Dental Implants as Strategic Supplementary Abutments for Implant-Tooth–Supported Telescopic Crown–Retained Maxillary Dentures: A Retrospective Follow-up Study for Up to 9 Years

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Purpose: The aim of this retrospective study was to present the results of implants and natural teeth used as combined abutments to support maxillary telescopic prostheses. ***Materials and Methods:*** Between 1997 and 2004, 22 patients with residual maxillary teeth underwent prosthodontic rehabilitation with supplementary implant placement of implant-tooth–supported telescopic prostheses. A total of 60 supplementary implants (mean: 2.9 implants; SD: 1.6; range: 1 to 5 per patient) were placed in strategic position and connected with 48 natural abutment teeth (mean: 2.2 teeth; SD: 0.9; range: 1 to 4 per patient) using telescopic crowns. The follow-up registration included implant and natural tooth survival rates and peri-implant and periodontal parameters, along with prosthodontic maintenance. Natural tooth abutments were additionally followed to compare their periodontal parameters at baseline to the follow-up examination. ***Results:*** After a mean of 38 months (12 to 108 months) no implants or natural tooth abutments were lost (survival rate: 100%). There was no fracture, endodontic treatment, loss, or intrusion of natural teeth used for telescopic abutments. Implant abutments showed high stability and excellent peri-implant soft tissue conditions. Natural tooth abutments used for double crowns also showed uneventful progress. A low rate of prosthodontic maintenance was seen, with implant screw abutment loosening as the most severe complication (3 of 60 implants; 5%). ***Conclusions:*** On the basis of this retrospective clinical review, the following conclusions were drawn: *(1)* successful function over a prolonged period and a minor complication rate of implant-tooth–supported telescopic maxillary dentures may be anticipated, and *(2)* the great variety of treatment modalities offered by tooth-implant support for telescopic prostheses appears to be useful as a treatment option for the maxilla in elderly patients. *Int J Prosthodont 2007;20:617–622.*

In recent decades, dental implants have become a fixed component of the wide range of treatment options in state-of-the-art odontology.[1–3] The use of dental implants predominantly focuses on fixed prosthetic reconstruction of single- or multiple-tooth gaps as well as removable and fixed prostheses for the edentulous arch.[1,2] In this context, a high success rate has been reported for implants and implant-supported prostheses, as well as for fixed and removable dentures.[1–3]

However, the combined use of tooth and implant support for fixed prosthetic rehabilitation of partially dentate arch sections is still considered as a viable treatment option.[4,5] The various connection modalities and the distance between the tooth and implant have been evaluated with varying success rates, with complications such as intrusion phenomenon in natural teeth and increased peri-implant bone loss considered the most frequent complications.[6,7]

In a recent study, the influence of the periodontal situation of residual teeth on the intrusion phenomenon with combined fixed tooth—implant treatment was described, and an intrusion phenomenon was seen less frequently with periodontally compromised abutment teeth than with abutment teeth without any periodontal

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Table 1 Characteristics of Implants Used as Telescopic Attachments

	Diameter (n and %)			
Length (mm)	3.8 mm	4.3/4.5 mm	5.0/5.5 mm	Total
10/11	–	–	1 (1.6)	1
13	20 (33.3)	2 (3.3)	–	22
15/16	34 (56.6)	2 (3.3)	1 (1.6)	37
Total	54 (90)	4 (6.6)	2 (3.3)	60

impairment.[8] When using rigid implant-tooth connections, teeth with compromised periodontal status appear to provide an advantage with regard to an intrusion.[6,8]

Similar to conventional partial prostheses, implant prosthetics utilize strategic abutments for the application of prosthetic treatment concepts.[9,10] In general, it is important in the preparation of removable partial prostheses to use any abutment options available to achieve a favorable support zone.[9–12] From a functional perspective and according to generally applicable prosthetic concepts, a polygonal and/or quadrangular and/or triangular abutment arrangement in the maxilla is considered a favorable support situation.[9,11,13]

Modern implant dentistry allows for the conversion of an unfavorable baseline situation resulting from the loss of abutment teeth into a favorable prosthetic environment.[12,13] Insertion of strategically placed implants may provide for positive abutment conditions and thus for the development of a favorable support zone.[14] For removable prostheses, the combined use of residual teeth and strategically placed implants in a favorable arrangement will provide for a wide range of new and optimized treatment options, and thus for an extensive and almost unlimited spectrum of new treatment possibilities.

