Clinical Outcome of Overdenture Treatment on Two Nonsubmerged and Nonsplinted Astra Tech Microthread™ Implants

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ABSTRACT

Background: The use of two implants for mandibular overdenture stabilization improves the patients' comfort and well-being. This treatment could be more cost-effective if surgery and prosthetic treatment could be performed by one clinician in the normal setting of a dental clinic.

Purpose: The aim of this retrospective clinical study was to describe implant success, restorative outcome, and the patients' opinion of mandibular overdenture treatment on two early-loaded, nonsplinted Astra Tech TiOblast Microthread™ (Astra Tech Dental, Mölndal, Sweden) implants.

Materials and Methods: Thirty-seven consecutive patients treated with implant-supported mandibular overdentures were invited for a clinical examination. Implant survival, marginal bone level, quality of implant and prosthetic treatment, and the patients' opinion by means of questionnaires were scored.

Results: Thirty-four patients attended the examination. Two implants were lost in one patient and the failure rate for the total group of patients was 3%. As 8 of the 33 remaining patients were still in the provisional loading stage, they were not included in the final clinical and radiographic examination. Based on 25 patients and 50 implants with a mean follow-up of 18.8 months (range 4–33), implant positioning and occlusion/articulation scored perfect in 74 to 80% of the cases. Retention of the dentures was rated perfect in 80%, but 20% needed minor activation of the attachments, 20% showed signs of abrasion, and 20% had already been repaired. The average marginal bone level was 0.8 mm below the reference point. The mean pocket depth was 2.1 mm, and 54% of the peri-implant tissues were free of bleeding. The patients were appreciative of the work carried out by their dentist and they indicated a significant improvement in their well-being and quality of life.

Conclusions: It can be concluded that the Astra Tech implant system was successfully used by the general dentist both surgically and prosthetically with minimal implant failures and prosthetic complications and that this led to high levels of patient appreciation and overall satisfaction.

KEY WORDS: dental implants, early loading, overdenture, patient satisfaction, quality, treatment quality

INTRODUCTION

Mandibular overdentures supported by two to four dental implants were introduced in the 1980s[1,2] and have proven to be good alternatives to conventional dentures, delivering a predictable and long-lasting prognosis.[3–5] Comparative studies have indicated that there is no difference in the clinical and radiographic state of patients treated with an overdenture on two or four implants with a two-stage delayed loading protocol on short-term[6] or long-term follow-up.[7] During the last decade, the classical two-stage surgical approach was

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replaced by a one-stage procedure without jeopardizing the clinical outcome, especially in the completely edentulous mandible.[8–10] The survival rate of overdenture supporting mandibular implants, either placed as a one- or two-stage procedure, has shown to be successful in over 96% of all cases.[11] The one-stage surgical approach followed by the early loading of mandibular overdentures supported by two implants showed good success rate at 1[12,13] and 2 years follow-up.[14,15] Immediate loading of mandibular overdentures on four splinted implants is verified to be a feasible treatment option.[16] With this in mind, it can be concluded that implant and prosthesis success is, in general, more than 95%, and this is irrespective of surgical procedure or loading time. A number of studies have compared different attachment systems on either single standing or splinted implants in the symphisis area. Various attachments provide different degrees of resistance against dislodging forces. Comparative studies have indicated that bar-clip anchorage or ball-O-ring anchorage behaves similarly when evaluating peri-implant health,[17] implant survival, and peri-implant bone preservation[18] or prosthetic maintenance and complications.[19,20] The McGill consensus statement[21] suggests that in the restoration of the edentulous mandible, a two-implant-retained overdenture should be the first treatment choice. In the Netherlands, an estimated 19% of the population above 16 years is edentulous, and 15% of denture wearers have complaints about loss of retention, stability of the denture, or pain.[22] The privately based dental insurance system provides dental health care for implant-supported mandibular overdenture treatment predominantly supported on two implants. As a consequence, the treatment demand is high, and a growing group of private nonspecialist dentists are taking postgraduate courses in order to provide this treatment in their daily clinical practice.

