Which Patient-Related Factors Influence the Outcome of Telescopic-Retained Removable Implant-Supported Dental Prostheses in Edentulous Patients?

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Purpose: To survey the clinical performance of telescopic-retained removable implant-supported dental prostheses (TR-RISDPs) in edentulous patients, as well as incidental maintenance measures and technical complications. Materials and Methods: In this retrospective analysis, the former presence of oral cancer, prosthesis location (maxilla or mandible), and participation in a follow-up program were analyzed as possible factors with an influence on survival and maintenance treatments of the TR-RISDPs and dental implants using Kaplan-Meier estimates. Results: A total of 86 TR-RISDPs (mean follow-up: 4.62 ± 3.24 years; maximum 13.8 years) and 465 implants (mean follow-up: 5.67 ± 3.59 years; maximum 16.5 years) were observed. Six (6.9%) of the TR-RISDPs had to be remade, and 11 (2.3%) implants failed. Regular attendance in the follow-up program showed significantly higher survival times and fewer maintenance treatments for the TR-RISDPs (P < .05). Implants in patients with former oral cancer showed significantly lower survival times (P < .001). Conclusions: TR-RISDPs in edentulous patients show excellent clinical outcomes. Regular check-ups are decisive for success. Int J Prosthodont 2022;35:690–696. doi: 10.11607/ijp.7834
is very cost-intensive and time-consuming in comparison to other attachment systems.\textsuperscript{14,19} The high frequency of necessary maintenance measures and complications with RISDPs, especially in conjunction with the respective anchoring system used, is commonly known.\textsuperscript{1,5,6,8,10,12--19}

As there is a lack of information on the clinical performance of TR-RISDPs, the present retrospective study should make a contribution to the current literature. The following null hypothesis was tested: the survival rate for TR-RISDPs and dental implants will not differ for (1) patients with vs without previous oral cancer disease; (2) the maxilla vs the mandible; or (3) patients who attended the follow-up program vs those who did not.

**MATERIALS AND METHODS**

This retrospective clinical study observed the existing clinical data of completely edentulous patients who were provided with TR-RISDPs at the Department of Prosthodontics, Justus-Liebig University Giessen, Germany, between January 2004 and January 2018.

All patients with remaining dentition, pre-existing tooth- or implant-supported prostheses, anchoring systems besides telescopic retention (eg, ball- or bar-retained prostheses), and/or obturators were excluded from the study. Only patients with a minimum follow-up of 6 months were included. In cases where the patient received TR-RISDPs in both arches, only one prosthesis was chosen at random for inclusion in the study to avoid bias from clustering of events.

To provide consistent standards, fully trained dentists performed treatment according to a defined treatment procedure. All dental implants were placed at the Department of Oral and Maxillofacial Surgery, Justus-Liebig University Giessen, using a two-stage surgical procedure. One week after implant uncovering, the first impression was taken for fabricating an individualized tray. The implant impression was taken using the pick-up method and a polyether impression material (Impregum Penta, 3M ESPE). All TR-RISDPs were manufactured in the same dental laboratory using only parallel-sided telescopic crowns and secondary copings made from a precious metal alloy (Bio Herador SG, Kulzer; Degulor M, Dentsply Sirona). The tertiary framework was made from a nonprecious metal alloy (Heroanium, Kulzer). After the maxillomandibular relationship was determined, control of the fit of the abutments (primary crowns) in the mouth took place using a control key. To create a minimum tension, the secondary copings and the tertiary framework were bonded intraorally using a compomer-based self-curing fixing cement (AGC Cem, Wieland Dental). After a wax try-in, the dental prostheses were finished using veneering composite for the tertiary crowns (Signum composite, Kulzer), a methacrylate copolymer for fabricating the denture saddles (Palaxpress, Kulzer), and acrylic resin denture teeth (SR Vivodent S DCL, Ivoclar Vivadent). After fitting the TR-RISDPs and final equilibration, the patients underwent a 30-day adaptation phase. A continuous annual follow-up program was offered to all patients provided with TR-RISDPs. During the follow-up appointments, the prostheses were checked for functionality (eg, assessment of occlusion, friction of the telescopic crowns, and congruence of the denture base), and the implants were checked using x-rays and periodontal parameters. The prostheses were indicated in need of replacement if they could not be repaired or remodeled after major damage or implant loss.

