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CLINICAL RESEARCH

# Prefabricated taper crowns for the retention of implant superstructures: Three-year results of a prospective clinical trial

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## ABSTRACT

**Statement of problem.** Nonrigid retainer systems for removable implant superstructures are associated with negative effects such as rocking and increased load on the denture base. Rigid retainer systems such as telescopic crowns reduce these negative effects, but their fabrication demands highly skilled dental technicians and is therefore expensive. Whether a protocol with prefabricated retainers will reduce production time is unclear.

**Purpose.** The purpose of this prospective clinical trial was to evaluate a prefabricated telescopic retainer and a treatment protocol including the intraoral luting of a framework.

**Material and methods.** A total of 23 participants (15 women and 8 men with a mean age of 61.6 ±2.9 years) were included. After 3 dropouts, 21 removable dentures (9 mandibular and 12 maxillary) retained by 91 delayed loaded Ankylos implants were investigated. All implants were restored with prefabricated conically shaped abutments (SynCone-abutment). The prefabricated corresponding cone matrix was assembled intraorally into a metal frame with autopolymerizing resin. After a loading period of 3 years, a follow-up examination investigated the fit of the framework, the prosthetic aftercare, the technical failures, and the retention force. A questionnaire was used to evaluate participant satisfaction. In addition, laboratory fabrication time and costs were compared with those of individually fabricated restorations.

**Results.** One mandibular implant was lost after 25 months (survival rate, 98.9%). The removable dentures showed no apparent rocking and minimal prosthetic maintenance during the 36-month trial. No dentures required relining. The retention force was scored as good in 17 participants and high (with 6 implants in the maxilla) and low (with 2 implants in the mandible) in 2 participants each. No technical failures occurred. An assessment of laboratory fabrication time and costs revealed reduced time and costs. Patient satisfaction was significantly increased ($P<.001$) over the entire observation time.

**Conclusions.** The SynCone retainer presented a time- and cost-efficient treatment option with sufficient long-term retention for removable dentures and high patient satisfaction. Mandibular prostheses restored with 2 implants had limited success. (J Prosthet Dent 2019;121:618-22)

Different attachment systems are used for retaining overdentures; some retention systems such as the bar and clip splint the implants, whereas others such as ball or Locator attachments do not. Unsplinted implants offer advantages such as lower cost and easier oral hygiene.[1] However, better retention and fewer maintenance problems have been reported for bar-clip attachments than for magnet or ball attachments.[2] Nevertheless, the success of bar and clip retention is limited by patient compliance, good oral hygiene, and manual dexterity. In general, attachment systems based on a nonrigid connection are susceptible to rocking of the prosthesis, a nonphysiological load of the alveolar ridge beneath the denture base, accelerated resorption of the alveolar ridge, and an increase in loss of retention during functional loading.[3] A rigid retainer system such as custom milled bars or telescopic crowns seems to minimize these negative effects and reduce the need for prosthetic maintenance.[4-8]

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## Clinical Implications

The prefabricated telescopic retainer investigated is a reliable and patient-friendly alternative to other retention options that combines the advantages of both rigid and nonrigid retainer systems in a time- and cost-efficient manner.

Long-term studies have demonstrated that telescopic crowns in conventional tooth-retained prosthodontics provide favorable periodontal and prosthodontic outcomes.[9,10] However, telescopic crowns are still not the routine approach for the retention of implant-supported dentures probably because they require high-precision dental treatment and high-quality technical work.[11] Prefabricated conically shaped abutments may combine the favorable characteristics of implant-supported telescopic retained prosthetics and reduce the workload for dental technicians and therefore the overall cost. A 2-year study of prefabricated conical crowns with a 5-degree conus reported stable complete-denture retention, a denture base of reduced size, and improved oral hygiene.[12,13]

As both treatment and maintenance costs may depend on the type of implant retention,[14-16] the research hypothesis was that retaining removable superstructures on conical, prefabricated components would reduce manufacturing costs and maintenance and improve retention and patient satisfaction.

