Treatment Outcomes of Implant-Supported Maxillary Obturator Prostheses in Patients with Maxillary Defects: A Systematic Review

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Purpose: To systematically review the current evidence on clinical and patient-reported outcomes of implant-supported palatal obturator prostheses. Materials and Methods: An electronic search of the PubMed, Web of Science, and Cochrane databases was carried out in June 2019. The titles and abstracts of all articles were screened by two independent reviewers. The references of the subsequently selected studies were further screened for potential articles. Assessment of the selected full texts was performed independently according to established inclusion and exclusion criteria. The quality of the selected studies was determined using the Newcastle-Ottawa scale. Interrater agreement on study selection was calculated using Cohen kappa statistic. Results: The search yielded a total of 2,797 records. Ten studies were selected for data extraction, with a Cohen kappa value of 0.856. Five studies were prospective, and five were retrospective. The survival rates for conventional implants ranged from 21.42% to 100%, whereas for zygomatic implants, the survival rates varied from 30% to 100%. Four studies reported prosthodontic complications, with screw loosening being the most common. Patient quality of life (QoL) was analyzed in six studies. Conclusion: In spite of the limitations of the present review, it can be concluded that the clinical outcomes are acceptable in terms of survival rates, implant and prosthodontic complications, and QoL associated with implant-supported maxillary obturator prostheses. QoL of implant-supported prostheses in these patients are acceptable. The general study design was not homogenous between studies. Int J Prosthodont 2020;33:429–440. doi: 10.11607/ijp.6642

Prosthodontic rehabilitation of the maxilla involves both the esthetic and functional restoration of the missing teeth and surrounding tissues. Extensive defects involving the basal bone of the maxilla may be congenital, such as cleft palate, or acquired due to trauma or surgical tumor resection. Patients who suffer these extensive defects tend to have a compromised oral-nasal partition manifesting as hypernasal speech, fluid leakage into the nasal cavity, and impaired masticatory function.

Maxillary defects can be managed by either a surgical or a prosthodontic approach. Surgical closure with a flap allowing for primary closure of the maxillary defect is the standard procedure in most developed countries; however, several factors can
contraindicate this surgery, such as the patient’s medical condition or the anatomical circumstances of the defect. In such situations, the use of palatal obturators is a recommended alternative.\textsuperscript{1,3–7} Palatal obturators are also useful as a provisional treatment during surgical reconstruction and for immediate esthetic rehabilitation in cases where tissue support is needed following reconstructive surgery.\textsuperscript{3}

The main objectives of prosthetic rehabilitation with palatal obturators are to separate the oral and nasal cavities, allowing for adequate deglutition and articulation; to support the soft tissues to restore the midfacial contour; and to obtain acceptable esthetic results.\textsuperscript{8}

The long-term success of a palatal obturator depends on its retention and stability.\textsuperscript{1,2} These features are influenced by the dental support, the residual alveolar ridge, the size of the bony defect, the size and extension of the denture base, and the occlusal relationship, along with the design of the prosthesis.\textsuperscript{3–5} In partially edentulous patients, palatal prostheses are designed following the basic principles of the removable partial denture, with use of the defect cavity, the maxillary bone, and the remaining teeth to provide additional support and retention to the prosthesis. Excessive forces may exert movement on the remaining teeth, causing unwanted effects.\textsuperscript{2,9} In edentulous patients, the hard palate, the residual alveolar process, and the defect cavity are the anatomical areas that provide stability to the prosthesis.\textsuperscript{5,6} Over time, conventional palatal obturators may become loose-fitting, irritating the mucosa and injuring the teeth where the retentive clamps settle, thus negatively affecting the patient’s oral health–related quality of life (OHRQoL).

