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Complications associated with the ball, bar and Locator attachments for implant-supported overdentures

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Abstract

Background: The purpose of this clinical study was to evaluate the complications associated with the different attachments used in implant-supported overdentures, including prosthetic problems and implant failures. A comparison of ball, bar and Locator (Zest Anchors, Inc, homepage, Escondido, CA, USA) attachments, in completely edentulous patients with two, three or four implants, was conducted.

Material and methods: A total of 36 edentulous patients (20 female, 16 male) with a mean age of 66.3 years, were enrolled in the study. The patients were treated with 95 implants, for the prosthetic restoration of the maxilla or the mandible. The mean follow-up time was 41.17 months. Prosthetic complications including, fractured overdentures, replacements of O-ring attachment and retention clips, implant failures, hygiene problems, mucosal enlargements, attachment fractures, retention loss and dislodgement of the attachments were recorded and evaluated. The recall visits at 3, 6, 12 months and, annually thereafter.

Results: Fourteen complications in the ball attachment group and 7 complications in the bar group were observed. No complications were observed in the locator group. The difference was found to be as statistically significant ($p=0,009$). Six of the 95 implants had failed. Totally 39 implant overdentures were applied. Three prostheses were renewed because of fractures.

Conclusion: Within the limits of the present study, it was concluded that the locator system showed superior clinical results than the ball and the bar attachments, with regard to the rate of prosthodontic complications and the maintenance of the oral function.

Key words: Complications, Implant-supported overdentures, locator attachments, ball attachments, bar attachments.

Introduction

Edentulism is considered a poor health outcome and may compromise quality of life. Implant supported overdentures provide a good opportunity for dentists to improve the quality of life and oral health. The prosthetic management of the edentulous patient has long been a major challenge for dentistry. The classical treatment plan for the edentulous patient is the complete removable maxillary and mandibular denture. This treatment is relatively inexpensive in comparison with the implant supported fixed prostheses, but it has several drawbacks. The implant-supported overdentures are recommended to overcome these drawbacks. (1, 2) These prostheses have many advantages in comparison with the conventional dentures, including good stability, good retention, improved function and esthetics and reduced residual ridge resorption. It is also possible to incorporate the existing denture into the new prosthesis. (2, 3) Another advantage is the reduced number of the implants and easier surgical procedure. (1)

In recent years, various attachments systems have been successfully used with removable implant overdentures. (4) All available attachment systems are designed to prevent vertical movement of the denture, and can be used as an isolated attachment mounted directly to the implant or attached to a bar system. (5) The choice of the attachment is dependent upon the retention required, jaw morphology, anatomy, mucosal ridge, oral function, and patient compliance for recall. (6)

Ball attachments and bar units for implant overdentures have evolved from the early 1960's. Ball attachments were considered the simplest type of attachments for clinical application with tooth-or implant-supported overdentures. (4) But, it is also well documented that O-rings gradually loose retention, and must be replaced periodically. On the other hand, increased technique sensitivity and costs but with favorable stability have been reported regarding the bar attachments. Other disadvantages of the bar system include mucosal hyperplasia, hygiene problems and the necessity of the retention clip's activation. (7, 8, 9) Many clinical studies evaluated the use of the bar and ball attachments in terms of various clinical parameters. (9, 10, 11)

The Locator attachment (Zest Anchors, Inc, homepage, Escondido, CA, USA) which was introduced in 2001, is a new system, which does not use the splinting of implants. This attachment is self-aligning and has dual retention and in different colors with different retention values. (6, 12, 13) Locator attachments are available in different vertical heights, they are resilient, retentive, and durable, and have some built-in angulation compensation. In addition, repair and replacement are fast and easy. (5, 14, 15) There is a lack of clinical studies on the Locator system. (15) In the authors' knowledge there is no documented clinical study which compare

the bar, ball and Locator system. Therefore, the present study was designed to compare the ball, bar and Locator attachment systems regarding the complications associated with the overdentures, attachments and implants.

