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Review Article

IMPLANT SURVIVAL RATE UNDER IMMEDIATE LOADING IN FULL-ARCH RECONSTRUCTION: A NARRATIVE REVIEW

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ABSTRACT

Immediate implant loading in full-arch rehabilitation has become prominent due to fewer visits than delayed implant loading and increased success reports. This study evaluates and compares the implant survival rate in full-arch reconstruction under immediate loading with delayed loading protocol. This review was conducted using online databases, including ResearchGate, PubMed, and MDPI database, combining the following terms: "Dental implants," "Immediate loading," "Delayed loading," and "Fixed Full-arch reconstruction." The inclusion criteria and search strategy were limited to human studies published in English. The selected articles were clinical studies or retrospective studies published between 2019 and 2024.

Immediate Loading (IL) vs Delayed Loading (DL): IL of implants in full-arch reconstructions has shown high survival rates comparable to DL. Studies report survival rates of 99.7% for IL and 97.2% for DL after five years of follow-up. IL has demonstrated excellent clinical outcomes, with minimal bone loss and high prosthesis survival rates. Immediate restoration protocols, such as the flat one-bridge technique, have also shown a 99.6% implant survival rate over a median follow-up of 86 mo. Immediate implant loading in full-arch reconstruction exhibited a high survival rate and predictable clinical outcomes, making them a viable option for the rehabilitation of edentulous patients. This protocol reduced the treatment time and enhanced patient satisfaction, thus offering a reliable alternative to the delayed loading method.

Keywords: Delayed loading, Dental implants, Fixed full-arch reconstruction, Immediate loading

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INTRODUCTION

Implant dentistry offers a dependable, long-lasting option for restoring missing teeth in patients who are either partially or completely edentulous, with high survival rates. Treatment choices for those with complete tooth loss include implant-supported fixed prostheses or overdentures, which have demonstrated high levels of patient satisfaction and enhanced quality of life [1]. Several studies have reported that fixed implant-supported prostheses are more effective in restoring aesthetics and chewing function, significantly enhancing patients' quality of life [2, 3]. Proper diagnostics and treatment planning are crucial for successful fixed rehabilitation, necessitating a well-designed implant restoration [3, 4].

The implant loading protocol plays a vital role in full-arch rehabilitation. Originally, long-term success was linked to procedures involving a healing time of three to six months before loading, which was believed to be necessary for reliable osseointegration [5]. However, to speed up treatment, a shortened healing period using a one-stage surgery has been proposed, where prostheses are fitted during the same procedure as the implant placement [6, 7].

The immediate functional loading protocol involves placing the prosthesis within a week of implant placement, requiring at least 30 Ncm of torque [8]. The success of this method relies on several factors: selecting appropriate patients, evaluating bone quality and quantity, determining the number and design of implants, ensuring initial implant stability, and managing occlusal forces [9]. Of these, implant stability is especially critical. Immediate loading of dental implants offers several advantages, such as shorter treatment times, improved aesthetics and function, elimination of temporary prostheses, avoidance of additional surgeries, and preservation of the alveolar ridges [10, 11]. This protocol, especially for full-arch fixed prostheses on multiple implants, has advanced to allow prosthesis placement on the same day as surgery, making it a reliable and predictable option for fully edentulous patients [12-14].

Patients with compromised periodontal health tend to have different outcomes from implant treatment compared to those without a history of periodontitis. They often experience lower implant survival rates, greater marginal bone loss, and a higher risk of peri-implantitis [15, 16]. A recent retrospective study analyzed the long-term survival of teeth and implants over 10 y or more in periodontal patients [17]. The study involved 58 patients undergoing periodontal therapy and maintenance, with clinical and radiographic assessments conducted at six sites per tooth or implant. The implant failure rate was 10.08%, with 9.8% due to biological causes. The implant failure rate was 83.3% for patients with recurrent periodontal disease, compared to 16.7% in those without recurrence. The study concluded that although patients with chronic periodontitis could retain most of their compromised teeth, they showed a higher tendency for implant loss than tooth loss [17].