The aim of this retrospective study was threefold. First, the study aimed to describe the clinical success of the Astra Tech Dental Implant System® (Astra Tech Dental, Mölndal, Sweden) when used by a general dentist providing both surgical as well as prosthetic therapy. Second, the study aimed to evaluate the quality of care of implant-retained overdenture therapy in the mandible as reflected through prosthetic and peri-implant variables. Third, the patients' opinion and appreciation of the treatment were assessed. Clinical examinations were performed by independent examiners from the University of Ghent Belgium, using implant success, peri-implant health, prosthetic outcome, and complications as criteria. The patients were examined after giving their written consent, and the study was accepted by the ethics committee at the University Hospital of Ghent.

MATERIALS AND METHODS

Patient Selection

From 2003 to 2006, 37 completely edentulous patients were consecutively treated with overdenture therapy on two nonsplinted implants with ball abutments in the mandible. The dentist (J.B.) performed implant surgery as well as prosthetic restoration. All patients were personally invited by mail or telephone to participate in a clinical examination by independent examiners (H.D.B.; F.R.).

Surgical and Prosthetic Protocol

TiOblast Microthread™ dental implants measuring 4 mm in width and ranging between 8 and 17 mm in length were installed according to the manufacturer's guidelines. In most cases, the existing removable denture was converted to a guide plate by drilling two access holes at the planned surgical sites being incisor or canine location. A full-thickness mucoperiosteal flap was prepared to expose the bone from canine to canine, and implant recipient sites were prepared under direct inspection using the direction guide plate and taking care not to perforate the bone. After the implant installation, healing abutments of 3- to 6-mm length were installed, depending on mucosal tissue thickness. The denture was relined with a soft relining material (Ufigel, Voco, Cuxhaven, Germany) either immediately or at the time of suture removal 7 to 9 days after surgery. With the healing abutments in direct contact with the relining material, the implants were subjected to functional loading. Antibiotics were given routinely starting 1 hour before surgery (clindamycin 300 mg three per day for 5 days). A plaque control regimen was instructed from day 0 by means of 0.05% chlorhexidine rinsing (Perio-aid, Dentaid, Houten, the Netherlands), and brushing on the healing abutment with a very soft toothbrush (Surgical Care, TePe, Malmö, Sweden) was advised at the discretion of the patient for 1 week. The patients were regularly checked until the new denture was prepared within 3 to 4 months on two Astra Tech ball abutment. In the denture basis, two Dalbo® Classic