Since their introduction, osseointegrated implants have been used extensively to improve prosthesis retention and stability.\textsuperscript{10} Maxillary defects may be rehabilitated using dental, pterygoid, and/or zygomatic implants, which aid in supporting and retaining the palatal obturator.\textsuperscript{10}

While the success of implant prosthodontics has been widely documented and published in the literature, to the present authors’ knowledge, few studies have reported the clinical outcomes of implant-supported maxillofacial prostheses.\textsuperscript{11–15} Therefore, the aim of this study is to review the current evidence on clinical and patient-reported outcomes of implant-supported palatal obturator prostheses.

**MATERIALS AND METHODS**

**Search Strategy**

This systematic review was conducted according to PRISMA guidelines\textsuperscript{16} and reports on the treatment outcomes (implant survival rates, implant and prosthetic complications, and patient satisfaction [QoL]) of implant-supported palatal obturator prostheses in partially dentate or edentulous patients with maxillary defects.

The term “partially edentulous patient” was used to define patients who were missing one or more, but not all, teeth. Patients who were missing all teeth were defined as “fully edentulous.” The focus question was: What are the implant survival rates, prosthodontic complications, and treatment outcomes in partially and fully edentulous patients with maxillary defects rehabilitated with implant-supported palatal obturator prostheses?

**PICOS Question**

A focus question was designed following the Population, Intervention, Comparison, Outcome, and Subjects (PICOS) format:

- **P:** Edentulous or partially edentulous patients with maxillary defects
- **I:** Implant-supported palatal obturator prostheses
- **C:** Not applicable (as only implant-supported palatal obturator prostheses were relevant)
- **O:** Implant survival rates, prosthodontic complications, and patient satisfaction (QoL)
- **S:** Randomized controlled clinical trials, cohort studies, case-control studies, cross-sectional studies, and case series

**Information Sources**

The following electronic databases were screened for potential studies, without time restriction, in June 2019: PubMed via Medline, Web of Science, and the Cochrane Library. The results were limited to studies written in English.\textsuperscript{17}


**Inclusion and Exclusion Criteria**

The eligibility criteria were as follows:

- Clinical studies reporting data on treatment outcomes and complications related to the implants and/or prostheses in patients rehabilitated with implant-supported palatal obturators
- Follow-up of at least 1 year
- Human studies with a sample size greater than five patients
Disagreements were solved by discussion between the reviewers to reach consensus, and if consensus was not reached, a third assessor would solve the disagreement (C.C.V.). Evaluation of the selected full texts was performed independently according to the inclusion and exclusion criteria. Cohen kappa statistic was calculated to define the inter-rater agreement in the study selection process.

**Data Collection Process**

Two reviewers (P.M.M. and A.H.), who were reciprocally blinded, extracted relevant data independently using standardized data extraction tables following the PICOS framework. Extracted data included the following: author; title; year of publication; study model; number of implants; type of implant; follow-up; and prosthodontic data. If this information was not provided, the study was considered as not providing enough information and was excluded from the selection.

**Quality of the Studies**

The Newcastle-Ottawa scale (NOS)\(^ {18}\) was used to assess the risk of bias in the prospective and retrospective studies included. The NOS scale uses a systematic approach based on three specific criteria: selection (S), comparability (C), and exposure (E). These are subdivided into nine criteria: S1 = adequate case definition; S2 = representativeness of the cases; S3 = selection of controls; S4 = definition of controls; C1 = comparability of cases; C2 = controls based on the analysis; E1 = ascertainment of exposure; E2 = same method of ascertainment for cases and controls; and E3 = nonresponse.
Of the final 10 articles included, 5 were prospective and 5 were retrospective studies. All patients had a follow-up of at least 1 year since placement of the prosthesis, and the maximum follow-up period was 10 years.

The quality assessment of the selected studies is summarized in Table 2. According to the NOS scale, one study had a score of 5 points; four had a score 6 points; two had a score of 7 points; and three had a score of 8 points. These scores reflect an adequate quality of the studies included in this review.

