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REVIEW ARTICLE

PROSTHETIC DRIVEN IMPLANTOLOGY- A REVIEW

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ABSTRACT:
Implants are fast becoming an integral part of modern dentistry. It is the only treatment modality where additional abutments can be created for improving the esthetics and function. When diagnostic protocol involves both the surgeon and the prosthodontist, the biomechanical, technical and esthetic compromises are circumvented. Careful planning, evaluation of all the diagnostic aids, mock wax up and using a surgical guide helps to accurately locate the implant fixture regarding the depth and angulation which is critical to the esthetic and biomechanical success of the prosthesis. The focus of modern implantology evolved from a "surgically driven approach" to a "prosthetically driven approach" with the goal of optimizing and maintaining esthetics. This review article describes the concept of Prosthetically driven implantology which will help clinicians to understand changing trends of modern implant dentistry.

Keywords: Prosthetic driven implantology, Treatment planning, Stents, Bone augmentation, Implant Biomechanics

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INTRODUCTION

The last decade has seen a profound shift in implant dentistry from function to esthetics, with esthetics enhancing the patient's need and desires. The focus evolved from a "surgically driven approach" to a "prosthetically driven approach" with the goal of optimizing and maintaining esthetics .The delicate balance between the function and esthetics must be maintained as they both complement the treatment outcome. Implantology has undergone changes in number of phases. The developing phase was the period during which we determined whether implants could be placed successfully with achievement of osseointegration. The prosthetic phase represented the development of prosthetic components and techniques that would afford the clinician the ability to place esthetic restorations. Today we realize that for a completely functional and esthetic restoration a complete hard and soft tissue harmony has to be achieved before or during implant placement[1].

Alveolar bone resorption after tooth loss

Alveolar bone is a specialized part of mandibular and maxillary bone that forms the primary support for teeth. It is composed of bundles of bone, which is built up in layers in a parallel orientation to the coronal-apical direction of the tooth. Alveolar bone is resorbed after tooth extraction or avulsion most rapidly during the first years. Extraction of anterior maxillary teeth is associated with a progressive loss of bone mainly from the labial side. The loss is estimated to be 40–60% during the first 3 years and decreases to 0.25– 0.5% annual loss thereafter. The cause for resorption of alveolar bone has been assumed to be due to disuse atrophy, decreased blood supply, localized inflammation or prosthesis pressure.[2]

Factors and conditions which must be taken into account when developing a treatment plan

1) **Age and Gender**-There is no evidence to suggest that age or gender affect the outcome of osseointegration in the short or the long term Dental implants are effectively ankylosed to the bone, for this reason implants are not placed until the facial skeleton has stopped growing; this being usually about 18 years of age

2) **The treatment planning process:**[3] Each patient presents with unique set of problems and treatment needs. Only by taking into account all of their individual circumstances including anatomical, functional, and aesthetic requirements. During the planning stages, many factors are considered for dental implants including patient's expectations and financial and time constraints

Figure 1: Treatment planning flow chart

3) **Special Investigations:**[2,3] Three-dimensional restorative planning (with CBCT scanners) is increasingly used to ascertain the difference between an ideal end result and the current situation. As well as missing teeth, the volume of missing alveolar bone and keratinised tissue and the effects of this loss on the patient's appearance and function must be evaluated in three-dimensions and within the functional boundaries of the masticatory system

Additional investigations that may be undertaken:

a. Good-quality clinical photography showing all standard views and site-specific views;

b. Two sets of study casts, one untouched and one used for planning;

c. Face bow and occlusal records for planning of whether the case will be reorganized (will the existing occlusion be accepted or does the occlusion need to be altered for best results);

d. A realistic tooth wax up or setup based on the above decision. At this point it will be possible to see whether the definitive restoration is likely to be fixed or removable.