However, the combination of tooth-implant support in removable prosthetics is a topic rarely covered in the literature.[12–14] Complex technicalities and difficulties in preparing homogenous anchoring options on teeth and implants are cited as the principal reasons for the rare use of this option.[14] The use of double-crown techniques on rotationally stabilized implants together with natural teeth may help in the manufacture of homogenous anchorage elements, thus facilitating the use of this combination.[15]

The present study aimed to provide long-term results on the state of the prostheses, implants, and residual teeth being used in the tooth-implant combination for anchoring removable prostheses with the double-crown technique.

Materials and Methods

Patient Cohort

The study was designed as a retrospective clinical investigation. The records of 22 patients (14 women, 8 men; mean age: 63.7 years; SD: 7.9 years) who received a maxillary removable partial denture retained by double crowns supported using a combination of natural teeth and dental implants between 1997 and 2004 were recruited. All patients showed a compromised periodontal situation (without signs of active periodontitis) and a reduced dentition with a mean of 2.9 teeth per patient (SD: 1.6; range: 1 to 7) presenting Kennedy classes I to IV situations (plus modifications). Inclusion criteria comprised the absence of strategic abutments for a triangular/quadrangular support of maxillary dentures.

In total, 48 natural teeth with a mean of 2.2 natural teeth per patient (SD: 0.9; range: 1 to 4) served as abutments for double crowns. At prosthesis placement, all natural teeth used as abutments for double crowns were initially evaluated for their stability (Periotest value) and pocket depth measurements.[16,17]

Overall, the 22 patients received 60 dental implants (mean: 2.7; SD: 1.2; range: 1 to 5) placed in strategic positions for increasing the number of abutments to achieving a triangular/quadrangular support for a removable maxillary denture. All implants were placed in a traditional delayed protocol. All implants had internal connections and a screw design (Frialit-2 or Xive, Friadent; Camlog root-line, Alltec). Table 1 shows the distribution of implant characteristics (implant type, implant length, and diameter) used in this study. Of the 60 implants used, 59 (98%) were longer than 10 mm. Maxillary sinus augmentation was performed for 8 implants.

Table 2 shows the locations of strategic implants placed, natural abutment teeth, residual teeth, and pontics of the 22 patients. With the supplementary implants, the overall number of abutments for double crowns increased from 2.2 (SD: 0.9; range: 1 to 4) natural abutments to 4.9 (SD: 1.4, range: 4 to 9) natural tooth and implant abutments per patient.

Prosthodontic Concept

The strategic implants and natural abutment teeth were provided with double crowns (telescopic crowns). The use of implants with rotationally stabilized internal connections allowed for direct preparation of the implant abutments (titanium) as primary crowns.[15] Primary (inner) crowns on natural teeth and secondary crowns on implant abutments and natural teeth were precisely cast (titanium or gold alloy) and connected to a cast

Table 2 Locations of Implants, Natural Abutment Teeth, Residual Teeth, and Pontics in the 22 Patients

