

Success and survival rates of mandibular overdentures supported by two or four implants: a systematic review

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Abstract: This systematic review evaluated the influence played by the number of implants on the results of rehabilitation treatment with mandibular overdentures on 2 or 4 implants. The literature search was conducted using PubMed, Embase and Cochrane databases. Specific terms were used in performing a search from January 1980 to January 2013. The search strategy was applied by two reviewers who extracted the data and compared the results. Discrepancies were resolved by discussion. Great heterogeneity was seen among the selected studies, in regard to survival rates, prosthesis failure and function rates. A medium degree of quality and methodological consistency was found in one study, and no studies showed a high degree. When considering the prosthesis success rate for 2 implants, there was a variation of 23% to 100%. However, when considering the survival rate, the result was 92% to 100%. For 4 implants, prosthesis survival rates showed less variation, i.e., 97.7% to 100%. Ball attachments were the most common type of abutment for 2 implants; however, there was a higher prevalence of bar abutments for 4 implants. Rehabilitations with 2 implants showed more complications and required more maintenance according to the connection type. Given the limitations of this review, mandibular overdentures with 4 implants showed better results with respect to survival and success rates, especially those with a bar connection. Further studies comparing these two treatment types are necessary to improve the scientific evidence in this area.

Descriptors: Dental Prosthesis; Dental Implants; Denture Retention; Dental Prosthesis Design.

Introduction

The use of implant-retained dentures has been an alternative for treating the edentulous mandible, since it allows fixation of the prosthesis to the edentulous ridge.¹ This has encouraged dental professionals to display and perform prostheses, such as overdentures retained by implants, as an option to solve the problem of edentulous patients. Treating patients by implant placement is a popular option for restoring function and esthetics,² and for improving oral function, masticatory efficiency and individual satisfaction.³

There is still some debate regarding the number of implants required to properly support dentures. Studies have shown good results for oral rehabilitation with implant-retained prostheses; however, overdentures with 2 and 4 implants must be compared in the long term, with respect to clinical characteristics, patient satisfaction and ease of care.⁴

In addition to the success rate of osseointegrated implants supporting dental prostheses, the prosthesis itself should also be taken into consideration when determining the overall success of the rehabilitation treatment.⁵ Thus, the goal of this systematic review was to demonstrate the variations in success or survival rates of overdentures when 2 or 4 implants are used to treat the edentulous jaw.

Methodology

Search strategy

The search was conducted by 2 reviewers, independently, using electronic databases (Pubmed/Medline, Embase, Cochrane), and was limited to clinical trials reporting the success of mandibular overdentures on 2 or 4 implants. A broad search was undertaken from January 1980 to January 2013 to identify the studies by title and abstract. The terms “overdenture,” “implant-retained,” “implant-supported,” “success,” “dental prosthesis,” “complete

mandibular denture” and “prosthetic outcome” were combined using “and” or “or,” and a total of 967 studies were identified for initial screening.

The titles and abstracts of all reports identified through the electronic searches were assessed by 2 reviewers, and both the inclusion criteria (publications in English, follow-up of at least one year, mandibular overdentures, success rates, survival rates, failure rates or prosthesis function rate of overdentures on two or four implants, and ball and/or bar attachments) and the exclusion criteria (laboratory studies, case reports, and cross-sectional data) were applied. The literature search yielded a total of 967 citations, 951 of which were excluded because they did not meet the inclusion criteria. Any disagreement between the reviewers in the search process was resolved either by reaching a consensus or by including the reference for subsequent review. Hand-searching of the selected journals, as well as searching the references of the selected studies was also performed at this point to include any paper not found in the electronic search. Finally, full-text copies of the remaining 16 studies (Tables 1 and 2) were obtained for a more detailed evaluation. The reasons for excluding another 5 studies are listed in Table 3.

The final studies that were included after passing the second phase of the review process were classi-

Table 1 - Results of studies with two implants.