e. Construction of a radiographic stent based on the tooth setup above with radiopaque markers that will show up on a CT scan;

f. A sectional or full arch scan as appropriate using modern cone beam CT (CBCT);

g. Analysis with suitable planning software to allow a realistic three-dimensional plan of implant and restorative component positions. This will allow the relationship between the final desired tooth positions and of the existing underlying bone to be visualized in three dimensions;

h. A decision as to whether sufficient bone exists and whether more advanced surgical procedures will be required to provide bone volume;

i. Where applicable, occasionally the manufacture of a surgical guide

4) Radiographs and CT Scans

Dental panoramic radiographs (DPR) and periapical radiographs (PA) can be used to evaluate sites for dental implant placement. They should be employed with caution particularly when considering implants in close proximity to vital structures such as the inferior alveolar nerve. Cone beam CT (CBCT) scanning gives an accurate three-dimensional image of the jaws and can be used to measure bone density but radiation dose is higher

5) Site Evaluation[4]

Evaluation of the planned site begins with a thorough clinical examination. Visual inspection and palpation will allow the detection of flabby excess tissue, narrow bony ridges, and sharp underlying ridges and undercuts that may limit implant placement. Clinical inspection alone may not be adequate if the thick overlying soft tissue is dense. Bone quality is one of the most significant prognostic factors in implant dentistry. As poor bone support leads to higher failure rates, accurate determination of the available bone quality, density and volume is mandatory to ensure predictable long-term results. Bone density and volume can be determined clinically and radiologically. Bone mapping procedures to be carried out to determine osseous morphology

6) Anatomical Factors

The major anatomical structures that need to be taken into consideration when planning dental implant placement are the maxillary sinus, nasal floor, inferior dental nerve and mental nerves.It should be remembered that the mental nerve sometimes has an anterior loop of up to 4mm. Another potential hazard is that perforation of the lingual cortex of the mandible could cause potentially life-threatening haemorrhage due to damage to the sublingual artery. Treatment planning of implant length must allow for a 2-mm margin from the apical end of the implant to the superior aspect of the inferior alveolar canal

Prosthodontically driven treatment concept[1]

One of the cardinal rules in implantology is that the implant placement surgery should be prosthetically driven. This means that the desired final restoration should be first planned and used as a guide for 3-D positioning of the supporting dental implant fixtures. If this cannot be readily achieved, site development (both hard and soft tissue) and regenerative procedures should be considered to allow the correct positioning of the implants according to the restorative requirements of the final case. Treatment planning should include discussion of, not only the recommended treatment, but all reasonable alternatives such as conventional options, their relative advantages, disadvantages and limitations. The patient should also be fully aware of all possible risks and how best to manage potential complications. Helvey G A stated that no. of factors are involved in achieving a successful outcome for an implant supported prosthesis

In these, a major factor is placement of implant fixture in buccolingual, mesiodistal and apicocoronal dimension .The esthetic and functions of final restoration are strongly affected by placement of implant fixture. Even small change in implant position can create a lot of problem for restoring prosthodontist.

Stent guided implant placement-

Surgical templates assist the clinician in accurately placing implants for optimal alignment and esthetics. Prosthetically-guided implant placement utilizes the diagnostic arrangement made from wax, acrylic teeth, or diagnostic disks to determine the optimal position for the dental implants. The surgical template is used to transfer the positional information in the diagnostic arrangement to the patient for accurate surgical placement of the implants. Surgical templates using similar guide sleeves can be made using computer-assisted technology.

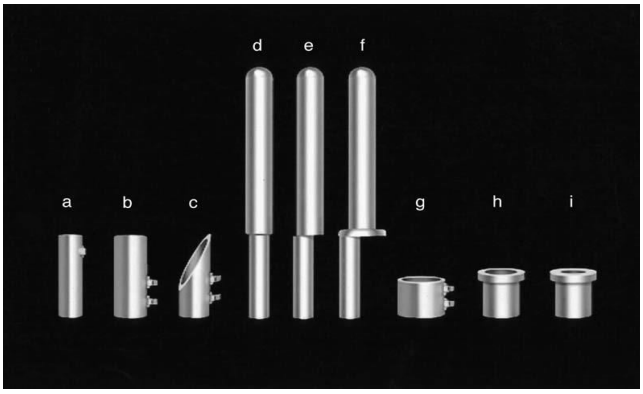

Figure 2: Guide Right template components: A, 2-mm drill insert; B, 3-mm straight cut anterior guide sleeve; C, 3-mm angle cut posterior guide sleeve; D, straight guide post; E, 1-mm offset guide post; F, 2-mm offset guide post; G, wide-diameter guide sleeve; H, 4-mm drill insert; I, 3-mm drill insert