## MATERIAL AND METHODS

Before the study, the sample size was calculated using statistical software (SPSS Statistics v17.0; SPSS Inc). A sample size of 22 participants was necessary to detect statistically significant differences ($\alpha$=.05; $\beta$=.80). Twenty-three participants (15 women and 8 men) with a mean age of 61.6 ±12.97 years were included in this prospective clinical trial. All had to be at least 18 years of age, completely edentulous in the maxilla and/or mandible, and have treatment planned for implant-supported prosthetics. The prospective implant sites had to be free from acute infections. The participants were informed about the treatment and study procedure and gave written informed consent. The study was approved by the Ethical Committee of Johann-Wolfgang Goethe University of Frankfurt/Main (registration number: 105/01) and conducted according to the fifth revision of the World Medical Association Declaration of 2000 in Helsinki and the STROBE (Strengthening the Reporting of Observational studies in Epidemiology) guidelines of 2007. The follow-up appointments were scheduled at a 3-month interval for the first year and a 6-month interval for the next 2 years.

The participants received 2 to 6 implants (Ankylos; Dentsply Sirona) depending on the individual treatment plan after clinical and radiological examination and consultation. In the mandible, a maximum of 4 implants were placed between the mandibular foramina. In the maxilla, implants were placed in the canine region and the first and second premolars to optimize esthetics. Participants requiring graft procedures for bone augmentation or sinus floor elevation were excluded from the study.

After a healing period of 3 months in the mandible and 5 months in the maxilla, the implants were exposed, and healing abutments were attached. All participants were provided with implant-supported prostheses retained with prefabricated telescopic attachments. A total of 11 mandibular and 13 maxillary dentures were supported by 104 Ankylos implants (33 mandibular and 71 maxillary). At the 3-year follow-up, 3 participants had dropped out because they had moved abroad, lack of interest in participating in the follow-up, or financial problems. After 3 years of loading, the remaining 21 prostheses (9 mandibular and 12 maxillary) supported by 91 implants were evaluated (Table 1). The restoration of the opposing dentition was not limited except that the 2 implant-supported mandibular prostheses (n=5) were opposed by a complete denture to avoid excessive loading.

The prefabricated telescopic retention system consisted of a patrix and a matrix. The patrix was a conically shaped titanium grade 2 (99.7%) abutment (SynCone; Dentsply Sirona) with a 5-degree taper. Abutments of different heights (1.5 mm, 3.0 mm, and 4.5 mm) were used depending on the mucosal thickness. The abutments were straight or angled to the implant axis by 15 or 22.5 degrees. The abutments connected to the Ankylos implant consisted of an internal tapered connection without an index and at an angle of 5.7 degrees, allowing unlimited rotation of the abutment within the implant interface. The matrix of the conically shaped telescopic retainer was a prefabricated, numerical, controlled milled coping made of a gold alloy (Degunorm alloy; DeguDent).

The prosthetic procedures were started 7 to 10 days after the second stage surgery and consisted of 3 appointments.[17,18] At the first session, the implant position was recorded. The impression posts served as retainers for an autopolymerizing resin (Protemp; 3M ESPE) to process a provisional jaw relation record. A denture framework that enveloped the secondary copings was cast from Cr-Co-Mb alloy (GM 800+; Dentaurum) into a 1-piece unit. A 100- to 150-µm space between the framework and the secondary copings was provided for the intraoral cementation of these 2 components. At the second appointment, the prefabricated telescopic abutments were seated to 15 Ncm using a torque wrench (Ankylos; Dentsply Sirona). The secondary copings were placed over the abutments, followed by an evaluation of the framework to determine that passive fit had been

**Table 1.** Distribution of prostheses and used abutments at the 3-year follow-up investigation (after dropouts)

| | Mandible | Maxilla | Total |
|---|---|---|---|
| Prostheses | 9 | 12 | 21 |
| Implants | 26 | 65 | 91 |

