Prosthetic Aspects and Patient Satisfaction with Two-Implant-Retained Mandibular Overdentures: A 10-Year Randomized Clinical Study

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Purpose: This study aimed to compare the prosthetic aspects and patient satisfaction with prosthetic care in two-implant-retained mandibular overdentures, whether implants were splinted with a bar or left with magnets or ball attachments. ***Materials and Methods:*** Thirty-six completely edentulous patients had two Brånemark implants placed in the mandibular canine area. A randomized procedure allocated patients into three groups of equal size, each with a different attachment system: bars, magnets, or balls. Prosthesis retention and mechanical as well as soft tissue complications were recorded in addition to patient satisfaction. A linear mixed model was fitted with attachment type and time as classification variables and adjusted by Turkey's multiple range test. ***Results:*** Ball-retained overdentures showed at year 10 the greatest vertical retention force (1,327 g), followed by bars (1,067 g) and magnets (219 g). In the ball group, need for tightening of abutment screws was the most common mechanical complication; in the magnet and bar groups, respectively, the most common complications were wear and corrosion, and the need for clip activation. Prosthesis stability and chewing comfort for the overdenture were rated significantly lower for the magnet group compared to the ball and bar groups. Prosthesis stability of the maxillary denture was rated significantly lower in the bar group compared to ball and magnet groups. ***Conclusion:*** The ball group scored best in relation to retention of the overdenture, soft tissue complications, and patient satisfaction at year 10. The bar group scored lower for comfort and stability of the maxillary denture. Magnets offered patients the least comfort. *Int J Prosthodont 2004;17:401–410.*

Many edentulous patients experience problems with their dentures, especially lack of stability and retention, together with a decrease of chewing ability.[1] One possibility for solving these problems is the use of endosseous implants to which an overdenture can be attached. Survival rates for different implant systems in overdenture treatment vary from 87% to 100%,[2] revealing that overdenture treatment has a good prognosis in the mandible. However, literature on prospective studies dealing with implant-retained overdentures with a follow-up period of at least 5 years is limited.[3–9]

Patient satisfaction is one factor that influences the success of an overdenture. Only a few studies deal with patient satisfaction with implant-retained mandibular overdentures. A multicenter randomized clinical trial compared two groups of patients: one group treated with implant-retained mandibular overdentures and a new maxillary denture, and a control group treated with a new set of complete dentures.[10] Implant-retained overdentures provided more satisfaction with regard to denture-related problems. Wismeijer et al[11] compared three implant-retained overdenture treatment modalities: two

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implants with ball attachment, two implants with an interconnecting bar, and four interconnected implants. All patients expressed satisfaction, and the three groups were not significantly different from one another. After 5 years, patients with two-implant–retained mandibular overdentures had higher satisfaction compared to complete denture patients.[9] These findings were confirmed in another randomized study in which patients underwent preprosthetic surgery and received new dentures.[12]

Attachment systems used to retain overdentures vary from bar, magnet, and ball attachments to rigid and nonrigid telescopic copings. Only a few longitudinal studies compare their clinical outcomes. Studies comparing splinted with unsplinted implants retaining an overdenture are rare and are seldom randomized controlled.[3,8,13–15] Gotfredsen and Holm[14] report that the frequency of technical complications/repairs per patient after 5 years is higher with a round bar compared to ball attachments in two-implant–retained overdentures in the mandible. Karabuda et al[15] found no significant differences between the bar and ball attachment types used for implant-retained overdentures with respect to patient satisfaction.

The aim of this randomized controlled trial was to evaluate differences in the clinical effectiveness of prosthetic care, including patient satisfaction, between splinted and unsplinted implants retaining a mandibular overdenture over a 10-year period.

Materials and Methods

Thirty-six edentulous patients (19 women and 17 men) with a mean age of 63.7 years (range 36 to 85 years) were selected. Exclusion criteria were: insufficient bone volume to harbor two implants with a minimum length of 10 mm, distorelationship, psychologic problems with the acceptance of a removable denture, gag reflex, less than 1 year of edentulism in the mandible, absence of a maxillary complete denture, and administrative or physical considerations that would seriously affect the surgical procedure or a longitudinal follow-up.