**RESULTS**

The initial electronic database search resulted in 2,786 articles, and the manual search yielded 11 additional articles (n = 2,797). Of these studies, 866 were duplicates and were removed. After an initial sweep to eliminate articles that were not relevant to the focus question, followed by screening of titles and abstracts, a combined total of 62 articles was selected for full-text analysis. A final total of 10 studies were selected in the review for data extraction. The flow of the entire search and the article identification process are shown in Fig 2.

**Study Characteristics**

Information from the selected studies, such as study design, aim of the study, sample size, methodology of assessment, and follow-up period, are shown in Table 1.

Of the final 10 articles included, 5 were prospective and 5 were retrospective studies. All patients had a follow-up of at least 1 year since placement of the prosthesis, and the maximum follow-up period was 10 years.

The quality assessment of the selected studies is summarized in Table 2. According to the NOS scale, one study had a score of 5 points; four had a score 6 points; two had a score of 7 points; and three had a score of 8 points. These scores reflect an adequate quality of the studies included in this review.

**Inter-Investigator Agreement**

The calculated k ± standard deviation (SD) range was 0.856 ± 0.072 (95% confidence interval [CI]: 0.716 to 0.997), which is defined as a good to almost perfect reliability between the two independent investigators (P.M.M. and A.H.). All disagreements were resolved by consensus between the two investigators, and the third reviewer (C.C.V.) was not needed.

**Patient Characteristics**

A total of 203 patients had been recruited in the selected studies. The age range of the patients varied from 24 to 81 years. These studies included 115 men and 79 women, and one study did not report patient genders.
The pathology causing the maxillary defects was reported in 9 out of 10 studies. Fourteen patients had congenital maxillary deformities, and 163 patients had acquired maxillary defects after treatment of neoplasms. Of the selected studies, only 7 reported reconstructive surgery. Four patients had hard and soft defects secondary to ablative surgery. The classification of maxillary defects was not homogenous among authors. The studies used a total of four different classifications to describe maxillary defects. Two of the included studies used the Okay classification, one used Aramany, three described their own classifications, and four did not classify maxillary defects. Only the Aramany4 and

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Characteristics of the Included Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>Year</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>Roumanas et al19</td>
<td>1997</td>
</tr>
<tr>
<td>Laine et al20</td>
<td>2002</td>
</tr>
<tr>
<td>Fukuda et al21</td>
<td>2004</td>
</tr>
<tr>
<td>Schmidt et al22</td>
<td>2004</td>
</tr>
<tr>
<td>Boyes-Varley et al23</td>
<td>2007</td>
</tr>
<tr>
<td>Landes et al24</td>
<td>2009</td>
</tr>
<tr>
<td>Katsoulis et al25</td>
<td>2013</td>
</tr>
<tr>
<td>Huang et al26</td>
<td>2014</td>
</tr>
<tr>
<td>El-Sayed et al27</td>
<td>2014</td>
</tr>
<tr>
<td>Wang et al28</td>
<td>2017</td>
</tr>
</tbody>
</table>

NR = not reported.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Quality Assessment of the Included Studies According to the Newcastle-Ottawa Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study</td>
<td>Selection</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>Roumanas et al19</td>
<td>★ 0 ★ ★ ★</td>
</tr>
<tr>
<td>Laine et al20</td>
<td>★ ★ ★ ★ ★</td>
</tr>
<tr>
<td>Fukuda et al21</td>
<td>0 0 ★ ★ ★</td>
</tr>
<tr>
<td>Schmidt et al22</td>
<td>0 0 ★ ★ ★</td>
</tr>
<tr>
<td>Boyes-Varley et al23</td>
<td>★ 0 ★ ★ ★</td>
</tr>
<tr>
<td>Landes et al24</td>
<td>★ ★ 0 0 ★</td>
</tr>
<tr>
<td>Katsoulis et al25</td>
<td>★ ★ ★ ★ ★</td>
</tr>
<tr>
<td>Huang et al26</td>
<td>★ ★ ★ ★ ★</td>
</tr>
<tr>
<td>El-Sayed et al27</td>
<td>0 0 ★ ★ ★</td>
</tr>
<tr>
<td>Wang et al28</td>
<td>★ ★ ★ ★ ★</td>
</tr>
</tbody>
</table>

