PROSTHODONTIC CONSIDERATIONS IN IMPLANT LOADING

Dr Sanath Shetty[1], Dr Rajesh Shetty[2], Dr Savita Dandakeri[1], Dr Mallikarjun Ragher[3], Dr Shrimaa Kateel[4]

[1]Professor, Department of Prosthodontics, Yenepoya Dental College
[2]HOD, Department of Prosthodontics, Yenepoya Dental College
[3]Reader, Department of Prosthodontics, Yenepoya Dental College
[4]Senior Lecturer, Department of Prosthodontics, Yenepoya Dental College

***Corresponding Author**
Dr Shrimaa Kateel
Email: shrimaakateel@gmail.com

ABSTRACT

The success of dental implant therapy hinges on the preservation of peri-implant bone, particularly the bone crest, which is vulnerable to physiological bone loss due to occlusal forces or implant overloading. The density of the available bone plays a pivotal role in determining the surgical approach, healing period, and timing for implant loading. Research indicates that the risk of implant failure increases when the implant is prematurely loaded. As a result, various loading protocols have been developed and studied to mitigate these risks. Implant loading is a critical step, as the implant becomes functional once connected to a prosthesis. Proper selection of the loading protocol is crucial for treatment planning, and it directly influences the implant's long-term success. The timing of implant placement is an essential factor in this decision, with three primary approaches: late implant placement (more than six months after extraction), early implant placement (4–8 weeks post-extraction), and immediate implant placement (on the same day as tooth removal). Each approach has specific advantages and challenges, which must be considered based on the patient's clinical situation. Understanding the optimal loading protocol and placement timing is fundamental in ensuring the stability and longevity of implants.

Keywords: Implant Loading, Peri-Implant Bone, Loading Protocols, Implant Placement Timing, Prosthodontic Considerations.

INTRODUCTION

A key aspect of evaluating the success of implant therapy lies in preserving peri-implant bone, especially the bone crest. This area is vital as it is prone to physiological bone loss during adaptation to occlusal forces or overloading.

The density of the available bone is a crucial factor influencing the surgical approach, healing period, and timing for loading. Studies have shown that the risk of implant failure rises when the implant is loaded and begins functioning. This has led to the development and exploration of various loading protocols.
An implant becomes functional once it is connected to a prosthesis. Therefore, selecting an appropriate loading protocol is an essential part of treatment planning. Additionally, the timing of implant placement impacts the chosen protocol.

Timing of Implant Placement[1]

- **Late Implant Placement**: Implants are placed after complete bone healing, typically more than six months post-extraction.
- **Early Implant Placement**: Implants are placed following soft tissue healing or partial bone healing, usually 4–8 weeks post-extraction.
- **Immediate Implant Placement**: Implants are inserted into the fresh extraction socket on the same day as the tooth removal.

Loading Protocols[2]

A loading protocol is defined by the time interval between implant placement and the attachment of the prosthesis. After placing an implant, clinicians decide on the optimal timing for loading. This often involves using a provisional prosthesis before final rehabilitation.

Types of Loading Protocols[3]

- **Conventional/Delayed Loading**: Implants undergo a healing period of more than two months before being connected to a prosthesis.
- **Immediate Loading**: Implants are connected to a prosthesis within one week of placement. This is further classified into:
  - *Immediate Functional Loading*: The prosthesis is in occlusal contact.
  - *Immediate Non-Functional Loading*: The prosthesis is not in occlusal contact.
- **Early Loading**: Implants are connected to a prosthesis between one week and two months post-placement. It is further divided into:
  - *Functional Early Loading*: The provisional prosthesis is in occlusal contact.
  - *Non-Functional Early Loading*: The prosthesis is kept out of occlusion.
- **Progressive Loading**: Introduced by Misch in 1983, this protocol involves gradually increasing tension during the prosthetic phase without overloading the implant. This gradual process, spanning 6–8 months, promotes bone maturation and enhances density and quality.