Each patient was provided with two turned implants (Brånemark system, Nobel Biocare) in the symphyseal area of the mandible to anchor the overdenture. A randomized procedure, based on a lottery without replacement of the tags, allocated the patients into three groups of equal size. In each group, a different attachment system was used: *(1)* egg-shaped Dolder bars (Cendres et Métaux), *(2)* magnets (model 1102, Dyna Engineering), or *(3)* ball attachments (model SDCB 115-17, Nobel Biocare).

Since some patients shifted from one group to another after allocation, the "intention to treat" principle was applied to prevent selection bias.[16,17] This means that patient-related aspects were evaluated in the originally allocated treatment groups regardless of the actual state of treatment at year 10. As a consequence, the contrast between the groups will probably diminish. To evaluate clinical aspects, only those patients who maintained the same attachment system from the baseline, referred to as the "pure group," were considered. Two methods were applied, referring to the intention-to-treat or pure group depending on whether patient or clinical aspects were investigated. The prosthodontic and surgical procedures are described elsewhere.[8,18]

Prosthetic Evaluation

The following prosthetic parameters were recorded:

- Prosthesis retention was recorded by means of a dynamometer (Correx) with a maximum capacity of 2,000 g. At 6, 12, 60, and 120 months after abutment connection, a metal loop was fixed onto the mandibular overdenture above an imaginary line connecting the two implants. This loop was fixed to the dynamometer by a wire. A vertical force was applied to dislodge the overdenture. Three measurements were made for each patient, and the mean was calculated. A previous study evidenced that the 95% confidence interval for repeated measurements was 10 g.[19]
- Mechanical complications of the abutment and attachment components were recorded at 4, 6, 24, 36, 48, 60, and 120 months after abutment connection.
- Soft tissue complications were recorded at prosthesis insertion and 60 and 120 months after abutment connection in the maxilla and mandible and expressed as number of sites.
- Patient satisfaction with the overdenture was investigated through two questionnaires. The first included questions—at 12, 60, and 120 months—in which patients gave their answers on an ordered scale with numbers ranging from 1 (very bad) to 9 (excellent). Another series of questions had to be answered with a "yes/no" response. Finally, some questions focused on a more descriptive answer (Table 1).[8] The second questionnaire was based on a visual analogue scale (VAS) at one time point (year 10), in which patients gave their answers as a crossed mark on a scale from 0 to 100 mm (low/worst to high/best) (Table 2).

Statistical Analysis

A linear mixed model (PROC MIXED) was fitted with attachment type and time as classification variables, incorporating a compound symmetric error structure model for observations of the same patient over time

Table 1 Questionnaire 1*

Question	Content
Part 1: Scale from 1 (very bad) to 9 (excellent)	
A	How do you find your prosthesis in general?
B	How well does your prosthesis remain in place?
C	How well can you eat with your prosthesis?
D	How well can you talk with your prosthesis?
E	How do you find the appearance of your prosthesis?
Part 2: Yes/no	
F	Do you avoid contact with other people because of fear of loosing your prosthesis?
G	Does your prosthesis bother your mind?
H	Does food impaction regularly occur under your prosthesis?
I	Were your expectations about your prosthesis realized?
J	Would you repeat the same treatment?
Part 3: Descriptive response	
K	How many times do you take out your prosthesis because of discomfort?
L	If you were to repeat the treatment, would you choose: *(1)* the same solution, or *(2)* a fixed prosthesis?

*Questions were first asked for the maxilla and repeated for the mandible.

Table 2 Questionnaire 2 (100-mm VAS)

Question	Content
1	Describe the extent of discomfort with your upper denture.
2	Describe the extent of discomfort with your lower denture.
3	How would you rate the fit of your upper denture?
4	How would you rate the fit of your lower denture?
5	Do you have difficulties speaking with your prosthesis?
6	How often does your prosthesis affect your socializing?
7	Are there activities you avoid because of the possibility of being embarassed by your prosthesis?
8	How often does your prosthesis affect your work?
9	How difficult is it for you to bite off soft foods?
10	How difficult is it for you to bite off hard foods?
11	How difficult is it for you to chew soft foods?
12	How difficult is it for you to chew hard foods?
13	How satisfied are you with the healing since your implant surgery?
14	Do you think your implant-supported prosthesis is actually part of you?
15	To what extent has your implant-supported prosthesis improved your social and work relationships with other people?

and correcting for confounding variables. *P* values for comparisons of between-group means were adjusted for simultaneous hypothesis testing according to the Tukey method of multiple comparisons. The overall threshold value for significance (α) was set at .050. SAS, version 8 for Windows software was used. Graphing was done using R, version 1.7 for Windows software.

