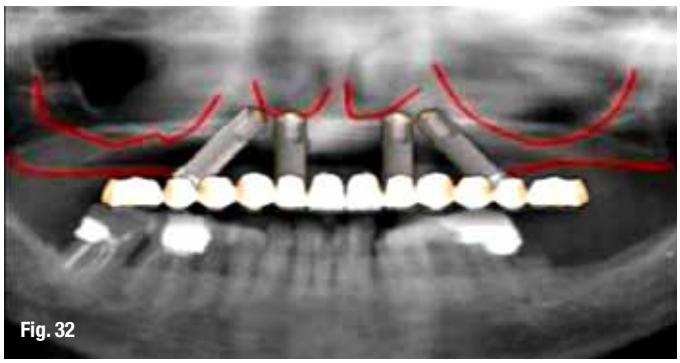


Fig. 31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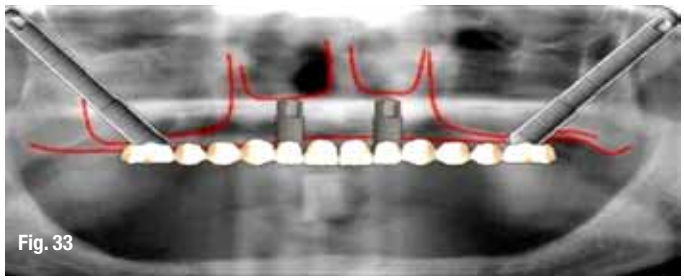
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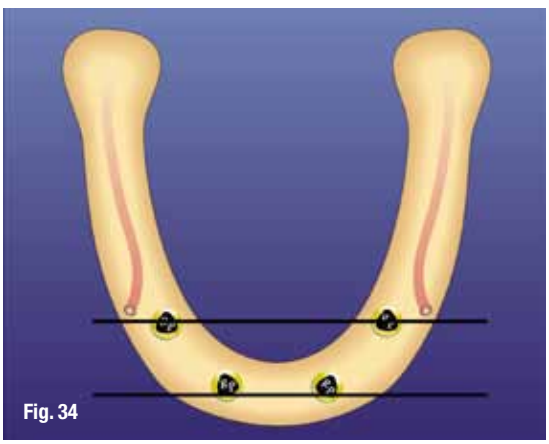


Fig. 34

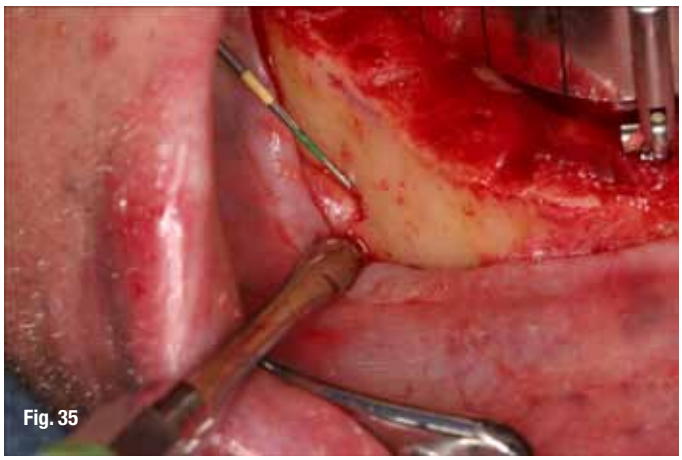


Fig. 35

Fig. 30: Four zones for evaluation of a panoramic radiograph.
Fig. 31: Bone present in zones 1, 2 and 3. Axial implants may be placed.
Fig. 32: Bone present in zones 1 and 2. A conventional tilted implant approach is used.
Fig. 33: Bone present in zones 1 and 4. A zygomatic implant approach is preferred.
Fig. 34: The position of the distal implants is limited by the exit of the inferior alveolar nerve from the mental foramen.
Fig. 35: Dissection of the loop of the nerve from the mental foramen.

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 0.5-1.0 mm 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 (Fig. 27). 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 (Figs. 28 and 29).

