
Comparison of Delayed and Immediate Implant Loading Protocols: A Literature ReviewAtif M. Almadani¹, Meshari H. Alanzi², Ahmed H. Abdel fattah³¹Department of Prosthodontics, University Hospital Tübingen, Faculty of Dentistry, Oslanderstreet 2-8, 72076 Tübingen, Germany²Department of Prosthodontics, University Hospital Tübingen, Faculty of Dentistry, Tübingen, German,³Professor and Consultant in Prosthodontics, Cairo Egypt

Abstract: Edentulism or the state of having tooth loss, in partial or complete form, often leads to difficulties in aesthetics, function, or comfort. The most common method of treating partial or complete edentulism is the implant-supported dental rehabilitation, with its favourable survival rates for replacing missing teeth and improving the quality of life of the patients. Several techniques have been developed, including the flapless approach, one-stage implant surgery, mini-implants, implants placed in fresh extraction pockets and others to compensate for the increasing need for less invasive and faster treatment. Delayed implant loading is commonly used for its established success and integrity, however, with the advancement of surgical dentistry, implant therapies nowadays often use immediate loading and early loading, specifically in mandibles with good bone quality. In our study, a literature review was made to discuss several studies conducted not later than 2010 that had attempted to identify the better loading protocol using different variables such as success rates, patient's satisfaction, physiological effects, and short- or long-term effects on the patients. Most of the mentioned studies have presented little significance or no significant difference between the immediate and delayed implant loading protocols, which may indicate that treatment to edentulism may vary, depending on the case of the patient. With the assistance of this literature review, a more rigid systematic review is recommended to further evaluate and compare the two loading protocols.

Keywords: delayed implant loading protocols, immediate implant loading protocols, edentulism, implant therapy

1. Introduction

Edentulism or the state of having tooth loss, in partial or complete form, often leads to difficulties in aesthetics, function, or comfort (Xu, et al., 2014). Factors associated with edentulism may include socioeconomic aspects, chronic disease conditions, unhealthy lifestyle habits, and other health-related factors (Peltzer, et al., 2014). In a study by Peltzer and colleagues (Peltzer, et al., 2014), data on the prevalence of edentulism from the World Health Organization's Study on global AGEing and adult health (SAGE) Wave 1 was analyzed. Adults aged 50 years and older from China, Ghana, India, Mexico, Russian Federation, and South Africa were subjected to multivariate regression to evaluate predictors of edentulism. The overall prevalence of edentulism was 11.7% in the six countries, with India, Mexico, and Russia has higher prevalence rates than China, Ghana, and South Africa, and this is expected to increase in the coming years.

The most common method of treating partial or complete edentulism is the implant-supported dental rehabilitation, with its favourable survival rates for replacing missing teeth and improving the quality of life of the patients (Xu, et al., 2014). With the increasing need for less invasive and faster treatment,

several techniques have been developed, including the flapless approach, one-stage implant surgery, mini-implants, implants placed in fresh extraction pockets and others (Xu, et al., 2014; Barone, et al., 2015; Mundt, et al., 2016). The flapless approach is an alternative and less invasive technique for implant surgery. This technique does not require soft-tissue flaps and suturing and has gained popularity since 2000. The flapless method has several advantages over the conventional technique, such as conservation of hard tissues, preservation of vascular supply, minimized surgical procedure time, lowered intensity and reduction of post-operative complications (Xu, et al., 2014). In the past, the recommended implant installation protocol is the two-stage surgery wherein implants are submerged followed by a healing period with no mechanical load of 3 months for the mandible and 6 months for the maxilla (Esposito, et al., 2013). However, the need for a less invasive and faster techniques that satisfy aesthetic requirements has led to the booming application of one-stage immediate prosthetic loading (Moraschini and Porto Barboza 2016). The one-stage (non-submerged) surgical implant technique positions the coronal part of the implant above the gingiva level in single-part implants, or the transmucosal healing abutments are

placed in two-part implants. This approach can make use of the immediate implant loading or not. One-stage implant also has several advantages including convenience for the patients especially the medically compromised ones, and the considerable low cost (Chrčanovic, et al., 2015). Mini-implants are recommended to be a prosthodontics substitute to standard-diameter implants for patients with narrow alveolar ridges (Shatkin and Petrotto 2012; Bidra and Almas 2013; Elsyad, et al., 2014; Preoteasa, et al., 2014; Mundt, et al., 2016). In order to simplify clinical procedures and to shorten the overall treatment time in implantation, the placement of implants into fresh sockets has become a promising area of research. Immediate implant placement decreases surgery and treatment time, morbidity, and most importantly, the costs for the patients (Wilson and Buser 2011; Covani, et al., 2012). Implants are sometimes coated with hydroxyapatite. This implant-surface treatment was developed to facilitate osseointegration and promote preliminary recuperation. This is usually done by applying hydroxyapatite on the surface using a plasma spray to generate depression, undercut, and porosity (de Groot, et al., 1987).

