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RESEARCH AND EDUCATION

Prosthetic complications with mandibular bar-retained implant overdentures having distal attachments and metal frameworks: A 2- to 12-year retrospective analysis

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ABSTRACT

Statement of problem. Long-term reports on 2-implant-retained overdentures having metal frameworks and bars containing distal attachments are scarce.

Purpose. The purpose of this retrospective study was to evaluate prosthetic complications with 2-implant-retained mandibular overdentures with metal frameworks having either screw- or cement-retained cantilevered bars with distal attachments.

Material and methods. Seventy-three edentulous study participants who had been treated with mandibular overdentures with 2 implants were included. The parameters assessed were acrylic resin fractures (base fracture, fracture at midline), debonding of teeth, opposing prosthesis fracture, need for relining or rebasing, abutment and bar screw loosening and fracture, ball or bar attachment or clip wear, fracture or detachment, bar fracture, and implant loss. Statistical analysis was performed by using the Mann-Whitney U test as the data were not normally distributed. The categorical variables between the groups were analyzed by using the Fisher exact test (α=.05).

Results. Twenty-seven prostheses had a cement-retained bar, and 46 bars were screw-retained. Of 73 overdentures, 68 were metal-reinforced. The mean observation time was 5.9 years with a range between 2 and 12 years. The most common complication was wear of the Rhein 83 polymer attachment followed by bar screw loosening. The cumulative survival rate for overdentures was 91.9% at 6.8 years. The service life of cement-retained prostheses was significantly longer (P<.05). Bar, resin base, and mid-line fractures were only seen with cement-retained prostheses. The number of times an attachment change was required did not differ between cement- and screw-retained bars. Of 191 implants, 3 were lost, and the cumulative survival rate was 93.5% at 7.5 years. No significant difference was found between retention types in terms of implant loss (P>.05).

Conclusions. Based on the participant population observed, the survival rates of 2-implant-retained mandibular overdentures and their implants in the medium term were high. Wear of the polymer attachment was commonly seen. Overdentures with cement-retained bars had bar or acrylic resin fractures. Mandibular 2-implant-retained overdentures with a screw-retained bar containing bilateral distal attachments had fewer prosthetic complications and high implant survival in the medium term. (J Prosthet Dent 2021;■:■-■)

Implant-retained overdentures (IODs) are a valid treatment option for edentulous patients,[1-11] with high prosthesis and implant survival rates in the anterior mandible.[7,8,12,13] Also, IODs have favorable esthetics, good patient satisfaction, are straightforward to clean, and provide enhanced quality of life compared with conventional complete dentures.[14-16]

Two to 4 implants have been suggested to retain an overdenture in the mandible.[15,17] However, when considering cost, quality of life, and patient satisfaction, the McGill[11] and York consensus[15] statements reported 2 implants to be adequate in the mandible.[11,15] The use of more than 2 implants to retain an IOD was recommended only for a dentate maxilla, implants <8 mm in length and <3.5 mm in diameter,

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Clinical Implications

Based on the findings of the present retrospective evaluation, mandibular 2-implant-retained overdentures with a metal framework and a screw-retained bar having distal attachments can be considered a successful option with few prosthetic complications.

sensitive mucosa, sharp mylohyoid projections, high muscle attachments, large V-shaped ridges, or patients with high retention needs.[5] Meijer et al[9] reported no statistical difference for clinical complications, radiographic bone loss, and patient satisfaction between 2 and 4 IODs.

Available attachment systems for IODs include bars or stud attachments such as ball or LOCATOR attachments.[4,5,18,19] Attachments improve function, but a consensus on the optimal overdenture attachment system is lacking, and patient demands, anatomic factors, implant systems, and cost need to be considered.[20] Various opinions have been voiced as to whether a rigid system such as a bar that splints the implants or a resilient system such as a ball or LOCATOR attachment is more advantageous.[21,22] Ball attachments are economic, hygienic, and less technique-sensitive than bar systems and are satisfactory for patients.[5] However, ball attachments lose retention over time, and regular replacements are required.[19,23,24] The LOCATOR system has dual retention with attachments in different colors, which represent varying retentive forces. Wear of the polymer attachment is the primary disadvantage of the system, and the abutment itself may also wear.[25-27] In addition, increased prosthodontic maintenance needs have been associated with the limited manual ability of elderly patients.[28,29]