_Intra-oral examination

Bone quality and quantity

Upon consideration of bone quantity, bone quality, resorptive patterns and maxillomandibular relationship, it usually becomes apparent that the actual amount of bone available for placement of implants in the edentulous patient may not only be limited but may also be present in areas remote from the original site of the natural teeth.

In the pre-maxilla, the tooth position may be much further forward than the implant position, and this may pose certain biomechanical disadvantages. In the posterior maxilla, the resorption pattern may be so severe that a cross-bite relationship may have to be

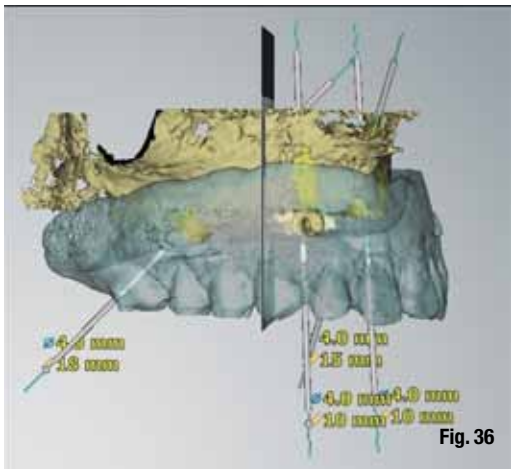
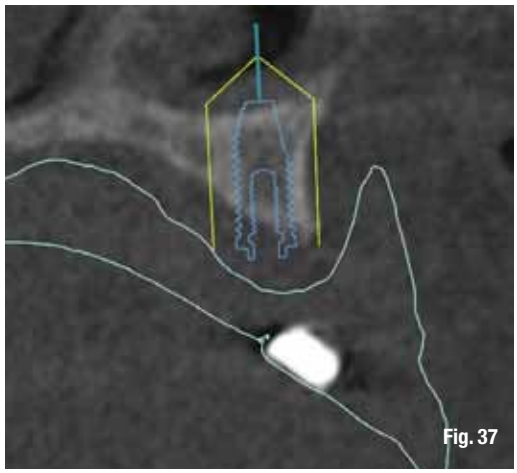


Fig. 36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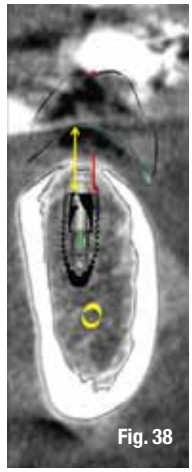
Fig. 38


Fig. 39


Fig. 40


Fig. 41


Fig. 42


Fig. 43


Fig. 44

utilized or, alternatively, the tooth position may have to be cantilevered facially so as to re-create the vertical and horizontal tooth relationships that existed prior to extraction.

The clinician's ability to evaluate the bone, both quantitatively and qualitatively, makes this one of the most challenging sites for successful implant placement.

When adopting graft-less options, there is a paradigm shift in thinking. The clinician is looking for bone masses to anchor the implants in the patient's native bone without subjecting the patient to any grafting procedures whatsoever. This often requires tilting implants and correcting angulations with multi-unit abutments.

When evaluating the patient's bone quantity, a number of diagnostic tools are required:

- Panoramic radiograph
- CT scan
- Clinical evaluation

_Panoramic radiograph

A panoramic radiograph serves as an initial survey to diagnostically assess the quantity of bone. Bedrossian10 describes dividing the maxillary bone into three zones, which allows systematic assessment of the available bone and the surgical approach required. The relationship between alveolus, nasal floor and the position and size of the maxillary sinus is evaluated. Bedrossian describes the zone between canine to canine as zone 1, the premolar region is zone 2 and the molar region is designated as zone 3. The authors propose an additional zone being the zygoma region designated zone 4 (Fig. 30). The presence or absence of these zones influences the surgical approach. If zones 1, 2 and 3 are present, axial implants may be placed (Fig. 31). If zones 1 and 2 are present, the tilted implant approach may be considered (Fig. 32). If only zones 1 and 4 exist, then the zygomatic implant approach should be considered (Fig. 33).

