



**EFFECT OF LOADING PROTOCOLS AND ATTACHMENT FIXING MECHANISM
ON THE SUCCESS OF THE SINGLE IMPLANT RETAINED MANDIBULAR
OVERDENTURE- A SYSTEMATIC REVIEW**

**Menon Prasad Rajagopal., Benny Thomas., Pradeep Samuel., Nidhin Ramabhadran
and Rahul Nageshraj**

Dept. of Prosthodontics, Educare Institute of Dental Sciences, Chattiparamba, Malappuram, Kerala

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ABSTRACT

Statement of the problem: The single implant mandibular overdenture (SIMO) is a cost effective, feasible alternative to the conventional 2 implant overdenture in the mandible. The clinical effectiveness and patient satisfaction have been studied in detail and a few systematic reviews have been done in this regard. The role of loading protocols on the longevity of the SIMO has not been the focus of any systematic review and neither has much attention been given to the type of attachment used. Most of the researchers have preferred to retrofit the overdenture using chair side relining techniques. The focus of this systematic review is to throw light on the effect of loading protocols and mode of attachment fixation on the success of the SIMO.

Methodology: Three electronic databases were utilized, namely PubMed, Ebsco and Science Direct. Additional hand searching was done to obtain maximum data. The search terms were Single And Midline Or Symphyseal And Implant And Overdenture. Literature published upto 25th June 2018 were included. Inclusion and exclusion criteria were defined and only randomized controlled trials or longitudinal studies with at least 1 year follow up were pooled to extract relevant data.

Results: A total of 318 patients were treated with the SIMO with a mean age of 61 years. The systematic review table summarized the mean age and number, type of study and follow up period, the loading protocol and type of attachment, the mode of fixing the attachment, the implant success rate and the prosthetic events and/or failures. The results showed that immediate loading was not as predictable as delayed loading and denture base fractures could be minimized by using low profile attachments and employing laboratory relining to secure the attachment.

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INTRODUCTION

The gold standard of mandibular implant retained overdentures has been the two implant protocol where two implants are placed in the interforaminal region preferably in the canine area¹. Expense is often a detriment for seeking implant treatment in the elderly population with their limited source of income. This is especially true for the developing world where basic dental treatment is also considered a luxury. The single implant retained mandibular overdenture (SIMO) has shown sufficient promise to improve the inherent deficiencies of a conventional complete denture. This treatment modality can reduce the expenses involved without significantly sacrificing the advantages. A few systematic reviews have been done to evaluate the clinical viability and effectiveness of the SIMO^{2,3}. Masticatory efficiency and comfort levels have been

considered in a few studies⁴. Loading protocols have been compared in the short run but very few longitudinal or randomized controlled trials over an extended period of time have been done to provide compelling evidence of the effectiveness of a proper clinical protocol. Comparisons of crestal bone levels in the different loading protocols by periodic radiographs are lacking in literature. Immediate loading in two implant retained overdentures in the mandible have been proven successful provided initial implant stability is optimal and micromotion is limited by splinting. The single implant overdenture does not permit splinting and micromotion can be difficult to control. A perusal of the literature also revealed that most of the clinicians attempted retrofitting of the attachments to the denture bases when the implants were loaded, and even when new dentures were made the bases were hollowed out to accommodate the attachments. The purpose of this systematic review is to compare the effect of immediate and delayed loading protocols on the success rates of implants and to identify probable causes of prosthetic maintenance events and failures.

*Corresponding author: **Menon Prasad Rajagopal**

Dept. of Prosthodontics, Educare Institute of Dental Sciences, Chattiparamba, Malappuram, Kerala

Objectives of the study

The systematic review attempts to identify effects of different loading protocols on the eventual success rate of the SIMO which can help clinicians to choose the most effective protocol. It also attempts to identify a trend in prosthetic failures related to the procedure involved in securing attachments to the denture base and the nature of attachments themselves.

MATERIALS AND METHODS

Search strategy

Three electronic databases were utilized, namely PubMed, Ebsco and Science direct. The search terms were Single and Midline or Symphyseal And Implant And Over denture. Literature published upto 25th June 2018 were included. PubMed produced 34 hits, Ebsco recorded 20 and Science Direct 78. Inclusion and exclusion criteria were defined to eliminate irrelevant data.