Response options were “yes” (1 point), “no,” and “cannot tell” (0 points for both). S1 = adequate case definition; S2 = representativeness of the cases; S3 = selection of controls; S4 = definition of controls; C1 = comparability of cases; C2 = controls based on the analysis; E1 = ascertainment of exposure; E2 = same method of ascertainment for cases and controls; E3 = nonresponse rate.
Table 3  Medical and Dental Characteristics and Oral Health–Related Quality of Life of Patients in the

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Pathology</th>
<th>Reconstructive surgery</th>
<th>Adjuvant radiotherapy/chemotherapy</th>
<th>Dropouts (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roumanas et al19</td>
<td>26</td>
<td>NM</td>
<td>NM</td>
<td>Yes/NM</td>
<td>13 (50)</td>
</tr>
<tr>
<td>Laine et al20</td>
<td>10</td>
<td>10 cleft palate (4 small, cleft-related fistulae, 6 large oronasal communications)</td>
<td>4 palatoplasty</td>
<td>NM/NM</td>
<td>1 (10)</td>
</tr>
<tr>
<td>Fukuda et al21</td>
<td>7</td>
<td>6 SCCs and 1 carcinoma in pleomorphic adenoma</td>
<td>3 free-tissue transfers and 3 skin grafts for soft tissue defects</td>
<td>5 patients/5 patients</td>
<td>NM</td>
</tr>
<tr>
<td>Schmidt et al22</td>
<td>9</td>
<td>1 ACC, 1 PLGA, 5 SCC, 1 mucormycosis, 1 atrophy/infection</td>
<td>NM</td>
<td>5 patients/NM</td>
<td>2 (22.2)</td>
</tr>
<tr>
<td>Boyes-Varley et al23</td>
<td>20</td>
<td>11 SCC, 1 MEC, 1 chondrosarcoma, 1 basal cell carcinoma, 2 ACC, 1 osteoblastic chondrosarcoma, 1 AB, 1 odontogenic keratocyst, 1 infection</td>
<td>Soft tissue reconstruction (Weber-Ferguson flap)</td>
<td>5 patients/NM</td>
<td>4 (20)</td>
</tr>
<tr>
<td>Landes et al24</td>
<td>15</td>
<td>1 amelogenesis imperfecta, 3 congenital cleft lip and palate, 1 maxillary osteosarcoma, 7 SCC, 1 ACC, 2 mixed salivary carcinoma</td>
<td>Local osteoplasty</td>
<td>7 postoperative radiotherapy/7 preoperative chemotherapy</td>
<td>0</td>
</tr>
<tr>
<td>Katsoulis et al25</td>
<td>46</td>
<td>36 (78%) SCC, 4 (9%) adenocarcinomas, 6 (13%) other unspecified tumors</td>
<td>Bone and soft tissue graft from fibula</td>
<td>20 patients/9 patients</td>
<td>19 (41.3)</td>
</tr>
<tr>
<td>Huang et al26</td>
<td>24</td>
<td>1 (4.2%) benign neoplasm, 6 (25%) SCC, 9 (37.95%) ameloblastomas, 3 (12.5%) adenoid cystic carcinomas, 3 (12.5%) mucoepidermoid carcinomas, 2 (8.3%) sarcomas</td>
<td>13 autogenous fibulas, 3 ilium, and 2 scapula grafts</td>
<td>NM/NM</td>
<td>3 (12.5)</td>
</tr>
<tr>
<td>El-Sayed et al27</td>
<td>8</td>
<td>1 AB, 3 myxomas, 1 ameloblastic carcinoma, 1 osteomyelitis, 1 keratocyst, 1 SCC</td>
<td>NM</td>
<td>NM</td>
<td>NM</td>
</tr>
<tr>
<td>Wang et al28</td>
<td>38</td>
<td>8 SCC, 7 AB, 5 maxillary sinus carcinomas, 6 nasopharyngeal carcinomas, 6 hemangiofibromas, 2 palate mixed tumors, 4 other unspecified indication</td>
<td>15 vascularized free flaps from fibula, 5 ilium grafts</td>
<td>11 patients/NM</td>
<td>NM</td>
</tr>
</tbody>
</table>

NM = not mentioned; SCC = squamous cell carcinoma; PLGA = polymorphous low-grade adenocarcinoma; AB = ameloblastoma; MEC = mucoepidermoid carcinoma.