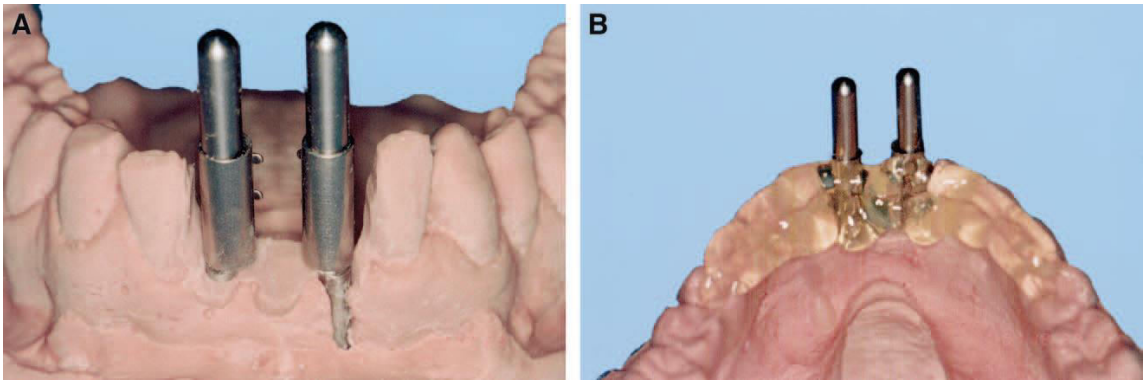

Figure 3: Surgical guide for implant placement

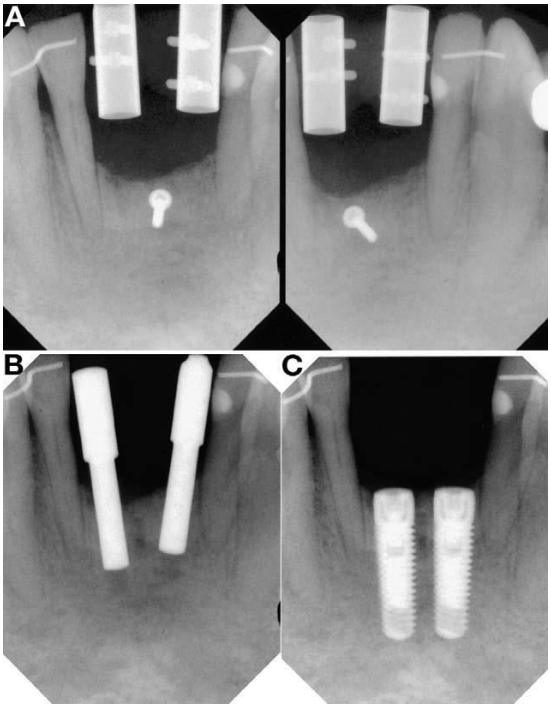

Figure 4: Implant placement using surgical guide

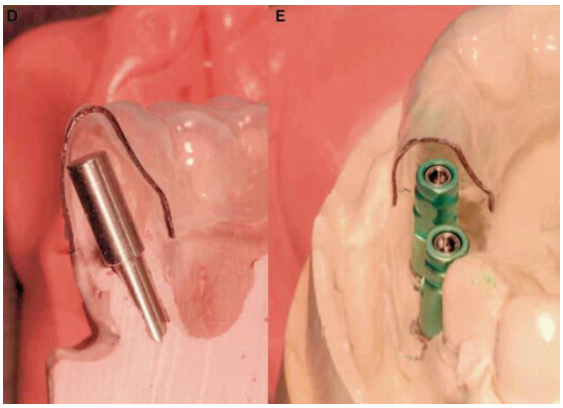

Figure 5: Placement of implant in three dimension with respect to model.