Treatment Modifiers Influencing Loading Protocol[2]

Certain clinical factors influence the choice of a loading protocol during the diagnostic, surgical, and maintenance phases. These include:

- The patient's medical condition and local risk factors, negate immediate loading protocol.

- Implant primary stability with insertion torque >25 Ncm and ISQ >60, allows you to load immediately.
- Implant dimensions and surface characteristics, has an effect on the loading protocol.
- Ample quality and optimal quantity of soft and hard tissues, can positively influence in immediate loading.
- Significant bone augmentation at placement, would desire a delayed loading protocol.
- Treatment plans tailored to patient-specific esthetic requirements, would necessitate an immediate loading protocol.

Key Considerations for Clinicians[4]

1. **Aesthetic Importance**: Immediate solutions may be prioritized for visible teeth.
2. **Oral Hygiene**: Poor hygiene can adversely affect osseointegration; immediate loading is not advisable for such patients.
3. **Occlusion and Wear Patterns**: Excessive forces can lead to implant failure. Rigid splinting is crucial for success.
4. **Bone Grafting Needs**: Extensive grafting may require delayed loading or larger implants.
5. **Implant Surface Treatment**: Modifications like SLA and SLActive implant surfaces, enhance osseointegration and primary stability.

Factors Affecting Immediate Loading[5]

1. **Cross-Arch Stability and Micromovement**: Adequate passive fit and controlled micromovements (<150 µm) ensure successful osseointegration.
2. **Interim Prosthesis**: Typically made from softer materials, they reduce load during healing but may risk fractures in full-arch cases.
3. **Definitive Restorations**: Immediate definitive prostheses provide better soft tissue outcomes but may need replacement if failures occur.
4. **Screw vs. Cement Retention**: Screw-retained prostheses are preferred for their ease of retrieval and maintenance during healing. Residual cement from cement-retained prostheses can compromise results.
5. **Occlusion**: Functional or non-functional loading is chosen based on the patient's dentition and biomechanical needs.

Cross-Arch Stability and Micromovements

Achieving cross-arch stability is essential for a rigid, bilaterally splinted interim prosthesis. Splinting mitigates the bending effects of lateral forces, reducing harmful stresses and evenly distributing masticatory forces across a broader surface area. Additionally, a cross-arch restoration with a proper passive fit minimizes excessive micromovement and ensures the stability necessary for successful osseointegration.

Excessive micromotion can lead to the formation of scar tissue by stem cells at the implant site, hindering osseointegration. However, controlled micromotion under 150 µm is generally well-tolerated, as it provides mechanical stimulation that promotes bone growth and bone-to-implant contact (BIC). Immediate loading techniques have demonstrated higher BIC percentages (71.1 ± 11.8%) compared to conventional loading (45.1 ± 16.1%), suggesting that low-amplitude mechanical strain may accelerate bone formation.

Immediate Loading and Prosthetic Fit[5]

In immediate loading, non-passive fit issues are less common. Static stresses from prosthetic misfit typically dissipate during the early stages of osseointegration, with bone resorption occurring within the first two weeks of healing. This process often leads to passive fit by the time the final restoration is completed. Conversely, in conventional loading, prosthetic misfit can introduce stress into the implant system, leading to uneven force distribution and potential prosthetic complications, such as loosening or implant failure, even years after placement. This is largely due to the ankylotic nature of osseointegration.

Interim Prosthesis[5]

Immediate loading often involves placing an interim prosthesis, which is replaced with a definitive prosthesis once the soft and hard tissues have healed. Interim prostheses are usually made from softer materials to minimize loads on the bone during healing but may be prone to fractures, especially in full-arch rehabilitations. This issue can be addressed by using an immediate definitive prosthesis that is fully functional.

For full-mouth rehabilitations, an interim prosthesis is typically recommended until osseointegration is complete. However, achieving a passive fit with interim prostheses can be challenging due to anatomical variations and the limited control over soft tissue healing. If an implant fails during osseointegration, any definitive prosthesis placed at the time of surgery would need replacement.