Bars are retentive but are costly, have technique-sensitive fabrication steps, and, in some cases, require the activation of retention clips.[5,22,30,31] Timmerman et al[32] concluded that mandibular 2-IODs with a bar can be an optimal choice in the medium term. Because mandibular implants are placed interforaminally, a cantilever with a single bar may be used to provide posterior support and to improve the stability of IODs.[20,33,34] Whether placing cantilevers on bars affects the clinical outcomes of IODs[8] has been evaluated, and some problems have been reported with the use of cantilevers.[35] However, studies that evaluated the clinical outcomes when this design was used are lacking. In addition, the authors are unaware of studies that investigated the effect of retention type (screw versus cement retention) on the performance of overdenture bars in the medium term.

Denture base fracture is a commonly seen complication with IODs.[23,36,37] Fracture occurs where stresses are concentrated and are associated with the location of the abutments.[38,39] The abutments commonly become the fulcrum of movement, and the denture base is thin around the abutments.[40] To decrease the incidence of fracture, reinforcement of acrylic resin with a metal framework has been recommended.[39-46] However, a comparison of 2-IODs with bar or ball attachments concluded that the presence of a reinforcing framework did not reduce the number of denture repairs.[29] Long-term reports for the performance of 2-IODs with metal frameworks are scarce. The purpose of this retrospective study was to document and report the prosthetic complications of mandibular 2-IODs with screw- or cement-retained cantilevered bars with distal attachments. The null hypothesis was that the complications would not be different depending on the retention type (cement versus screw retained) of the bars.

MATERIAL AND METHODS

This retrospective study was carried out on edentulous study participants who had been treated with overdentures with 2 implants placed interforaminally in the mandible. The study protocol had been approved by the local ethics committee (D-KA 15/25). The inclusion criteria were an edentulous mandible with 2 implants, a cantilevered bar-retained overdenture with or without a metal framework, and prostheses that had been delivered between 2 and 12 years before the examination. One hundred sixty-one study participants were treated between 2004 and 2014 with mandibular IODs and had signed consent forms before treatment. The study participants were interviewed by telephone and assigned randomly (www.random.org) to 1 of 4 prosthodontists for clinical examination. Seventy-three of 161 participants with an age range between 48 and 92 years were examined (mean age: 66.6 years). Three had died, and the others (88) could not attend for various reasons.

Mechanical complications with IODs were clinically examined and included acrylic resin-related fractures (base fracture or fracture at midline); debonding of teeth from the resin base; opposing prosthesis fracture; need for relining or rebasing; abutment and bar screw loosening or fracture; wear, fracture, or detachment of the ball or bar attachment or clip; bar fracture; and implant loss (Table 1). In addition, the service life of the prostheses, participant age and sex, diameter and length of implants, oral hygiene, number of dental examinations, and type of maxillary dentition were also recorded. Thirty-six study participants had maxillary complete dentures, and 3 had a maxillary IOD. Twenty-two study participants had a removable partial denture (RPD), 3 had a complete natural dentition, and 9 had maxillary

Table 1. Distribution of opposing arch and sex for complications

Complication	Number of Patients	Male	Female	Complete Denture	Removable Partial Denture	Fixed Prosthesis	Overdenture	Natural Teeth
Attachment wear	53	21	32	23	20	6	2	2
Bar screw loosening	8	4	4	4	3	1	0	0
Need for relining	6	2	4	5	1	0	0	0
Fracture of opposing prosthesis	6	4	2	5	1	0	0	0
Fracture at the midline of prosthesis	5	1	4	3	0	2	0	0
Debonding of the teeth	5	3	2	0	2	2	2	0
Bar clip fracture	5	4	1	3	1	0	1	0
Need for rebasing	4	4	0	2	2	0	0	0
Bar fracture	3	2	1	2	1	0	0	0
Implant loss	2	1	1	0	1	1	0	0
Resin base fracture	2	1	1	1	0	1	0	0
Bar screw fracture	1	1	0	0	1	0	0	0
Abutment screw loosening	1	1	0	1	0	0	0	0
Overdenture clip detachment	1	1	0	0	1	0	0	0

fixed prostheses (4 with tooth-supported fixed dental prostheses and 5 with a combination of implant- and tooth-supported fixed dental prostheses).