Inclusion criteria

- Literature published in English language
- Clinical studies/ trials involving use of a single mandibular implant in the midline and opposed by complete dentures.

Exclusion criteria

- Case reports and case series.
- Retrospective studies.
- Review of literature.
- Anecdotal references.
- Trials with less than 12 month follow up.
- In vitro studies.

A gross screening was done to eliminate duplicates, case reports, review of literature and in vitro studies after which 24 articles remained. Additional hand searching was done on basis of the references of the articles collected and an additional 7 were obtained. The two investigators of the study (R.M.P & T.B) independently reviewed the collected literature and selected 16 of them based on the criteria mentioned above. They assessed the methodology of the studies based on the Jadad scale⁵. Differences of opinion between the two researchers regarding inclusion and exclusion of studies were resolved through mutual discussion and a consensus was reached after deliberation with a third author (S.P).

Data pooling and extraction

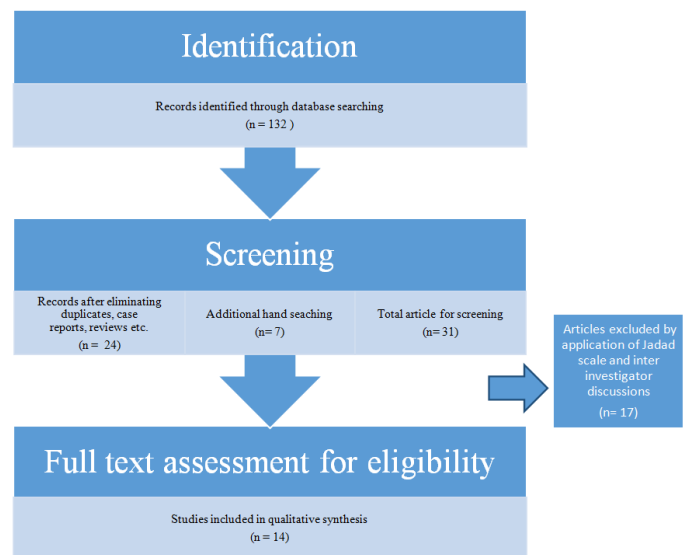
From the available literature, the following data was extracted

- Age group and male to female ratio of patients.
- Type of study and follow up period.
- Loading protocol.
- Success rates and success criteria described.
- Mode of attachment fixation to the denture base
- Type of attachments used
- Prosthetic failures and maintenance events.

The collected data was subjected to analysis. A meta analysis was not considered feasible due to heterogeneity of study designs involved⁶.

RESULTS

The database search using the words mentioned above yielded 132 titles after elimination of duplicates and screening. The application of inclusion and exclusion criteria ensured that only 16 titles remained⁷⁻²². The 16 articles selected for full text screening was again subjected to scrutiny and a further 2 were eliminated. One was a study protocol by Passia *et al* in 2014²¹ and the other was an RCT by Mundt *et al* in 2016⁴ which compared pain and discomfort parameters in immediate and delayed loading which were not relevant to our review.



Flow chart

A total of 318 patients were treated with the SIMO with a mean age of 61 years. The systematic review table (Table 1) summarizes mean age and number, type of study and follow up period, the loading protocol and type of attachment, the mode of fixing the attachment, the implant success rate and the prosthetic events and/or failures.

Implant success rate

The implant success criteria mentioned in the studies were primarily of Roos *et al*²² followed by Albrektsson *et al*²³. Eight of the studies reported a success rate of 100%, three studies reported 80% and two reported 91% success. One study did not mention the implant survival rate. An important observation is that the studies with 80% survival rate employed immediate loading as their loading protocol and 91% success rate was seen in studies which employed early loading. There were no RCTs with immediate loading and a 5 year follow up as most of the immediate loading studies followed up for a period of 1 year only.

Attachment type

All the studies except two used exclusively ball attachments. Of the two one used a combination of ball and locator attachments¹² and one used only locators¹⁸. It is noteworthy that the study using locators recorded no prosthetic events or denture base fractures over a one year period. The study using the combination of attachments reported denture base fractures but failed to mention as to which group the fractures occurred.