Results

Patient Dropout and Cross-over

At year 10, five, two, and three patients had dropped out from the bar, magnet, and ball groups, respectively. Nine patients had died, and one had been unable to continue the controls because of severe illness, leaving 26 patients for evaluation.

During the observation period, four patients from the magnet group changed attachment systems. At years 6 and 8, two of these patients changed to the ball group; at year 3, another one changed to the bar group; and at year 6, the fourth patient changed to a fixed complete prosthesis. In the ball group, one patient changed at year 9 to the bar group.

Prosthetic Outcome

At year 10, the highest mean vertical retention force was measured in the ball group (1,327 g, range 500 to 2,000 g), followed by the bar group (1,067 g, range 101 to 2,000 g); the magnet group had the lowest mean vertical retention force (219 g, range 50 to 483 g). These data held true for patients ($n = 21$) followed with the same attachment system from baseline only (pure group).

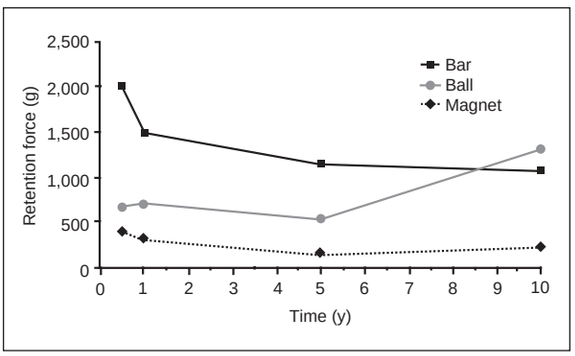

Fig 1 Mean retention force of overdentures in the patients followed with the same attachment system (pure group) from 6 to 120 months for the three groups (n = 21 patients).

Table 3 Frequency Distribution of No. of Prosthetic Complications per Patient for the Pure Group

Complication	Bar group (n = 7 patients total)	Magnet group (n = 6 patients total)	Ball group (n = 8 patients total)
Condition of retention elements			
Wear	5	17	6
Corrosion	0	11	0
Fracture	0	0	8
Loosening of abutment screw			
One abutment	2	5	14
Two abutments	1	0	1
Loosening of gold screw			
One attachment	2	2	—
Two attachments	0	0	—
Activation of clip	17	—	—
Change of clip	3	—	—
Change of rubber ring			
One attachment	—	—	2
Two attachments	—	—	4
Change of O-ring housing			
One attachment	—	—	3
Two attachments	—	—	12
Change of magnet			
One attachment	—	1	—
Two attachments	—	20	—
Rebasing of overdenture	1	4	3
Remounting of overdenture	0	1	1
New overdenture made	3	2	2
Overdenture fracture	1	1	2
New maxillary denture made	3	2	2
Rebasing of maxillary denture	4	3	3
Remounting of maxillary denture	2	0	0
Maxillary denture fracture	3	7	3
Maxillary denture tooth fracture	1	0	1
Total No. of complications	6.9	12.7	8.4

Comparing the retention forces between 6 months after abutment connection and year 10, a decrease of retention force took place for the bar and magnet groups, whereas a remarkable increase was observed for the ball group. The change of retention force over time in the bar, magnet, and ball groups was –913, –158, and +651 g, respectively (Fig 1).

Table 3 presents the number of times prosthetic complications per group occurred during the 10 years. Comparison of the attachment complications revealed that, in the magnet group, renewal of one or both magnets (21 times in six patients) took place most often; in the bar group, activation of the clip (17 times in seven patients) was most common; and in the ball group, renewal of one or both O-ring housings (15 times in eight patients) and one or both abutment screws loosening (15 times in eight patients) took place most often.

Soft tissue complications in the maxilla at prosthesis insertion and years 5 and 10 were not significantly different between the groups. In the mandible, decubitis ulcer occurred significantly more often in the magnet group compared to the ball ($P = .007$) and bar groups ($P = .006$) and occurred significantly more often at year 10 compared to year 5 ($P = .020$).