Computer-based electronic health records from the department were used for data collection. The following data were taken: placement date and date of renewal of the TR-RISDPs as the start- and endpoint values for calculating survival probability; placement date (start-point value) and date of removal due to failure (target event) of the implants for calculating survival probability; type, number, and date of complications and maintenance treatments of the prostheses if carried out; and type, number, and date of complications with dental implants. Maintenance measures were counted starting 30 days after placement of the TR-RISDPs to ensure an initial adaptation phase. A Kaplan-Meier estimate with 95% CI was used for survival analysis. If none of the target events occurred, the date of the final visit of the patient was set as the target event. The variables presence of oral cancer prior to treatment, prosthesis/implant location (maxilla or mandible), and regular participation in follow-up visits were analyzed as covariates (log-rank test, $P < .05$). Cox regression was performed as well.

All patients previously consented to having their data used anonymously for the purpose of scientific evaluation. Nevertheless, the present investigation was approved by the ethics committee of the Justus-Liebig University (reg no. 164/11).

**RESULTS**

Out of 132 eligible patients, 46 were excluded from the study because they showed single remaining teeth ($n = 33$) or different anchoring systems ($n = 13$). Therefore, 86 patients (48 women and 38 men, mean age $63.6 \pm 10.3$ years) with 86 TR-RISDPs (28 in the maxilla and 58 in the mandible) and 465 implants (196 in the maxilla and 269 in the mandible) were included in the analysis.

A total of 42 (48.8%) patients were treated with TR-RISDPs because they could not cope with a conventional prosthesis due to a severely atrophied jaw; 35 (40.7%) patients received TR-RISDPs following previous oral cancer surgery and could not be restored with a conventional prosthesis because of unfavorable bone conditions; and 9 (10.5%) patients asked directly for...
treatment with TR-RISDPs because they did not want a conventional prosthesis. The number of implants used per TR-RISDP is displayed in Table 1.

A total of 35 (40.7%) patients had undergone oral cancer surgery prior to treatment. Of these patients, 11 received reconstructive surgery using a fibular transplant. Of all patients provided with TR-RISDPs, 52 (60.5%) participated regularly in the annual follow-up program. The mean ± standard error (SE) expected survival time for TR-RISDPs was 12.71 ± 0.51 years (95% CI: 11.70 to 13.71 years) compared to 6.95 ± 0.60 years (95% CI: 5.40 to 8.50 years) (Fig 2 and Table 3).

None of the other factors showed a significant influence on the survival of the TR-RISDPs. Therefore, the first two null hypotheses could not be rejected.

Survival of Dental Implants
A total of 2.3% (n = 11) of the implants were lost. Two implants fractured, and 9 had to be removed because of massive bone loss following a peri-implant disease. Seven (2.7%) implants failed in the BEGO group and 4 (1.9%) in the Xive group.

The mean ± SD expected survival time of the implants was 15.8 ± 0.21 years (95% CI: 15.3 to 16.2 years). After 5 and 10 years, 98.4% and 92.8% of the implants were still in function (Fig 3).

Dental implants in patients with a history of oral cancer showed a significantly lower survival probability in comparison to patients without former oral cancer disease (P < .001). The mean survival time of dental implants in former oral cancer patients was a mean ± SE of 11.55 ± 0.55 years (95% CI: 10.47 to 12.63 years) in comparison to 16.10 ± 0.18 years (95% CI: 15.73 to 16.23 years) in patients without previous oral cancer (Fig 4 and Table 4).

None of the other factors showed a significant influence on the survival of the implants. Thus, the last two null hypotheses could not be rejected.

Maintenance Measures
Overall, 222 maintenance treatments had to be performed for 65 (75.5%) TR-RISDPs (Table 5).

The mean ± SD expected survival time until the first maintenance treatment became necessary was 2.53 ± 0.42 years (95% CI: 1.69 to 3.37 years; Fig 5).

Regular attendance in the follow-up program showed a significant influence on the time until the first maintenance treatment became necessary (P < .01). Patients who attended the follow-up program regularly showed a mean survival time of 3.22 ± 0.57 years (95% CI: 2.08 to 4.35 years), whereas patients who did not showed a mean survival time of 1.14 ± 0.30 years (95% CI: 0.54 to 1.74 years) (Fig 6).

None of the other factors showed a significant influence on time to first maintenance measure. Thus, the first two null hypotheses could not be rejected.
DISCUSSION

The fact that only 6 TR-RISDPs (6.9%) had to be replaced and only 11 implants (2.3%) failed during the observation period is highly positive, but also rather critical for the statistical evaluation. This means that, with the high proportion of censored data, the survival function did not fall below 50% as expected. This in turn means that calculation of the median could not be carried out, since the previously defined event (prosthesis renewal or implant replacement) did not occur within the observation period for a sufficient number of cases.