	FDI tooth no.														Totals		
Patient	17	16	15	14	13	12	11	21	22	23	24	25	26	27	I	A	Ab
1	–	I	I	X	I	X	X	A	A	A	X	I	I	–	5	3	8
2	–	I	I	X	A	A	A	A	X	I	I	X	I	–	5	4	9
3	–	A	X	X	I	X	X	X	X	I	A	X	A	–	2	3	5
4	X	X	I	X	I	X	X	X	A	A	X	X	X	–	2	2	4
5	–	X	X	I	X	I	X	X	X	A	X	A	X	–	2	2	4
6	X	X	I	X	I	X	X	X	A	A	X	X	X	X	2	2	4
7	–	X	X	A	A	I	X	X	I	A	I	X	X	–	3	3	6
8	–	X	I	X	I	T	T	T	T	A	X	I	X	–	3	1	4
9	–	X	X	I	X	I	X	X	A	X	A	X	X	–	2	2	4
10	–	X	I	X	I	X	X	A	A	A	X	X	X	–	2	3	5
11	–	A	X	X	A	T	T	T	T	A	X	X	I	–	1	3	4
12	–	X	X	I	A	X	X	X	X	I	X	X	X	A	2	2	4
13	–	X	I	X	I	X	X	X	X	I	X	A	X	–	3	1	4
14	–	I	X	I	X	I	X	X	X	A	I	X	I	–	5	1	6
15	–	X	A	X	A	X	X	X	X	I	X	I	X	–	2	2	4
16	X	X	X	X	I	I	T	T	T	T	A	A	X	X	2	2	4
17	–	X	X	I	X	I	X	X	X	A	X	I	X	–	3	1	4
18	–	I	A	X	I	X	X	X	X	I	X	I	A	–	4	2	6
19		I	X	I	I	X	X	X	X	A	X	A	A	–	3	3	6
20	–	X	X	I	X	I	X	X	X	A	X	A	X	–	2	2	4
21	–	X	I	X	I	T	T	T	T	A	X	I	X	–	3	1	4
22	–	A	X	X	I	X	X	X	X	I	A	X	A	–	2	3	5

I = implant; A = natural tooth abutment; T = residual tooth; X = pontic; Ab = total abutments.

titanium/cobalt-chromium-molybdenum alloy framework. For a passive fit, the framework and secondary crowns were luted intraorally after temporary placement (Nimitec Cem, 3M ESPE). Eighteen patients received complete overdentures and 4 received partial dentures with minimized palatal support where some anterior teeth remained uncovered (Table 2). To achieve sufficient retention or to improve the retention between inner and outer telescopic crowns, the authors used the TC-SNAP (Si-Tec) in a similar manner as described by Krennmair et al[15] situated in the outer telescopic crown (Marburg double crown). Denture bases, occlusion, and articulation were fabricated as described previously.[3,12–14] All prostheses had antagonist occlusion. Natural teeth or a fixed prosthesis on natural teeth were present in 8 patients (36.4%), prostheses on implants were present in 5 patients (22.7%), and removable prostheses were present in 9 (40.9%) patients.

Follow-up Examination

To collect updated clinical information, patients were recalled for a follow-up examination. All patients were in a strict recall program and given regular hygienic maintenance. At the final follow-up, survival rates of implants and natural teeth were evaluated. In addition, peri-implant structures and periodontal parameters were evaluated.

The recall program for the implants included assessments of peri-implant marginal bone loss (mm); pocket depth (mm); plaque, bleeding, and gingival indices (grade 0 to 3); and implant mobility (Periotest, Siemens), along with implant survival time (months) as described in previous studies.[15] Peri-implant marginal bone loss (mm) was assessed radiographically, including an orthopantomogram and/or single periapical radiographs.[15,17,18] The distance between the crestal bone level and a defined marking on the implant (lateral border of the implant platform) was measured for each implant from the initial radiographs (following implant placement) and from the final radiographs. Initial radiographs were then compared with the follow-up radiographs. Probing (pocket) depth was defined as a mean value of measurements at 4 sites (mesial, distal, lingual, buccal) using a calibrated periodontal probe (Hu-Friedy). Implant mobility was measured with the Periotest at the abutment close to the implant edge when the prostheses were removed for cleaning or for checking the abutment screws during the follow-up examination.[16] Plaque, bleeding, and gingival indices were assessed as described in previous studies, and the presence of calculus (score 1) or the absence of calculus (score 0) was assessed [15,17–19]

Follow-up evaluation of natural teeth included examination of their clinical outcome (loss, endodontic treatment, fracture, intrusion). In addition, tooth stabil-

Fig 1a Strategic implants for supplementary abutments in the canine region.