Fig. 36: Diagnostic and treatment planning using computer simulation software.
Fig. 37: Computer-simulation software allows virtual implant placement.
Fig. 38: CBCT can also give an indication of soft-tissue thickness.
Fig. 39: Diagnostic denture set up illustrating minimal resorption.
Fig. 40: Diagnostic denture set up illustrating moderate resorption.
Fig. 41: Patient approves incisal-edge position and smile.
Fig. 42: Patient is being treatment planned for an implant supported fixed denture (hybrid).
Fig. 43: Occlusal registration with denture in place.
Fig. 44: Putty is used to replicate intaglio of denture.


Fig. 45

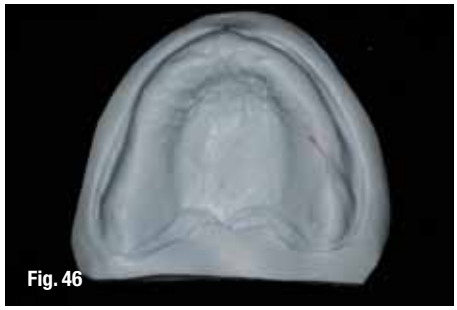
Fig. 46


Fig. 47


Fig. 48

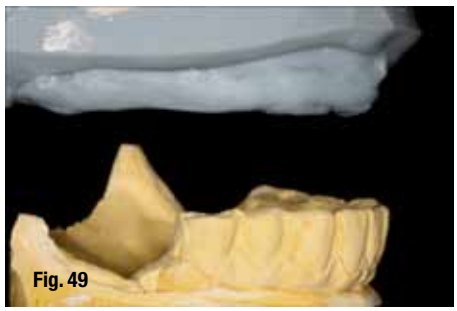
Fig. 49

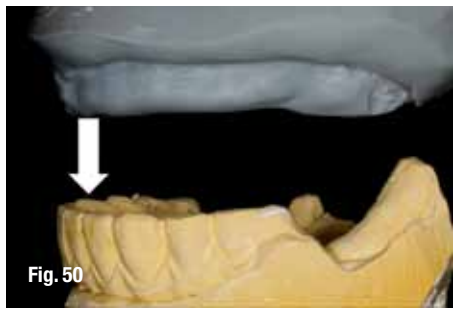
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Fig. 51

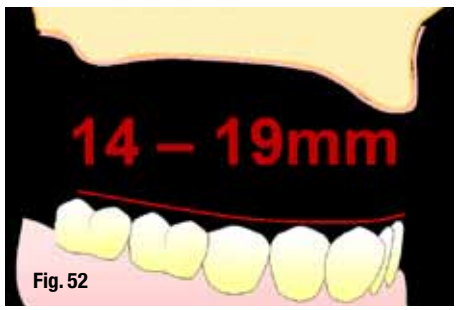

Fig. 52

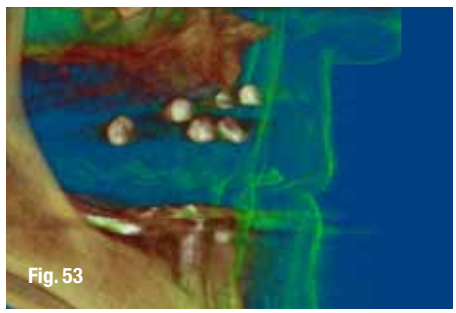
Fig. 53

Fig. 45: Intaglio of denture.
Fig. 46: Putty cast replicating intaglio of denture.
Fig. 47: Retention grooves made in putty cast.
Fig. 48: Maxillary denture and putty cast mounted against opposing occlusion using occlusal registration material.
Fig. 49: Denture can be removed from putty cast so that amount of restorative space can be evaluated.
Fig. 50: Measurement made from ride to opposing occlusion.
Fig. 51: A clear acrylic resin duplicate denture can also be used to evaluate restorative space.
Fig. 52: For a fixed implant supported denture (hybrid), 14–19 mm of space is required from the head of the fixture to the opposing occlusion.
Fig. 53: CT scan and software can be used to calculate amount of restorative space required.