Table 3  Mean Time (y) to Replacement of TR-RISDPs by Attendance in Follow-up Program

<table>
<thead>
<tr>
<th>Participation in follow-up program</th>
<th>Mean</th>
<th>SE</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>12.705</td>
<td>0.513</td>
<td>11.699</td>
<td>13.712</td>
</tr>
<tr>
<td>No</td>
<td>6.947</td>
<td>0.794</td>
<td>5.391</td>
<td>8.504</td>
</tr>
<tr>
<td>Total</td>
<td>12.049</td>
<td>0.593</td>
<td>10.886</td>
<td>13.211</td>
</tr>
</tbody>
</table>

SE = standard error.

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loss) must occur in at least 50% of the cases. For this reason, the calculated mean value of survival time was recorded. However, due to the high number of censored cases in the present study, the calculated mean survival times of the TR-RISDPs and dental implants should be viewed with caution. Apart from these statistical difficulties, this study benefits from many positive aspects. The standardized treatment and manufacturing process of the TR-RISDPs, as well as the exact documentation of each treatment step, follow-up visit, and necessary maintenance measure, ensures high-quality data.

The calculated 5- and 10-year survival probabilities of 95.8% and 88.6%, respectively, for TR-RISDPs, as well as the reasons for replacement, are in accordance with the current literature. Other studies have reported higher survival probabilities for TR-RISDPs, up to 100% after 3 to 10 years. The reasons for this can be seen in the lower amount of observed

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### Table 4  Mean Time (y) to Loss of Implants by Presence of Former Oral Cancer Disease

<table>
<thead>
<tr>
<th>Oral cancer</th>
<th>Mean</th>
<th>SE</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>11.553</td>
<td>0.550</td>
<td>10.476</td>
<td>12.630</td>
</tr>
<tr>
<td>No</td>
<td>16.106</td>
<td>0.187</td>
<td>15.739</td>
<td>16.472</td>
</tr>
<tr>
<td>Total</td>
<td>15.805</td>
<td>0.218</td>
<td>15.378</td>
<td>16.232</td>
</tr>
</tbody>
</table>

SE = standard error.

### Table 5  Type and Frequency of Necessary Maintenance Measures

<table>
<thead>
<tr>
<th>Maintenance measures</th>
<th>Total</th>
<th>First</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elimination of pressure spots</td>
<td>70 (31.5)</td>
<td>20 (30.8)</td>
</tr>
<tr>
<td>Acrylic resin base repair</td>
<td>47 (21.2)</td>
<td>11 (16.8)</td>
</tr>
<tr>
<td>Improvement of friction(^a)</td>
<td>40 (18.0)</td>
<td>15 (23.1)</td>
</tr>
<tr>
<td>Reline</td>
<td>30 (13.5)</td>
<td>12 (18.5)</td>
</tr>
<tr>
<td>Retightening abutment screw</td>
<td>17 (7.7)</td>
<td>2 (3.1)</td>
</tr>
<tr>
<td>Correction of occlusion</td>
<td>11 (4.9)</td>
<td>3 (4.6)</td>
</tr>
<tr>
<td>Facing repair</td>
<td>7 (3.2)</td>
<td>2 (3.1)</td>
</tr>
<tr>
<td>Total</td>
<td>222 (100)</td>
<td>65 (100)</td>
</tr>
</tbody>
</table>

Data are reported as n (%). \(^a\)Increase (apposition of alloy by laser welding into the secondary crown) or reduction of friction.
TR-RISDPs in some of these other studies, as well as the exclusion of patients with oral cancer, in comparison to the present study.

The significantly higher survival probabilities of TR-RISDPs in patients who attended a follow-up program regularly in comparison to those who did not (P < .05) have not been analyzed in many other studies. Only Rehmann at al13 investigated this factor, but they did not observe a significant effect on TR-RISDP survival. A reason for this result in the present study can be seen in the fact that possible complications are recognized early by participating regularly in the follow-up program, and therefore major damage can be prevented.

The presence of former oral cancer disease did not show any significant influence on the survival of the TR-RISDPs in the present study, which suggests a good clinical performance of the prostheses in this group of patients as well. This is also demonstrated in other studies.16,21 Nevertheless, Nelson et al12 reported lower survival rates for implant-supported overdentures in oral cancer resection patients in comparison to patients without prior cancer surgery and argued that these results were based on the higher mortality rate in this group.

The connection between location of the prosthesis and survival of the TR-RISDPs showed no significant influence in the present study, whereas other studies reported better survival times of prostheses located in the mandible,1,7,13,14 arguing that this was because the bone quality in the mandible is better.