Table 4 Frequency Distribution of No. of Sites* and Patients with Mucosa Complications in Mandible only for the Pure Group

Complication	Bar group		Magnet group		Ball group	
	Sites	Patients	Sites	Patients	Sites	Patients
Prosthesis insertion						
Mucositis	0	–	0	–	0	–
Soreness	0	–	0	–	2	1
Decubitis ulcer	1	1	0	–	0	–
Hyperplasia	1	1	2	1	0	–
Flabby ridge	0	–	0	–	4	2
Year 5						
Mucositis	6	3	0	–	0	–
Soreness	0	–	0	–	0	–
Decubitis ulcer	0	–	3	2	0	–
Hyperplasia	4	3	3	2	4	2
Flabby ridge	0	–	0	–	2	1
Year 10						
Mucositis	3	2	2	1	0	–
Soreness	0	–	0	–	0	–
Decubitis ulcer	1	1	7	4	1	1
Hyperplasia	2	1	0	–	0	–
Flabby ridge	0	–	0	–	0	–

*The mandible was divided into four sites: left and right posterior and anterior.

Table 5 Mean Scores of Questionnaire 1* for Overdenture, Following Intention-to-Treat Principle

Question/group	Year 1	Year 5	Year 10	Mean
A. How do you find your lower prosthesis in general?				
Bar	7.9	8.7	8.1	8.2
Magnet	8.1	6.6	7.7	7.5
Ball	7.9	7.8	8.2	8.0
B. How well does your lower prosthesis remain in place?				
Bar	8.3	8.0	8.1	8.1
Magnet	7.3	6.3	8.2	7.3†
Ball	8.6	8.9	8.3	8.6†
C. How well can you eat with your lower prosthesis?				
Bar	7.8	8.7	8.3	8.3
Magnet	6.7	6.4	7.6	7.2†
Ball	8.5	8.5	8.2	8.4
D. How well can you talk with your lower prosthesis?				
Bar	8.3	7.8	8.4	8.2
Magnet	8.5	7.3	8.6	8.1
Ball	8.5	8.6	8.1	8.4
E. How do you find the appearance of your lower prosthesis?				
Bar	7.8	8.2	8.4	8.1
Magnet	8.5	7.7	8.4	8.2
Ball	8.3	7.7	8.0	8.0

*See Table 1; scale ranged from 1 (very bad) to 9 (excellent).
†Statistically significant difference ($P < .050$).

Mucositis occurred significantly more often in the bar group compared to the ball group ($P = .020$) (Table 4).

Patient Satisfaction

Answers to the first questionnaire for the overdenture at years 1, 5, and 10 did not differ significantly between the groups for general satisfaction, phonetics, or esthetics. Prosthesis stability was rated significantly lower in the magnet group compared to the ball group ($P = .002$). Chewing comfort was rated significantly lower in the magnet group compared to the ball ($P = .004$) and bar groups ($P = .020$) (Table 5).

Answers to the first questionnaire for the maxillary denture indicated that all patients in the three groups were satisfied in terms of general satisfaction, phonetics, esthetics, and chewing comfort. A significant difference was noticed for prosthesis stability: Patients in the bar group were less satisfied compared to those in the ball ($P = .002$) and magnet groups ($P = .025$) (Table 6).

At year 10, food impaction occurred regularly in all groups, although all patients were satisfied and their

Table 6 Mean Scores of Questionnaire 1* for Maxillary Denture, Following Intention-to-Treat Principle

Question/group	Year 1	Year 5	Year 10	Mean
A. How do you find your upper prosthesis in general?				
Bar	8.1	7.0	7.4	7.5
Magnet	8.3	8.3	8.0	8.2
Ball	7.8	7.9	8.1	7.9
B. How well does your upper prosthesis remain in place?				
Bar	7.9	6.1	6.7	6.9
Magnet	8.0	7.7	8.4	8.0
Ball	8.3	8.9	8.1	8.4
C. How well can you eat with your upper prosthesis?				
Bar	7.8	8.4	7.7	8.0
Magnet	8.0	7.9	7.8	8.0
Ball	8.5	8.7	8.2	8.5
D. How well can you talk with your upper prosthesis?				
Bar	7.9	7.9	8.3	8.0
Magnet	8.5	8.1	8.6	8.4
Ball	8.1	8.9	8.1	8.4
E. How do you find the appearance of your upper prosthesis?				
Bar	8.0	8.4	8.1	8.2
Magnet	8.5	8.3	8.5	8.4
Ball	8.3	8.2	8.1	8.2

*See Table 1; scale ranged from 1 (very bad) to 9 (excellent).
†Statistically significant difference ($P < .050$).

