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**Purpose:** The purpose of this retrospective clinical study was to evaluate the clinical outcomes of nonprecious alloy (NPA) vs precious alloy (PA) telescopic crown–retained removable partial dentures (TRPDs), the factors influencing survival, and the type and number of maintenance procedures required during the observation period. **Materials and Methods:** This retrospective clinical study is based on 462 patients with a total of 572 TRPDs on a total of 1,946 abutment teeth. The following parameters were analyzed with Kaplan-Meier analysis: sex; alloy type; denture location; number and distribution of abutment teeth (Kennedy Class); vitality of abutment teeth; dentition in the opposing arch; and participation in follow-up visits. **Results:** The mean observation period was 3.87 ± 3.15 years (2.99 ± 2.52 years for NPA-TRPDs and 5.36 ± 3.53 years for PA-TRPDs; maximum 11.01 years). During the observation period, 4.2% (n = 24) of the TRPDs ceased functioning and 8.3% (n = 161) of the abutment teeth had to be removed. The calculated 5- to 10-year survival probabilities were 96.1% and 84.0%, respectively, for the TRPDs. The number of abutment teeth was the only parameter that significantly (P < .05) impacted this probability, whereas the vitality of the abutment teeth and the type of alloy significantly (P < .05) impacted the survival probability of the abutment teeth. NPA-TRPDs needed significantly earlier initial treatment than PA-TRPDs (P < .05). **Conclusion:** The type of alloy seems to have no impact on TRPD survival, but seems to have an influence on the survival of the abutment teeth. There are also differences in maintenance between NPA- and PA-TRPDs. Int J Prosthodont 2018;31:459–464. doi: 10.11607/ijp.5820

Nowadays, more and more people aged 65 years and above are partially edentulous. Due to better prophylactic programs, people are able to keep their natural teeth for longer; therefore, more people in this age require partial dentures. Telescopic crown–retained removable partial dentures (TRPDs) are a well-established treatment option for restoring patients retained removable partial dentures (TRPDs), the factors influencing survival, and the type and number of maintenance procedures required during the observation period. Materials and Methods: This retrospective clinical study is based on 462 patients with a total of 572 TRPDs on a total of 1,946 abutment teeth. The following parameters were analyzed with Kaplan-Meier analysis: sex; alloy type; denture location; number and distribution of abutment teeth (Kennedy Class); vitality of abutment teeth; dentition in the opposing arch; and participation in follow-up visits. Results: The mean observation period was 3.87 ± 3.15 years (2.99 ± 2.52 years for NPA-TRPDs and 5.36 ± 3.53 years for PA-TRPDs; maximum 11.01 years). During the observation period, 4.2% (n = 24) of the TRPDs ceased functioning and 8.3% (n = 161) of the abutment teeth had to be removed. The calculated 5- to 10-year survival probabilities were 96.1% and 84.0%, respectively, for the TRPDs. The number of abutment teeth was the only parameter that significantly (P < .05) impacted this probability, whereas the vitality of the abutment teeth and the type of alloy significantly (P < .05) impacted the survival probability of the abutment teeth. NPA-TRPDs needed significantly earlier initial treatment than PA-TRPDs (P < .05). Conclusion: The type of alloy seems to have no impact on TRPD survival, but seems to have an influence on the survival of the abutment teeth. There are also differences in maintenance between NPA- and PA-TRPDs. Int J Prosthodont 2018;31:459–464. doi: 10.11607/ijp.5820

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because NPAs are more rigid (230 to 430 HV) in comparison to PAs (50 to 300 HV). Due to these material properties, it is more difficult to achieve acceptable retention between primary and secondary crowns when manufacturing NPA-TRPDs.

Nevertheless, no information has been found regarding whether NPA-TRPDs show results comparable with those of PA-TRPDs. Thus, it was the aim of the present study to evaluate possible differences between NPA-TRPDs and PA-TRPDs regarding needs for maintenance and clinical performance. The following null hypothesis was tested: the (1) survival rates and (2) maintenance needs would not differ between NPA-TRPDs and PA-TRPDs.

### Materials and Methods

The data of 637 patients who received TRPDs at the Department of Prosthodontics, Justus-Liebig-University, Giessen, Germany, between 2004 and 2015 were included in this study. Patients with dental implants (n = 152) or maxillary defects after oral cancer surgery (n = 9), patients who never showed up after denture placement (n = 8), and cases in which the data about the type of alloy were missing (n = 6) were excluded from the study. This resulted in a convenience sample of 462 patients (209 women, 253 men; mean age 61.5 ± 10.0 years) who received 572 TRPDs on a total of 1,946 abutment teeth.

