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COMPARATIVE EVALUATION OF THE IMPACT OF DIFFERENT PROSTHODONTIC METHODS (EARLY LOADING IMPLANTATION AND TRADITIONAL BRIDGEWORK) ON PATIENTS' QUALITY OF LIFE IN THE RESTORATION OF DENTAL ARCH DEFECTS

Akhmadzhonov M.A.
Assistant of Department of orthopedic dentistry and orthodontics,
Andijan State Medical Institute

RELEVANCE
The restoration of dental arch defects is a cornerstone of modern dentistry, directly impacting patients' functional, aesthetic, and psychological well-being. While traditional fixed partial dentures (bridges) have been a reliable solution, dental implants offer a conservative and biomechanically sound alternative. Within implantology, early functional loading protocols have gained prominence, aiming to shorten treatment times and improve patient satisfaction. However, a comprehensive comparative analysis of early loading implant protocols versus traditional bridgework, particularly concerning their long-term effects on bone physiology, microcirculation, and patient-reported quality of life, remains a critical area of investigation. This study aims to provide a comparative evaluation of these treatment modalities to establish evidence-based recommendations for clinical practice.
Keywords: Dental implantation, early functional loading, traditional bridge prosthesis, quality of life, osseointegration, 3D radiography, Laser Doppler Flowmetry (LDF), implant stability.

АКТУАЛЬНОСТЬ
Восстановление дефектов зубных рядов является краеугольным камнем современной стоматологии, напрямую влияющим на функциональное, эстетическое и психологическое благополучие пациентов. В то время как традиционные несъемные мостовидные протезы были надежным решением, дентальные имплантаты представляют собой консервативную и биомеханически обоснованную альтернативу. В имплантологии протоколы ранней функциональной нагрузки приобрели особую значимость, поскольку они направлены на сокращение сроков лечения и повышение удовлетворенности пациентов. Однако всесторонний сравнительный анализ протоколов имплантации с ранней нагрузкой и традиционного мостовидного протезирования, особенно в отношении их долгосрочного влияния на физиологию кости, микроциркуляцию и качество жизни по оценкам пациентов, остается важнейшей областью исследований. Данное исследование направлено на проведение сравнительной оценки этих методов лечения с целью разработки научно обоснованных рекомендаций для клинической практики.
Ключевые слова: Дентальная имплантация, ранняя функциональная нагрузка, традиционный мостовидный протез, качество жизни, остеоинтеграция, 3D-рентгенография, лазерная допплеровская флоуметрия (ЛДФ), стабильность имплантата.

INTRODUCTION
The loss of natural teeth, resulting from caries, periodontal disease, or trauma, leads to partial edentulism, a condition that compromises masticatory function, aesthetics, and phonetics, thereby negatively affecting an individual's overall quality of life (QoL). The primary goal of prosthetic dentistry is to restore these functions and improve patient well-being. For decades, the standard of care for replacing one or more missing teeth has been the fabrication of a traditional

fixed partial denture, commonly known as a dental bridge. This method has a high success rate but necessitates the preparation (grinding) of adjacent, often healthy, teeth to serve as abutments, which can increase their susceptibility to future complications.

The advent of dental implantology has revolutionized restorative dentistry. Dental implants offer a tooth-preserving alternative by providing a standalone foundation for prosthetic crowns and bridges within the alveolar bone. The success of dental implants is predicated on the biological process of osseointegration, where the implant surface forms a direct, stable connection with the surrounding bone tissue. The loss of teeth invariably leads to the progressive atrophy of the alveolar bone due to the absence of physiological chewing loads that stimulate bone maintenance. Dental implants help to mitigate this process by reintroducing functional forces into the bone, thereby preserving its structure and volume.

Traditionally, implant treatment followed a two-stage, delayed loading protocol, involving a healing period of 3 to 6 months after implant placement before the final prosthesis was attached. While highly predictable, this lengthy process often leads to patient dissatisfaction due to the extended treatment duration and the need for temporary restorations. This has fueled interest in accelerated protocols, such as early functional loading, where the prosthesis is placed within a few weeks of implant surgery. The core challenge of this approach lies in achieving successful osseointegration while subjecting the implant to masticatory forces at a very early stage.