**Table 2.** Questionnaire investigating patient satisfaction, prosthesis movement, and level of comfort

| | | | | |
|---|---|---|---|---|
| 1) Are you satisfied with your prosthesis in general? | | | | |
| Satisfied | | Dissatisfied | | |
| 2) Do you feel that your prosthesis rocks move during speaking or mastication? | | | | |
| Satisfied | | Dissatisfied | | |
| 3) How would you rate the level of comfort with your prosthesis? | | | | |
| Very good | Good | Sufficient | Bad | Very bad |

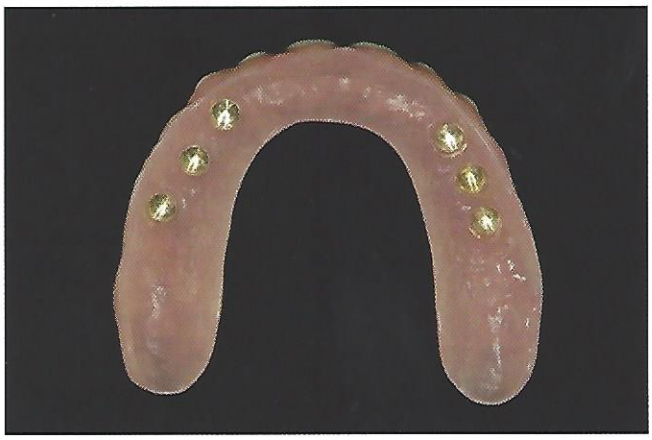

**Figure 1.** Intaglio surface view of removable maxillary denture with integrated prefabricated telescopic matrices splinted by metal scaffold.

achieved. A thin layer of autopolymerizing composite resin (Nimetic Cem; 3M ESPE) was applied to the adhesive surfaces of the framework and cemented over the secondary copings intraorally. An interocclusal record and an impression of the soft tissue areas were made. The definitive prosthesis with the prefabricated telescopic retainer was completed on the new definitive cast, and the acrylic resin flanges were removed at the third appointment (Fig. 1).

Follow-up appointments were scheduled every 3 months for the first year and subsequently every 6 months. At these examinations, accuracy of fit of the denture, occurrence of pressure points, and need for relining of the denture base were evaluated. In addition, repair of the denture base or denture teeth, decementation of the prefabricated matrix of the adhesive interface, repeat of intraoral cementation, loosening/breaking of the abutment, retention of the dentures/need to replace the retentive components, or rocking of the prosthesis (evaluated by an alternate unilateral loading) were evaluated and documented. The clinical examinations were performed by one of the authors (G.T.) experienced in the field of implant and prosthetic dentistry. Evaluation of denture retention on a 3-point scale (low, good, or very high) was subjectively determined by both the participants with questionnaires and by the dentist.

Laboratory time and costs were evaluated with a survey sent via email to 12 representative German dental laboratories. The laboratories were selected according to their experience with different telescopic retainer systems, including the SynCone system. The costs and manufacturing time of the technical service of 3 treatment protocols for dentures retained on 4 implants in the mandible were analyzed and compared: 4 individually cast telescopic retainers (individual cast group), 4 telescopic retainers with a ceramic patrix and an electroplated matrix[17,18] (electroplated group), and 4 prefabricated SynCone telescopic retainers (prefabricated group). The working time and manufacturing costs for the prefabricated group were used as a reference and were defined as 100% at each laboratory.

The efficacy of the implant-retained removable dentures with the SynCone system was evaluated by using a self-administered questionnaire to rate the general satisfaction before implant insertion and after implant-retained prosthetic rehabilitation. The questionnaire consisted of questions referring specifically to the existing and new prosthesis and questions recording general satisfaction with retention, mastication, esthetics, and speech. A total of 20 questions were listed and evaluated (Table 2). The questionnaires were completed initially and annually during the 3-year follow-up.

The data were analyzed with statistical software (SPSS Statistics v17.0; SPSS Inc). The Wilcoxon signed-rank test was used as a nonparametric alternative to the paired Student *t* test. The nonparametric Friedman test was used when more than 2 variables were compared ($\alpha$=.05).