In the mandible, the goal of implant placement is to have the largest possible antero-posterior spread. The position of the mental foramen limits the placement of the two distal implants. Tilting the distal implant platform distal to the mental foramina increases the AP spread and limits the distal extension of the cantilever.

A safe clinical guideline would be to place the implant 2 mm anterior to the most anterior aspect of the inferior alveolar loop. The intended diameter of the implant must be kept in mind; in most clinical circumstances, a 4 mm diameter implant is placed, the radius of the implant being 2 mm so the implant must be placed 4 mm anterior to the loop of the inferior alveolar nerve.[10]

Most surgeons will dissect out the position of the nerve and identify it clinically prior to implant placement (Fig. 35).

_CT scan

Use of the panoramic radiograph does have limitations. With a panoramic radiograph, the width of the mandible cannot be ascertained, and the loop of the mental foramen and its exit cannot be accurately measured. A CT scan proves invaluable in evaluating the patient about to undergo full-mouth implant rehabilitation.

CT scans are extremely useful in evaluating the trajectory of the bone in the maxilla. When a patient has been edentulous for a significant period of time, pneumatization of the sinuses makes placement of implants very difficult.

With information from the CT scan, implants can be inclined to avoid the maxillary sinuses [11], or alternative procedures that utilize existing anatomical sites offering reduced morbidity and minimal invasion of the existing structures can be utilized. Various software programs can be utilized to further enhance the treatment-planning process by allowing the clinician to plan surgical placement of the implant virtually and to identify any possible complications that might occur (Fig. 36).

Zygomatic implants can be placed to engage the zygomatic bone inferolateral to the orbital rim and provide anchorage for a fixed prosthesis in conjunction with anterior implants.[12]

To obtain maximal benefit from such a scan, a radiographic template is highly recommended.[13] Titanium pins or gutta-percha markers should be incorporated into an acrylic resin duplicate of the diagnostic denture set up. The markers are oriented


Fig. 54

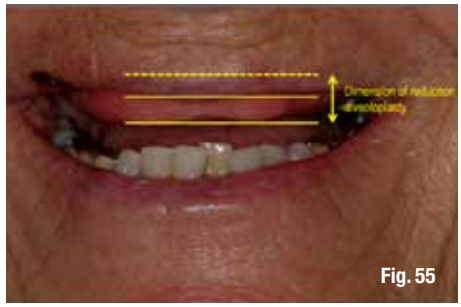
Fig. 55


Fig. 56


Fig. 57

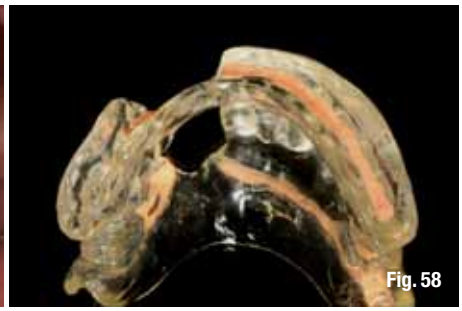
Fig. 58

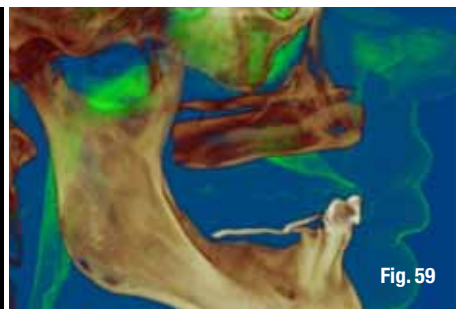
Fig. 59


Fig. 60


Fig. 61


Fig. 62

perpendicular to the occlusal plane and should end apically at the height of the prospective clinical crown margin.