Development of immediate implant loading protocol

Branemark introduced the osseointegration system in 1977, wherein an ideal healing period of 3-4 months without loading to achieve osseointegration of dental implants (Branemark, et al., 1977; Branemark, et al., 1983). Any disturbance in the osseointegration is suggested to result to failure of the implant (Gao, et al., 2012). However, this non-loading period has become a dilemma especially to patients because of the lack of function and aesthetics (Moraschini and Porto Barboza 2016). With the advancement of dentistry over the past few decades, this non-loading period has become shorter (Zhu, et al., 2015). Implant therapies often use immediate loading and early loading, specifically in mandibles with good bone quality. Immediate loading is the placement of an interim prosthesis within 72 hours of implant placement, while early loading is defined as the loading of implants after a 6-week to 2-month healing period (Xu, et al., 2014).

The findings of Meloni, et al., in 2012 presented that the immediate loading of single mandibular molar implants restored with non-occluding temporary crowns is a credible alternative to the conventional loading protocol. The immediate loading technique was found to be comparable to the delayed loading technique in terms of stability. Another study conducted in India by Guruprasada and colleagues (2013) assessed and compared the effectiveness of immediate implant loading protocol over conventional

implant loading protocol in partially edentulous mandible. They have shown in this particular study that immediate implant loading protocol has a highly acceptable clinical success rate in partially edentulous lower jaw. However, implant survival rate of immediate loading is still lower than that of the conventional loading protocol. A comparison of the survival rates of immediate loaded short implants versus short implants that were loaded following a delayed protocol in posterior areas of partially edentulous jaws with moderate-severe alveolar bone resorption was reported to have a significantly high survival rates from immediately loaded short implants. Henceforth, this study suggested that immediate function of short implants placed on free ends can be an alternative in the treatment protocol of patients with severe bone resorption, especially if implants are splinted to longer ones (Alvira-Gonzalez, et al., 2015). Testori and colleagues (2014) evaluated the reliability of immediate implant and immediate loading techniques in edentulous jaws, which resulted to an increase in failure rate of the maxilla when applied with immediate implant and immediate loading protocol, however, there is no significant change in the failure rate of the mandible when applied with the same techniques. Thus providing dental practitioners an alternative treatment in transitional patients.

Comparison of immediate and delayed implant loading in different implant surgery procedures

A. Flapless procedure

To evaluate the effectiveness and safety of immediate loading versus early loading of dental implants placed using the flapless procedure for replacing missing teeth, Xu and colleagues¹ used randomized controlled trials from databases such as the Cochrane Central Register of Controlled Trials, MEDLINE, EMBASE, CNKI database, VIP database, WANFANG Database, and World Health Organization International Clinical Trials Registry Platform Search Portal. The included trials reported a high implant success rate of 96.5-100% for both immediate loading and early loading methods. However, there were no significant differences seen in implant failure rates, peri-implant marginal bone-level changes, and complications between the two procedures. Moreover, patients preferred immediate loading because of its convenience. It was emphasized by the authors of this review that more high-quality evidence is recommended to arrive at a more conclusive claim because their current evidence was insufficient in assessing the optimal loading protocol due to the small sample size (Xu, et al., 2014).

B. Submerged and non-submerged dental implants

Although, immediate loading of implants minimizes the duration of the treatment and provides the patients with an acceptable aesthetic appearance, there is also a higher risk of implant failure. Hence, a meta-analysis aimed to differentiate the survival rate, postoperative complications, and marginal bone loss of non-submerged immediately loaded dental implants with those submerged delayed loaded implants is useful. After the careful selection of previous related literature, Chrcanovic, et al. (2015) found that there is a statistically and clinically significant difference between the two procedures, ultimately favouring the submerged delayed loading implant technique in assessing implant failure rate. There was no observe significant effects on the occurrence of postoperative infection or on marginal bone loss between the two different techniques (Chrcanovic, et al., 2015).

