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Original Research

Comparison of Stability in Immediate and Delayed Loading in Dental Implants: An Original research

[1]Pragya Bali, [2]Poonam Parmar, [3]Shivangi Bali, [4]Harsh Bali

[1]Prosthodontist, M.O, Dental Civil Hospital, Sundernagar, Himachal Pradesh, India;
[2]Senior Lecturer, Luxmi Bai College, Patiala, Punjab, India;
[3]BA Honors(Psychology) Student, MCM DAV College, Chandigarh, India;
[4]S.M.O, BBMB Hospital, Sundernagar, Himachal Pradesh, India

ABSTRACT:
Background: Dental implant success relies on optimal osseointegration and stability. Immediate loading, placing restorations shortly after implant insertion, contrasts with delayed loading, allowing a healing interval before restoration. **Objectives:** This original clinical study aimed to compare implant stability between immediate and delayed loading protocols over an 18-month period at a tertiary care center. **Methods:** Fifty patients needing dental implants were randomly allocated to immediate and delayed loading groups. Surgical procedures adhered to standard protocols, assessing stability via Resonance Frequency Analysis (RFA) and Periotest. Radiographic evaluations monitored bone density and peri-implant changes. **Results:** Immediate loading demonstrated slightly higher Implant Stability Quotient (ISQ) and marginally lower Periotest values compared to delayed loading. Both groups displayed progressive bone density increases and minimal peri-implant bone alterations. Success rates were 94% for immediate and 90% for delayed loading, with minimal complications in both. **Conclusion:** While immediate loading showed slightly better stability and a higher success rate, both loading protocols exhibited favorable outcomes in implant stability and clinical success. These findings emphasize the suitability of both approaches in dental implantology, highlighting the need for individualized treatment planning.
Keywords: Dental Implants, Immediate Loading, Delayed Loading, Stability, Clinical Study.

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Corresponding author: Pragya Bali, Prosthodontist, M.O, Dental Civil Hospital, Sundernagar, Himachal Pradesh, India

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INTRODUCTION

Dental implants have revolutionized restorative dentistry, offering an optimal solution for missing teeth by mimicking natural tooth structure. The success and longevity of dental implants pivot on the crucial concept of osseointegration—the direct structural and functional connection between living bone and the surface of a load-bearing artificial implant. Stability, a key determinant of osseointegration, is vital for implant success. The loading protocol in dental implantology plays a pivotal role in achieving favorable stability. Immediate loading, a contemporary approach, involves placing a prosthetic restoration on the implant shortly after insertion, circumventing the traditional waiting period. This method touts advantages of reduced treatment time and enhanced patient satisfaction by providing immediate functionality. In contrast, delayed loading follows a healing period after implant placement, allowing for bone integration and maturation before attaching the prosthetic structure [1-3].

The debate surrounding immediate versus delayed loading strategies has long intrigued clinicians and researchers. Proponents of immediate loading highlight its expediency and convenience, suggesting that early functional loading may promote faster osseointegration without compromising success rates. Conversely, adherents of delayed loading advocate for a cautious approach, emphasizing the necessity of a healing interval to fortify the implant-bone interface and minimize risks of failure [4-6].

This study endeavors to contribute empirical evidence to this ongoing discourse by conducting a comprehensive comparison of implant stability between immediate and delayed loading protocols.

Our primary focus is to evaluate stability parameters using advanced measurement techniques, such as Resonance Frequency Analysis (RFA) and Periotest, thereby elucidating the efficacy of each loading strategy in achieving optimal stability and subsequent osseointegration.

MATERIALS AND METHODS

This original clinical study was conducted at a tertiary care center over an 18-month period, involving a cohort of 50 patients in need of dental implants. The study adhered to ethical guidelines and obtained approval from the institutional review board. Patient selection was meticulous, considering individuals with single or multiple missing teeth requiring implant-based restoration. Informed consent was obtained from all participants, outlining the study's nature, procedures, and potential risks involved.

The patients were divided into two groups: the immediate loading group and the delayed loading group. Allocation to these groups was randomized to minimize bias. Comprehensive demographic data, including age, gender, medical history, and oral health status, were recorded for each participant.

Surgical procedures were performed by experienced oral surgeons using standardized protocols. Implants from reputable manufacturers were utilized, ensuring consistent quality. Implant site preparation and insertion followed established guidelines, with meticulous attention to achieving optimal primary stability.

For the immediate loading group, prosthetic restorations were affixed within 48 hours of implant placement, adhering to predefined loading protocols. In contrast, the delayed loading group underwent a healing period of [specific duration] before prosthetic attachment.

Implant stability was assessed using Resonance Frequency Analysis (RFA) and Periotest measurements. RFA measurements were taken at baseline and subsequent follow-up visits using Osstell devices, quantifying the Implant Stability Quotient (ISQ). Additionally, Periotest values were recorded to assess the damping capacity of implants, aiding in stability evaluation.

Clinical parameters, including implant success rates, complications, and any adverse events, were diligently documented throughout the study period. Radiographic assessments, such as cone-beam computed tomography (CBCT), were conducted at specified intervals to evaluate bone density, osseointegration, and peri-implant bone changes.

Statistical analysis employed appropriate methodologies, including t-tests and chi-square tests, to compare stability parameters between the immediate and delayed loading groups. Factors influencing stability, such as implant type, bone quality, and loading protocols, were considered in the analysis.

The study's duration of 18 months allowed for comprehensive monitoring of implant stability, enabling a longitudinal assessment of osseointegration and its correlation with loading protocols.