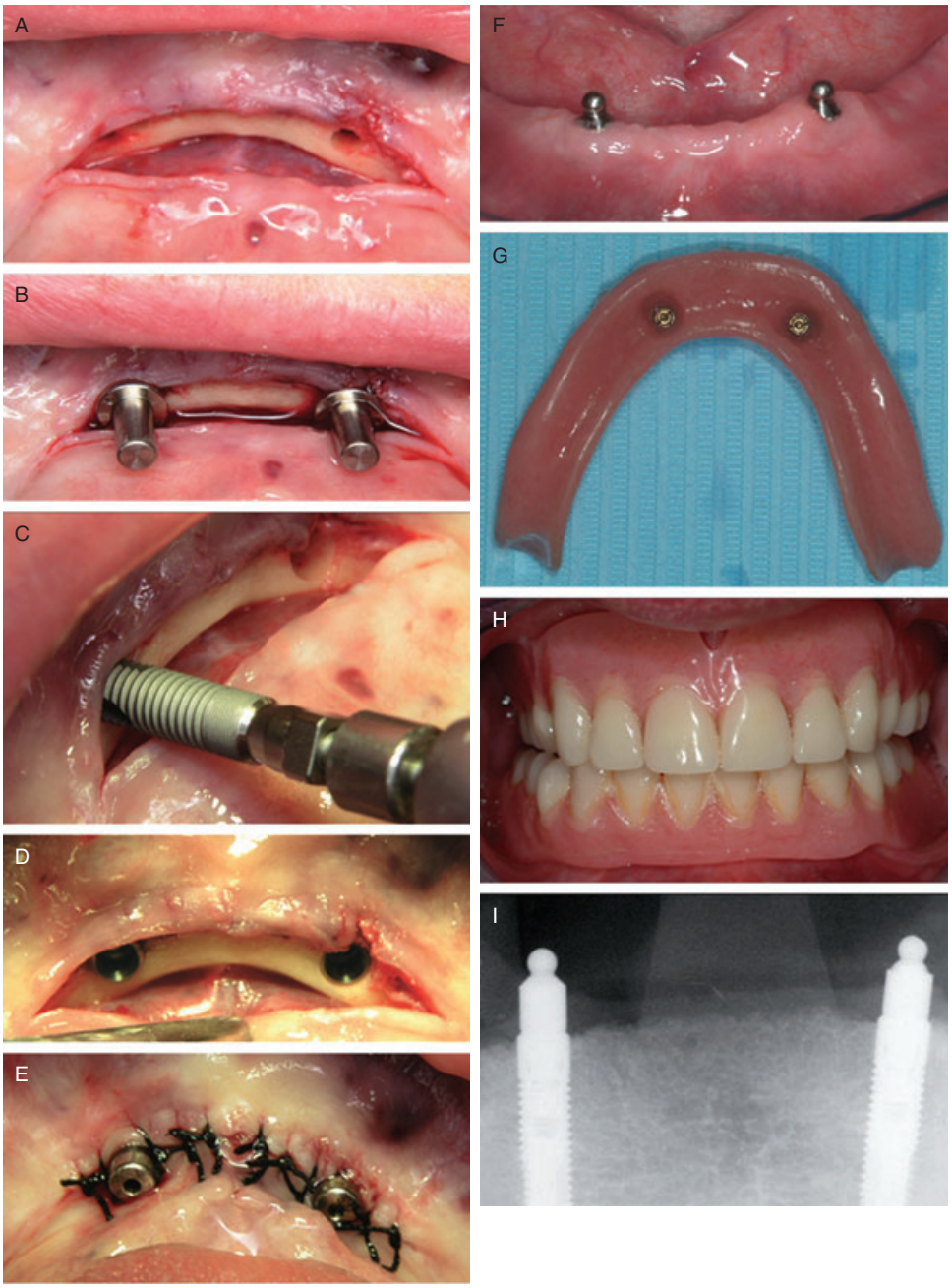

Figure 1 Case report. A crestal incision is made from canine to canine on the alveolar crest (A), and the implant recipient sites are prepared as parallel as possible (B). The TiOblast Microthreaded implant is inserted with a 30 to 40 Ncm initial torque force, allowing proper initial stability (C). Care is taken to seat the implant neck completely into the bone and flat with the alveolar crest (D). Healing abutments are chosen in order to have a 1.5- to 3-mm supramucosal location (E) to allow retention into the soft relining material and to avoid mucosal overgrowth because of postoperative swelling. After 2 to 3 months of healing, the healing abutments are replaced with the ball abutments, and the retention connector (G) allows for good seating of the denture, which is entirely mucosal supported (H). These two implants are representative for the best cases with nearly no radiographically detectable bone loss after 1 year of functional loading.

attachments were installed (Cendres & Métaux, Biel, Switzerland). A case report indicating this procedure is shown in Figure 1. The final prosthesis was in place within 4 months after implant installation, and all patients received a new complete denture in the maxilla. After finalizing the prosthetic treatment, the patients were given oral hygiene instruction and scheduled for professional maintenance by an oral hygienist at least

once a year. The recall interval was individually determined, depending on the patient's oral hygiene level and treatment need.