A total of 259 TRPDs were placed in the maxilla, and 313 were placed in the mandible (variable: denture location). Kennedy Class was used to measure the variable number and distribution of abutment teeth: 479 of the arches were classified as Kennedy Class I, 79 as Kennedy Class II, and 14 as Kennedy Class III. A total of 360 of the TRPDs were manufactured with NPAs and 212 with PAs (variable: type of alloy). Regarding the variable opposing dentition, 231 of the patients had combined dentures with fixed and removable parts opposing the restoration area, 165 had removable dentures, 120 had fixed partial dentures, 42 had no dental prosthesis or natural dentition, and 14 had implant-supported prostheses.

There were 1,473 abutment teeth that showed vitality, 249 treated by root canal (145 of these teeth were treated with a metal core), and 224 with no data available (variable: vitality of abutment teeth). The variable number of abutment teeth is shown in Table 1.

All patients with a residual dentition were offered treatment with either TRPDs or RPDs with metal clasps. As in Germany, TRPDs are a standard treatment option for patients with three or less remaining teeth per arch, whereas patients with more than three remaining teeth per arch often receive RPDs with metal clasps, often because of the costs. The TRPDs were delivered as part of the clinical courses taught in the department under the strict supervision of experienced full-time teachers following a standardized protocol. The patients individually decided whether to receive an NPA-TRPD or PA-TRPD; the costs were the decisive factor for most of the patients. All TRPDs were fabricated in the same dental laboratory. After incorporation of the TRPDs, all patients were asked to participate in a continuous annual follow-up program.

The statistical analysis was performed using a Kaplan-Meier estimate with 95% confidence intervals (CIs) for survival analysis. Survival was defined as the time between incorporation (start point value) of the TRPDs and the time the TRPDs had to be renewed (end point value). Maintenance was defined as initial adjustments directly following denture insertion and maintenance needs during the functional period starting 30 days after insertion.

The variables of sex, denture location, number and distribution (Kennedy Class) of abutment teeth, vitality of abutment teeth, type of alloy, dentition in the opposing arch, and participation in follow-up visits were analyzed as covariates of the survival function (log rank test, P < .05). Additionally, a Cox regression analysis was carried out to analyze the impact of the covariates on the survival probability and to calculate the hazard ratio (HR) for the risk of TRPD ceasing function.

This study was approved by the ethics committee of the Justus-Liebig-University, Giessen, Germany (Reg No.164/11) and registered in the German Clinical Trials Register (DRKS-ID: DRKS00009701).

### Results

The mean observation time was 3.87 ± 3.15 years (2.99 ± 2.52 years for NPA-TRPDs and 5.36 ± 3.53 for PA-TRPDs; maximum 11.01 years). The number of TRPDs...
remaining at risk after a specific observation period is shown in Table 2. During the observation period, 4.2% (n = 24) of the TRPDs ceased functioning, and 8.3% (n = 161) of the abutment teeth were removed.

Survival of TRPDs

The mean ± standard deviation (SD) expected survival time of the TRPDs was calculated to be 10.31 ± 0.14 years (95% CI: 10.04 to 10.57). The outcome probability for all TRPDs was 96.1% after 5 years and 84.0% after 10 years (Fig 1). The reasons for renewal were loss of abutment teeth (n = 20) and technical failures (n = 4).

The number of abutment teeth was the only parameter influencing TRPD survival that was significant (P < .05). Thus, TRPDs with one abutment tooth (n = 21) showed a significantly lower mean survival time, which was 7.67 ± 0.62 years (95% CI: 6.45 to 8.88 years), in contrast to TRPDs with three abutment teeth (n = 173), which was 10.55 ± 0.16 years (95% CI: 10.24 to 10.86 years) (Fig 2). None of the other parameters showed any significant impact (P > .05) on the final clinical outcome. Thus, part one of the null hypothesis could not be rejected.

Survival of Abutment Teeth

The expected survival time of the abutment teeth was calculated to be 9.79 ± 0.10 years (95% CI: 9.60 to 9.99 years). The outcome probability for all abutment teeth was 92.0% after 5 years and 68.9% after 10 years (Fig 3). A total of 8.3% (n = 161) of the abutment teeth were removed during the observation period. The reasons for removal were: periodontal disease (n = 83), fracture of the abutment teeth (n = 57), and decay (n = 21).

The type of alloy showed a significant impact on the survival of the abutment teeth (P < .05). Abutments with NPA primary crowns (n = 1,430) showed a mean survival time of 9.33 ± 0.17 years (95% CI: 8.99 to 9.67 years) in contrast to abutments with PA primary crowns (n = 716), which showed a mean survival time of 10.01 ± 0.12 years (95% CI: 9.78 to 10.24 years) (Fig 4). Cox regression showed that abutment teeth with NPA-TRPDs had a significantly higher risk for removal in comparison to abutment teeth with PA-TRPDs (HR: 2.04).