Authors (year)	Sample	Number of implants	Follow-up (years)	Attachment	Rate for implants		Rate for prostheses		Quality evaluation
					Survival	Success	Survival	Success	
Naert <i>et al.</i> ⁷ (1988)	43	2	2.5	Bar	-	97.7%	-	97.7%	Low
Ferrigno <i>et al.</i> ⁸ (2001)	84	2	10	Ball	97.1% (2 and 4 implants)	-	98.8%	-	Low
Watson <i>et al.</i> ⁹ (2002)	72	2	1	Ball	-	-	98.6%	83.3%*	Low
Walton ¹⁰ (2003)	Group 1: 50	2	2-4	Ball	-	-	92%	23%*	Medium
	Group 2: 50			Bar			96%	63%*	
Mackie <i>et al.</i> ¹¹ (2011)	106	2	5	Ball	-	-	96.84%	58.5%*	Low
De Kok <i>et al.</i> ¹² (2011)	10	2	1	Ball	100%	-	100%	100%*	Low

*Six-field protocol by Payne *et al.*²³ (2001).

Table 2 - Results of studies with four implants.

Authors (year)	Sample	Number of implants	Follow-up (years)	Attachment	Rate for implants		Rate for prostheses		Quality evaluation
					Survival	Success	Survival	Success	
Donatsky ¹³ (1993)	19	4	1	Ball	-	98%	100%	-	Low
Chiapasco <i>et al.</i> ¹⁴ (1997)	194	4	2–13	Bar	-	96.9%	98.5%	-	Low
Makkonnen <i>et al.</i> ¹⁵ (1997)	15	4	5	Bar	97.4%	-	100%	-	Low
Ferrigno <i>et al.</i> ⁸ (2002)	44	4	10	Bar	97.1% (2 and 4 implants)	-	97.7%	-	Low
Romeo <i>et al.</i> ¹⁶ (2002)	20	4	2	Bar	-	100% (Immediate loading) 97.5% (Conventional loading)	-	100%	Low
Heschl <i>et al.</i> ¹⁷ (2011)	32	4	5	Bar	-	98.6%	100%	-	Low

Table 3 - Studies excluded and reason why.

Authors (year)	Exclusion criteria
Adell <i>et al.</i> ¹⁸ (1990)	A mean of 6 implants was used
Johns <i>et al.</i> ¹⁹ (1992) Hutton <i>et al.</i> ¹⁰ (1995) Jemt <i>et al.</i> ²¹ (1996)	A maximum of 4 implants were placed but only 2 were connected to the abutments. However, one of the sleepers was activated at some point of the treatment. Thus, 3 implants were evaluated
Fartash <i>et al.</i> ²² (1996)	Individual assessment of success rate for 2 or 4 implants was not reported

fied according to the quality assessment of pre-established characteristics, in order to document the methodological strength of each paper.⁶ The variables investigated in the quality assessment are listed in Table 4. The sample size was considered adequate when the sample size calculation was presented. Measurement methods were considered valid when a measurement error test was presented. Each study was classified based on the following scores:

- low (0–5 points),
- medium (6–8 points) or
- high (9–10 points).

Results

The database search initially yielded 967 titles. Sixteen studies^{7–22} were evaluated initially, but only 11 met the inclusion criteria and were ultimately