For the impressions and fabrication of overdentures, all study participants were treated by following the same steps. An open-tray impression was made with an elastomeric impression material (Soft Monophase; 3M) in an acrylic resin custom tray (Arasta LC; Dokuz Kimya). The bar (OT CAP castable bar; Rhein 83) was cast from a metal alloy (WIRONIUM RP; Bego) including the ball attachment (OT strategy; Rhein 83) in the design distally bilaterally (Fig. 1). Some of the bars were galvanic gold plated. The metal framework (WIRONIUM RP), when used, was adjusted, airborne-particle abraded with 250-μm Al_2O_3 (Basic Classic; Renfert GmbH), and finished by using conventional laboratory procedures (Fig. 2).[40] During the delivery session, the bar was inserted, the passive fit was evaluated with a 1-screw test, and the screws were tightened with a torque driver according to the manufacturer's recommendation. The fit of the bar was confirmed with periapical radiographs (Fig. 3). If a screw loosened, the bar was removed, and the procedures repeated. The cement-retained bars were constructed in the same way and cemented with zinc phosphate cement (Adhesor; Pentron) on custom-made abutments. The same acrylic resin denture tooth brand (Major Dental) and acrylic resin brand for the denture base (ProBase Hot; Ivoclar Vivadent AG) were used for all the IODs (Fig. 4).

Statistical analysis was performed by using a software program (SPSS Statistics v17.0; SPSS Inc). All numerical data were expressed as median values (minimum-maximum). For each continuous variable, normality was checked with the Kolmogorov-Smirnov and Shapiro-Wilk tests and by histograms. Comparisons were made using the Mann-Whitney U test as the data were not normally distributed. The categorical variables between the groups were analyzed by using the Fisher exact test (α=.05).

Figure 1. Overdenture bar with distal attachments.

RESULTS

A total of 191 implants were examined (76 NucleOSS Implants, 101 TSV; Zimmer Biomet, 2 Astra; Dentsply Sirona, 8 Straumann Bone Level; 4 Frialit; Friadent GmbH). Of 73 prostheses, 27 had a cement-retained bar (36.9%), and 46 prostheses had screw-retained bars (63.1%). The number of bars with each retention type was not significantly different (P>.05). No significant difference was found between the screw-retained and the cement-retained bars when the study participants' age was considered (P=.26). Sixty-eight prostheses were metal-reinforced, and 5 acrylic resin dentures which had no metal reinforcement were also evaluated.

The mean observation time for all study participants was 5.9 years with a range between 2 and 12 years. The

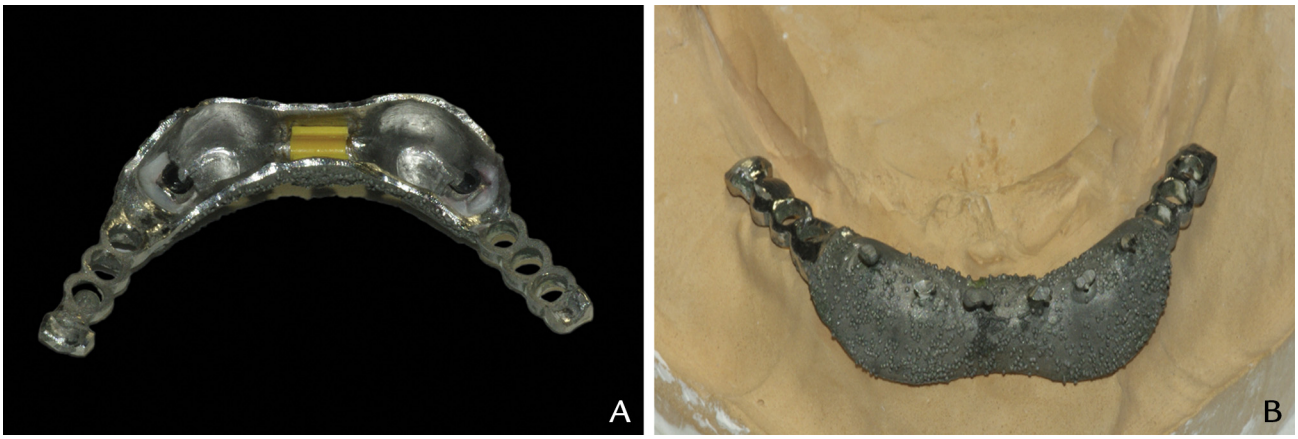

Figure 2. Metal cast framework. A, Intaglio view; B, occlusal view.