Mode of attachment fixation

Only two studies used laboratory relines as a mode of attachment fixation and one used both lab relines and chair side relines while the remainder exclusively used chair side relines to locate the matrix and patrix. The significant observation is that one RCT with a follow up period of 5 years reported no denture base fractures.

DISCUSSION

The systematic review focused on randomized controlled trials and longitudinal studies to ensure maximum data significance. Studies with follow up periods of less than 1 year were eliminated to ensure validity of data. The implant success rates were mostly defined by criteria defined by Roos *et al* and Albrektsson *et al*. Immediate loading is very popular among clinicians which is evidenced by the greater number of studies employing the protocol.

Systematic Review **Table 1**

Sl.no	mean age and no of patients	Type of study and follow up period	Loading protocol, attachment type	Mode of attachment fixation	Implant success rate and criteria	Prosthetic failures/ maintenance events
1 Cordioli, Majzoub & Castagna	74 years, 21	Longitudinal study, 5 years	Conventional, ball attachment	Chair side relining	100%, Albrektsson <i>et al</i>	Replacement of the matrix in 90% cases
2 Liddelow & Henry	70 years, 28	Longitudinal, 1 year	Immediate and progressive, ball attachment	Chair side relining	100%, Roos <i>et al</i>	Denture base fractures in 3 cases
3 Walton <i>et al</i>	68 years, 42	RCT, 1 year follow up	6 week loading, ball attachment	Chair side relines	100 %, no mention	Matrix replacements(37) and denture base fractures(5).
4 Kronstrom <i>et al</i>	53 years, 14	RCT, 1 year	Immediate loading, ball attachment	Chair side relines	80%, no mention	Matrix replacements(10), denture base fractures(2)
5 Liddelow & Henry	68 years, 25	Longitudinal, 3 year	Immediate loading, ball attachment	Chair side and Lab relines	100%, Roos <i>et al</i>	Denture base fractures in 3 cases of chair side relines
6 Alsabeeha <i>et al</i>	68 years, 34	RCT, 1 year	Early loading, ball attachments and locators	Chair side relines	91.7%, Albrektsson <i>et al</i>	Maintenance of patrix/matrix mainly followed by denture base fractures.
7 Harder <i>et al</i>	66.7 years, 11	Longitudinal, 3.5 years	2 month loading Ball attachment	Chair side relines	no mention	Matrix replacements and followed by denture base fractures.
8 Kronstrom <i>et al</i>	56 years, 11	RCT, 3 years	Immediate loading, ball attachment	Heat cured lab relines	9 failures in 1 st year	Matrix maintenance only and no denture base fractures.
9 Bryant <i>et al</i>	29 patients	RCT, 5 years	6 week loading, ball attachments	Lab processed heat cure resin	100%	Matrix and patrix maintenance events followed by denture base fractures
10 Passia <i>et al</i>	66.7 years, 11	Longitudinal study, 62 year	2 month loading, ball attachments	Chair side relines	100%	Matrix related maintenance events and denture base fractures
11 Tavakolizadeh <i>et al</i>	59 years, 10	RCT, 1 year	6 week loading, ball attachments	Chair side relines	100%, Roos <i>et al</i>	O ring replacements in 2 cases
12 Alqutaibi <i>et al</i>	58.2 years, 28	RCT 1 year	Delayed loading, locators	Chairside relines	100%	No events recorded
13 Kronstorm <i>et al</i>	59.4 years	RCT 5 years	Immediate loading, ball attachments	Lab relining	82%	“O” ring replacements and no denture base fractures recorded
14 Nogueira <i>et al</i>	63.4 years, 43	RCT 2 years	Combination of immediate and delayed, ball attachments	Chair side relining	91%	Matrix replacements and midline denture fractures

It was also noted that in the 3 year longitudinal study which used both relines techniques, denture base fractures in the study were only observed for the chair side relines patients. None of the studies remade the dentures even when delayed loading protocol was employed and remaking was restricted to situations where the original denture was beyond repair. The RCT with a 5 year follow up by Bryant *et al* which compared between 1 and 2 implant overdentures showed greater denture base fractures for the 1 implant group.