The respective 5- and 10-year survival probabilities of 98.4% and 92.8% for dental implants, as well as the reasons for implant failure, are in accordance with the current literature.3,4,9,21,22 Berglundh et al2 reported an implant loss of > 5% after 5 years in function for overdentures, which represents a higher failure rate in comparison to the present study (2.3%).

Dental implants in patients with a former presence of oral cancer showed a significantly lower survival probability in comparison to patients who did not suffer from former oral cancer (P < .001). This is likely due to the fact that bone quality is often worse after radiation therapy, which has also been reported in other studies.3,23 However, some studies report good results using implant-supported dental prostheses in former oral cancer patients despite associated radiation therapy but also reported lower survival rates in reconstructed bone flaps.12,21 Nelson et al12 also argued that the lower survival rate of the dental implants in these patients is also related to the increased mortality rate of oral cancer patients.

The placement of dental implants in the maxilla or mandible, as well as regular attendance in a follow-up program, did not show any significant influence on the survival of the dental implants in the present study. However, some studies reported better survival times for dental implants located in the mandible and explained this on the basis of the better bone quality in comparison to the maxilla.1,9,22

The high number of total maintenance measures (n = 222) in comparison to other studies might be due to the fact that a larger amount of patients and a longer observational period were observed in the present study.5,10,14 Also, all kinds of maintenance measures, including minor adjustments like pressure spot removal or major repairs for which a dental technician was needed, were documented and evaluated. The type of maintenance measure performed most often, elimination of pressure spots, was in accordance with the current literature.5,10,13,14,17 Accordingly, complications regarding the attachment system (eg, improvement of the friction) are stated as a frequent problem with TR-RISDPs.5,10,13,18 Krennmaier et al10 observed implant-retained overdentures with either ball or telescopic crown attachments in the edentulous mandible and reported less complications in the TR-RISDP group. Nelson et al12 found that rigid fixation of the implant-supported prostheses minimized technical and biologic complications.

The mean survival time until the first maintenance measure became necessary was 2.5 ± 0.4 years, and the most frequently performed initial maintenance measures were pressure spot removal (n = 20), improvement of friction (n = 15), and relining (n = 12). Comparable results have been reported in other studies.5,13,14,18 The significantly lower amount of necessary first maintenance measures of TR-RISDPs in patients who attended follow-up appointments regularly compared to those who did not attend (P < .001) has not been observed in many other studies yet, although Rehmann et al13 showed similar results.

Neither the location of the TR-RISDPs nor the presence of former oral cancer disease influenced the time until the first maintenance measurement in the present study. In contrast, some other studies have reported a higher amount of necessary maintenance for prostheses located in the maxilla.1,14

CONCLUSIONS

TR-RISDPs in edentulous patients show excellent clinical outcomes. As can be seen from the present study, regular monitoring of TR-RISDPs contributes significantly to reducing the number of prosthetic maintenance measures and complications and to improvement in survival times. With regular follow-up appointments, possible complications are recognized in good time and can thus be eliminated at an early stage without causing any further damage. However, when treating tumor patients with TR-RISDPs, the shorter survival times of the dental implants should be taken into account during treatment planning.
This study aimed to compare survival of single-tooth implants (SI) and teeth receiving initial endodontic treatment (IET), nonsurgical endodontic retreatment (NET), and surgical endodontic retreatment (SET). The secondary aims were to determine success rates and to identify factors associated with the survival and success of implant and endodontic treatments. A retrospective cohort study using electronic health records (January 1, 1995 to April 30, 2017) was conducted. Every case that qualified for the study in SI (n = 321), NET (n = 211), and SET (n = 79) was included, and cases in IET (n = 642) were selected at random with a case-to-SI ratio of 2:1 for data extraction efficiency. Statistical analyses were conducted to compare survival rates and to estimate success rates among the four groups after adjusting for confounders. The 3-year survival rates for SI, IET, NET, and SET were, respectively, 99.0%, 92.1%, 90.5%, and 89.5%, while the 5-year survival rates for SI, IET, NET, and SET were 99.0%, 87.6%, 84.4%, and 81.1%. Generally, the SI group had the highest survival rate, and the SET group had the lowest survival rate. Short implants (< 8 mm) were significantly associated with implant failure (P < .01). Teeth with composite restorations had lower survival rates in IET and NET than other restorations (P < .01 and < .01). Within the limitations of this study, single-tooth implants and the endodontic treatments yielded predictable survival and success rates in the short term, but the survival and success rates of endodontic treatments dropped more rapidly than single-tooth implants during the longer follow-up period.