Okay9 classifications considered dentition status, but it was described in five studies.19–21,24,28 In total, 35 partially edentulous and 46 fully edentulous patients were included in the present study.19–21,24,28

Radiotherapy was reported in seven of the selected studies. Fifty-three (26.11%) patients received radiotherapy.19,21–24,28 Three articles reported adjuvant chemotherapy in 21 patients (10.34%), but it was not clear whether this was combined with radiotherapy.21,25

Six studies mentioned patient dropouts (n = 42) during the follow-up period, but only five reported the reasons. Of the dropouts, 6 were because of serious health conditions, and 34 because of death.19,20,22,23,25,26

Table 3 describes these characteristics.

Oral Rehabilitation Characteristics and Reconstructive Surgery

Of the 10 included studies, only 2 mentioned the use of provisional obturators.20,22 Bone augmentation procedures prior to implant placement were reported in 4 studies. A total of 54 patients required grafts: 3 sinus-lift grafts; 5 inlay-antral grafts; 3 inlay-antral and lateral grafts; 2 sinus-inlay grafts; 1 split-crest procedure; and 40 bone grafts (Table 4).19–21,24,25,28

All studies mentioned prosthetic information, but exhibited data heterogeneity (Table 5).19–28

Implant Survival

A total of 416 dental implants and 140 zygomatic implants were placed, with follow-up periods ranging from 1 to 10 years. Dental implant survival rates were reported in nine studies and ranged between 30% (n = 10; follow-up of 2 to 3 years)27 and 100% (n = 30; follow-up of 8 years).19–26

Immediate implant placement was carried out in six studies, but only four provided information about the number of immediate implants (n = 97).19,21,22,24

Zygomatic implants were placed in combination with dental implants in seven studies, with survival...
rates ranging from 21.42% (n = 28; follow-up of 2 to 3 years)\textsuperscript{22} to 100% (n = 40; follow-up of 8 years).\textsuperscript{21} Two studies did not report survival rates (Table 4).\textsuperscript{24,27,28}

### Marginal Bone Loss

Four articles measured and reported data on dental implant marginal bone loss using mesial and distal radiographic measurements at follow-up.\textsuperscript{19–21,26} The data of the four studies varied between 0.17 mm and 1 mm, and the follow-up periods between 1 and 10 years.

Roumanas et al\textsuperscript{19} give data ranging from 0.73 to 0.61 mm for anterior implants and 0.28 to 0.65 mm for posterior implants with a follow-up period from 6 to 66 months.\textsuperscript{19} Laine et al\textsuperscript{20} give a mean range of 0.095 to 1.542 mm from 2 to 7 years.\textsuperscript{20} Fukuda et al\textsuperscript{21} give a mean range of 0.42 mm at the first year and 0.61 mm at the second year of follow-up.\textsuperscript{21} Finally, Huang et al\textsuperscript{19} contributed data ranging from 0.6 mm at the first year to 1.2 mm at the seventh year\textsuperscript{26} (Table 4).