Prosthetic failures and events

Most of the studies employed the six point assessment scale to classify prosthetic complications as routine maintenance and failures. The most common complications were loss of retention due to wear of the retentive o rings. The matrix replacement was the next common occurrence followed by denture base fractures. Relining of the denture was often required but that can hardly be called a prosthetic complication as it is an integral part of any removable prosthesis service and follow up. Tooth fractures were occasional and mostly accidental.

It is also to be noted that none of the delayed loading studies had low success rates whereas studies with success rates as low as 80 percent employed immediate loading. The concept of immediate loading is primarily built upon two essential requisites namely good primary stability and limited micromotion²⁴. The authors opinion that the lower success rates with SIMO could be due to the fact that a single implant is more prone to micromotion as a splinting action is impossible. The concept of early loading states that implants can be loaded by 6 weeks and many studies have used this protocol with good results²⁵. It is the opinion of the authors based on the results of the study that delaying the loading of a SIMO will guarantee greater surgical success rates. More number of long term RCTs employing immediate loading should be conducted to have concrete evidence on that matter and till that time, it is better to delay the loading of the SIMO. Most clinicians prefer to work with ball attachments as they are versatile and thus most of the studies have used them. Vertical height availability is crucial to prevent denture base weakening when the attachment occupies space. Ball attachments do occupy some space vertically though not as much as bars. Low profile attachments like locators and

magnets can be useful in cases with limited vertical space. One study using locators as attachments did not report any denture base fractures though another using a combination of locators and ball attachments showed mixed results^{12,18}. Chair side relining is the most common method employed by clinician to locate the attachments. This procedure requires hollowing out the denture base at the implant site and picking up the matrix with a self cure resin. This is very easily done in the clinic but can significantly weaken the denture base especially if vertical height is less than optimal. Lab relines can counter this by increasing the thickness of the base during processing steps and also by using heat cure resin. Heat cure resin has lower residual monomer content and has better mechanical properties and this could explain the lesser denture base fractures seen in studies with lab relines²⁶. One significant observation is a RCT with a 5 year follow up which used lab relines and had no incidence of denture base fractures¹⁹. In the comparative study by Bryant *et al*, the one implant group showed greater denture base fractures which was reasoned as the result of excessive rocking and movement adjacent to the single implant¹⁵. It is the opinion of the authors by analyzing the results that lab relining and using low profile attachments can significantly reduce denture base fracture incidences in the SIMO.

Regular maintenance events in most studies were relining due to bone resorption in areas remote from the implants and loss of retention of the attachments. The rocking movement around the implants often led to wear of the nylon ring(O ring) within the matrix. Replacement of the "O" ring is a fast procedure provided the ring is lodged in a metal housing, otherwise it is cumbersome and can lead to excessive grinding of the denture base leading to possible further weakening of the base.

Majority of the work done on the SIMO has been with existing complete denture wearers and chair side relining done later to accommodate the attachments. Some have attempted lab relines too. The literature shows almost no evidence of attempts to remake dentures after a conventional delayed loading period. Majority of the prosthetic events are replacement of the matrix components and O rings. This presumably could be due to excessive movement of the denture base around the ball attachments. According to the prosthesis movement classification of Misch²⁷, the SIMO creates the PM 6 movement which implies movement and rotation around all planes. This factor could be the reason behind the frequent wear and replacement of the matrix components.

Majority of researchers have employed ball attachments and a very few locator attachments. High profile attachments could occupy space in the vertical dimension and this becomes an issue when there is limited interocclusal space. Chair side relines in such cases could significantly weaken the denture base and this is evident in the incidence of denture base fractures. Low profile attachments like magnets and locators could be the way in cases with limited vertical height and chair side relining. Longitudinal studies or RCTs comparing different attachment systems and different modes of attachment fixation could shed more light on this grey area.

CONCLUSION

The SIMO can be a reliable alternative to the more conventional two implant supported overdenture if loading is delayed and laboratory relining or remaking with heat cure

resins is followed. Low profile attachments like locators and magnets require lesser denture base hollowing and could reduce prosthetic failures even in chair side relines.

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