Screw-Retained vs. Cement-Retained Prostheses[5]

Interim prostheses are retrieved periodically (e.g., every two weeks) for procedures such as suture removal, implant stability checks, and soft tissue evaluations. A screw-retained interim prosthesis is generally preferred due to its ease of retrieval and reduced risk of complications. In contrast, cement-retained prostheses are harder to retrieve and may compromise tissue healing if residual cement remains. Additionally, screw-retained prostheses offer greater flexibility for angle corrections (40°–90°) compared to cement-retained options (10°–30°).

Occlusion in Immediate Loading[5]

There are two types of occlusion in immediate implants:

1. **Immediate Functional Loading**: Interim prostheses are in full occlusion, typically used in fully edentulous patients.
2. **Immediate Non-Functional Loading**: Temporary restorations are out of occlusion, serving primarily for aesthetics and soft tissue guidance during healing. This approach reduces biomechanical overloading and is often used for partially edentulous patients.

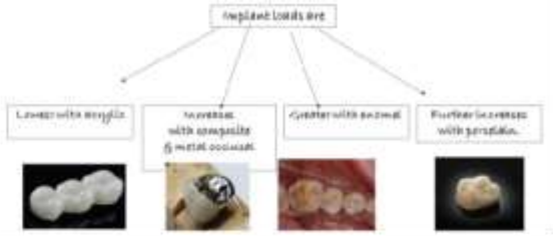
Regardless of the occlusal concept chosen, the following guidelines should be followed in immediate loading:

- **Implant Restoration Design**:
  - Reduce the size of the occlusal table.
  - Posterior teeth should have narrower occlusal platforms compared to natural teeth to avoid cantilevered contacts.
  - Flat cusps minimize lateral forces, while a horizontal fossa design distributes forces evenly.
- **Occlusal Contacts**: [6]
  - Limit occlusal contacts to no more than two per implant.
  - Primary contact should be centered over the implant head, with secondary contact within 1 mm of the periphery.
  - Avoid cantilever extensions to prevent non-axial forces.
  - Patients should adopt a soft diet during the initial healing period to minimize stress on the implants.

Implant Design, Surface, and Number

- **Design**: Screw-type implants with active threads enhance primary stability and load distribution.
- **Length**: Longer implants improve stability, especially in poor-quality bone.
- **Surface Roughness**: Increased roughness enhances bone-implant contact.
- **Number and Distribution**: Full-arch restorations in the maxilla require more implants compared to the mandible, with proper anteroposterior spread being critical.

STRESSES EXERTED ON THE IMPLANT BY DIFFERENT PROSTHETIC MATERIALS[7]



Materials for Conventional Implant Prosthesis

Framework Materials:

- **Casted**
- **Milled:** Titanium, PEEK, Zirconia, Cobalt Chromium

Layering Materials:

- Acrylic
- Composite resin
- Ceramic

Postoperative Prosthetic Complications in Immediate Loading Across Different Treatment Phases[9]

1. Diagnostic and Surgical Phases

Occlusal Vertical Dimension: Acrylic or resin is commonly used for fixed implant-supported prostheses. However, these materials lack strength and require a bulkier design, necessitating a minimum restorative space of 12–15 mm per arch. Insufficient space can lead to higher fracture rates of the prosthesis.

Smile Line and Transition Zone: The transition zone, or the prosthesis-gingival junction, may become visible. In such cases, additional alveolar ridge reduction might be required during surgery to address aesthetic concerns.

Planning-Related Complications:
Implant placement must follow a prosthetically driven plan to accommodate the structure of the future prosthetic framework.

Lip Support:
Patients with long-term use of removable prostheses may require a buccal flange for adequate lip support to achieve aesthetically pleasing results.

Soft Tissue Issues and Graft Failure:

- Lack of keratinized tissue can lead to peri-implant pain, compromising oral hygiene and increasing the risk of soft and hard tissue damage.
- The treatment plan must ensure that keratinized tissue surrounds the implants, either through proper implant placement or grafting procedures.

2. **Transitional Prosthodontic Phase**

This phase begins immediately after implant loading with an interim prosthesis, typically made from acrylic material. It overlaps with the definitive prosthetic phase.