### Treatment Complications

Six of the studies reported data on implant surgical complications: five implants were unexposed in one study (n = 102), two implants did not achieve osseointegration (n = 60), one implant had peri-implantitis (n = 62), one implant produced mucosal dehiscence, another three implants damaged the zygomatic nerve; other complications were fistulae, localized infections, and flap dehiscence. Other complications included two implants associated with chronic inflammatory lesions, the removal of five zygomatic implants, and five dental implants lost due to unspecified reasons (Table 4).\textsuperscript{19,20,23–26}

Data on prosthodontic complications were only reported in four studies, with no homogeneity or clear data (Table 5).\textsuperscript{20,23,24,26} Of these studies, only one provided data on technical complications, which included structure sectioning (0.5%), screw fracture (2.3%), prosthesis fracture (6.8%), screw loosening (9.1%), and prosthesis mobility (6.8%) (n = 20).\textsuperscript{24}

One removable prosthesis was changed to a fixed reconstruction due to the patient being unable to adapt to treatment. Landes et al\textsuperscript{24} reported the need for four new prostheses (26%), in which two bars were replaced by telescopic abutments for retention (13.33%, n = 15).

### Patient Satisfaction and QoL

Regarding patient satisfaction and oral health–related QoL, six studies carried out quality of life measurements, as summarized in Table 4.\textsuperscript{20,21,25–28} However, there was a lack of homogeneity and standardization among these studies. Two studies\textsuperscript{25,28} used validated QoL questionnaires: the Oral Health Impact Profile-14 (OHIP-14); the Obturator Functioning Scale (OFS); the European Organization for Research and Treatment of Cancer Core Quality of Life Questionnaire (EORTC QLQ-C30); and the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire module for patients with head and neck cancer (EORTC QLQ-H&N35). Of the other studies,
Table 4  Implant Outcomes and QoL Data

<table>
<thead>
<tr>
<th>Study</th>
<th>Follow-up, y</th>
<th>No. of immediate implants</th>
<th>Bone graft for implant placement</th>
<th>No. of implants</th>
<th>Type of implants</th>
<th>Implant characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roumanas et al&lt;sup&gt;19&lt;/sup&gt;</td>
<td>10</td>
<td>38</td>
<td>3 sinus lift grafts</td>
<td>102</td>
<td>DI</td>
<td>Titanium screw type (Nobel Biocare)</td>
</tr>
<tr>
<td>Laine et al&lt;sup&gt;20&lt;/sup&gt;</td>
<td>1–8</td>
<td>NM</td>
<td>8 bone grafts (5 inlay-antral, 3 inlay-antral and lateral-onlay)</td>
<td>50</td>
<td>DI</td>
<td>Cylindrical screw type (Brånemark System [Nobel Biocare], ITI [Straumann])</td>
</tr>
<tr>
<td>Fukuda et al&lt;sup&gt;21&lt;/sup&gt;</td>
<td>1–6</td>
<td>8</td>
<td>2 sinus-inlay grafts, 1 split-crest graft</td>
<td>30</td>
<td>DI</td>
<td>Endosteal (Astra Tech)</td>
</tr>
<tr>
<td>Schmidt et al&lt;sup&gt;22&lt;/sup&gt;</td>
<td>2–3</td>
<td>38</td>
<td>NM</td>
<td>38</td>
<td>10 DI, 28 ZI</td>
<td>NM</td>
</tr>
<tr>
<td>Boyes-Varley et al&lt;sup&gt;23&lt;/sup&gt;</td>
<td>8</td>
<td>NM</td>
<td>NM</td>
<td>106</td>
<td>66 DI, 40 ZI</td>
<td>Machined surface (Southern Implants)</td>
</tr>
<tr>
<td>Landes et al&lt;sup&gt;24&lt;/sup&gt;</td>
<td>1–8.5</td>
<td>13</td>
<td>All patients</td>
<td>60</td>
<td>24 DI, 36 ZI</td>
<td>Brånemark System (Nobel Biocare) (ZI); MKII and IV Brånemark Fixture (Nobel Biocare); Nobel Speedy (Nobel Biocare); Straumann (SLA) (DI)</td>
</tr>
<tr>
<td>Katsoulis et al&lt;sup&gt;25&lt;/sup&gt;</td>
<td>1–5</td>
<td>NM</td>
<td>NM</td>
<td>24</td>
<td>21 DI, 3 ZI</td>
<td>NM</td>
</tr>
<tr>
<td>Huang et al&lt;sup&gt;26&lt;/sup&gt;</td>
<td>6</td>
<td>In 10 patients (no. NM)</td>
<td>NM</td>
<td>88</td>
<td>79 DI, 9 ZI</td>
<td>35 Straumann and 53 Nobel Biocare; implant diameters varied from 3.75–4.1 mm, lengths from 10–50 mm</td>
</tr>
<tr>
<td>El-Sayed et al&lt;sup&gt;27&lt;/sup&gt;</td>
<td>3</td>
<td>NM</td>
<td>NM</td>
<td>16</td>
<td>DI</td>
<td>Tapered SwissPlus (Zimmer implants)</td>
</tr>
<tr>
<td>Wang et al&lt;sup&gt;28&lt;/sup&gt;</td>
<td>8</td>
<td>NM</td>
<td>NM</td>
<td>42</td>
<td>18 DI, 24 ZI</td>
<td>Straumann (DI) and Nobel Biocare (DI and ZI)</td>
</tr>
</tbody>
</table>