Table 7 No. of Patients Giving a Positive Answer to Questionnaire 1, Following Intention-to-Treat Principle*

	Bar group			Magnet group			Ball group		
Question	Year 1 (n = 12)	Year 5 (n = 9)	Year 10 (n = 7)	Year 1 (n = 12)	Year 5 (n = 11)	Year 10 (n = 9)	Year 1 (n = 12)	Year 5 (n = 11)	Year 10 (n = 9)
F. Do you avoid contact with other people because of fear of loosing your prosthesis?	1	0	0	0	2	0	0	0	0
G. Does your prosthesis bother your mind?	4	1	0	0	1	0	0	0	0
H. Does food impaction regularly occur under your prosthesis?	7	5	5	9	10	7	8	6	5
I. Were your expectations about your prosthesis realized?	11	9	7	10	5	8	12	9	9
J. Would you repeat the same treatment?	12	8	7	11	11	8	12	10	9

*Excluding one patient who changed to a fixed complete prosthesis.
n = No. of patients per group.

"expectations were realized" with their prostheses, except for one patient in the magnet group. The prosthesis did not "bother their mind" any longer, and patients' social lives were no longer affected because they were not "fearful of loosing" the overdenture any longer. All of the patients would "repeat the same treatment," except one patient in the magnet group (Table 7).

At year 10, the majority of patients seldom removed the overdenture because of discomfort. All patients would repeat the same treatment instead of a fixed solution, except one in the magnet group and one in the bar group (Table 8). Answers to the second questionnaire at year 10 revealed no significant differences between the three groups, except for question 1, related to discomfort of the maxillary denture, for which the bar group scored significantly lower compared to the magnet ($P = .040$) and ball groups ($P = .002$) (Fig 2).

Discussion

The fact that 10 of 36 patients dropped out is an inherent phenomenon for long-term follow-up studies, especially for highly aged study groups. Neither gender nor age at implant placement significantly differed between the dropout patients in the three groups. Two methods were applied at the year-10 evaluation to compare the results between the three groups, since some patients shifted from their original groups to another. The first method, used to investigate the patient outcome, followed the intention-to-treat principle[16,17] to prevent selection bias. All patients were evaluated

Table 8 Distribution of Patients Who Answered Questionnaire 1, Following Intention-to-Treat Principle*

Question	Bar group			Magnet group			Ball group		
	Year 1 (n = 12)	Year 5 (n = 9)	Year 10 (n = 7)	Year 1 (n = 12)	Year 5 (n = 11)	Year 10 (n = 9)	Year 1 (n = 12)	Year 5 (n = 11)	Year 10 (n = 9)
K. How many times do you take out your prosthesis because of discomfort?									
Never	9	5	2	10	9	7	12	10	8
1/day	2	2	3	0	0	0	0	0	1
< 5/day	1	2	2	2	2	1	0	1	0
> 5/day	0	0	0	0	0	1	0	0	0
L. If you were to repeat the treatment, would you choose: *(1)* the same solution, or *(2)* a fixed prosthesis?									
Same	11	7	6	9	6	8	10	11	9
Fixed	1	2	1	3	5	1	2	0	0

*Excluding one patient who changed to a fixed complete prosthesis.
n = No. of patients per group.