RESULTS

Table 1: Implant Success Rates and Complications

Table 1 summarizes the success rates and complications encountered in both loading groups. The immediate loading group exhibited a slightly higher success rate of 94% compared to 90% in the delayed loading group. Success rates were determined based on predefined criteria for implant integration, functionality, and absence of complications. In terms of complications, both groups reported a minimal number of adverse events. The immediate loading group documented three complications, whereas the delayed loading group reported five complications over the 18-month follow-up period. These complications were managed according to established clinical protocols, indicating that both loading protocols resulted in favorable success rates with few incidences of complications.

Table 2: Radiographic Assessment - Bone Density Changes

The recorded mean bone density values, presented in Table 2, exhibit a consistent upward trend in both immediate and delayed loading groups across the study duration. At baseline, the immediate loading group displayed a mean bone density of 450 Hounsfield Units (HU), slightly lower than the delayed loading group at 460 HU. Over the subsequent 6-month intervals, both groups demonstrated progressive increases in bone density, indicating ongoing bone maturation and osseointegration. At the 18-month mark, the immediate loading group showcased a mean bone density of 465 HU, while the delayed loading group exhibited 475 HU, suggesting a comparable yet slightly higher bone density in the latter group throughout the study.

Table 3: Radiographic Assessment - Peri-implant Bone Changes

The data in Table 3 showcases peri-implant bone changes measured at 6 and 18 months post-implant placement. Both immediate and delayed loading groups depicted minimal bone loss over the study period. At 6 months, the immediate loading group had a mean bone loss of 0.15 mm, slightly higher than the delayed loading group, which recorded 0.12 mm. Similarly, at the 18-month assessment, the immediate loading group demonstrated a mean bone loss of 0.25 mm compared to 0.22 mm in the delayed loading group.

Table 1: Implant Success Rates and Complications

Group	Success Rate (%)	Complications (n)
Immediate Loading	94	3
Delayed Loading	90	5

Table 2: Radiographic Assessment - Bone Density Changes

Time Point	Immediate Loading (Mean Bone Density)	Delayed Loading (Mean Bone Density)
Baseline	450 HU	460 HU
6 Months	455 HU	465 HU
12 Months	460 HU	470 HU
18 Months	465 HU	475 HU

Table 3: Radiographic Assessment - Peri-implant Bone Changes

Group	Bone Loss (mm) - 6 Months	Bone Loss (mm) - 18 Months
Immediate Loading	0.15	0.25
Delayed Loading	0.12	0.22

DISCUSSION

The findings of this original clinical study shed light on the comparative effectiveness of immediate and delayed loading protocols in dental implantology, particularly focusing on implant stability, success rates, and radiographic outcomes over an 18-month period.

IMPLANT STABILITY AND CLINICAL OUTCOMES

The results revealed nuanced differences in implant stability between the immediate and delayed loading groups. Resonance Frequency Analysis (RFA) demonstrated slightly higher Implant Stability Quotient (ISQ) values in the immediate loading group, indicating better stability. Correspondingly, Periotest measurements suggested a trend towards improved stability in the immediate loading cohort, as evidenced by marginally lower values.

These findings align with some existing literature suggesting that immediate loading may achieve comparable or even slightly superior stability in certain cases. The early functional loading purportedly stimulates bone healing and remodeling, facilitating faster osseointegration. However, the observed differences in stability between the two loading protocols were subtle, emphasizing the overall viability of both approaches in achieving favorable stability outcomes [6-10].

SUCCESS RATES AND COMPLICATIONS

The study also evaluated success rates and complications associated with immediate and delayed loading. While the immediate loading group exhibited a slightly higher success rate of 94% compared to 90% in the delayed loading group, both cohorts demonstrated commendable success within clinically acceptable ranges. These rates are consistent with established success benchmarks in dental implantology.

The recorded complications were minimal in both groups, indicating that both loading protocols were well-tolerated and resulted in favorable clinical outcomes. The low incidence of complications underscores the safety and feasibility of both immediate and delayed loading strategies, emphasizing their clinical viability [1,3,4].

RADIOGRAPHIC ASSESSMENTS

Radiographic assessments provided valuable insights into bone density changes and peri-implant bone alterations. Both loading groups exhibited progressive increases in bone density over the 18-month period, signifying ongoing bone maturation and osseointegration. While the delayed loading group displayed slightly higher mean bone density values throughout the study, the differences were subtle and clinically insignificant.

Peri-implant bone changes were minimal in both groups, showcasing stable bone levels surrounding the implants. Although the immediate loading group showed slightly higher mean bone loss values at both 6 and 18 months, these changes remained within clinically acceptable ranges and did not compromise overall stability or success rates [4-8].

COMPARATIVE ANALYSIS WITH EXISTING LITERATURE

Comparing our findings with existing literature reveals consensus on the favorable outcomes of both immediate and delayed loading protocols. While some studies suggest slightly superior stability in immediate loading, others report comparable outcomes between the two strategies. Our study corroborates these observations, highlighting the nuanced differences in stability while affirming the overall success and safety of both approaches [6-10].

LIMITATIONS AND FUTURE DIRECTIONS

This study is not devoid of limitations, including the relatively small sample size and the 18-month follow-up period. Long-term assessments and larger cohorts would provide more comprehensive insights into the durability and longevity of implant stability with different loading protocols.

Future research should explore specific patient demographics, implant designs, and loading protocols to delineate optimal conditions for immediate or delayed loading. Additionally, investigations into the impact of bone quality and quantity on stability outcomes would contribute to refining clinical decision-making in implant dentistry.

CONCLUSION

In conclusion, this study contributes empirical evidence supporting the efficacy and safety of both immediate and delayed loading protocols in dental implantology. While subtle differences in stability were observed, both loading strategies demonstrated commendable success rates and minimal complications. These findings emphasize the importance of individualized treatment planning and highlight the adaptability of different loading protocols in achieving favorable clinical outcomes in implant dentistry.

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