

Number of implants for mandibular implant overdentures: a systematic review

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PURPOSE. The aim of this systematic review is to address treatment outcomes of Mandibular implant overdentures relative to implant survival rate, maintenance and complications, and patient satisfaction. **MATERIALS AND METHODS.** A systematic literature search was conducted by a PubMed search strategy and hand-searching of relevant journals from included studies. Randomized Clinical Trials (RCT) and comparative clinical trial studies on mandibular implant overdentures until August, 2010 were selected. Eleven studies from 1098 studies were finally selected and data were analyzed relative to number of implants. **RESULTS.** Six studies presented the data of the implant survival rate which ranged from 95% to 100% for 2 and 4 implant group and from 81.8% to 96.1% for 1 and 2 implant group. One study, which statistically compared implant survival rate showed no significant differences relative to the number of implants. The most common type of prosthetic maintenance and complications were replacement or reattaching of loose clips for 2 and 4 implant group, and denture repair due to the fracture around an implant for 1 and 2 implant groups. Most studies showed no significant differences in the rate of prosthetic maintenance and complication, and patient satisfaction regardless the number of implants. **CONCLUSION.** The implant survival rate of mandibular overdentures is high regardless of the number of implants. Denture maintenance is likely not influenced substantially by the number of implants and patient satisfaction is typically high again regardless of the number of implants [J Adv Prosthodont 2012; 4:204-9]

KEY WORDS: Denture; Overlay; Mandibular prosthesis; Dental implants; Outcome assessment; Patient satisfaction

INTRODUCTION

A mandibular implant supported overdenture is an excellent treatment option for fully edentulous patients in terms of masticatory function, chewing ability and patient's satisfaction. To improve support and stability of a denture, various numbers of implants (typically one, two, or four) have been recommended for mandibular implant overdentures. McGill¹ and York² consensus reports declared that the two implants overdenture for the mandible was recommended as the first treatment option for edentulous patients.

Four implants have been suggested as one of the treatment options for edentulous patients seeking mandibular implant overdentures. However, in terms of prosthetic maintenance and complications, and patient satisfaction, two and four implant groups do not appear to be significantly different.³ Therefore, two implants have been considered to be a more reasonable treat-

ment option based on presumed cost-effectiveness. Meanwhile, a single implant has recently been proposed to be adequate for retention of the mandibular overdenture and suggested as an alternative for edentulous patients.^{4,7} However, very few studies have compared the number of implants in a manner useful for clinical decision-making. A recent review showed patient satisfaction and function of the prosthesis did not seem to be dependent on the number of implants.⁸ However, the review lacked methodological description, which means a narrative rather than systematic approach. Therefore we conducted a controlled systematic review, focused on comparing outcomes between various numbers of implants.

This systematic review aimed to address treatment outcomes related to the number of implants for mandibular implant overdentures in terms of 1) implant survival rate, 2) maintenance and complications, and 3) patient satisfaction.

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MATERIALS AND METHODS

The PICO format (Population, Intervention, Comparisons, Outcomes)⁹ was used to define a clear clinical question. In comparative clinical studies involving completely edentulous participants (P) requiring mandibular implant overdentures opposing conventional maxillary complete denture (I) with various numbers of implants (one, two, and four) (C), what were the survival rate of implants, prosthetic maintenance and complications, and patient satisfaction outcomes (O).

A systematic literature search was conducted using the combined Mesh terms ("mandibular prosthesis" or "Denture, Overlay") and ("dental implants" or "dental prosthesis, implant supported") and ("clinical study" or "comparative study" or "outcome assessment" or "epidemiologic studies" or "intervention studies" or "patient satisfaction") and limited by ("Human" and "English") in the databases, Medical Literature Analysis and Retrieval System Online (MEDLINE). The aim was to identify all publications comparing the number of implants for up to and including August 1, 2010.

The electronic search was further augmented by hand search through the following journals: Clinical Implant Dentistry and Related Research, Clinical Oral Implants Research, Implant Dentistry, International J of Oral and Maxillo-facial Implants, International J of Oral and Maxillo-facial Surgery, International J of Periodontics & Restorative Dentistry, International J of Prosthetics, J of Clinical Periodontology, J of Dental Research, J of Oral Implantology, J of Oral and Maxillo-facial Surgery, J of oral Rehabilitation, J of Periodontology, J of Prosthetics, J of Prosthetic Dentistry, and Periodontology 2000.