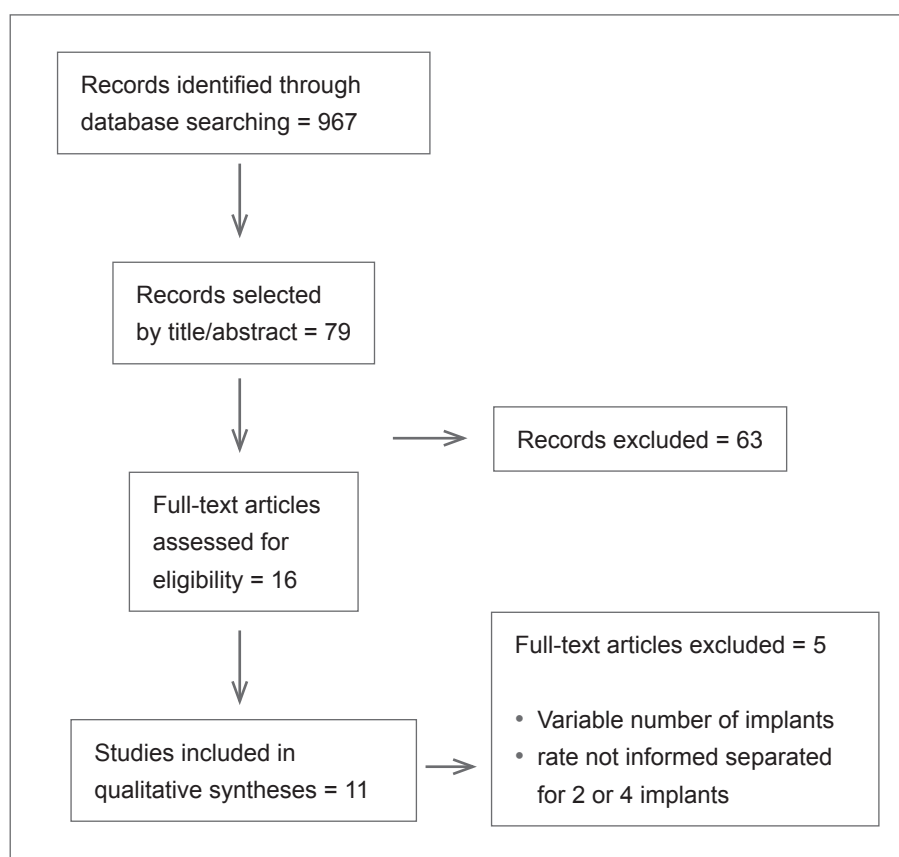
Table 4 - Characteristics and scores used for quality analysis of selected papers.

Characteristic	Score
Adequate study design: randomized clinical trial, prospective study, controlled clinical trial, longitudinal study	3
Clinical trial	1
Adequate sample size	1
Adequate description of selection process	1
Valid measurement methods	1
Use of method of error analysis	1
Blinded measurement evaluation	1
Valid statistical methods	1
Confounding factors included in analysis	1

selected for analysis^{7–17} (Figure 1). Methodological issues such as sample size, follow-up, attachment system, quality of assessment and results for implants and prostheses were described (Tables 1 and 2). Studies with unclear methodological issues, such as reports with a different number of implants, were excluded^{18–22} (Table 3).

This systematic review included randomized controlled trials,¹⁶ non-randomized controlled trials,^{9–12} prospective studies^{7,8,13,15,17} and retrospective studies.¹⁴ Randomized clinical trials (RCT) present a better evaluation of treatment results when adequate methods are used. However, since RCTs were

Figure 1 - Search process.



uncommon for the topic researched, the clinical guidance provided to dental clinicians would be limited if this review were based solely on RCTs. Thus, it was decided that other study designs of overdentures retained by 2 or 4 implants should be included.

Only one study¹⁰ showed a medium degree of quality and methodological consistency (Table 1); most showed a low degree, and none showed a high degree. The sample size, statistical analysis and confounding factors were the most significant flaws.

The main results evaluated in the studies with overdentures (OD) focused on the influence of the number of implants on OD success. Several data were evaluated, including implant success and survival rates, prosthesis failure and functional rates. Five studies described overdenture performance with 2 implants,^{7,9-12} and five reported the use of 4 implants.¹³⁻¹⁷ One study⁸ showed results for both 2 and 4 implants. In regard to the attachment system, the ball attachment was the most commonly used system for 2 implants, and bars, for 4 implants.

The prosthesis survival rates for 2 implants ranged from 92%¹⁰ to 100%.¹² However, when the protocol described by Payne *et al.*²³ was used to define success rate based on different criteria (success, survival, unknown, loss, retreatment by relining or replacement), the rate ranged from 23%⁹ to 100%.¹² For other authors,^{8,13,14,16,17} individual criteria were used to define the outcomes. As can be observed, these individual criteria are reflected in the results. Authors who used the criteria successfully were stricter and sought to follow predetermined evaluation criteria. In contrast, those who used survival rates, considered only the prostheses that remained in use, despite the fact that complications may have occurred.