This article, based on the proposed research framework of Akhmadjonov M.A., aims to conduct a comprehensive, comparative clinical study evaluating the efficacy of implant-supported prostheses with early functional loading against traditional bridgework for restoring small dental arch defects. The study's primary objectives are: To evaluate the dynamics of bone tissue healing around intraosseous screw-retained implants using 3D radiography. To assess the changes in blood supply in the peri-implant area using Laser Doppler Flowmetry (LDF). To determine the stability of dental implants before and after the application of early functional loading at various intervals. To compare these outcomes with those of traditional bridgework and a delayed-loading implant group, ultimately assessing the impact on patient quality of life.

By integrating objective clinical parameters (radiographic, microcirculatory, stability) with subjective patient-reported outcomes, this research seeks to provide robust evidence to guide clinicians in selecting the most appropriate treatment modality for their patients.

LITERATURE REVIEW

The challenge of edentulism and bone atrophy - The loss of a tooth sets off a cascade of biological events, most notably the resorption of the alveolar ridge. The alveolar bone is load-dependent; the physiological stimuli transmitted through the periodontal ligament during mastication are essential for maintaining its density and volume. The removal of a tooth eliminates this stimulation, leading to disuse atrophy. This progressive bone loss can complicate future prosthetic treatment, whether with implants or traditional bridges, by reducing the available foundation. Understanding the biomechanics of masticatory forces and their distribution is crucial for designing prostheses that can maintain bone health.

Traditional vs. Implant-supported prostheses - Traditional fixed bridges have long been a reliable treatment for partial edentulism. Their main advantage lies in their relative simplicity and shorter treatment time compared to conventional implant protocols. However, their most significant drawback is the need for aggressive preparation of adjacent abutment teeth, which can compromise their long-term vitality. Furthermore, the pontic (artificial tooth) of a bridge does not transmit physiological loads to the underlying bone, meaning the atrophy of the alveolar ridge continues unabated.

Dental implants, by contrast, are root-form substitutes that are placed directly into the jawbone. They offer several key advantages:

- Preservation of Adjacent Teeth: Implants do not rely on neighboring teeth for support.
- Bone Preservation: They transmit masticatory forces to the surrounding bone, stimulating it and preventing resorption.
- Improved Biomechanics: An implant-supported crown functions as an independent unit, closely mimicking the natural tooth.

The success of implant therapy hinges on achieving and maintaining osseointegration, a concept first introduced by Brånemark. The quality and quantity of the host bone are paramount factors in determining the potential for successful osseointegration and, consequently, the long-term success of the treatment.

Loading protocols in implantology - The timing of the application of functional load to a dental implant is a critical determinant of clinical success. Three primary protocols exist:

Delayed (Conventional) Loading: The implant is left submerged beneath the gingiva for 3-6 months to allow for undisturbed osseointegration before the prosthesis is attached. This is the most traditional and well-documented approach.

Early Loading: The prosthesis is connected to the implant much sooner, typically between 1 week and 2 months after placement. This protocol requires excellent primary stability of the implant.

Immediate Loading: The prosthesis is attached within 48 hours of implant surgery. This is the most demanding protocol and is reserved for cases with optimal bone quality and high initial implant stability.

The proposed research focuses on early functional loading, a protocol that offers a compromise between the safety of delayed loading and the patient-centered benefits of immediate loading. It aims to shorten the edentulous period, reduce the number of surgical interventions, and improve patient comfort and satisfaction.

Advanced diagnostics for assessing implant success - To objectively evaluate the efficacy of different loading protocols, advanced diagnostic tools are essential. The proposed study rightfully incorporates state-of-the-art methods:

3D Radiography (CBCT): Cone-beam computed tomography provides detailed, multi-planar images of the jawbone, allowing for precise quantitative assessment of bone density, marginal bone loss around the implant, and the overall healing process. This is superior to traditional 2D radiography for evaluating the complex 3D structure of the implant-bone interface.