Rehabilitating edentulous patients with implant-supported prostheses has revolutionized dental treatment, offering enhanced functional and aesthetic outcomes [1]. Implant loading protocols, whether immediate or delayed, play a crucial role in determining these prostheses' success and survival rates [5, 6]. Immediate loading (IL) involves placing and loading implants in a single surgical session, while delayed loading (DL) requires a healing period before loading [5, 8]. This narrative review aims to evaluate and compare the survival rates of implants under immediate versus delayed loading protocols in full-arch reconstructions, focusing on clinical outcomes and technical considerations.

MATERIALS AND METHODS

This review was conducted using the ResearchGate, PubMed, and MDPI databases, combining the following terms: "Dental implants," "Immediate loading," "Delayed loading," and "Fixed Full-arch." The inclusion criteria and search strategy were limited to human studies published in English. The selected articles were clinical studies or retrospective studies published between 2019 and 2024.

The population, intervention, comparison, outcome (PICO) question was, "Do patients undergoing full-arch reconstruction with immediate loading of dental implants show similar survival rates

and complication outcomes as those undergoing delayed loading?" According to these criteria, the population included patients requiring full-arch dental implant rehabilitation; the intervention was full-arch reconstruction with immediate loading of dental implants, and the comparison was with patients undergoing delayed loading of dental implants. The primary outcome was the implant survival rate, while complication rates and long-term stability were secondary outcome.

Table 1: The variable of PROMs from the included studies

Review	Velasco-ortega (2022) [18]	Thome (2021) [20]	Marconcini (2021) [19]
Research design	Clinical study (305 IL implants)	Retrospective study (627 IL implants and 340 DL implants)	Retrospective study (494 IL implants)
Duration follow-up	The mean period of 41.3±19.6 mo	Five years	Seven years
Implant survival rate	The implant survival rate was 100%	The implant survival rate was 99.2% for the IL group and 97.9% for the DL group, resulting in an overall survival rate of 98.8%	After seven years, the overall implant survival rate was 99.6%, with only three implants failing
mean marginal bone loss	The mean marginal bone loss was 1.51±1.16 mm, with higher bone loss in patients with chronic medical conditions and smokers than in normal	During the follow-up period, a higher number of implants in the DL group experienced bone loss, either exceeding or falling below 2 mm	The average change in marginal bone level was 0.32 mm, with a standard deviation of 0.50 mm
Patient satisfaction	Not mentioned	IL leads to shorter treatment times, crucial for patient satisfaction	High patient satisfaction was reported with full-arch rehabilitation using IL, although OHRQoL results were not shown in numbers

Abbreviations: IL = immediate loading, DL = delayed loading, OHRQoL = Oral Health-related Quality of Life

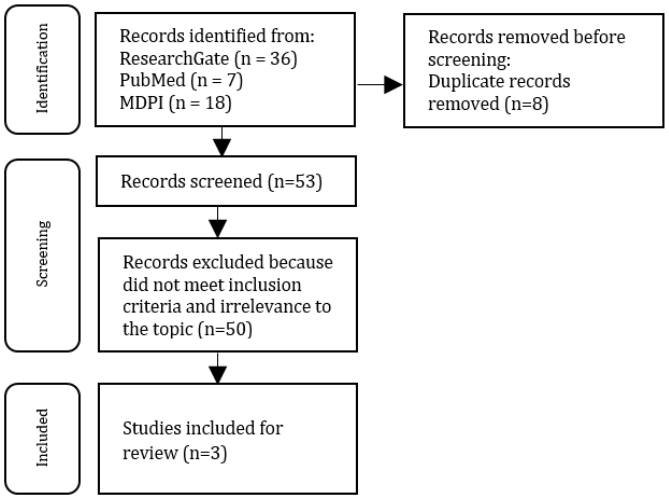

Fig. 1: Prisma flow chart

RESULTS

The literature search yielded a total of 61 records across three electronic databases: ResearchGate (n = 36), PubMed (n = 7), and the MDPI (n = 18). After the removal of 8 duplicate records, 53 titles and abstracts were screened. During the title and abstract screening, 50 records were excluded based on did not meet inclusion criteria and irrelevance to the topic A total of 3 full-text articles were assessed.