Clinical Examination

Implant survival was related to absence of clinical mobility, signs of infection or pain, and limited marginal bone loss as described by Albrektsson and Isidor.[23] Implant stability was examined clinically by rocking the implant between two instrument handles. Peri-implant health was determined by means of the peri-implant probing depth and the modified plaque and bleeding index.[24] The clinical examination parameters were assessed on four implant sites (midmesial, middistal, midbuccal, and midlingual) and afterwards recalculated on implant level and in addition, averaged on patient level. Furthermore, prosthesis retention, abrasion, damage of the prosthesis, occlusion, and implant positioning were assessed on a 4-unit scale for being either perfect, acceptable, adjustable, or to be corrected.[25]

Radiographic Evaluation

Digital apical radiographs were taken from each individual implant using a guiding system in order to obtain the x-ray direction perpendicular to the film. Whenever the implant threads were unclear, new radiographs were taken until the bone value could be determined. The computer calliper available in the data program (Visiquick, Thomas Monitor Systems, Amsterdam, the Netherlands) was used for detailed examination of marginal bone level under appropriate magnification. The lower edge of the smooth bevel of the coronal part of the implant was the baseline reference point as shown in Figure 2.

Patient's Opinion Questionnaire

The patients were given nine questions (in Dutch) pertaining to their appreciation regarding the general dentist's approach with the implant–prosthetic treatment and the satisfaction with the treatment outcome. They could choose between five options ranging from very negative (score 0) to very positive (score 4), and the average score per question was calculated.

RESULTS

In total, 37 patients had received 74 implants and ball abutments in the mandible. Three patients could not attend the examination because they were ill ($n = 1$) or had moved to another area ($n = 2$). The remaining 34 patients (mean age 63.6 years; SD 10.3; range 39–85; 13 females, 21 males) gave a written consent for the examination. The mean follow-up time for the whole group was 14.1 months. One of the 34 patients had lost both implants of 8- and 9-mm length within 8 weeks after surgery, probably related to smoking habits (>1 package a day) and/or overloading. Figure 3 shows the orthopantomographic image of the failure patient before and after surgery. Thus, the overall survival rate was 97%. In 8 of the 33 remaining patients, the final denture was not yet in place because they had been operated within 3 months prior to the examination date and therefore, these patients were not included in the final clinical and radiographic investigation. In total, 25 patients (13 females and 12 males) with implants of 15 ($n = 42$), 13 ($n = 6$), or 9 mm ($n = 2$) and a functioning time of 18.8 ± 7.6 months (range 4–33) were examined in detail. The patients were, on average, 60.5 years old (SD 9.2; range 42–81) and wearing a complete removable denture in the maxilla. Five patients indicated they were smoking more than 10 cigarettes per day. There was no

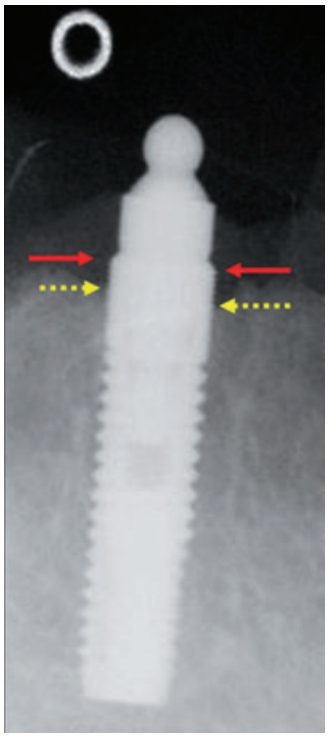

Figure 2 Radiographic image of the worst case after 1 year of loading. The bone level is measured from the red arrow (implant bevel) to the yellow arrow.