Laser Doppler Flowmetry (LDF): LDF is a non-invasive technique used to measure microcirculatory blood flow. In implant dentistry, it can be used to monitor the revascularization and healing of peri-implant tissues. A healthy blood supply is a prerequisite for successful osseointegration and soft tissue health. Comparing blood flow dynamics between early and delayed loading protocols can provide valuable insights into the biological response to different treatment modalities.

Implant Stability Measurement: Primary stability (the mechanical stability of the implant immediately after placement) is a key prerequisite for successful early loading. Secondary stability (biological stability achieved through osseointegration) is essential for long-term function. Devices that measure the implant stability quotient (ISQ) through resonance frequency analysis are commonly used to quantify this parameter objectively.

MATERIALS AND METHODS

Study population - The clinical study was designed to include 90 patients aged 25 to 61 years with no significant systemic diseases (background pathology). The cohort consisted of 55

women and 35 men. All patients presented with small, bounded (Kennedy Class III) edentulous spaces in the mandible.

Study groups - The 90 patients were allocated into three treatment groups:

Group 1 (Delayed Loading Implant Group; n=28): Patients in this group received two-stage intraosseous screw-retained dental implants. The final metal-ceramic bridge prosthesis was placed after a conventional healing period (typically 3-4 months for the mandible) to allow for complete osseointegration before loading.

Group 2 (Early Loading Implant Group; n=31): This group received intraosseous screw-retained dental implants, and the final metal-ceramic bridge prosthesis was fixed one month after the implant placement surgery, representing an early functional loading protocol.

Group 3 (Traditional Bridge Group; n=38): This control group received traditional tooth-supported metal-ceramic bridges to restore the edentulous space. The teeth adjacent to the gap were prepared to serve as abutments for the prosthesis.

In Groups 1 and 2, intraosseous screw-type implants served as the prosthetic supports. All patients across all three groups were scheduled to be restored with metal-ceramic bridgework to ensure consistency in the final prosthetic material.

Assessment and Follow-up - A comprehensive set of diagnostic and follow-up examinations was planned for all patients. Methods of Investigation:

- Clinical-Stomatoscopic Examination: Standard clinical assessments of soft tissue health, plaque accumulation, and prosthetic integrity.
- 3D Radiographic Analysis: Cone-beam computed tomography (CBCT) scans to assess peri-implant and peri-radicular bone levels and density.
- Laser Doppler Flowmetry (LDF): Measurement of mucosal blood flow in the area of the restored defect to evaluate tissue vitality and healing.
- Mobility Assessment: Measurement of implant stability (e.g., using resonance frequency analysis) and abutment tooth mobility.
- Quality of Life Assessment: A validated questionnaire, such as the Oral Health Impact Profile (OHIP-14), would be used to assess patient-reported outcomes regarding function, comfort, and aesthetics.
- Statistical Analysis: Appropriate statistical tests to compare the outcomes between the three groups.
- Follow-up Schedule: Patients were scheduled for control examinations at 3 months, 6 months, 1 year, and 2 years after the final prosthesis placement. The specific diagnostic tests (3D radiography, LDF, mobility) were to be conducted at more frequent intervals: 1 month, 3 months, 6 months, 9 months, and 12 months to closely monitor the dynamic changes during the healing and adaptation phase.

RESULTS AND DISCUSSION

As the provided text is an abstract for a proposed study, this section will present anticipated results based on existing scientific literature, structured around the study's design. These expected outcomes will be used to fuel a comprehensive discussion.

Expected clinical and radiographic outcomes - It is anticipated that both implant groups (Groups 1 and 2) will demonstrate high survival rates over the 2-year follow-up period, comparable to the success rates reported in the literature for their respective loading protocols.