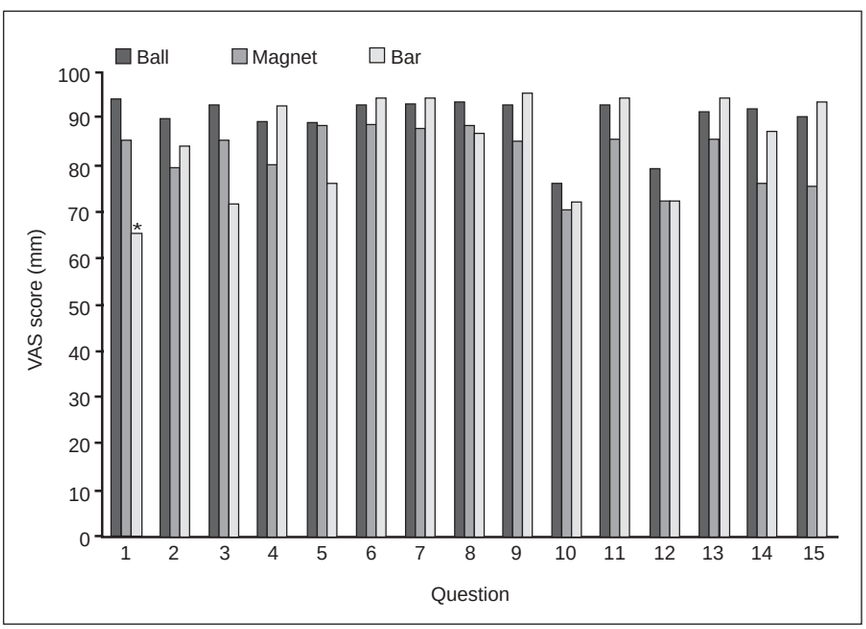

Fig 2 Patient satisfaction based on VAS (questionnaire 2), following intention-to-treat principle (see Table 2). *Significant difference ($P < .050$).

in the originally allocated treatment groups, regardless of the actual treatment state at year 10. The latter might result in decreased contrast between the groups.[17]

Lee et al[20] investigated the problem of the definition of actual treatment rather than as-prescribed treatment. They used several definitions to classify patients as having received or not received treatment as prescribed. These definitions, when used in as-treated analyses, provided results that were at times inconsistent or counter-intuitive and neither helped to confirm nor further explain the intention-to-treat analysis. The second method considered only those patients who kept the same attachment system from baseline, called the pure group. This approach was used only to investigate the clinical outcome of the attachment system (retention force and mechanical and soft tissue complications), not to rate patient outcome.

It was clear that most patients (n = 4) who did not receive treatment as prescribed were originally allocated to the magnet group. Those patients requested a "better" retention system, and one even requested a fixed complete prosthesis. The one patient who shifted from balls to a bar was not dissatisfied, but wanted to have the same attachment system "given to [her] friend," also participating in the study.

At year 10, the ball attachments provided the highest vertical retention force for the overdenture, followed by the bar; the magnet attachments had the lowest vertical retention force. These results corroborate previous reports[8,21–23] and an in vitro study.[24] The latter reports that magnet attachments result in the greatest denture

movement compared to bar and ball attachments. Contrary to our expectation and previous studies from the same study population,[8,25] there was a remarkable increase in the retention force in the ball group, whereas a further decrease occurred in the bar and magnet groups. The decrease in the retention force of the bar group, also reported in previous studies,[8,25] might be explained by deactivation of the bar/clip component over time, which did not lead to discomfort for the patients as such. Contrary to the reactivation of the clip in the bar group at the patient's request, in the other two groups, the retention elements were renewed each time the components were fractured or showed advanced wear, and especially when patients complained of retention loss. The increase in the retention force in the ball group might be explained by the complete settling of the overdenture base that took place over the years, contrary to bars and magnets, which function as a "pivoting" device for the overdenture. Only in the ball attachments was a space maintainer of 1 mm used each time an O-ring housing was renewed, and the ball–O-ring housing contact was metal acrylic, leaving space for more wear. Nobel Biocare headquarters confirmed that the rubber rings have not been modified over the years.

Activation of the clip was the most common complication in the bar group; 65% of clip activations happened during the first 5 years. Many other studies report this relative complication.[26–29] In the magnet group, the most common complication was renewal of the magnets because of wear and corrosion. A prospective study up to 5 years using Astra Tech implants reports a high incidence of loosening of the magnetic keeper on the implants (18/21 patients), loss of function of magnets (9/21), and magnet replacement (5/21).[30] Corrosion of magnetic attachments occurs by two mechanisms: first as a result of the breakdown of the encapsulating material, and second by diffusion of moisture and ions through the epoxy seal of the encapsulating material.[31]

In the ball group, renewal of the O-ring housing and rubber ring, and abutment screw loosening were the most common complications. The same complications were reported in several other studies.[6–8,25,32–36] Abutment screw loosening decreased to nearly zero when Nobel Biocare provided for each abutment height (3, 4, and 5.5 mm) a corresponding abutment screw length. This is in contrast with another study with a mean evaluation time of 3 years.[37] All abutment screws were tightened manually over the whole study. A torque driver available today may be advised as well. It is worth mentioning that parallel alignment of the two implants is a prerequisite to keep ball component wear to a minimum.