RCT, quasi-randomized and comparative clinical trial studies on mandibular implant overdentures (MIO) until August, 2010 were selected. Only root form endosseous standard implants were considered. The opposing dentition was conventional complete maxillary denture. Finally, only studies published in English were included. Meanwhile, case reports or technical reports without a statistical comparison were excluded. The duration of follow-up period less than 1 year of function was excluded as were studies without implant survival, prosthetic or patient satisfaction evaluation. Both rigid types of applications such as milled bar or combinations of attachment types, and cantilevered applications of attachments were also excluded. Papers without abstracts were also excluded (Table 1).

At the outset, two independent reviewers evaluated selection of the articles based on the established inclusion and exclusion criteria. The sample size, patient age, observation period, type of implant, number of implant, type of attachment, treatment outcomes and the outcome of statistical analysis were extracted from each included article. Analysis was based on the implant survival rate, prosthetic maintenance and complications, and patient satisfaction.

Table 1. Final inclusion and exclusion criteria for systematic review

Inclusion Criteria
• RCT and clinical trial studies on mandibular implant overdentures (MIO) until August, 2010
• Comparative studies between implant numbers on MIO with the same implant attachments
• Root form endosseous standard implants
• Upper complete denture
• Published in English
Exclusion Criteria
• Case reports or technical reports without statistical comparison
• Study duration less than 1 year of function
• Rigid type of application with milled bar or telescopic abutments
• Combination or Cantilevered application of attachments
• Paper without abstract

The implant survival rate denotes the percentage of implants still present at follow-up after initial placement of implants. Prosthetic maintenance and complications denoted mechanical damage of the implant superstructures. Among these, 'matrix or clip loosening', 'detachment or loss of matrix' and 'fracture of mandibular denture-base' were reported. Prosthetic maintenance and complications were classified to the type and frequency relative to the number of implants as far as possible. Patient satisfaction concerning chewing ability, phonetics, and social function were evaluated by mean "a score of six scales questionnaire", a visual analogue scale (VAS), or in some cases by mention of patient preference.

RESULTS

The PubMed search yielded 1098 titles. Thirteen publications were selected by independent screening of the titles and abstracts from the PubMed search. According to the established inclusion exclusion criteria. In addition, one publication was also included by hand search (Fig. 1). Based upon reading the fourteen full text articles, a total of eleven studies were finally selected and divided according to the number of implant (one, two, or four) in terms of survival rate of implants, prosthetic maintenance and complications, and patient's satisfaction. Eight studies^{3,10-16} compared 2 and 4 implant groups with bar attachments. Three studies^{7,17,18} compared 1 and 2 implant overdenture group with ball attachments (Table 2).

Six papers^{7,10,11,14,15,18} presented data on the implant survival which ranged from 95.0% to 100% for 2 and 4 implant group and from 81.8% to 96.1% for 1 and 2 implant group, the latter range including 81.8% survival for immediately loaded implants. In a comparison of 2 and 4 implant group, Meijer *et al.*¹¹ showed that there was no significant difference between the groups. Visser

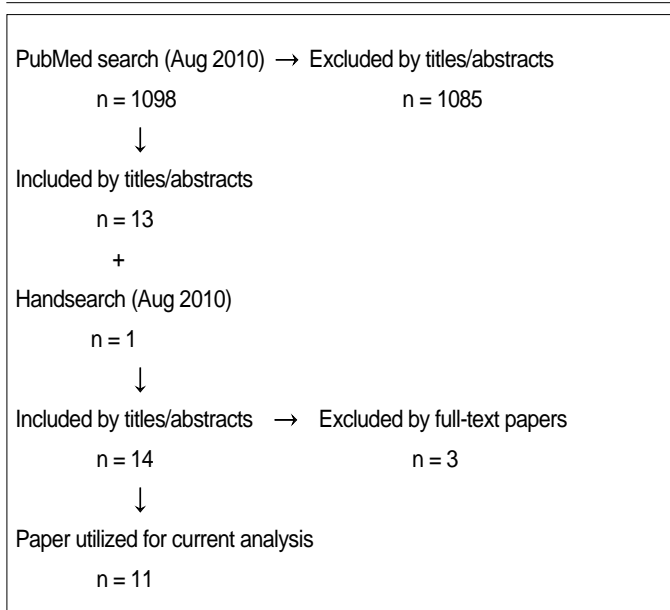


Fig. 1. Flowchart of search strategy.

*et al.*¹⁴ showed a survival rate of 98.3% for a two implant group and 100% for a four implant group without statistical analysis. A pooled survival rate of 99.4% was presented by Batenburg *et al.*¹⁰ and that of 97.9% was presented by Wismeijer *et al.*¹⁵ Meanwhile, in a comparison of 1 and 2 implant groups, Walton *et al.*⁷ showed a pooled survival rate of 96.1%. Kronstrom *et al.*¹⁸ showed the lowest pooled sur-

vival rate of 81.8% following immediate loading.