C. One-stage implant surgery

To compare the implant survival, marginal bone loss, and complications in immediate and conventional loading of single implants in the posterior mandible, a meta-analysis was devised by Moraschini and Barboza (2016). Results of their study showed that the difference between immediate loading and conventional loading did not affect the implant survival rates. There was no statistically significant variation in marginal bone loss. The complications, specifically the probing depth was greater in the immediate loading technique, however, data in this aspect was still insignificant (Moraschini and Porto Barboza 2016).

D. Mini-implants

A study currently conducted in Germany aimed to compare the success rates of immediately loaded mini-implants and those with delayed loading (Mundt, et al., 2016). Results of this study are still not available, but holds great promise in showing the significant impact of the two loading techniques when applied in a different implant surgery procedure.

E. Implants placed in fresh extraction sockets

Barone, et al. (2015) aimed to assess and compare the overall clinical outcome of delayed and immediate loading procedures for implants placed in fresh extraction sockets. The results showed similar outcomes for the delayed and immediate loading protocols. There were no significant differences found between the two procedures in terms of bone resorption, and midfacial gingival margin. Since their study is still on-going, progress reports showed that the immediate group appeared to have a slow and gradual changes primarily regarding the mesial and

distal aspects. While in the delayed group, the loss of papillary soft tissues and bone resorption were abrupt and localized, respectively before and after restoration. There is also evident reestablishment of the papillary soft tissues. Furthermore, immediate loading procedure seemed to be more promising than delayed because of its shorter healing times and lower costs (Barone, et al., 2015).

F. Implants with hydroxyapatite coating

Implant survival rate was compared between immediate and delayed loading after application of hydroxyapatite coat on implants. One year after loading, the crestal bone resorption was assessed retrospectively. The researchers reported that hydroxyapatite-coated implant placed in the maxillary and mandibular posterior areas recorded short-term clinical success regardless of the loading technique used. Mean bone loss, and bone resorption rate were not significantly different between the immediate and delayed loading groups. However, even with the limitation of the duration of this study, the authors still suggested that hydroxyapatite-coated implants can secure a high success rate under immediate loading (Kim, et al., 2013).

G. Locator attachments

A randomized controlled clinical trial was conducted by Elsyad, et al. (2011) to evaluate and compare crestal bone loss and clinical outcomes of immediate and delayed loaded implants supporting over dentures with locator attachments. Introduced in 2001, the locator attachments are self-aligning, have dual retention, and are available in different colours with different retention values (Trakas, et al., 2006; Evtimovska, et al., 2009). Furthermore, these locators provide higher retention and stability in comparison with call connectors and magnets (Trakas, et al., 2006; Evtimovska, et al., 2009; Kleis, et al., 2010). The study arrived at a conclusion that, within the limitations of short-term clinical trial, immediately loaded two implants supporting a locator-retained mandibular overdenture are correlated with more vertical bone resorption when compared to delayed loaded implants after 1 year. However, this study showed no significant difference in clinical outcomes between loading protocols and marginal one loss was significantly associated with probing depth.

Assessment of immediate and delayed loading protocols in short-term studies

A systematic literature review conducted by Al-Sawai and Labib (2016) showed the comparison of the clinical performance of the delayed loading and immediate loading implants. The studies presented consistent results of success rates of immediately

loaded implants over those from delayed loading. According to the findings, there is indication that immediate loading protocols demonstrate high implant survival rates and could be cautiously recommended for certain clinical situations. However, studies with a high level of evidence, especially randomized controlled trials, performed over a longer period of time are greatly needed to show a clear benefit over conventional and other loading types.

The aim of the study conducted by Lahori, et al., (2012) was to determine the variations in the peri-implant quality, crestal bone level, and implant stability for mandibular implant retained overdentures with ball attachments using delayed and immediate loading techniques. This study concluded that the changes in the crestal bone level and implant stability values were insignificant for the two groups. However, the implant stability was improved over time (12 months after the first assessment) and the crestal bone loss was noted to have decreased rate over the duration of the study. There was also a wide range of individual differences for the bone density changes but a general improvement in density was noted.

To compare the effects of immediate loading and delayed loading on peri-implant crestal bone loss around maxillary implants after long-term functioning, a retrospective review was done in the course of 10 years with partially edentulous patients. This study reported 1% failure rate over the decade because of one implant failure with no known cause. The clinical and radiologic findings ultimately showed that there is no significant difference between the immediately loaded and delayed loaded implants when used to fully restore edentulous or partially dentulous patients (Harel, et al., 2013).

A study by Duda, et al., (2016) compared the time-dependent outcome of immediately loaded one-piece implants with delayed loaded one-piece and two-piece implants. They analyzed marginal bone loss of the patients using x-ray radiography every 6 months, 1 year, and 3 years. There was no statistically significant difference in marginal bone loss between immediate and delayed loaded one-piece implants, but a more notable marginal bone loss around in maxillary implants than in mandibular implants.