DI = dental implants; ZI = zygomatic implants; NM = not mentioned; OFS = Obturation Functioning Scale; EORTC-H&N35 = European Organization for Research and Treatment of Cancer Core Quality of Life module for head and neck cancer (35 questions); VAS = visual analog scale; MHI = Mental Health Inventory; FC = facial contour; PC = prosthesis comfort; Pr = pronunciation; PF = prosthesis function; PS = partially satisfied; FS = fully satisfied.

one used a visual analog scale,<sup>19</sup> another used two types of masticatory efficiency tests,<sup>21</sup> and the remaining two used their own questionnaires.<sup>26,27</sup>

The overall results regarding patient satisfaction show, in most cases, an improvement in QoL. However, few studies revealed no differences. The questionnaire results are summarized in Table 4.

**DISCUSSION**

**Patient Characteristics**

In their systematic review, Brändao et al<sup>29</sup> compared surgical reconstruction to prostodontic rehabilitation to analyze their impact on QoL, concluding that the QoL of patients treated with obturator prostheses and patients treated with free-tissue transfers were similar. Also, Sharaf et al<sup>30</sup> reported that surgical reconstruction improved patient QoL compared to rehabilitation with prostheses, but found that the latter was effective provisionally following ablative surgery. However, neither of these systematic reviews analyzed the influence of osseointegrated implants in aiding palatal obturator support; therefore, it was not possible to compare the results of the present review with those obtained in these two reviews.

Only one study described the influence of radiotherapy on implants.<sup>19</sup> The literature indicates that radiation may negatively affect implant survival, especially when the implants are placed in the maxilla. However, there was no difference in implant survival rates when they were placed 12 months before or after radiotherapy in patients rehabilitated with palatal obturators.<sup>31</sup>

**Maxillary Defects**

Regarding the classification of maxillary defects, the analysis of the data obtained is in accordance with
study by Bidra et al,\textsuperscript{32} confirming that there is no classification that combines surgical and prosthodontic requirements.

**Oral Rehabilitation Characteristics and Reconstructive Surgery**

In terms of the effectiveness of reconstructive surgery and dental implants, according to the literature, the use of implants in combination with reconstructive surgery (before or after) is a predictable option in cases of partially or fully edentulous patients.\textsuperscript{33}

**Implant Survival**

Implants placed for subsequent maxillary rehabilitation should ideally be positioned in the residual bone and not in regenerated bone because the first shows better survival rates.\textsuperscript{20–23}

Depending on the nature of the defect and the prosthetic design, the implants should be placed where there is enough remaining bone. However, with this strategy, the implant may often be angulated or without keratinized mucosa surrounding its neck. Therefore, these rehabilitations require a multidisciplinary treatment approach.\textsuperscript{10–16,34,35}

Two systematic reviews showed high zygomatic implant survival rates, ranging between 95.8% and 99.9%, in the rehabilitation of the atrophic maxilla, as well as in patients with maxillary defects (between 78.6% and 94.6%).\textsuperscript{36,37}