The results of this narrative review are based on three selected studies that met the inclusion criteria. These studies encompass both clinical and retroactive designs, focusing on implant survival rates and marginal bone loss under immediate and delayed loading protocols. The three studies we obtained have also received ethical approval and were conducted in accordance with the principles outlined in the Declaration of Helsinki. The findings are summarized in table 1, highlighting the implant survival rates, mean marginal bone loss, and follow-up durations. The outcomes provide a comparative perspective on the effectiveness and longevity of immediate loading protocols versus delayed loading in full-arch reconstructions, offering valuable insights into their clinical applications and implications.

DISCUSSION

This discussion highlights the survival rates of implants under immediate loading in full-arch reconstruction based on findings from three studies by Thomé *et al.*, Velasco-Ortega *et al.*, and Marconcini *et al.* Velasco-Ortega's study examined the clinical outcomes of immediate functional loading in patients with a history of periodontitis. In total, 305 implants were placed in 27 patients, 14.8% of whom were smokers, and 25.9% had chronic medical conditions [18]. The immediate functional loading approach revealed key results: no implant loss was reported, resulting in a 100% survival rate, with an average marginal bone loss of 1.51±1.16 mm [18]. Peri-implantitis occurred in 10.2% of the implants, affecting 37% of patients, while 18.5% experienced technical complications like prosthetic screw loss, resin fractures, or ceramic chipping [18]. All patients had a history of periodontitis, a condition known to negatively influence implant success, leading to increased peri-implantitis and bone loss. Over an average follow-up period of 41.3 mo, 37% of patients developed peri-implantitis, and 18.5% encountered prosthetic complications [18].

The success of implants in this study was assessed using several factors. This included implant stability, with no evidence of

loosening or movement during the follow-up period, and the absence of radiolucency around the implants, which indicated proper bone integration as observed in radiographic evaluations [18]. Furthermore, there were no signs of mucosal infection or pus around the implant sites, and patients did not experience any ongoing pain related to the implants [18]. Marginal bone loss was also within acceptable clinical limits, averaging 1.51±1.16 mm [18].

However, the study identified several causes of implant failure and complications. Peri-implantitis was a significant issue, affecting 31 implants (10.2%) in 10 patients (37%), with a higher incidence among those with chronic medical conditions and smokers [18]. Technical complications were also noted, with five patients (18.5%) experiencing issues such as the loss or fracture of the prosthetic screw, acrylic resin fracture, and ceramic chipping [18]. Furthermore, patients with chronic medical conditions exhibited statistically significant higher marginal bone loss, contributing to implant complications [18]. Smoking was another risk factor, as smoking patients had higher marginal bone loss and a higher incidence of peri-implantitis compared to non-smokers. However, not all differences were statistically significant [18].

Marconcini *et al.* assessed the long-term effectiveness of a surgical prosthetic approach for the immediate restoration of dental implants. The research involved 66 patients who received 494 implants supporting 75 full-arch prostheses, with a median follow-up period of 86 mo. The implant survival rate was 99.6%, with only three failures observed, all of which occurred in smokers [19]. The patients in this study were healthy adults with good oral hygiene who consistently attended follow-up appointments. Implants were inserted with a torque exceeding 35 Ncm, with patients receiving a temporary restoration within 48 h and a permanent prosthesis within a year. The absence of patient complaints, peri-implant infections, implant mobility, and noticeable bone-level radiolucency were used to measure implant success [19]. Failures were primarily related to smoking habits, with three implants failing in three different patients, all smokers. These failures did not compromise the overall success of the prostheses [19]. The study concludes that the flat one-bridge technique is viable for immediate full-arch restorations, providing excellent long-term outcomes. The study highlighted that the primary reasons for implant failure were related to smoking, with no other significant risk factors identified [19].