_Clinical evaluation

The mucosal quality and thickness can be assessed by palpation, sounding or with the help of CT scans (Fig. 38). In patients with periodontal disease and pocketing, there may be an excess of gingval tissue when the teeth are extracted. This must need to be excised, so when the implants are placed, they are not too deep beneath the tissue. In almost every dentate patient, alveolectomy will be required when treatment planning for a fixed implant supported denture (hybrid). Following alveolectomy, there will be an excess of tissue. It is the surgeon's responsibility to ensure that when the patient is ready to immediate load, the abutment margins are all supragingical.

_Incisal-edge 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.

To determine if a fixed or removable restoration would be appropriate, a wax try-in is done without a flange. For a fixed restoration, the clinical crown should ideally end up at the soft tissue level of the alveolar ridge. In this situation, minimal resorption would have occurred, interarch space will be favorable and an optimal tooth-lip relationship is present (Fig. 39).

When a large vertical distance exists between the cervical aspect of the tooth and the alveolar ridge but the tooth-lip relationship is favorable, pink ceramic may be utilized to disguise the tooth length and a fixed restoration is still possible (Figs. 40 and 41).

When there is both a vertical and horizontal discrepancy between the ideal position of the tooth and

Fig. 54: Window technique.
Fig. 55: Alveolectomy can also be calculated using the patients highest smile line.
Fig. 56: Over-erupted mandibular anterior teeth. Patient requiring alveolectomy prior to implant placement.
Fig. 57: Complete dentures at wax try in at the correct CR and VDO.
Fig. 58: Mandibular denture is duplicated and radio-opaque marker placed.
Fig. 59: CBCT is taken and, with appropriate imaging software, the amount of alveolectomy required is calculated.
Fig. 60: Bone reduction guide is placed intra-orally and correct CR and VDO verified.
Fig. 61: Marking made on bone in reference to bone reduction guide.
Fig. 62: Guide removed.

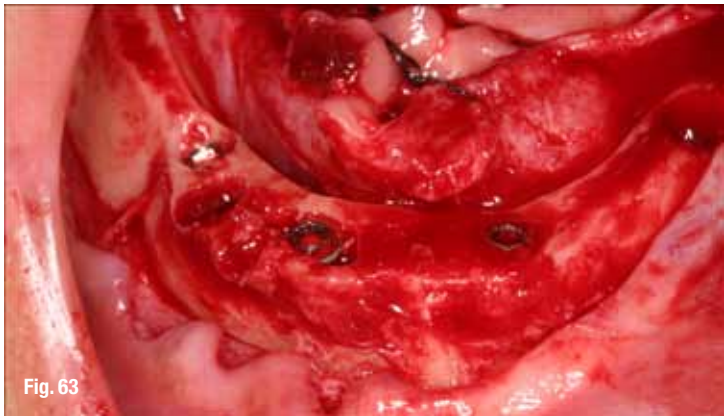
Fig. 63


Fig. 64

Fig. 63: Alveolectomy performed and implants placed at same level.
Fig. 64: Adequate restorative space created.

the alveolar ridge, and the tooth lip relationship is not optimal, this may be an indication for use of a removable prosthesis. The flange will provide adequate lip support, and the teeth can be positioned appropriately to satisfy the parameters of esthetics.

_Inter-arch space

Jaw shape has a significant influence on prosthesis design. The resorption of alveolar bone has been a considerable issue in prosthodontics for as long as clinicians have tried to replace missing intra-oral structures.

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.[14] An efficient method of evaluating inter-arch space in a patient with an edentulous maxillary arch is to construct a diagnostic putty cast. A facebow record is made with the patient's denture in-situ. Putty is inserted into the intaglio of the patient's denture, and this is then mounted on the upper member of an articulator. In this manner, we now have a replica of the patient's maxillary denture bearing area.

An impression is then made of the opposing arch and a diagnostic cast poured. Occlusal registrations are made between the mandibular arch and the opposing denture and, subsequently, the mandibular cast is mounted. This technique can be utilized for fully edentulous patients also (Figs. 42-50). The mounted casts can now be utilized to evaluate the available inter-arch space, and decisions can be made with regards to the anticipated prosthesis design.