The clinically acceptable position for an individual implant is not a single point but rather a zone. To develop an ideal emergence profile and to maintain buccal bone for support of soft tissue, the most facial surface of the implant should be approximately 1 mm palatal to the planned implant crown as it exits the gingiva. If bone has been lost from the facial aspect of the planned implant site, then hard tissue grafting to restore appropriate dimensions may be indicated. There is leeway to place the implant further palatally, but if the implant is more than 2 mm palatal to the ideal position, esthetics and function may be compromised. Guidelines for vertical positioning of the implant interface in esthetic zones include a 2-mm position apical to the cementoenamel junction of adjacent teeth and 3 mm apical to the planned free gingival margin of the implant, or in situations where there has been clinical attachment loss on adjacent teeth, at the level of the bone crest. surgical guide designs include guides with metal tubes that only allow for the use of an initial pilot drill, guides with open channels that allow use of all drill sizes and give surgeons greater freedom, and guides that are computer designed and fabricated to direct all steps of the drilling sequence and may also direct placement of the implant. The effect of surgical guide design could be influenced by the number of missing teeth. For single edentulous sites, the adjacent teeth provide anatomic landmarks to guide implant position, whereas large edentulous spaces have fewer anatomic landmarks, and surgical guides may have a greater effect on placement accuracy.

Bone augmentation procedure-[5]

Tooth loss for different reasons may leads to alveolar resorption.

Shortage of bone can prevent proper positioning of dental implants according to prosthetic needs and treatment planning, unless the volume of hard and soft tissues is increased before implantation.

In the esthetic area it is essential not only to achieve well anchored implants but also sufficient soft and hard tissue in order to obtain natural looking result.

Augmentation with Bone Grafts-

Autogenous bone is still considered the golden standard in the bone regeneration procedures. Studies have shown that autogenouscancellous bone produces successful and predictable results.

Autogenous bone grafts may act mostly as scaffolds and are thus more osteoconductive than osteoinductive even though osteogenic activity may have remained in the spongious part of the graft.

Guided Bone Regeneration: [5]

GBR may be performed in conjunction with the placement of the implants or during a surgical intervention prior to implant placement. The staged approach is primarily chosen in situations with large bone defects or in esthetic situation, to allow positioning of the implants in the prosthetically desired position. Hence, the alveolar ridge is augmented in a first surgical intervention. After the appropriate time for healing, the implants are then placed into a site of sufficient bone volume

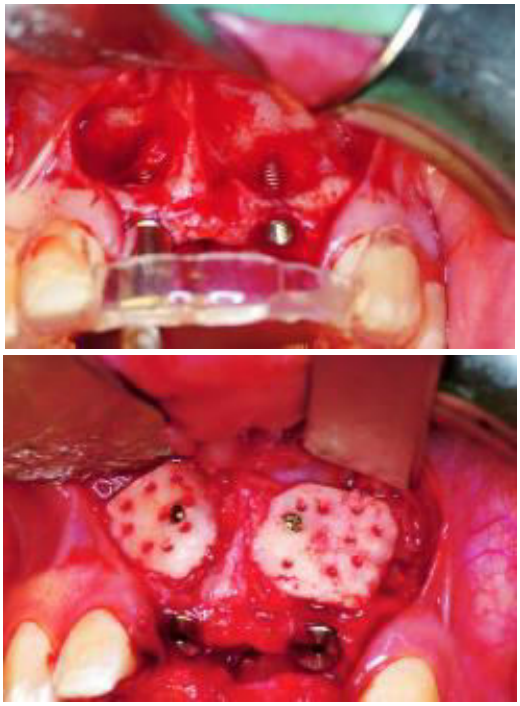

Figure 6: Bone grafting procedure for proper orientation of implant placement

Other techniques that can be utilised before implant placement-

a) Bone Expansion and Split Crest Techniques- to increase overall volume of bone housing surrounding implant.

b) Sinus Floor Augmentation Techniques- to displace anatomic limit of sinus to incease height of bone.

c) Soft Tissues Augmentation- for esthetic rehabilitation of missing tooth and its supporting structure.