Six studies^{7,11,13,14,17,18} presented data on prosthetic maintenance and complications. Replacing new clips or reattaching loose clips was the most common type of prosthetic maintenance and complications with 2 and 4 implant overdentures with bar attachments, followed by repairing a fractured denture base or artificial teeth. According to Visser *et al.*,¹⁴ a 2 implant overdenture group had a tendency for a greater need of prosthetic aftercare than that of a 4 implant overdenture. However, the study by Stoker *et al.*¹³ and Meijer *et al.*¹¹ showed no significant difference in rate of prosthetic complications between 2 and 4 implant group (Table 3). Meanwhile the 1 year randomized controlled study by Walton *et al.*,⁷ found that the most frequent maintenance event was repairing a broken denture around the implant in the 1 implant group and replacing a loose matrix in the 2 implant group, but the differences were not statistically significant. In a follow-up of this study from 1 to nearly 5 years, Gonda *et al.*¹⁷ also found a tendency for slightly more frequent denture base fractures in the 1 implant group beyond the first year, but the rate also was not significantly different. Replacing retentive O-rings was reported as the most common prosthetic maintenance, in the study of immediately loaded 1 and 2 implant groups by Kronstrom *et al.*¹⁸ but there was no significant difference in rates (Table 4). Most studies showed no significant differences in the rate of prosthetic maintenance and complication regardless the number of implants in both 2 and 4 implant groups, and 1 and 2 implant groups.

Five studies^{3,11,14,16,18} presented patient satisfaction comparisons for mandibular implant overdentures. The methods to measure

Table 2. Included papers by inclusion criteria

Study	Year	Study design	No. of Patients /Implants	Follow-up (year)	Implant type	Type of attachment
Wismeijer <i>et al.</i> ¹⁶	1997	RCT	110/283	1.3	ITI	Bar
Batenburg <i>et al.</i> ¹⁰	1998	RCT	60/180	1	IMZ	Round bar
Wismeijer <i>et al.</i> ¹⁵	1999	RCT	110/283	1.6	ITI	Egg-shaped dolder bars (Centres and Methaux, Switzerland)
Payne <i>et al.</i> ¹²	2000	RCT	59/113	3	Brånemark	Round bar (NobelBiocare, Sweden)
Timmerman <i>et al.</i> ³	2004	RCT	110/294	8	ITI	Egg-shaped dolder bars (Centres and Methaux, Switzerland)
Visser <i>et al.</i> ¹⁴	2005	RCT	60/180	5	IMZ	Round bars
Stoker <i>et al.</i> ¹³	2007	RCT	110/294	8	ITI	Egg-shaped dolder bars (Centres and Methaux, Switzerland)
Meijer <i>et al.</i> ¹¹	2009	RCT	60/180	10	IMZ	Round bars, golden Ackermann clips (Preat Corporation, USA)
Walton <i>et al.</i> ⁷	2009	RCT	86/128	1	ITI	Ball, gold matrix (Straumann, Switzerland)
Gonda <i>et al.</i> ¹⁷	2010	RCT	85/128	1.4	ITI	Ball, gold matrix (Straumann, Switzerland)
Kronstrom <i>et al.</i> ¹⁸	2010	RCT	36/55	1	Brånemark	Ball (NobelBiocare, Sweden), O-ring

RCT: randomized controlled trial.

ITI (Straumann, Waldenburg, Switzerland), Brånemark (NobelBiocare, Göteborg, Sweden), IMZ (Friedrichsfeld AG, Mannheim, Germany).

how much patients were satisfied with their denture mostly depended on a questionnaire. Several items such as speech, aesthetics, retention, mastication, and social function were used and the scales of patient satisfaction varied across studies. The four studies^{3,11,14,16} comparing 2 and 4 implant group showed that there was no significant difference between the groups (Table 3). Walton *et al.*⁷ evaluated overall patient satisfaction with a VAS scale and also showed no significant difference between 1 and 2 implant group (Table 4). However, the participants were on average far more satisfied after overdenture treatment than before treatment irrespective of the number of implants. All studies showed there was no significant difference in patient satisfaction regardless the number of implants in both 2 and 4 implant groups, and 1 and 2 implant groups.