Figs 1b and 1c Inner crowns of natural teeth and implants for combined overdenture anchoring.

Fig 1d Maxillary overdenture in a horseshoe design.

ity (Periotest), pocket depth, plaque and bleeding indices, and calculus status were evaluated in a similar manner as for the peri-implant evaluation to illustrate the progress of the natural abutment teeth. [15,17] The data obtained for the natural teeth (Periotest, pocket depth) were compared with findings at the time of prosthesis placement (initial findings) and at the follow-up examination.

Postinsertion Maintenance

During the follow-up period, prosthetic postinsertion maintenance of natural teeth and implants was evaluated. For the inner telescopic crown, the following parameters were assessed: *(1)* implant maintenance: implant loss/fracture, abutment/screw loosening, abutment fracture; and *(2)* natural tooth maintenance: tooth fracture, caries, endodontic treatment, extraction, intrusion. For the outer telescopic crown and the prosthesis, the following prosthetic maintenance parameters were assessed: activation of the matrix (implant crown/natural crown); tooth/prosthesis fracture; and prosthesis repair, relining, and margin adjustment (extension/reduction).

Statistical Analysis

The parameters were recorded in a descriptive statistical manner, tabulated, and evaluated. The survival rate of implants and natural teeth was analyzed using a cumulative life table analysis. Categorical variables for nonparametric data were compared using the chi-square test, and mean values were tested with the *t* test. Statistical significance was set at $P < .05$.

Results

All 22 patients were available for follow-up after a period of 12 to 108 months (mean: 38 months; SD: 14.6). The 22 patients had received 22 telescopic maxillary dentures with triangular (n = 3) or quadrangular (n = 19) support. Figs 1a to 1d show the intraoral situation of patient 3.

Overall, 108 abutments with double-crown treatment (60 implants and 48 natural teeth) were evaluated. No implants or abutment teeth were lost during the follow-up period. Table 3 shows the relative time of service of the prostheses as well as that of the implants and natural teeth used as abutments. Nearly 50% of the abutments (n = 53) showed a service time of more than 3 years.

Peri-implant conditions such as radiographic marginal bone resorption (mean: 2.2 mm; SD: 1.0 mm), pocket depth (mean: 2.4 mm; SD: 0.8 mm), Plaque Index (mean: 0.3; SD: 0.4), Gingival Index (mean: 0.3, SD: 0.5), Bleeding Index (mean: 0.3; SD: 0.5), calculus (mean: 0.2, SD: 0.2), and Periotest values (mean: –2.1; SD: 1.7) showed healthy peri-implant structures at the final examination.

For the abutment teeth, no significant differences were seen between the findings of stability (Periotest mean: 6.8; SD: 4.1 versus mean: 7.9; SD: 5.7) and pocket depth (mean: 2.8 mm; SD: 0.9 mm versus mean: 3.2 mm; SD: 1.5 mm) obtained initially and those at the follow-up, respectively. Additionally, the periodontal parameters (Plaque Index mean: 0.5, SD: 0.6; Gingival Index mean: 0.5, SD: 0.5; Bleeding Index mean: 0.6, SD: 0.6; calculus mean: 0.4, SD: 0.2) also showed an acceptable hygienic status. No cases of tooth loss, intrusion, tooth fracture, or endodontic treatment were encountered during the follow-up period.

Prosthetic maintenance was limited to minor interventions. For the inner implant abutment, 3 cases of screw loosening occurred. For the outer abutment, matrix activation (Si-Tec activation) was necessary in 2 cases. Further, 3 cases of tooth fracture occurred, and 4 patients required denture margin adaptation.