Implant biomechanics-[2,3]

Biomechanics: The application of mechanical laws to living structures, specifically thelocomotor systems of the body; The study of biology from the functional viewpoint; An application of the principles of engineering design as implemented in living organisms

Dental biomechanics is the relationship between the biologic behaviour of oral structures and the physical influence of a dental restoration.

Implant subjected to myriad variety of forces during function. A significant percentage of failures are due to unfavourable forces or overload. Knowledge regarding biomechanics will help to design and plan an implant that can safely withstand the functional needs.

A key biomechanical function of any successful dental implant is the ability of the interfacial tissues to support masticatory forces for a long period of time

Factors that influence the biomechanics of implants are Available bone, The number and placement of implant, The significance of implant angulation with respect to occlusal surface, Implant body design, Crest module considerations, Apical design consideration.

Implant Protective Occlusion (IPO) was previously known as medial positioned-lingualized occlusion. This occlusal concept refers to an occlusal plane that is often unique and specifically designed for the restoration of endosteal implant, providing an environment for improved clinical longevity of both implant and prosthesis. IPO - Medial positioned lingualized occlusion is based on:
Narrow occlusal table.
occlusal table width similar to width of implant body.
Increasing surface area.
Design of occlusion in favour of weakest arch.
Decreasing force of occlusal contacts.
Eliminating or reducing all shear loads to implant to bone interface.
Posterior disocclusion by anterior components.
Initial contacts on only natural teeth and later on multiple contacts on both teeth and implants

GUIDELINES TO FOLLOW-

- Infraocclusion upto 30 microns of implant supported restoration
- No balancing contacts on cantilevers.
- No guidance on single implants.
- Freedom in centric.
- Occlusal table directly proportional to implant diameter.
- Narrow occlusal width.
- Implant length – crown ratio ideal – 1:2 acceptable – 1:1 for removable denture.
- Avoidance of cantilever length. Maximum 10 and 20 mm is advised.7 mm is optimum
- Shallow central fossae with tripodal cuspal contacts.
- No contact in lateral excursion.
- Slight contact in centric occlusion.

Implant rehabilitation should always be prosthodontically driven. This philosophy promotes a reduction in implant micromovement through appropriately positioned and loaded restorations. If restorations are inappropriately designed, loss of osseointegration and/or prosthetic failure is more likely to occur. Axial implant loading is a desirable treatment goal because lateral forces greater than 30 Ncm have been shown to produce micromotions greater than 100 mm. Nonaxial loading can also contribute to loosening of abutment screws, a major cause of prosthodontic failure

RECENT ADVANCES BASED UPON PROSTHODONTIC DRIVEN IMPLANTOLOGY

a) Prosthetically driven guided surgery (Noble Biocare)[8]

- Diagnostic, treatment planning and guide surgery systems:
- Safe and predictable implant insertion.
- All clinical indications.
- Prosthetic driven planning.
- Minimally invasive surgery.
- Single-source for treatment components and support.
- Reliable digital dentistry partner

b) Bioimplant: Individualised Zirconium Implants: Austrian Surgeons have designed a system to produce via CAD/CAM individualized Zirconium Dental Implants for use in case of immediate implant placement. In short, after a tooth is extracted it is scanned and a zirconium copy is milled. The milled copy has macro-retentive features which help secure the new implant in the extraction socket. They report a 90% success rate.

c) Implant Guidance System:Innovative Implant Technology has released an innovative kit to aid in the planning and placement of dental implants in a variety of clinical situations.It features color-coded ‘measuring blade’ that aid in determining the optimal implant size for a particular edentulous space. The measuring pins are used during placement to ensure optimal implant –tooth and implant-implant spacing.

SUMMARY AND CONCLUSION

Implants are fast becoming integral part of modern dentistry. When diagnostic protocol involves both surgeon and prosthodontist, the biomechanical, technical, esthetic compromises are circumvented. Careful planning evaluation 0f all diagnostic aids, mock wax up, and using surgical guides in combination with any hard or soft tissue augmentation if required helps to accurately locate implant fixture regarding depth and angulation which is critical to esthetic and biomechanical success of prosthesis

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