Materials and Methods

The study was carried out in the Department of Oral and Maxillofacial Surgery, Istanbul University, Dentistry Faculty. The population of this prospective randomized clinical study, constituted of 36 patients (16 male, 20 female) who have been treated with implant supported-mandibular or maxillary overdentures. The implants were placed between between the time period from 2004 to 2009. The age of the patients ranged between 43 and 89 years with a mean age of 66.3 years. Patients with adequate bone volume and with a complete edentulous mandible or maxilla, were included in the study. Patients with uncontrolled systemical health problems were excluded. The patients agreed with a written informed consent. The individuals have been randomly assigned to the ball, bar and Locator attachment groups

The surgical procedures were performed using different implant systems such as Astra Tech, BioHorizons, Bio-Lok, Endopore, Frialit, ITI and Swiss Plus. A total of 95 implants (24 in the maxilla, 71 in the mandible) were placed. The implant-supported prosthesis were applied, 2 to 3 months after the placement of the implants. Nine (4 male, 5 female) patients received bar attachments, 19 (8 male, 11 female) received ball attachments and 8 patients (4 male, 4 female) received locator attachments. Bilaterally balanced occlusion was performed on all of the prosthesis. Once treated, each patient's information was updated regularly according to the frequency of recall visits.

The complications encountered, were associated with the overdentures, attachments and implants. Fractured overdentures, replacements and/or activations of O-rings and retention clips, implant failures, hygiene problems, mucosal enlargements, attachment fractures and retention loss in the attachments were recorded.

The recall visits were at 3, 6, 12 months and, annually thereafter. 10 patients (4 in ball group, 6 in bar group) with a total of 29 implants had completed a follow-up period of ≥ 5 years.

-Statistical analysis

Statistical analyses were prepared with NCSS 2007 program package. Univariate analysis was used to evaluate the descriptive statistical methods (mean and standard deviation) and the differences between the groups. Comparisons of the qualitative data were presented with Chi-square test. Tukey's multiple comparison test was used to compare the subgroups. Statistical significance was set at $p < 0,05$.

Results

A total of 21 complications (14 in ball group, 7 in bar group) were observed. The distribution of patients with regard to the complications is summarized in table 1. Nineteen patients were present without any complication. On the other hand, seventeen patients were present with various complications associated with attachment types, prostheses or implants. No statistically significant difference was observed among the complication negative and complication positive groups regarding to the gender of the patients, location of the overdentures (maxilla and/or mandible), the utilized implant systems and the number of the implants. On the other hand, the difference was statistically different regarding the type of the attachment ($p=0,009$). The summary is given in table 2. 70.6% of the patients in the ball group and 29.4% of the patients in the bar group had complications. No complications were observed in the locator group.

-Complications associated with the prosthesis and the attachments

No complaints such as mucositis, erosive lesions, ulcerations of the soft tissues or candidal infections were observed.

In the ball attachment group, implant failures, O-ring replacements and mucosal enlargements were frequently observed in comparison to hygiene complications and fractured overdentures. Three of 19 patients (15.7%) had received O-ring replacement. The mucosal enlargements which were seen in 3 of 19 patients (15.7%) were treated surgically and 2 patients (10.5%) with fractured overdentures had received new prostheses.

The most frequent complications in the bar group, were associated with the retention clips. In 3 of 9 patients

(33.3%) retention clips were replaced. One patient needed activation of retention clip. One patient's bar was fractured and repaired. One patient needed a new prosthesis because of the fracture of the overdenture.

On the other hand, no prosthetic complications were observed in locator group consisting of 8 patients.

The difference among the ball, bar and locator groups, was not statistically significant regarding the replacement of the attachment fragments and fractured overdentures ($p=0.826$ $p=0.626$).

-Complications associated with the implants

Six implants failed. Four of the failed implants (66.6%) were in the maxilla and the remaining in the mandible. No early implant failure was observed. The majority of the implant failures were seen at least 2 years after implant loading. Implant failures were observed in the patients which were present with a complaint of instability of the overdentures. Five of the failed implants (83.3%) were in the ball group, the other one was in the bar group. There was no implant failure in the locator group. The difference among the ball, bar and locator groups was not statistically significant regarding the implant failure ($p=0,516$).

In one patient who received 2 implants in the mandible, an infection around the implant was observed 4 years after the implant loading. On the clinical examination a slight mobility was observed. Antimicrobial therapy and the surgical treatment of the peri-implantitis were performed in this patient which were in the ball attachment group.

Two implants were fractured in one patient, who received 4 implants in the maxilla. The fractured implants were removed. The implants and the overdenture were

Table 1. The distribution of the patients with regard to complications.

Complications	Ball group	Bar group	Locator group
	N=19	N=9	N=8
Replacement of attachment components	3	3	0
Overdenture fracture	2	1	0
Implant failure	4	1	0
Activation of attachment components	0	1	0
Hygiene problem	1	0	0
Mucosal enlargement	3	0	0
Attachment fracture	0	1	0
Peri-implantitis	1	0	0

Table 2. The distribution of the complication negative and positive groups.