High survival rates were observed in the studies with four implants. The results were based on personal evaluation and criteria established by the authors regarding prosthesis function^{8,13,15-17} or failures.¹⁴

Discussion

The parameters for prosthetic success showed

great variability among the studies as a result of different methodologies and criteria. This becomes a challenge for significant synthesis and comparison of results. The authors used the terms success and survival as two independent characteristics. Success was defined as rehabilitation that remained unchanged, not requiring any intervention during the entire observation period, and that proceeded under ideal conditions. Survival was defined as the rehabilitation remaining *in situ* with or without modification and clinical management over the observation period,²⁴ even when repairs were made. Thus special attention had to be given when comparing the results of each parameter.

The different results were a consequence of different sample sizes, follow-up periods, attachment systems and complications. An adequate evaluation should take into consideration all of these aspects to show the prosthetic success in general, and any conclusions should be addressed carefully before applying them to dental practice.

Considering that randomized, controlled clinical trials present excellent quality, further evaluation should be conducted based on this type of study, to compare appropriate sample sizes with 2 and 4 implants and different attachment systems. It is important to highlight that any unexpected complications requiring clinical intervention should be classified as treatment complications and described in the clinical trials (prospective and retrospective), seeing that a trend was observed to report only positive results.

There were wide-ranging results for overdentures retained by 2 implants based on pre-established criteria.²³ The only study with a 100% success rate was a short-term follow-up,¹² and, most probably, the evaluation period was not long enough to show any complications. Although some authors suggested that failures usually occur during the first year and decrease over time,^{9-11,25} medium- and long-term follow-ups are recommended to assess prosthesis performance,⁸ in order to determine the real trend.

A minimum of 2 and up to 4 implants are required for rehabilitation with overdentures.²⁶ Some authors concluded that 2 implants are enough and presented this option as a low-cost alternative.^{4,12} However, this alternative has some limitations and

a number of complications related to the prosthetic components,⁹⁻¹¹ and also to non-axial load transfer, posterior bone resorption and prosthesis rotation²⁷ The protocol with 4 implants showed better results and optimum survival rates in four studies.^{13,15-17} In two other studies,^{8,14} the long-term follow-up results may justify these rates. Four implants provide better stability, and avoid both movement and excessive loading, which may compromise osseointegration.¹⁴

The attachment system plays an active role in prosthesis success rates, reflected in prosthetic maintenance and complications. Ball attachments revealed complications, such as being time-consuming and incurring costs related to wearing and loosening of matrix and patrix components that had to be changed. They also incur movement in different directions, resulting in damage and ring wear.⁹⁻¹¹ This kind of attachment is used basically with two implants. In contrast, the bar attachment showed better results for rehabilitation with two and four implants. Some studies suggested that implants splinted with bars are a favorable alternative to minimize rotational movement and provide vertical load transfer,^{14,16} and to avoid implant micromovement and prosthetic repairs.²⁸ Bearing this in mind, it is important that these complications be recorded when analyzing prosthesis maintenance during follow-ups.

Walton¹⁰ evaluated the success rate based on pre-established criteria²¹ to assess any difference in prosthetic maintenance between ball and bar attachments. After a 3-year follow-up, the bar-clip system exhibited a statistically significant difference in its success rate. The ball attachment required 5 times more repair than the bar system, thus lowering its success rate to 23%.

Other factors are also important in analyzing the results, such as maintenance period, types of complications and failure, time and type of repair, complexity of procedures, and prosthesis design. Although it is difficult to predict the complications, these factors should be considered during treatment planning and be informed to the patient, since they will influence treatment success.

Not only is the success of implants and prosthesis at issue, but the occurrence of complications that must be considered in evaluating the treatment.

Biological failures, costs and patient satisfaction regarding function and esthetics should also be included in the final results.

Few studies showed that mandibular overdentures retained by 4 implants are an adequate alternative for an edentulous mandible, based on better success rates and prostheses survival, especially with the bar attachment system.

Conclusion

Given the limitations of this review, mandibular

overdentures with 4 implants showed better results with respect to survival and success rates, especially those with a bar connection. Further studies comparing these two treatment types are necessary to improve the scientific evidence in this area. With this in mind, long-term, randomized and appropriately designed clinical studies are recommended.

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