DISCUSSION

This systematic review of randomized and comparative clinical trials examined the treatment outcomes of mandibular implant-supported overdentures relative to implant survival rate, maintenance complications, and patient satisfaction. Data related to implant survival rates were insufficient to conduct a statistical meta-analysis on those factors, so data were descriptively analyzed. The follow-up period of the trials ranged from 1 to 10 years, and the survival rate of the implants in 10 of the 11 trials ranged from 95% to 100% under conventional loading. One trial loaded one or two implants with an overdenture immediately on implant insertion and reported the lowest implant survival rate of 82% after one year.¹⁸ It is reasonable to conclude therefore that the prognosis of one

Table 3. Survival rate, prosthetic maintenance and complications, and patient satisfaction of the implant mandibular overdentures comparing 2 and 4 implants

Study	Year	Number of Implant	Implant survival rate (%)	Type of prosthetic maintenance	Rate of prosthetic complication	Patient's satisfaction
Wismeijer <i>et al.</i> ¹⁶	1997	2 vs 4	NR	NR	NR	NS
Batenburg <i>et al.</i> ¹⁰	1998	2 vs 4	99.4	NR	NR	NR
Wismeijer <i>et al.</i> ¹⁵	1999	2 vs 4	97.9	NR	NR	NR
Payne <i>et al.</i> ¹²	2000	2 vs 3 - 4	NR	NR	NR	NR
Timmerman <i>et al.</i> ³	2004	2 vs 4	NR	NR	NR	NS
Visser <i>et al.</i> ¹⁴	2005	2 vs 4	99.9 2:98.3 4:100	Replacing or fastening clip	Single bar > Multiple bar	NS
Stoker <i>et al.</i> ¹³	2007	2 vs 4	NR	Replacing or fastening clip	NS	NR
Meijer <i>et al.</i> ¹¹	2009	2 vs 4	98.1(NS) 2:95 4:100	Replacing or fastening clip	NS	NS

NS: Not significantly different, NR: Not recorded.

Table 4. Survival rate, prosthetic maintenance and complications, and patient satisfaction of the implant mandibular overdentures comparing single and 2 implants

Study	Year	Number of implant	Implant survival rate (%)	Type of prosthetic maintenance	Rate of prosthetic complication	Patient's satisfaction
Walton <i>et al.</i> ⁷	2009	1 vs 2	96.1	Retightening matrix, Repairing denture due to denture fracture	NS	NS
Gonda <i>et al.</i> ¹⁷	2010	1 vs 2	NR	Repairing denture due to denture fracture	NS	NR
Kronstrom <i>et al.</i> ¹⁸	2010	1 vs 2	81.8 (NS)	Replacing O-ring	NS	NR

NS: Not significantly different, NR: Not recorded.

or more implants loaded conventionally after a few months is excellent independent of the number of implants.

The most common complication in maintaining implant overdentures involves loosening of attachment devices and fractured dentures. There was some indication that fractured dentures are more common during the first year when the denture rests only on one implant.⁷ However, the incidence of fractures seems to even out between the group in subsequent years.¹⁷ Nonetheless, there might be some benefit, at least during the first year, in reinforcing the denture base around the implant.¹⁹ It is important also to realize that the duration of the trial reporting on overdentures with one implant is still relatively short. Perhaps as time progresses, the stress concentrated by one implant rather than multiple implants, on the denture may indeed result in a greater incidence of fractures.

The number of implants did not increase significantly the satisfaction of the patients with the overdenture. Apparently patient satisfaction following the transition to an implant supported denture from conventional mucosal support is very substantial in all of the trials we reviewed. Consequently, any subtle advantage that might occur from multiple implants, at least in the short-term, is not measureable, and especially when the psychometric instrument, such as a structured questionnaire, is relatively insensitive.²⁰ Indeed, the difference between satisfaction from dentures on one or two implants did not appear even with the potentially more sensitive VAS used by Walton *et al.*⁷

The single implant overdenture has benefits for cost effectiveness, and the optimally simplified surgical and prosthetic procedures. Component cost was significantly saved in a single implant group.⁷ Time savings for the single implant were 22% at implant placement, 16% for relining to add the attachment, and 24% for postsurgical complications and denture adjustments.⁷ However, a review study²¹ on seven single implant overdenture publications up to August, 2008 found the single implant survival rate was 100% under conventional loading and about 82% under immediate loading. A mandibular single implant overdenture may be considered very promising treatment option based on this review.²¹ However, several dangers related to surgical placement of single implants in the mandibular midline were reported.²¹⁻²⁴ For example, severely resorber residual ridge and the presence of certain blood vessels in the central of mandible might cause severe hemorrhage during surgery in the floor of the mouth. Despite this problem, it is reasonable to state that the outcome of overdentures on a single implant seems very encouraging as a cost-effective and relatively non-invasive procedure with a very acceptable prognosis at present.

CONCLUSION

The survival rate of implant supporting mandibular overdentures

is high regardless of the number of implants. Denture maintenance is likely not influenced substantially by the number of implants and patient satisfaction is typically high again regardless of the number of implants supporting and retaining the overdenture.

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