## RESULTS

Twenty participants with a total of 91 implants in the maxilla and mandible presented at the follow-up appointments. One implant was lost leading to an implant survival rate of 98.91%. The implant loss occurred in the mandible 25 months after loading in a patient with a superstructure supported by 4 implants.

Denture base adjustments because of pressure points had to be performed in 3 patients 1 week after insertion. The 21 prostheses needed no relining over the 3-year observation time, and no base or framework fracture occurred. Acrylic tooth fractures were noticed in 6 participants about 2, 12, 14, 16, and 24 months after insertion. In one participant, acrylic tooth fractures occurred 3 times in the maxillary denture (Fig. 2). No loosening or breakage of the implants or abutments or framework-to-coping bond failures occurred. Intraoral cementation had

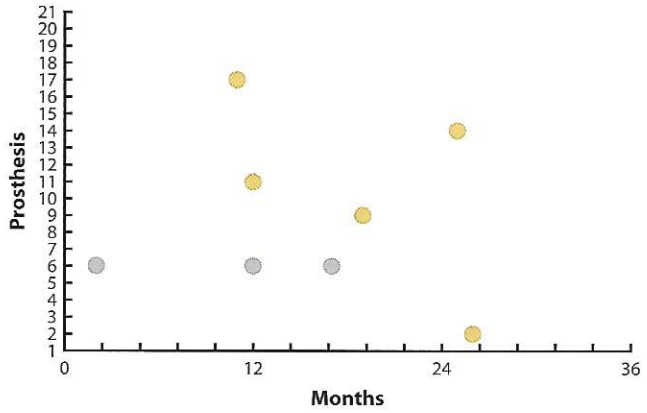


**Figure 2.** Frequency of occurrence of acrylic resin tooth fracture (*silver* dots: maxillary denture; *gold* dots: mandibular denture).

**Table 3.** Fabrication time and costs needed in dental laboratories (n=12) for different double-crown attachments

| Group Comparison with Regard to Time Benefits | | | |
|---|---|---|---|
| | **Individual Cast Group** | **Electroplated Group** | **Prefabricated Group** |
| Time ±SD (%) to prefabricated group | 216.6 ±82.2 | 201.1 ±65.1 | 100 |
| Costs ±SD (%) to prefabricated group | 179.6 ±35.9 | 178.80 ±27.5 | 100 |

SD, standard deviation.

to be corrected in 1 participant after an error during the procedure that led to a detectable rocking of the framework.

The retention force needed to dislodge the denture was scored as good in 17 participants, high immediately after denture insertion in 2 participants with 6 implants in the maxilla, and low in dentures on 2 implants in the mandible. Low retention was documented in 2 participants immediately after denture insertion and in 3 further participants over the 3-year follow-up. Therefore, SynCone secondary copings were replaced in 5 participants, leading to improvement in 3 participants. For the remaining 2 participants, SynCone abutments and copings with a retentive part height of 6.5 mm were fabricated and inserted into the existing prostheses leading to increased participant satisfaction.

The difference in the relative average fabrication times and costs (calculated as percentages) of double-crown retained removable dentures on 4 implants in the mandible is illustrated in Table 3. Working time and costs for the prefabricated group were defined as 100%. The relative fabrication time and cost of the individual cast group (time: 216.6 ±82.2%; costs: 179.6 ±35.9%) and the electroplated group (time: 201.1 ±65.1%; costs: 178.8 ±27.5%) were higher in each laboratory than the time and cost for the prefabricated group.

A significant difference was detected in the general satisfaction of the participants between their existing and new prostheses. Only 23.8% were satisfied with their