Discussion: The slightly higher expected marginal bone loss in the Early Loading Group (Group 2) compared to the Delayed Loading Group (Group 1) is consistent with some studies, which suggest that early micromotion can lead to minor initial remodeling at the implant crest. However, this difference is expected to be clinically insignificant and stabilize after the first year

of function. The high implant stability (ISQ) values anticipated for both implant groups would confirm successful osseointegration.

For Group 3, while bone loss at the pontic site will continue, the key parameter to monitor is the health of the abutment teeth. The expected rate of complications (e.g., secondary caries, need for root canal therapy) highlights the primary drawback of the traditional bridge approach—the biological cost to otherwise healthy teeth. The 3D radiographic analysis would be crucial in quantifying these bone level changes with high precision, offering a clear advantage over 2D imaging.

Expected microcirculation and healing dynamics - Laser Doppler Flowmetry is expected to reveal distinct patterns of blood flow recovery. Immediately after surgery, all implant sites would show a hyperemic response, followed by a gradual return to baseline.

Discussion: The Early Loading Group (Group 2) might exhibit a slightly more prolonged period of elevated blood flow compared to the non-loaded sites in Group 1 during its initial healing phase. This could reflect the bone's adaptive remodeling response to the early introduction of functional stimuli. However, it is hypothesized that by the 3-month mark, the LDF readings for both implant groups will stabilize and show no significant difference, indicating the establishment of a healthy and mature peri-implant mucosal seal. This finding would provide biological validation for the safety of the early loading protocol, demonstrating that early functional forces, when controlled, do not compromise tissue perfusion and can even stimulate a robust healing response.

Expected impact on patient quality of life - The most significant differences between the groups are anticipated in the patient-reported outcomes and quality of life (QoL) metrics.

Discussion: The initial QoL assessment at 1 month is expected to show a dramatic advantage for Groups 2 and 3. Patients in the Early Loading (Group 2) and Traditional Bridge (Group 3) groups receive their final restorations quickly, leading to a rapid improvement in function, aesthetics, and psychological comfort. In contrast, the Delayed Loading group (Group 1) must endure a prolonged period with a temporary, often removable, prosthesis, which would be reflected in a higher (worse) OHIP-14 score at this stage.

Over the long term (2 years), it is expected that both implant groups will report slightly better QoL scores than the bridge group. This could be attributed to factors like improved confidence in the stability of the restoration and the ease of cleaning around individual implant crowns compared to a bridge. Patients with implants often report a feeling of having their "own teeth" back, a psychological benefit that is hard to quantify but is a powerful driver of patient satisfaction. The key takeaway is that the early loading protocol is expected to combine the short-term QoL benefits of traditional bridgework with the long-term clinical and functional advantages of dental implants. This approach directly addresses the primary drawback of conventional implant therapy—the waiting time—making a superior treatment modality more accessible and appealing to patients.

CONCLUSION

Based on the proposed study design and evidence from contemporary dental literature, this research is poised to demonstrate that the restoration of small dental arch defects using implant-supported prostheses with an early functional loading protocol is a highly effective and predictable treatment. This method is expected to yield clinical, radiographic, and biological outcomes comparable to the traditional delayed loading protocol while offering a significantly improved patient experience and quality of life in the short term.

The anticipated findings will support the following conclusions:

Early functional loading, when applied in cases with good primary implant stability, does not compromise the process of osseointegration. The use of advanced monitoring tools like 3D radiography and Laser Doppler Flowmetry will provide objective evidence of successful bone and soft tissue healing.

The primary advantage of the early loading protocol is the substantial reduction in overall treatment time, which translates directly into higher patient satisfaction and a faster return to normal function and aesthetics compared to conventional delayed loading.

Compared to traditional bridgework, both implant-based solutions offer the significant long-term benefit of preserving adjacent tooth structure, thereby reducing the risk of future complications with abutment teeth and contributing to better overall oral health.

Ultimately, the research is expected to validate the methodology of early functional loading on intraosseous dental implants as a patient-centered, scientifically sound, and highly successful treatment modality that can stimulate bone healing and provide a superior alternative to both delayed implant loading and traditional prosthodontics.

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