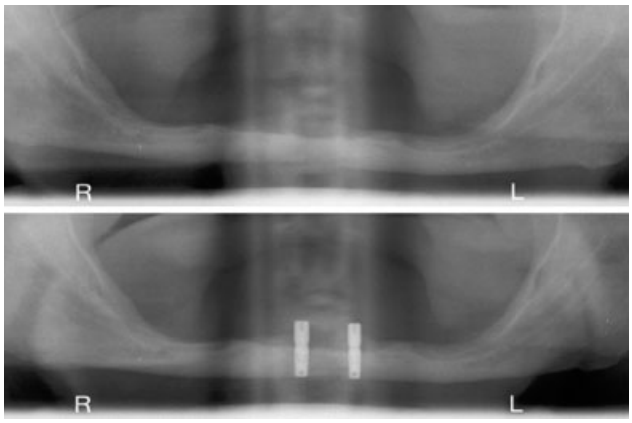

Figure 3 Pre- and postoperative orthopantomogram showing a failure case: two Astra Tech TiOblast implants of 8 and 9 mm in length, respectively, were lost. No signs of infection or surgical trauma were visible and presumably, the implants were lost because of overloading or smoking habits.

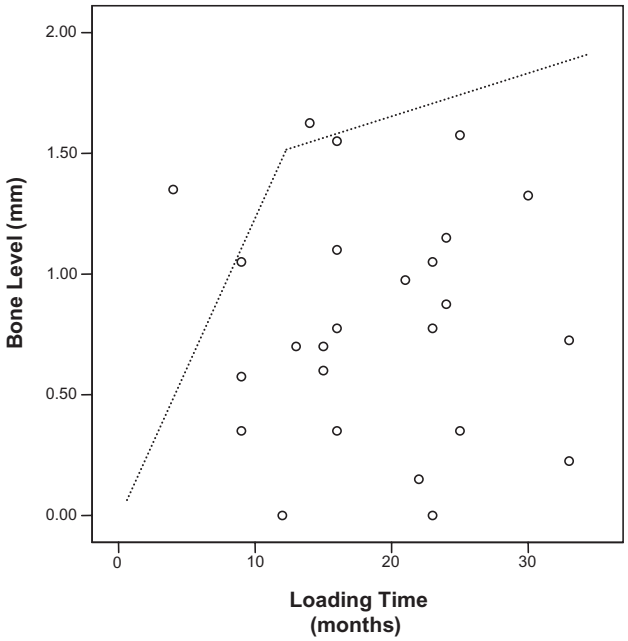

Figure 4 Marginal bone level measured from implant bevel in millimeter expressed per patient in relation to loading time in months. The dotted line shows the suggested maximum bone loss according to the success criteria of Albrektsson and Isidor.[23]

detailed information on the time of edentulousness. All examined implants were clinically immobile, without signs of pain, and all supporting a functional overdenture.

Radiographic marginal bone levels were measured at all 50 implants in the 25 final patients from the bevel of the coronal implant part to the bone (Table 1). As *t*-test revealed no difference between the mesial and distal bone values, the mean value per implant was calculated, and both implants were averaged to obtain the value on a patient level. Average bone level below the reference point was calculated as 0.8 ± 0.48 mm (mean ± SD; range 0–1.6) after a functioning time of 18.8 ± 7.6 months (range 4–33). The mean bone level calculated only for the 21 patients with at least 1 year of loading time was 0.8 mm (range 0–2). All individual patient values, in relation to loading time, are shown in Figure 4. The dotted line mimics the limit of acceptable bone loss according to the success criteria described by Albrektsson and Isidor.[23] Allowing 1.5 mm during the first year and a further maximum of 0.2 mm yearly, only two patients in the present study reported a slightly increased bone level, giving a calculated implant success rate of 92%.

The average probing depth was 2.1 mm (SD 1.0; range 0.5–5), and only two implants exhibited a probing pocket depth deeper than 3 mm. The mean plaque index was 0.9 (SD 1.0; range 0–4) with only two patients showing abundant plaque (index 3–4). Mean bleeding index was 0.8 (SD 0.9; range 0–3). Thirteen of the patients were completely free of bleeding, but four showed abundant bleeding on probing, which affected the mean value. The Pearson correlation showed a highly significant correlation between presence of plaque and the presence of bleeding ($p < .02$) on the left

TABLE 1 Bone to Implant Contact Level Measured from the Implant Bevel (Expressed in Millimeter) Mesially and Distally from the Implants as well as on a Patient Level

	Implants	Minimum	Maximum	Mean	Standard Deviation
Bone distal 43	25	0	2.2	0.94	0.71
Bone mesial 43	25	0	2.6	0.72	0.66
Bone mesial 33	25	0	1.9	0.56	0.58
Bone distal 33	25	0	2.3	0.97	0.65
Patient bone level	25	0	1.6	0.79	0.48

and right implants, but this did not significantly correlate with radiographically measured bone level.