		Complication (-)		Complication (+)		
		n:19		n:17		
Gender	Male	9	47,4%	7	41,2%	$\chi^2:0,765$
	Female	10	52,6%	10	58,8%	$p=0,682$
Maxilla/Mandible	Man	13	68,4%	12	70,6%	
	Max	5	26,3%	3	17,6%	$\chi^2:0,496$
	Max-Man	1	5,3%	2	11,8%	$p=0,481$
Implant System	Astra Tech	7	36,8%	1	5,9%	
	BioHorizons	0	0,0%	2	11,8%	
	Bio-Lok	0	0,0%	1	5,9%	
	Endopore	0	0,0%	2	11,8%	
	Frialit	0	0,0%	1	5,9%	
	ITI	7	36,8%	7	41,2%	$\chi^2:10,9$
	Swiss Plus	5	26,3%	3	17,6%	$p=0,091$
Number of Implants	2	14	73,7%	9	52,9%	
	3	2	10,5%	1	5,9%	$\chi^2:2,91$
	4	3	15,8%	7	41,2%	$p=0,232$
Attachment Type	Locator	8	42,1%	0	0,0%	
	Ball	7	36,8%	12	70,6%	$\chi^2:9,34$
	Bar	4	21,1%	5	29,4%	$p=0,009$

renewed and the attachment system was changed to be locator. No complications were observed 1 year after the use of locator attachment, in this patient.

Discussion

The bar, ball and Locator attachment systems have been used in implant-supported overdentures. Several studies have been reported the evaluation of the ball and bar attachment systems. (7, 9, 10, 16) On the other hand, there is a lack of clinical study which investigate the Locator attachment system. (15) The present study evaluated the comparison of the bar, ball and Locator attachment system with regard to a clinical point of view.

There is strong evidence that retention is of great importance for the patient’s satisfaction. Several studies evaluated the ball and bar attachments regarding the retention force and prosthetic complications. Sadowsky (7) reported that solitary ball attachments appear to be less costly and less technique sensitive. However, ball attachments seem to be less retentive than the bar design. Naert and colleagues (16) reported that single attachments provide lower retention than do bars for fixation of overdentures. Kiener and colleagues (11), evaluated the prosthetic complications with implant-supported overdentures in the maxilla. The most frequent finding was retightening of the bar screw and adjustments

of the bar retainers. In a multicenter study on overdentures which were splinted with 2 implants, the need of clip activation was reported as 62% of the study group and clip fracture was reported in 33% of the patients. (17) Walton and colleagues (18) evaluated the prosthetic outcomes with implant overdentures, and reported that approximately 84% of the patients with ball-attachment dentures needed at least 1 repair, versus 20% of those with a bar-clip mechanism. On the other hand, Karabuda and colleagues (10) reported that there was no differences in prosthetic complications for the ball and the bar attachment systems. In the present study, ball and bar clip replacements were commonly seen. One patient had need retention clip activation in the bar group. No retention clip fracture was observed in the ball and bar group.

Van Kampen and colleagues (19) evaluated initial retention force, loss of retention force after 3 months of function and postinsertion maintenance and complications associated with the use of magnet, bar-clip and ball attachments in mandibular overdenture treatment. Functional maintenance complications related to the attachments were predominantly observed in 11/36 magnet attachments. Functional problems in the ball attachment group were relatively rare, easily manageable and seen in 4/36 attachments. The bar-clip attachments exhibited no maintenance problems at all. On the other hand, an *in vitro* study reported by Tokuhisa and colleagues (20), showed that the use of the ball/O-ring attachment could be advantageous for implant-supported overdentures with regard to optimizing stress and minimizing denture movement overdentures. In the present study, 15.7% of the patients in the ball group and 55.5% of the patients in the bar group had complications associated with the attachments including replacement of attachment components, activation of attachment components and attachment fracture. No retention problem was recorded in the Locator group.

Few studies evaluated clinically the Locator system, in comparison to the other attachments. Kleis and colleagues (15) compared the Locator system with with two traditional designs (a rotational gold matrix and a rubber O-ring type) and reported that Locator system showed a higher rate of maintenance than the ball attachments. In the present study no complications associated with postinsertion maintenance or implants were observed in the locator group. Therefore Locator was found more advantageous in a clinical point of view.