Table 3 Relative Age (Time of Service) of Dentures, Implants, and Natural Teeth Used for Double-Crown Abutments

Service time (y)	Denture n (%)	Implant abutment n (%)	Tooth abutment n (%)	Total abutments n (%)
< 1	22 (100)	60 (100)	48 (100)	108 (100)
> 1	22 (100)	60 (100)	48 (100)	108 (100)
> 2	16 (73)	42 (70)	35 (73)	77 (71)
> 3	10 (45)	27 (45)	26 (54)	53 (49)
> 4	5 (23)	16 (27)	15 (31)	31 (29)
> 5	4 (18)	14 (23)	13 (27)	27 (25)

Discussion

Combined tooth-implant support in removable prosthetics is rarely discussed in the literature.[13,14] Principally, the basic rules and guidelines of classical prosthetics for the manufacture of removable partial prostheses should also be applicable and used in implant prosthetics.[9] The insertion of dental implants in strategically favorable positions can provide for a favorable abutment situation and thus allow for a variety of new prosthetic anchoring options for a removable prosthesis.[9,10] This treatment option provides for new perspectives, especially for elderly patients with few remaining but still functional residual teeth.[14,19] For this patient population requiring implant placement at strategically favorable positions, this type of surgical intervention frequently represents only a minor burden. Thus, especially for elderly patients, this rather simple intervention with minor invasiveness allows for the execution of a prognostically favorable treatment concept.[14,19]

Several studies reported that the long-term prognosis for double crown–supported removable partial prostheses depends on the number of abutment teeth available.[20–22] A small number of abutment teeth will negatively affect the long-term prognosis of the prosthesis. Significant differences in the long-term behavior have been reported between treatments with fewer than 3 abutment teeth and those with 4 or more.[20–22] With 3 abutment teeth for the prosthesis, the long-term prognosis after 5 years will decrease from 90% to 70%, while prognostic survival rates of more than 85% after 5 years have been reported by virtually all authors when using 4 or more abutments.[20,22]

The results of the present study provide data on the combination of implants and natural teeth to anchor removable prostheses. Insertion of the additional implants increased the mean number of abutments from 2.2 ± 0.8 residual teeth to 4.9 ± 1.4, representing an increase of more than 100%. No implants or abutment teeth were lost during the follow-up period, with complete survival of all prostheses. Thus, it may be assumed that by increasing the number of abutments with strategically placed implants the prognosis of both natural abutment teeth and the complete technical restoration is enhanced.[14,23,24]

Interestingly, no intrusion phenomenon in the residual teeth or increased peri-implant bone loss were observed.[6,8] Since the residual dentition was assessed as periodontally compromised, this confirms previous reports that periodontally compromised natural teeth benefit the implant-tooth connection.[8] The nearly unchanged stability values and periodontal parameters for the natural teeth in the follow-up examination versus the baseline findings suggest that this combination plus stabilization using dental implants provides for a beneficial progress of natural abutment teeth.

Regarding the type of anchorage, homogenous anchorage for each prosthesis appears to be favorable with respect to cost, manufacture, and handling.[14,15] Thus, the double-crown technique represents an ideal

type of anchorage.[15,20–22] When using implants with rotationally stabilized internal connections, the abutment can be directly processed as an inner telescope. Since the additional manufacture of an inner telescope then becomes unnecessary, this solution not only simplifies and facilitates technical processing, it also reduces the cost.[15]

It has been established that the use of a single attachment shows a favorable effect on dental hygiene, especially in elderly patients. Assessment of hygienic parameters for implant abutments and natural tooth abutments demonstrated satisfactory soft tissue conditions for both abutments.[15,25,26]

Proper selection of the remaining natural teeth and their periodontal health are of primary importance for the use of this type of prosthetic solution. The results of the present study show that periodontally compromised teeth without signs of periodontitis may nevertheless be used with high success rates in combination with removable anchorage of dental implants.[27,28] With careful clinical selection, periodontal compromise of residual teeth used as abutment teeth will not adversely affect outcome.[27,28]

Overall, the results of this study show that single implants placed in strategic positions provide for a virtually indefinite range of options for removable prostheses with high success rates. The combination of implant and tooth support using double crowns in the field of removable prostheses represents a treatment option with improved long-term prognoses of the technical constructions.

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