Implant positioning and occlusion/articulation were scored as perfect in 74 and 80% of the cases, respectively. The retention of the dentures was perfect in 80%, but 20% needed minor activation of the attachments, which was done immediately. Twenty percent of the dentures showed signs of abrasion, and 20% had been repaired because of damage. In the average 19 months of loading, five patients had prosthetic complications, two dentures were broken, two had a damaged tooth replaced, and one attachment had been replaced.

The patients' satisfaction and opinion related to the treatment are listed in Table 2 (questions translated from Dutch into English).

TABLE 2 Patient's Opinion on Satisfaction and Treatment Outcome Scored on a Scale Ranging from Very Negative (Not at All = Score 0) to Very Positive (Very Much = Score 4)

Question	Mean ± Standard Deviation (range 0–4)
1. Are you positive about the fact that your dentist performed the surgical treatment?	3.9 ± 0.3 (3–4)
2. Did the fact that your dentist performed both the surgery and the prosthetics influence your decision to undergo treatment?	3.8 ± 0.4 (3–4)
3. Would you have done the implant treatment if your dentist had referred you to another surgeon?	2.6 ± 0.8 (1–4)
4. Would you have done the implant treatment if your dental insurance would not have reimbursed the treatment?	2.1 ± 1.0 (0–4)
5. Would you undergo the same treatment if necessary?	3.6 ± 0.5 (3–4)
6. Would you recommend the implant treatment to others (family members, friends . . .)?	3.7 ± 0.5 (3–4)
7. Score your appreciation of the treatment (performance of professional care).	3.9 ± 0.3 (3–4)
8. Score the information you have received prior to treatment.	3.7 ± 0.5 (3–4)
9. To what extent is the received information mimicking the reality after treatment?	3.6 ± 0.5 (3–4)

Results are expressed as mean ± standard deviations and range of answers; $n = 25$ patients.

DISCUSSION

The overdenture treatment protocol evaluated in this clinical study can be summarized as a one-stage surgical approach, whereby early functional loading was applied with a relined denture on two nonsplinted implants within 10 days after surgery. It is one of the few studies applying functional load in such a short time frame after surgery and, to our knowledge, is one of the first to describe the clinical outcome in overdenture therapy as obtained by nonspecialists.

Although the criteria for immediate loading (loading within 4 days after surgery) as agreed upon by the scientific community today were not met, clinically, it can be considered as being very close to immediate loading. Choosing to wait from 7 to 10 days before functionally loading the two implants was based on the clinical findings from the literature. In a study with an immediate loading protocol on two nonsplinted implants,[13] 40% of the patients could not wear the denture because of postoperative swelling, causing pain and mucosal irritation. It was therefore considered more practical to reline the denture at the moment of suture removal. At this time, the healing abutments are completely load bearing. This is a slight deviation from the original protocol that advocated generous relief on the undersurface of the denture with spacing around the healing abutments to avoid any torque force or initial loading. In the present study, the healing abutments were functionally loaded, albeit with a relining material. It is essential, however, that the choice of the abutment height is appropriate. Care was taken to leave the abutment only 1 to 2 mm above the mucosal crest and to correctly adapt the posterior fit of the denture in order to improve the mucosal support. As a consequence, the lever effect on the implants is minimized. In a few cases, the healing abutments were replaced by shorter ones during the course of the initial healing to avoid overloading complications. The healing abutments were replaced by ball abutments after soft tissue healing and initial bone remodeling. In a one-stage surgery in the mandible, this is known to occur within the first 3 months.[26] With this approach, early relining of the final prosthesis could be avoided, which is cost beneficial. The original components and prosthetic

technique recommended by the manufacturer were used, and the appropriate abutment height was chosen with the retention ball placed as close as possible to the mucosa. The denture was completely resilient, aiming for balanced occlusion and articulation.