Thomé conducted a study to assess the survival rates of implants and prostheses in full-arch rehabilitation, utilizing platform-switched Morse taper connection implants with either immediate or delayed loading over up to five years. The study examined 967 implants, with 627 receiving IL and 340 receiving DL. Implant survival rates were 99.7% for IL and 97.2% for DL, resulting in an overall survival rate of 98.8% [20]. Prosthesis survival was 100% for both groups. Notably, the DL group experienced significantly greater bone loss than the IL group. The IL approach demonstrated consistently high survival rates and greater patient satisfaction due to shorter treatment times and reduced bone loss compared to DL [20].

The study involved completely edentulous adults treated between 2013 and 2014, with exclusions for those with uncontrolled systemic conditions or inadequate follow-up information. The groups were similar in gender, smoking habits, and systemic health. Most implants in the IL group were placed with higher insertion torques, between 32 and 60 Newton-centimeter (N. cm), linked to better survival rates [20].

The immediate loading protocol for full-arch rehabilitation with dental implants is most appropriate for patients who are in good systemic health, with no significant chronic medical conditions [20]. The protocol is particularly effective when implants demonstrate adequate primary stability, typically with an insertion torque of ≥35 N. cm [19]. Patients with sufficient bone quality and quantity to support implants, as well as those who have controlled periodontal conditions, particularly in cases of a previous history of periodontitis, are also ideal candidates for this treatment [18]. Additionally, ensuring the use of an appropriate number of implants, generally more than six-is essential for the stable support of the prosthesis [19, 20].

The studies reviewed indicate that immediate loading can result in high implant survival rates, especially when the patient exhibits good bone quality and adheres to proper post-operative care [20]. For patients with a history of periodontitis, maintaining controlled periodontal health and regular follow-up is crucial in reducing the risk of complications like peri-implantitis and bone loss [18]. Furthermore, the reduced treatment time associated with immediate loading not only improves the rehabilitation process but also enhances patient satisfaction [19].

Success criteria for implants included the absence of mobility, fractures, or infections necessitating removal, while their continued functionality and presence defined prosthesis success [20]. Failures were mostly attributed to early loss, often due to insufficient osseointegration, health conditions, smoking, implant dimensions, and bone quality. Late failures were linked to peri-implantitis and loading conditions [20].

Immediate vs. delayed loading

The main comparison in the studies focuses on immediate loading (IL) versus delayed loading (DL) of dental implants. Thome *et al.* found that IL had a survival rate of 99.2%, while DL showed a slightly lower rate of 97.9% during a follow-up period of up to five years [20]. Similarly, Velasco-Ortega *et al.* observed high survival rates for IL, reinforcing the notion that immediate loading is highly viable [18]. Marconcini *et al.* also support this with a reported implant survival rate of 98.6% for IL, indicating that IL can achieve results comparable to or better than DL [19].

Additional studies have reported similar findings. For instance, a retrospective analysis by Niedermaier *et al.* found a 97.0% overall survival rate for 2,081 implants under immediate loading protocols [21]. Browaeys *et al.* observed a 97.9% survival rate for Osseotite implants over a seven-year follow-up, further confirming the efficacy of IL protocols [22].

Bone loss and complications

One issue with immediate loading is the risk of greater bone loss. Thome *et al.* observed that a significantly higher number of implants in the DL group experienced bone loss exceeding 2 mm compared to the IL group. This indicates that IL may be more effective in maintaining bone levels [20]. Velasco-Ortega *et al.* observed similar trends, indicating lower bone loss with immediate loading protocols [18]. Marconcini *et al.* also highlighted reduced complications and better bone maintenance with IL, pointing towards its effectiveness [19].

Vervaeke *et al.* observed negligible bone loss in their study on immediate loading in the maxilla, reporting an average peri-implant bone loss of 0.27 mm after two years [23]. Similarly, Gosai and Anchlia reported stable bone-to-implant contact with immediate loading, average bone loss was 0.33 after 1 y [24].