Managing Parafunctional Habits:
Patients with bruxism or a history of fractured restorations require extra precautions to prevent overloading and subsequent fractures, which can weaken the prosthesis at repair sites.

Implant Fractures:
Implant fractures can occur due to:

- Overloading
- Poor implant design
- Use of narrow implants in high occlusal load areas
- Improper occlusal concepts
- Bruxism
- Lack of passive fit

Bone Loss:
Excessive load or an absence of passive fit can result in bone loss around the implant.

3. Definitive Prosthodontic Phase

Occlusal Adjustments:

- Occlusal contacts should be evenly distributed bilaterally to reduce wear on the prosthetic teeth.
- Tools like T-scan can assist in identifying and correcting uneven occlusal forces, ensuring smooth transitions in and out of centric relation.

Prosthesis Contours:

- The intaglio surface should be flat to convex rather than festooned, ensuring it fits closely against the tissue.
- Buccolingual profiles must be smooth to facilitate phonation and avoid speech difficulties.

Phonetic Considerations:
Improperly contoured prostheses may lead to phonetic challenges, emphasizing the need for precise design.

4. Maintenance Phase and Related Issues

Soft-Tissue Hyperplasia:
This can occur beneath overdentures due to:

- Poor oral hygiene
- Insufficient space between the bar and tissue

Hygiene Considerations in Prosthesis Design:

- Superstructures must be designed to allow access for standard oral hygiene tools.
- Adequate interimplant distance and ovate pontic designs are essential.
- Avoid concave or ridge-lap designs that are difficult to clean and maintain.

Conclusion

The success of implant therapy hinges on careful planning, execution, and maintenance, with an emphasis on preserving peri-implant bone, particularly the bone crest. Key factors such as bone density, implant placement timing, and loading protocols play pivotal roles in achieving predictable outcomes. A thorough understanding of loading protocols, implant design, prosthetic materials, and patient-specific modifiers ensures a tailored approach that minimizes complications and enhances long-term success.

Attention to occlusal forces, prosthesis contours, and hygiene accessibility further supports implant longevity and patient satisfaction. With advancements in implant surface technology and innovative treatment protocols, clinicians can now provide more efficient and predictable solutions while addressing individual patient needs. This comprehensive approach fosters improved functional and aesthetic outcomes, setting the foundation for sustainable implant therapy success.

REFERENCES

1. Chen ST, Buser D. Esthetic outcomes following immediate and early implant placement in the anterior maxilla—a systematic review. Int J Oral Maxillofac Implants. 2014 Jan 1;29(Suppl):186-215.
2. ITI Treatment Guide Vol 4 :- Loading Protocols In Implant Dentstry – Edentulous Patients
3. Misch CE. Contemporary Implant Dentistry-E-Book: Contemporary Implant Dentistry-E-Book. Elsevier Health Sciences; 2007 Nov 26.
4. Porter JA, Von Fraunhofer JA. Success or failure of dental implants? A literature review with treatment considerations. General dentistry. 2005 Nov 1;53(6):423-32.
5. Ghoul WE, Chidiac JJ. Prosthetic requirements for immediate implant loading: a review. J Prosthodont. 2012 Feb;21(2):141-54.
6. Y Y Chen, C L Kuan, Y B Wang, Implant occlusion: biomechanical considerations for implant supported prostheses, J Dent Sci, 3(2), 2008, 65 - 74.
7. Lum LB, Beirne OR, Curtis DA. Histologic evaluation of Hydroxylapatite coated versus uncoated titanium blade implants in delayed and immediately loaded applications. Int J

Oral Maxillofac Implants. 1991;6:456-462.

8. Soliman TA, Tamam RA, Yousief SA, El-Anwar MI. Assessment of stress distribution around implant fixture with three different crown materials. Tanta Dental Journal. 2015 Dec 1;12(4):249-58.
9. Balwani TR, Godbole SD, Sathe S, et al. Prosthodontic complications associated with immediately loaded fixed implant-supported prostheses - a review. J Evolution Med Dent Sci 2020;9(45):3394-3398