Only two out of the 68 examined implants (97.3%) failed in the initial healing stage in a heavy smoker. He was treated with very short implants, installed in predominantly cortical bone. The failure could be because of overloading. As can be seen on the radiograph in Figure 3, relatively long healing abutments were installed to avoid gingival overgrowth during the initial healing. This has probably created an unfavorable lever moment on the implants. Furthermore, the predominantly cortical bone in a smoker is probably more prone to complications because it is less vascularized. It seems clinically unwise to recommend immediate loading of nonsplinted implants in a smoker provided with short implants.

The present treatment outcome obtained by one dentist is comparable to studies reporting an implant survival rate of 95.7%, although marginal bone levels were not reported.[27] Apparently, a one-stage surgical approach and the early loading on nonsplinted fixtures do not jeopardize the clinical outcome. Gotfredsen and Holm[28] published a less than 2% fixture failure rate with overdentures loaded conventionally after a classical two-stage procedure, and marginal bone loss was 0.6 mm. In the present study, the mean marginal bone loss calculated from the reference point was 0.8 mm during the first year. This value is far within the range accepted by the European Federation for Periodontology,[23] allowing 1.5-mm bone loss during the initial first year and 0.2 mm additionally after each subsequent year of loading. Expressed on an individual patient level (see Figure 4), 92% of the implants were considered a success. Compared with fixed mandibular reconstructions on four to five splinted early-loaded Astra Tech implants, the survival outcome is only slightly lower. Collaert and De Bruyn[29] described 25 mandibular cases whereby early loading within 18 days yielded a 2-year survival rate of 100% and corresponding bone loss of 0.7 mm. Table 2 indicates that marginal bone level did not correlate with the loading time. In other words, some implants lose nearly no bone after a longer functioning period, while others lose some bone initially. The peri-implant health was rated as good-perfect, which is also because of a strict maintenance protocol. The patients were seen for maintenance by an oral hygienist, on an individually decided basis, every 3 to 6 months. These results were similar to those described by other authors using the same implant system.[15,28,30,31]

The external examiners rated the implant positioning perfect in 74% of the cases because of the proper planning and use of denture during the drilling procedure. The retention of the dentures was perfect in 80% of the cases, but 20% needed minor activation of the attachments, which was done immediately. The reactivation of the attachment is commonly described as a normal feature and should be taken into account when proposing implant-retained overdenture treatment.[26,28,31] An average complication per patient per year of 0.6, requiring minor technical modifications of the overdenture or the attachment mechanism, has been reported.[28] The high repair rate of 20% of the denture and signs of abrasion after a relatively short function time is similar to the complication rate described in a group of complete implant-supported bridges on four to six implants.[32]

The overall patient satisfaction scored from several questions was above 90%, and patients would recommend the treatment to others and were prepared to undergo the same procedure again. They indicated that they appreciated that the dentist did not refer them to another surgeon and that this indeed influenced their decision to a great extent. The patients pointed out that they would be more hesitant in choosing the given treatment in case the dental insurance did not reimburse their costs. This study does not offer any conclusions with respect to the patients' financial condition or the real impact on their personal economical situation and the choice to undergo implant treatment. There was no other alternative investigated because all patients benefited from the insurance conditions for reimbursement.

CONCLUSIONS

Overdenture treatment on two nonsubmerged and nonsplinted implants connected with ball attachments is a feasible treatment option for edentulous patients in the mandible. Providing both surgical and prosthetic treatment by a general dentist can have an impact on the cost-benefit outcome and can reduce the barriers for implant treatment in clinical daily practice.

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