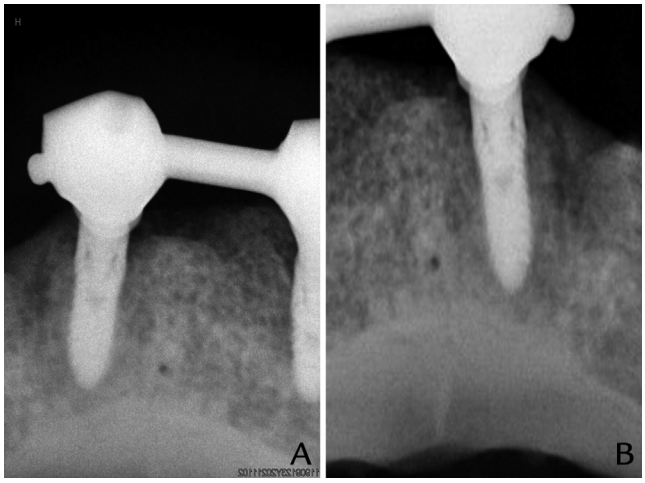

Figure 3. Representative postoperative periapical radiographs. A, Left implant. B, Right implant.

Figure 4. Overdenture intaglio surface.

most common complication was the wear of a polymer attachment, which was observed in 72.6% of the participants followed by bar screw loosening seen with 10.9% of the participants. The need for relining and fracture of opposing prostheses (The prostheses were repaired from the fracture line.) was observed with 8.2% of the participants. Fracture at the midline of prosthesis, debonding of teeth from the resin base, and bar clip fracture were each seen in 6.8% of the participants. The need for rebasing was seen in 5.4%; bar fracture in 4.1%; implant loss (Two Zimmer Biomet implants were lost.) and resin base fracture in 2.7%; bar screw fracture, abutment screw loosening, and overdenture clip detachment each in 1.3% of the participants (Fig. 5). The mean ±standard deviation time for the first change of the polymer attachments was 3.72 ±2.2 years, and the mean ±standard deviation number of changes was 1.74 ±0.86 per study participant. The number of times an attachment was changed was 1 for 21 study participants, 2 for 16 study participants, 3 for 12 study participants, and 4 for 4 study participants. In 20 study participants, no changes were needed. The number of times an attachment change was required did not differ between cement-retained and screw-retained bars (P=.424) (Table 2).

The cumulative survival rate for the overdentures was 98.6% at 1.3 years, 96.8% at 4 years, and 91.9% at 6.8 years (Fig. 6). The service life of cement-retained prostheses was significantly longer than that of screw-retained prostheses (P<.05) (mean: 8.00, standard deviation: 2.465, median: 7.00 for cemented group, mean: 4.80, standard deviation: 1.470, median: 5.00 for screw-retained group). However, 3 bar (P=.047), 3 resin base (P=.047), and 5 midline (P=.005) fractures were only seen with cement-retained prostheses, which led to a significant difference between the type of retention for each complication (Chi-Square and Fisher exact test, P=.047 for bar and resin base fracture, Chi-Square and Fisher exact test, P=.005 for midline fractures). In case of bar fracture, a new bar and an IOD was fabricated. In

Figure 5. Bar screw loosening.

case of midline, resin base, and tooth fracture, the repairs were performed in the same laboratory by 1 dental laboratory technician. The type of the complication, the opposing arch, and the study participants' sex are displayed in Table 1.

Mucosal hypertrophy under distal attachments was identified in 4 study participants, under bar in 8 study participants, and both under distal attachments and bar in 7 study participants. Three implants (2 under a cement-retained bar after 2 years of delivery of the bar and 1 under a screw-retained bar after 5 years) had been lost in 2 study participants. In case of implant loss, a new implant had been inserted immediately, and when the osseointegration was obtained, the prosthesis was fabricated. Cumulative survival rate was 98.9% at 2 years, 98.2% at 4.5 years, and 93.5% at 7.5 years (Fig. 6). No significant difference was found between retention types in terms of implant loss (P=.551).

DISCUSSION

The prosthetic complications with 2-implant-retained overdentures were evaluated in the present study, and IODs were observed to be functional and cost-effective in the medium term, consistent with previous studies.[6,47-49] It had also been previously reported that 2-implant-retained bar overdentures have adequate retention, and a similar outcome was observed in the present study considering the average of almost 4 years before the first change of the polymer attachment.[11,15,47,50-52] However, IODs did present with prosthetic complications although most were repairable and reversible. The observed complications varied depending on the retention type of the bar, and therefore, the null hypothesis was rejected.