A significant difference (P < .01) was observed between mean survival time of vital abutment teeth (n = 1,473), which was 9.91 ± 0.10 years (95% CI: 9.71 to 10.10), and that of endodontically treated abutment teeth with post-and-core builds (n = 145; 9.21 ± 0.31 years [95% CI: 8.59 to 9.83]) and those without post-and-core builds (n = 104; 8.34 ± 0.46 years [95% CI: 7.43 to 9.26]) (Fig 5). Cox regression also showed a significantly higher risk for removal of endodontically treated abutment teeth without post-and-core builds in comparison to vital abutment teeth (HR: 2.9).
Almost all dentures (n = 488) needed initial adaptation and/or later maintenance. The most frequent initial treatment was the removal of pressure spots (33.1%), followed by adaptation (lowering) of retention in the NPA group (25.9%); this was only necessary in 6.3% of the PA group (P < .05) (Table 3). NPA-TRPDs needed significantly earlier initial treatment than PA-TRPDs (0.038 ± 0.007 years [~14 days] vs 0.151 ± 0.110 years [~55 days], respectively). Also, dentures located in the mandible needed earlier initial treatment compared to those in the maxilla (0.036 ± 0.005 [~13 days] vs 0.307 ± 0.099 years [~112 days], respectively).

During the functional period, the first maintenance was necessary after a mean time of 2.27 ± 0.13 years. The most frequent reasons for maintenance during the functional period were removal of pressure spots (19.0%); adjustment/correction of the occlusion (13.3%); recementation of the primary crowns (13.1%); and relining (12.5%) (Table 4). PA-TRPDs needed maintenance more often than NPA-TRPDs. Thus, part two of the null hypothesis could be rejected. None of the parameters analyzed showed a significant impact on maintenance needs.

**Discussion**

Using a retrospective longitudinal study design, this study aimed to evaluate the survival probability and maintenance needs of NPA- and PA-TRPDs. Retrospective studies have natural shortcomings, as they must rely on the data available; nevertheless, they are helpful as long as data of higher evidence (eg, RCTs) are missing. This applies to the topic investigated in the current study in particular. The differing group sizes (NPA-TRPDs = 360; PA-TRPDs = 212) and the differing mean observation periods (2.99 ± 2.52 years for NPA-TRPDs and 5.36 ± 3.53 years for PA-TRPDs) could be seen as methodical difficulties and therefore as weaknesses of the study. Furthermore, it would have been desirable to include other clinical parameters.
The calculated 5- and 10-year survival rates for NPA-TRPDs (95.9%) and for PA-TRPDs (96.5%; \( P > .05 \)) in the present study are comparable with other publications.\(^{1 \text{-} 23} \) The calculated extraction rate for the abutment teeth (8.3%) and the reasons for removal correspond to the data found in the literature.\(^{6,8,9,13,20,22,23} \) The extraction rate is a good number, especially when considering that teeth with a critical prognosis (eg, with a reduced periodontium) are often used as abutment teeth for TRPDs.\(^{16} \)

Although the type of alloy showed no significant impact on TRPD survival (\( P > .05 \)), it did have an impact on the survival of abutment teeth (\( P < .05 \)). Despite the fact that abutment teeth with NPA-TRPDs showed a lower 10-year survival rate in comparison to abutment teeth with PA-TRPDs (67.7% vs 71.8%, respectively; \( P = .004 \)), the use of NPA-TRPDs cannot be advised against in general,\(^{6} \) as this result could be explained by the fact that there were differences in the mean observation time and in group sizes. The fact that primary teeth showed a significantly higher survival rate in comparison to endodontically treated abutment teeth (\( P = .001 \)) has also been documented in other studies.\(^{3,4,7,11,21,22} \) The use of endodontically treated teeth as abutment teeth for TRPDs should therefore be considered critically, especially with regard to the cost-benefit relationship. However, should successful endodontically treated teeth be used as abutment teeth for TRPDs, they should be treated with a post-and-core build-up to achieve better survival rates for the TRPDs.

TRPDs with less than three abutment teeth showed a lower survival rate than TRPDs with three or more abutment teeth, which is also presumed in other studies.\(^{4,7,13,17} \) Although there are others that have shown contrary results,\(^{3,12,22} \) Nevertheless, TRPDs with only one abutment tooth still offer a higher oral comfort in comparison to full dentures, and their mean survival time (7.67 ± 0.62 years) is sufficient. Therefore, they should be considered a treatment option for elderly patients with a reduced dentition because they can be modified stepwise into a full denture, which is also cost effective.