At year 10, hyperplasia underneath the bar occurred in one patient in the bar group and one patient in the ball group who changed to the bar group. The dead space beneath the bar, which prevents good access for cleaning, may cause a soft tissue inflammatory response under the bar attachments.[38] Soft tissue complications in the maxilla were independent of the treatment system used for retaining the overdenture in the mandible. In the mandible, the ball group showed the fewest soft tissue complications. This might be related to the excellent settling of the overdentures on the denture-supporting area, which indirectly reflects the highest vertical retention force and improvement over time. The magnet group revealed the most soft tissue complications, with common decubitis ulcer increasing over time. Mucositis was more frequently observed in the bar group, with the highest absolute decrease in retention force over time highlighting a decrease in denture base adaptation.

Overall patient satisfaction with the overdenture was high. In the ball group, patients were more satisfied about the overdenture stability compared to the magnet group, corroborating the data of Burns et al.[39] In the ball group, chewing ability was rated better compared to the magnet and bar groups. This probably reflects that the ball group had the best retention force for the overdenture over time.

Food impaction under the overdenture occurred in all groups at year 10, but there was a trend for less food impaction in the ball group, followed by the bar and magnet groups (five of nine patients, five of seven patients, and seven of nine patients, respectively). Again, this could be due to the good settling of the denture base in the ball group.

As patient satisfaction was evaluated by a VAS model at year 10, all patients were equally satisfied; satisfaction with the treatment ranged from 70% to 95%.[11] Only patients in the bar group found their maxillary denture less comfortable than the other groups. This discomfort reflects the decrease of stability of the maxillary denture. Instability of the maxillary denture with implant-supported overdentures in the mandible has been reported in several studies.[37,40,41] However, others[9,10] found no differences between mandibular overdenture and mandibular complete denture groups related to complaints about the maxillary denture.

Opposing denture maintenance, such as rebasing and fracture of the maxillary denture, is the most common complication for the maxilla. This happened in 52% of the dentures, indicating the high force patients can exert with their overdentures, in agreement with previous studies.[42,43]

Conclusions

1. The ball group presented the highest vertical retention capacity of the overdenture at year 10 and

a remarkable increase in this retention capacity over time, whereas a decrease occurred in the magnet and bar groups.
2. The most common complications for the unsplinted implants were renewal of the O-ring housing and magnets, whereas the most common problem for the splinted implants was activation of the clip.
3. The ball group showed the fewest soft tissue complications, and the magnet group showed the most. Mucositis was more frequent in the bar group; decubitis ulcer was more often recorded in the magnet group.
4. Patient satisfaction with the mandibular overdenture was rated similar for splinted and unsplinted groups, but the magnet group scored lower for chewing comfort and stability compared to the ball group. The bar group scored lower for comfort and stability of the maxillary denture.
5. The incidence of shifting from the magnet group toward the other groups underlines the lower level of comfort achieved with the former.

Acknowledgments

The authors are indebted to both Nobel Biocare, Sweden, and Dyna, Netherlands, for providing the ball and magnet attachments, respectively. Mr W. Coucke, Statistician, is acknowledged for his advice in the statistical analysis.

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Literature Abstract

Current Concepts and Techniques in Complete Denture Final Impression Procedures

Over the past several decades, the philosophies and techniques of impression making have been topics of controversy among academicians. The objective of this study was to determine which concepts, techniques, and materials are currently prevalent in the teaching of final impression technique for complete dentures in the clinical curriculum of predoctoral US dental schools. The questionnaire was mailed to the chairperson of the prosthodontic/restorative department of 54 US dental schools requesting information on concepts taught and materials and techniques used for final impression making in the predoctoral clinical complete denture programs. The results from this study show that the majority of schools (71%) teach the selective-pressure technique for final impression making; the majority of schools (64%) use modeling plastic impression compound for border molding the final impression tray; 39% of the schools do not place vent holes in the final impression tray, 30% of schools place more than one hole, and 27% place one hole only; the majority of schools (98%) use custom trays for final impressions. Ninety-eight percent of the schools border mold the custom tray, and 70% of schools use a visible light-cured (VLC) resin composite material to make the trays. Thirty-six percent of the schools teach the Boucher impression technique, and 34% teach the modified Boucher impression technique. The authors concluded that predoctoral clinical complete denture educational programs agree on many aspects of final impression making; however, there is variability in their teaching regarding the impression philosophy and the materials used.

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