To evaluate and compare peri-implant health, marginal bone loss, and success of immediate and delayed implant placement for rehabilitation with full-arch fixed prosthesis, a randomized, single-blind, clinical initial trial was conducted by Pellicer-Chover, et al., (2014) They reported that with the limitations of their study such as the short duration and small sample size, there was no statistically significant differences in implant success and peri-implant marginal bone loss between immediate and delayed

implants with fixed full-arch prostheses. Moreover, peri-implant health presented no statistically significant variances for any of the studied parameters (crevicular fluid volume, plaque index, gingival retraction, keratinized mucosa, probing depth, modified gingival index and presence of mucositis) at the follow-up evaluation after a year.

Evaluation of immediate and delayed loading protocols in long-term (retrospective) studies

Only few studies were done to assess the long-term effects of immediate loading technique. An example is the study by Romanos, et al., (2016) wherein they evaluated the long-term clinical and radiographic findings of immediately loaded implants in a prospective, randomized, split-mouth clinical trial in the posterior mandible with 15 years of follow-up. This study found that immediate loading does not have a negative impact on the long-term prognosis of dental implants in the posterior mandible. Moreover, it was suggested to have caused improvement on the stability of the implant and can be correlated with minimal crestal bone loss when platform switching and a one-abutment concept with a Morse-tapered connection were used.

To differentiate the surgical protocol efficacy of immediate and delayed implant loading in edentulous maxillae contrasted by restored mandibular dentitions over an observational period of 6 years or longer. Findings from this study presented that patients who received immediate and delayed implant loading showed similar survival outcomes, however, it was noted that there was less marginal bone loss in the immediately loaded implants than that of the delayed loaded implants over the 6-year course of study (Tealdo, et al., 2014).

Previous studies have shown that delayed placement of implant abutments has correlation with peri-implant marginal bone loss, but data are still lacking in long-term researches in modifying surgical and prosthetic techniques after implant placement. To address this, a study by Berberi, et al., (2014) determined the marginal bone loss around titanium implants placed in fresh extraction sockets using two loading protocols after a 5-year follow-up period. After the intended single-tooth replacement among the patients, results showed that there is a significant reduction in marginal bone loss in one-stage immediate implant placement into fresh extraction sockets over the conventional two-stage technique. They concluded within the limitations of their study that immediate loading of implants placed in fresh extraction sockets reduced marginal bone loss and did not affect the success rate of restorations.

Jokstad and Alkumru (2014) conducted a study to measure the success of loading four implants with a

pre-existing denture converted to a fixed dental prosthesis on the day of the implant surgery and differentiate this with delayed loading. The 5-year randomized controlled trial reported that implants in the anterior mandible loaded immediately with a converted pre-existing denture resulted to related clinical outcomes compared to the varying outcomes for the delayed loading technique.

Other factors that may affect the efficacy of immediate and delayed loading techniques

Previous studies have shown correlation between smoking and implant-related parameters such as impaired healing, higher postoperative complications, increased peri-implant bone loss, and failure rate of implants placed in grafted bone, reduced mineral density, and poor papilla regeneration (Twito and Sade 2014; Dawson and Jasper 2015; He, et al., 2015; Raes, et al., 2015; Tran, et al., 2016). A study conducted by Al Amri, et al., (2017) compared the peri-implant soft tissue parameters, bleeding on probing, and probing depth and crestal bone loss of immediately loaded and delayed loaded implants in smoker and non-smokers. They concluded within the limitations of their study that tobacco smoking aggravates peri-implant soft tissue inflammation and crestal bone loss around immediately loaded and delayed loaded implants. However, the loading techniques showed no significant effect on the peri-implant hard and soft tissue status in healthy smokers and non-smokers.

In term of aesthetics, immediate and early implant placement in the anterior maxilla showed acceptable outcomes. However, there can be a risk of midfacial mucosa recession in this type of loading leading to a necessity of further research using more suitable biomaterials and longer duration of the investigation (Chen and Buser 2014).

2. Conclusion

In conclusion, several studies have attempted to identify the better loading protocol using different variables such as success rates, patient's satisfaction, physiological effects, and duration of the investigation. Most of the mentioned studies have presented no significant difference between the immediate and delayed implant loading protocols, which may indicate that treatment to edentulism may vary, depending on the case of the patient. However, with the assistance of this literature review, a more rigid systematic review can be done to further evaluate and compare the two loading protocols.

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