Nearly all of the observed TRPDs needed some kind of maintenance procedure; thus, the need for maintenance was a bit higher in the present study compared to the literature.\(^{3,6,7,14,15,16} \) The most common maintenance procedure was the removal of pressure spots, followed by recementation of primary crowns, adjustment/correction of the occlusion, and relining. These results are comparable with other studies.\(^{7,14,15} \)

More maintenance was necessary for PA-TRPDs. It was apparent that NPA-TRPDs needed a reduction of friction more often, whereas PA-TRPDs needed increasing of the friction. This might be explained by their differing material properties and the technical problems resulting from trying to set an acceptable retention between primary and secondary crowns, especially for the NPA-TRPDs. During the adaptation period, 79.1% of the necessary measurements could be carried out by the dentists themselves, whereas during the period of function, 50% of the necessary maintenance measurements had to be carried out by dental laboratories, which results in extra costs. Initial adaptation was necessary earlier in NPA-TRPDs (13 days vs 106 days for PA-TRPDs) and in dentures located in the

<table>
<thead>
<tr>
<th>Maintenance Interventions During Period of Function Categorized by Type of Alloy</th>
<th>NPA</th>
<th>PA</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removal of pressure spots</td>
<td>211</td>
<td>266</td>
<td>457</td>
<td>19.0</td>
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<tr>
<td>Adjustment/correction of occlusion</td>
<td>133</td>
<td>188</td>
<td>240</td>
<td>13.3</td>
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<tr>
<td>Relining</td>
<td>118</td>
<td>183</td>
<td>301</td>
<td>12.5</td>
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<tr>
<td>Adjustment/repair of acrylic material</td>
<td>121</td>
<td>137</td>
<td>258</td>
<td>10.7</td>
</tr>
<tr>
<td>New veneering of secondary crown</td>
<td>102</td>
<td>138</td>
<td>240</td>
<td>10.0</td>
</tr>
<tr>
<td>Adjustment of retention (lowering)</td>
<td>112</td>
<td>22</td>
<td>139</td>
<td>5.8</td>
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<tr>
<td>Repair of metal framework</td>
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<td>45</td>
<td>102</td>
<td>4.0</td>
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<tr>
<td>Adjustment of retention (increasing)</td>
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<td>68</td>
<td>101</td>
<td>4.2</td>
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<tr>
<td>Renewal of metal framework</td>
<td>16</td>
<td>25</td>
<td>42</td>
<td>1.0</td>
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<tr>
<td>Abutment teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recementation of primary crowns</td>
<td></td>
<td>156</td>
<td>316</td>
<td>13.1</td>
</tr>
<tr>
<td>Insertion of a dental core</td>
<td>68</td>
<td>48</td>
<td>116</td>
<td>4.8</td>
</tr>
<tr>
<td>Manufacturing of new primary crowns</td>
<td>9</td>
<td>5</td>
<td>14</td>
<td>0.6</td>
</tr>
<tr>
<td>Total</td>
<td>1,140</td>
<td>1,267</td>
<td>2,407</td>
<td>100.0</td>
</tr>
</tbody>
</table>
mandible (14 days vs 112 days for TRPDs in the maxilla); a reason for this could be that nearly 26% of the NPA-TRPDs needed a reduction in retention for initial adaptation due to their material properties and the resulting difficulties setting an acceptable retention. During the period of function, only the variable opposing dentition seemed to influence the maintenance need. Therefore, fixed dental prostheses and natural teeth as opposing dentition caused an earlier need for maintenance than removable dental prostheses. This might be caused by the fact that patients with fixed dental prostheses or natural teeth achieve higher chewing forces than patients with removable dentures. Further studies based on a higher level of evidence are needed to validate the outcomes of this treatment modality.

Conclusions

Within the limitations of this retrospective study, it can be concluded that NPA-TRPDs are a viable alternative to PA-TRPDs in clinical use. The type of alloy seems to have no significant influence on the survival of the TRPDs, but did show a considerable impact on the long-term success of the abutment teeth. Though PA-TRPDs showed a slightly higher need for maintenance in comparison to NPA-TRPDs, most of this maintenance could be carried out by the dentists themselves and therefore did not incur any extra costs. According to the cost-benefit relation of both alloys (PA and NPA), the use of NPA rather than PA saves nearly 40% of the costs; thus, in the clinical situation of a partial dentition with three remaining teeth, the use of NPA should be preferred.

Acknowledgments

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References