The most commonly seen complication was the wear of the polymer attachment (bar clip and ball attachment) in 72.6% of study participants. Attachment wear may have been from repetitive removal and insertion of prostheses, inaccurate insertion by the study participants

Table 2. Mean number of years before first change of polymer attachment and mean number of times polymer attachments changed

Polymer Attachment Change	Number of Times	Years
Mean	1.74	3.72
Median	2.0	4.0
Standard deviation	0.86	2.2
Minimum	1	1
Maximum	4	12

(lack of understanding regarding path of insertion), or excessive occlusal loads. Even though it was not possible to access the details in the charts for the exact distribution of worn polymer attachments, the wear was observed more with ball attachments than with bar clip attachments. The rate of occurrence was expected to be approximately 6 years in average for prostheses in service. Chaffe et al[53] reported that the replacement of inadequately retentive ball attachment polymers makes up 27% of all complications, which was followed by denture adjustments (26%). In addition, Akoğlu et al[7] stated that the most common prosthetic complication was fracture of the mandibular denture and the replacement of polymer attachments. However, Suzuki et al[54] reported denture tooth and denture base fractures to be the most commonly seen complications for overdentures after 0 to 8 years. The authors stated that maxillary overdentures had denture tooth fractures mostly because of the horizontal component of the occlusal force. In the present study, 6% of the mandibular overdentures experienced tooth fractures. The authors suggest that the low rate of occurrence of tooth fracture may be because only mandibular prostheses were evaluated, which are probably subjected to a minimal horizontal component of the occlusal loads. Maxillary overdenture teeth may have an increased number of fractures because of their angulation in relation to the direction of occlusal forces. That 58 of 73 IODs were opposed by a removable denture, either complete (36) or partial (22), may also explain the low percentage of tooth fractures on mandibular IODs in the present study. In addition, the small size of distal attachments may have allowed adequate thickness for acrylic resin and teeth around them, which may have limited the number of fractures.

The fractured dentures in the study by Suzuki et al [54] were not reinforced. However, in the present study, 93.1% of the overdentures were reinforced with a metal framework, and only 2.7% of all overdentures experienced a fracture (2 metal-reinforced, 1 unreinforced acrylic resin overdenture). The attachment's metal housing incorporated in the framework design may have minimized fractures that could have occurred around the abutments.[39] This rate was 36.1% in the study by Akoglu et al,[7] where the dentures were in