Fracture of the prosthesis, attachments and the fracture of implants occur as a result of biomechanical stress. (21) Goodacre and colleagues (22), reported the incidence of the overdenture prosthesis fracture as 12%. The causes of the fractures and the concept of stress management for the success of implants was reported by Misch. (21) In the present study, 3 overdentures (2 in ball, 1 in bar

group) were renewed because of the fracture associated with biomechanical stress.

Waddell and colleagues (23) evaluated the failures of bars in the maxillary overdentures. Prosthodontic maintenance requirements throughout the two years of the bar units revealed only one bar fracture in year 1 and two bar fractures in year 2. A total of 3 fractured bars as well as 2 additional intact bars revealed signs of stress corrosion. In the fractured bars, evidence of corrosion was demonstrated. Goodacre and colleagues (22) reported the incidence of the overdenture clip/attachment fracture as 16%. In this study, 1 bar fracture occurred in the mandible. The possible cause was the lack of parallelism of implants.

Many investigators have evaluated mucosal reactions to different attachment systems. The majority of the clinical studies indicate that mucosal enlargements are most commonly found underneath maxillary prostheses regarding implant overdentures. (12) Mucosal irritations and stomatitis were also commonly observed in maxillary overdentures. (11) Payne and colleagues (24) reported that there is a need for prospective reports to evaluate the incidence of mucosal enlargement with mandibular overdentures in relation to design of the prosthesis, different dental implant systems. Klemetti and colleagues (25) reported that, to avoid soft-tissue problems in mandibular overdenture treatment with ball attachments, the amount of attached gingiva, as well as the pressure of the lip and the grade of alveolar atrophy, should be carefully assessed during treatment planning. If the labial musculature is tense or the amount of attached gingiva is limited, the implants should not be placed too deep or too labially, which might prevent gingival growth over the abutments. In the present study the mucosal enlargements were observed in the mandible and only in the ball group. The common cause of this mucosal problem was associated with the lack of adequate attached gingiva. No mucosal enlargement was recorded in Locator group.

Locator attachments are in different colors (clear, pink, blue, green, orange, red) and each has a different retention value. (6) Evtimovska and colleagues (6) evaluated two implant attachment systems (Hader bar and clip, Locator system). This *in vitro* study demonstrated that retentive values of the Locator attachments are reduced significantly after multiple pulls. In the present study the blue was used and there was no need to increase the retention value. No problem of retention associated with the Locator system was recorded in comparison to ball and bar designs.

Implant survival was defined as the percentage of implants initially placed that was still present at follow-up. (26) Attard and colleagues (3), reported long-term prosthodontic and implant-related treatment outcomes of patients treated with implant- supported overdentures.

Cumulative implant success was reported as 96.14% at 15 years. The majority of the studies which evaluate the implant-supported overdentures reported that the failed implants were commonly observed in the maxilla in comparison with the mandible as observed in the present study. (25) The majority of the failures was associated with severe peri-implantitis. On the other hand two implants were lost in the same patient because of the fracture. The probable cause of the implant fractures was associated with the parafunctional habits of the patient. An accurate analysis of the situation and the treatment time available will guide the choice of which course of action to take in the cases of implant fracture: 1. removal of the implant, 2. modification of the existing prosthesis, or 3. modification of the fractured implant. (27) In this case, it was not possible to modify the existing prosthesis or implant, therefore removal of the implant was chosen as a management. The implant and the prosthesis were renewed.

It appears that the attachment system does not influence the success rate of implants. Other factors, such as bone quality and quantity, arch morphology seem to play far more important roles in implant survival rates. (12) In the present study there was no statistically significant difference between the ball, bar and locator group regarding the implant failure ($p=0,339$) The authors agree with Trakas and colleagues (13), which reported that the correct placement of the implants affects the maintenance of the attachment systems.

Sadowsky (7) reported that, there was no statistical difference when long-term maintenance is compared among mandibular implant overdentures retained by 2 implants in contrast to those retained by 3 or more implants. The present study, showed no any statistical difference, regarding the number of implants, among the complication negative and complication positive groups

Within the limitations of this study, it is concluded that all the attachment systems were useful. No significant difference was observed between the attachment systems regarding the implant failure, replacement of the attachment fragments and fractured overdentures. However ball and bar attachment fragments required more service. On the other hand Locator attachment was found more advantageous to ball and bar systems, regarding the rate of complications in clinical practice. Further studies are still needed, including the comparison of ball, bar and Locator attachment systems used in implant overdentures.

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