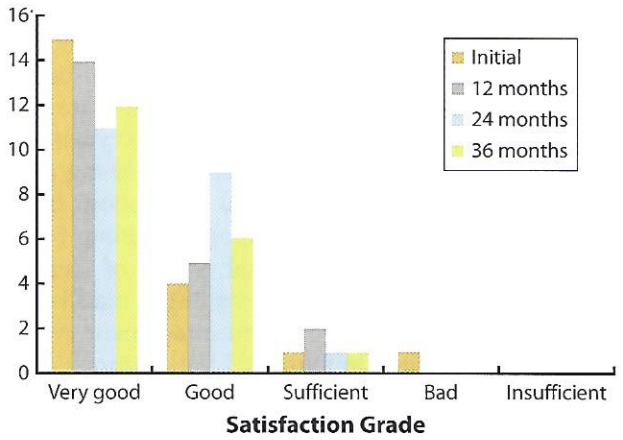


**Figure 3.** Wearing comfort of patients with new prosthesis over 3-year follow-up period. Friedman test showed no significant differences ($P$=.249).

prostheses before the study, whereas 95.2% were generally satisfied immediately after the insertion of the new dentures ($P$<.001) and 100% at the 24- and 36-month follow-up. No time-related significant difference was detected according to the Friedman test ($P$=.391).

Initially, 2 SynCone prostheses (9.5%) exhibited rocking due to fabrication issues. Twelve to 24 months after insertion, 95.2% of the participants described the prostheses as permanent. At the end of the 36-month follow-up, none of the prostheses exhibited any micromovement or rocking. The Friedman test showed no time-related significant differences ($P$=.194). None of the prostheses caused patient discomfort during the observation period, with 90.5% of the participants reporting very good or good comfort 6 months after insertion and 94.7% showing the same 36 months after insertion (Fig. 3). This difference was not statistically significant ($P$=.249).

## DISCUSSION

The results of this prospective clinical study led to acceptance of the research hypothesis that retention of removable superstructures on conical, prefabricated components reduces manufacturing costs and maintenance while at the same time improving retention and patient satisfaction. Retention on prefabricated components led to comparably low manufacturing time and costs and postinsertion maintenance at a high level of retention, patient satisfaction, and no micromovement or rocking of the prosthesis. However, the increase in patient satisfaction with the new denture compared with the existing denture must be viewed cautiously.

The results of the present study confirm previous reports of the favorable performance and low maintenance of telescopic crowns compared with other retainer systems such as ball attachments.[4] Retrospective analysis of Locator-retained dentures over a loading period of

almost 5 years reported loss of retention in almost 70% of participants.[3] Bergendal and Engquist[7] evaluated 64 dentures retained by round bar with clips or ball attachments. Fifty overdentures needed denture base adjustment over an observation period of 10 years. Unlike other studies, no prosthesis needed relining in the present study, indicating minimal resorption of the alveolar ridge. Smedberg et al[8] reported relining 8 of 20 overdentures in a 2-year clinical study of dentures retained by bar and clip foundations in the maxilla.

The retention forces of different attachment systems have been investigated in vitro.[19-22] Van Kampen et al[21] reported 29.8 N for bar and clip attachments, 28.0 N for ball attachments, and 8.7 N for magnet attachments. An in vitro investigation of the retentive characteristics of the SynCone conical crown system demonstrated a comparably lower, but almost constant, retentive force between 5 and 10 N.[22] However, comparison of in vitro studies has to be made with caution as experimental designs and the attachment systems studied differ.

In the present study, dentures in the maxilla retained on 5 to 6 implants and dentures in the mandible retained on 4 implants provided adequate retention force. In contrast, all 5 dentures retained on 2 implants in the mandible presented insufficient retention force. In 2 of these participants, replacement of the short telescopic abutments by longer ones improved the retention to a good clinical level. However, rating the retention force subjectively by patient and dentist does not allow quantification or comparison with other studies.

The present study has limitations, including a small number of participants leading to low statistical power. However, this study detected limitations in prostheses retained on 2 implants in the mandible.

## CONCLUSIONS

Based on the findings of this prospective clinical trial, the following conclusions were drawn:

1. The conically shaped prefabricated telescopic retainer system presents an efficient retention system for implant-retained removable dentures with an optimal accuracy of fit.
2. No resorption of the alveolar ridge at the denture base, low need for prosthetic aftercare, few technical failures, and high participant satisfaction were found.
3. However, with only 2 interforaminal implants, SynCone components needed to be adjusted with a longer retentive element to achieve adequate retention.

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