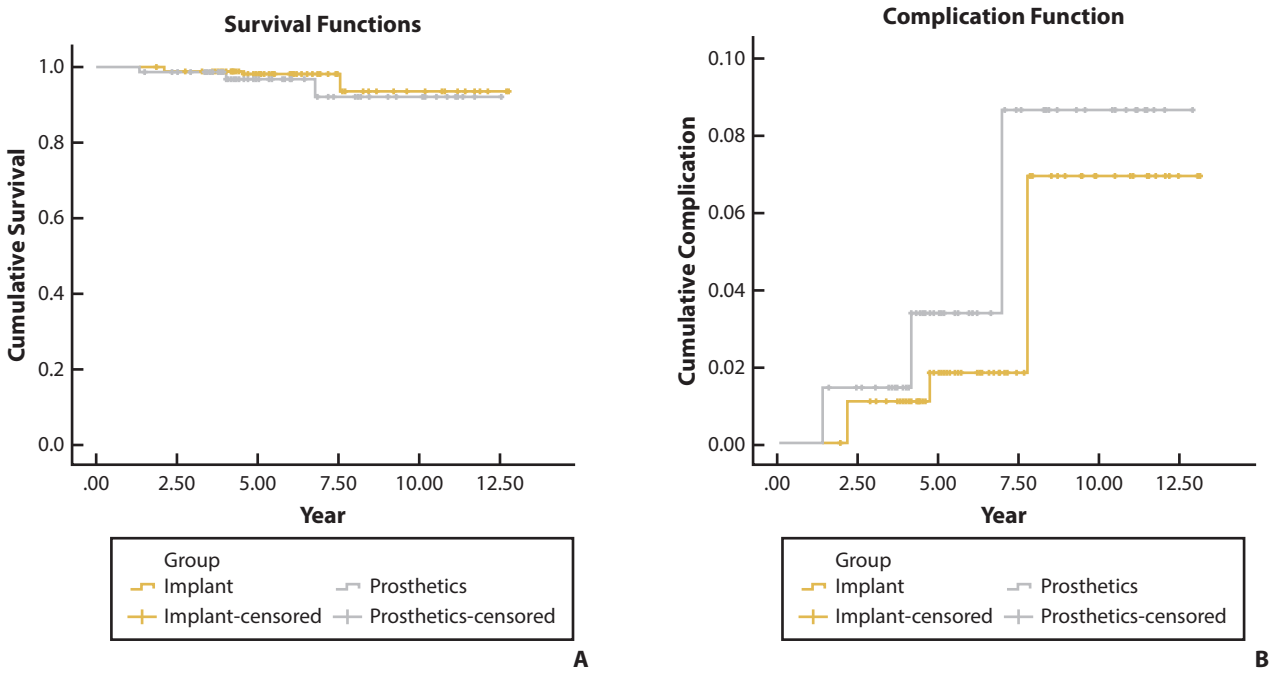

Figure 6. Implant and prosthetic cumulative plots. A, Survival. B, Complications.

acrylic resin, and 15.3% fractured in the study by Gonda et al [39] even though the dentures were reinforced. Walton and MacEntee[55] reported that 5.8% of removable implant-supported prosthesis repairs involved acrylic resin fractures. Balch et al[44] also suggested a metal framework for overdentures, which can be designed to accommodate individual attachments or bar attachments. Again, that the majority (58 of 73) of opposing dentures were removable may also have contributed to a low percentage of IOD fractures in the present study.

The mean time to change the polymer attachments for the first time was 3.72 years (44.74 months), which is much longer than the time reported in the study by Chaffee et al (9.86 months).[53] Akça et al[56] reported this time as 42.9 months for ball and 25.07 months for LOCATOR attachments. The favorable results in the present study may be because of the use of bar attachments which had 3 retainer clips. The angular difference of implants can be compensated for when designing bars, and the attachments survive longer than LOCATOR or ball clip attachments. When implants are not parallel to each other, polymer attachments wear earlier than they would when implants are parallel.[29] The opposing dentition, being mostly a removable denture (45 out of 53), may also have prolonged the time to change the polymer attachments in the present study. Bar screw loosening occurred mostly when an IOD opposed a removable denture (7 of 8) and, in one instance, a fixed prosthesis. The bars were all cast as computer-aided technology had not been integrated in the laboratory's system when the bars were fabricated, and improved results regarding screw loosening may be possible when bars are milled.

The service life of cement-retained prostheses was significantly longer than that of the screw-retained prostheses ($P<.05$) because the screw-retained bars had been fabricated more recently. Bar fracture, fracture at the midline of the prosthesis, and resin base fracture occurred in the cement-retained group ($P<.05$). Three bar fractures occurred with IODs opposing removable dentures, and 5 midline fractures and 2 resin base fractures occurred when IODs opposed complete dentures or a fixed dentition. A clear conclusion could not be drawn as to the effect of the opposing arch on the complications because of the low number of complications. The authors are unaware of clinical studies that have investigated cement-retained bar overdentures, and more studies are needed for comparisons to be possible.

One of the clinical implications of the present study, within the observation time, was that mandibular 2-IODs with cement- or screw-retained bars with distal attachments provide a reliable and successful treatment option for edentulous patients. Because this was a retrospective study, the information was limited compared with a balanced prospective study. The analyzed convenience sample was treated in a single clinic with a lack of randomization, and the results were only exploratory. The biological complications of overdentures were not evaluated. Not all study participants were accessible by telephone. In addition, 7% of overdentures had not been metal reinforced, too few to make statistical comparisons

considering metal reinforcement as an effect. The present study represents only bar-retained overdenture prostheses, but further investigation should be considered for different types of attachment systems to be compared for their retention mechanisms. The present retrospective study reported the performance of bar-retained overdentures in the medium term, and future studies are needed to evaluate overdentures older than 10 years and to further investigate the performance of cement-retained bars.

CONCLUSIONS

Based on the findings of this retrospective clinical study, the following conclusions were drawn:

1. The survival rates of 2-implant-retained mandibular bar overdentures having distal attachments and their implants were high in the medium term.
2. The wear of polymer attachment was the most commonly seen complication.
3. Overdentures with cement-retained bars had bar or acrylic resin fractures, whereas screw-retained bars had none.

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