An alternative method is to duplicate the patient's existing denture in clear acrylic resin. Thickness of the maxillary denture base and the flange will give the clinician an idea of the amount of resorption that has taken place. The clinician will also be able to view the position of the ridge in relation to the cervical position of the teeth. In patients where no space exists between the cervical position of the teeth and the residual ridge, alveolectomy is advised if treatment planning a fixed implant supported denture (Fig. 51).

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 esthetics and hygiene. If space is limited, re-establishing a patient's vertical dimension or altering the opposing occlusion should be considered.[14]

Guidelines for space requirements are between 14-16 mm. (Fig. 52). Heat-processed resin requires 2-3 mm to provide adequate strength as a denture base material.[15] 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.

_Communicating bone reduction to the surgeon

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 perform 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 (Fig. 53).

Window in duplicate of denture. In this technique, a duplicate denture made of clear acrylic resin is positioned intra-orally. The surgeon then asks the patient to smile.

After anesthesia, the surgeon makes a window in the duplicate denture, scoring the bone at the position of the highest smile line. On raising the flap, this marking serves as an indication of the amount of alveolectomy required (Fig. 54).

Intra-operative determination. In a patient with excessive display of the residual ridge crest, the surgeon may ask them to smile and then perform the alveolectomy 5 mm above the highest smile line (Fig. 55).

Bone reduction guide. This works well for patients who have only a few teeth remaining. A complete denture set-up is done at the correct centric relation and vertical dimension of occlusion (Figs. 56, 57). The jaw relation records are verified. (This clinical example will illustrate a mandibular bone-reduction guide). The lower denture is duplicated in clear acrylic resin and a radiographic marker placed (Fig. 58). A CT scan is taken with the radiographic guide in place. The patient is also wearing the opposing maxillary denture.

On the CT film, measurements can be made using the radiographic marker and using the existing teeth as a reference (Fig. 59). On the day of surgery, the maxillary denture and the duplicate mandibular appliance are placed intraorally. CR and vertical dimension of occlusion are verified (Fig. 60). The surgeon marks a line on the bone identifying the amount of reduction required (Fig. 61). The guide is removed, the teeth are extracted and the bone planed down to the marked line. Once the bone has been leveled, the implants are placed (Figs. 62-64).

Editor's note: Please watch for Part 2 of "Graft-less solutions in implant dentistry" in the next issue of *Implants* magazine. That part will include treatment protocol, gaining restorative space, implant surgery and postoperative protocol.

_References

1) Branemark PI, 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 Supple 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, tables 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;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;32:345–356.
5) Turkyilmazl, 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;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. Journal Prosthet Dent Vol 82, No 2 188–196.
7) Jivraj S, Chee W, Corrado P. Treatment planning of the edentulous maxilla. Br Dent J. 2006 Sep 9;201(5):261–79.
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 24:195–239,1966.
9) Tjan AH, Miller GD, The JG. Some esthetic factors in a smile. J prosthet dent 1894;51:24–28.
10) E Bedrossian. Implant treatment planning for the edentulous patient. Mosby Elsevier 2008.
11) Krekmanov L, Kahn M, Rangert B et al. Tilting of posterior mandibular and maxillary implants for improved prosthesis support. Int J Oral maxillofac Implants 15(3):411,2000.
12) Balshi TJ, Wolfinger GJ, BalshiSF. Int J Oral Maxillofac Implants. 1999 May-Jun;14(3):398–406
13) Schwarz MS, Rothman SL, Rhodes ML, Chafetz N. Computed tomography: Part II. Pre-operative assessment of the maxilla for endosseous implant surgery. Int J, Maxillofac Implants. 1987;2:143–148.
14) Wicks, RA. A systematic approach to definitive planning for osseointegrated implant prostheses. Journal of Prosth Vol3, No 4 (Dec) 1994:pp237–242.
15) Naert I, DeClercq M, Theuniers G, et al. Overdentures supported by osseointegrated fixtures for the edentulous mandible. A 2.5-year report. Int J Oral Maxillofac Impl 1988;3:191–196.

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