Patient satisfaction and treatment duration

Immediate loading shortens treatment duration and increases patient satisfaction due to quicker functional and aesthetic restoration. Thome *et al.* emphasized that IL leads to shorter treatment times, crucial for patient satisfaction [20]. Busenlechner *et al.* observed that immediate loading provided excellent outcomes when converting failing maxillary dentition to full-arch rehabilitation, significantly enhancing patient satisfaction [25]. In line with these findings, Agliardi *et al.* noted that immediate loading protocols in patients with severely atrophic maxillae also resulted in high levels of patient satisfaction. These consistent results across different conditions underscore the reliability and effectiveness of immediate loading techniques in improving patient outcomes in full-arch rehabilitations [26].

Higher survival rates in immediate loading implants

The higher survival rates observed in immediate loading implants can be attributed to several factors. Firstly, immediate loading protocols often require a high level of primary stability at the time of implant placement. Implants achieving higher insertion torques are more likely to remain stable, which is crucial for successful Osseo integration. Studies have shown that higher insertion torque

correlates with better implant survival rates [27]. Additionally, immediate loading minimizes the risk of micromotion that can occur with delayed loading. Micromotion during the healing phase can disrupt osseointegration, leading to implant failure. By immediately loading the implant, the prosthesis helps stabilize the implant and reduce micromotion [28].

Primary stability is crucial for achieving effective osseointegration during the early stages of healing [18, 19]. When implants are placed with sufficient primary stability, as evidenced by a high insertion torque (e. g.,>35 N. cm), [18, 19] it reduces unwanted micromotion, allowing immediate functional loading of the prosthesis [18, 19] This process not only minimizes the healing time but also ensures that mechanical loading applied during rehabilitation stimulates bone remodeling and supports the osseointegration process [18, 19]. Studies have shown that when implants experience controlled loading shortly after placement, they integrate effectively with the bone and exhibit strong long-term stability [18, 19].

Moreover, immediate loading may stimulate bone remodeling and adaptation around the implant. The functional load applied immediately after implant placement can enhance the bone's response, promoting better integration and stability [29]. Furthermore, immediate loading reduces treatment time and offers immediate functional and aesthetic benefits, which can improve patient compliance with postoperative care instructions. Satisfied patients are likelier to follow maintenance protocols, increasing implant survival rate [25].

This review has limitations that the limited scope of included studies, as the review is based on findings from only three studies. This narrow focus may not fully represent the broader spectrum of research on this topic and could restrict the generalizability of the conclusions. The study designs are randomized vs retrospective, follow-up duration and implant sample sizes are varied significantly. This makes direct comparison challenging. Including a wider range of studies with larger sample sizes would enhance the comprehensiveness of the findings. Future research addressing these gaps is essential for achieving a more conclusive understanding of implant survival rates under immediate loading protocols. There is a need for randomized controlled trials comparing immediate vs delayed loading in periodontitis patients, or long-term studies with a duration of 10 y.

CONCLUSION

The immediate loading technique achieved a high implant survival rate of 99.7%. Immediate implant loading in full-arch reconstruction demonstrates high survival rates and predictable outcomes, making it a viable alternative to delayed loading. The studies reviewed indicate that IL provides survival rates similar to, if not superior to, those of DL, with additional benefits such as reduced treatment time and higher patient satisfaction. These findings support the adoption of immediate loading protocols for rehabilitating edentulous patients, making it a highly effective option for full-arch reconstructions.

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CONFLICT OF INTERESTS

The authors declare no competing interests.

AUTHORS CONTRIBUTIONS

Conceptualization, H. D. S., I. K., S. L., A. D., D. A., and V. H.; data collection H. D. S., I. K.; analysis, H. D. S., I. K., S. L., A. D., D. A., and V. H.; writing original draft preparation, H. D. S., I. K.; writing review and editing, H. D. S., I. K., S. L., A. D., D. A., and V. H.; supervision, S. L., A. D., D. A., and V. H. All authors have read and agreed to the published version of the manuscript.

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