In this review, implant survival in irradiated patients ranged between 21.42% and 100%. The literature indicates that global implant survival data in irradiated patients is between 88.9% and 92.2%.\textsuperscript{31,38} Data in the studies with lower survival rates (21.42% and 69.2%) were reported in irradiated patients and in implants

<table>
<thead>
<tr>
<th>Marginal bone loss</th>
<th>Survival rate (%)</th>
<th>Implant complications</th>
<th>QoL questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.44 mm and 0.17 mm per y for anterior and posterior implants, respectively, per y</td>
<td>69.2 (63.6 irradiated, 82.6 nonirradiated)</td>
<td>Of 12 immediate implants placed at tumor resection, 4 failed and 1 was buried.</td>
<td>NM</td>
</tr>
<tr>
<td>0.415 mm per y</td>
<td>87.5 at 5 y</td>
<td>1 mucosal dehiscence, 1 peri-implantitis.</td>
<td>VAS (unclear, but in most cases, score was better than before)</td>
</tr>
<tr>
<td>0.41 mm at 1 y, 0.61 mm at 2 y</td>
<td>100</td>
<td>NM</td>
<td>Ueda masticatory test (mean 77.1), Hirose test (excellent)</td>
</tr>
<tr>
<td>NM</td>
<td>21.42 ZI, 30 DI</td>
<td>NM</td>
<td>NM</td>
</tr>
<tr>
<td>NM</td>
<td>96 DI, 100 ZI</td>
<td>3 implants lost.</td>
<td>NM</td>
</tr>
<tr>
<td>NM</td>
<td>85 ZI, 92 DI</td>
<td>2 chronic inflammation and explantation, 2 ZI not loaded, resection of fully osseointegrated implant in 3 ZI and 2 DI, 6 infraorbital nerve injury, and 2 zygomatic facial nerve injuries</td>
<td>OHIP-14 (mean score 25 ± 12)</td>
</tr>
<tr>
<td>NM</td>
<td>88.7 at 5 y</td>
<td>4 implants not osseointegrated, 1 developed fistula and infection, 3 osteoradionecrosis, 2 not loaded due to unfavorable situations.</td>
<td>EORTC QLQ-C30 (72.1 ± 21.6), EORTC QLQ H&amp;N (60%, 10 patients not at all, or 2 a little bit)</td>
</tr>
<tr>
<td>NM</td>
<td>0.2 ± 0.3 mm at loading (88 implants), 0.9 ± 0.2 mm at 11 y (15 implants)</td>
<td>88.6</td>
<td>4 implants had dehiscence of the flap, 6 implants failed, and 9 implants removed due to peri-implant infection.</td>
</tr>
<tr>
<td>NM</td>
<td>NM</td>
<td>NM</td>
<td>14-item questionnaire made by the authors</td>
</tr>
<tr>
<td>NM</td>
<td>NM</td>
<td>NM</td>
<td>OFS (mean score 38), EORTC-H&amp;N (mean score 53), OHIP (mean subscale score: 65, mean total score: 56)</td>
</tr>
</tbody>
</table>
placed in compromised bone sites during ablative surgery.22,27

Regarding the survival rates of the prostheses, no study analyzed the survival of implant-supported palatal obturators. Therefore, the present analysis considered implant-supported overdentures. Maxillary overdenture survival rates were lower than mandibular ones, with survival rates as low as 71% at 5 years.39–41

The use of provisional obturators during reconstructive surgery and the healing process has been described in the literature as improving graft stability and oral health–related QoL; however, only two studies in the present review reported their use.23,25,42

Marginal Bone Loss in Implants
In implant dentistry, marginal bone loss is considered an important parameter for assessing long-term treatment success. Conventionally, vertical bone loss of 2 mm of bone surrounding the implant neck during the first year of functional loading is regarded as a successful result in some classifications and consensus statements.43–45 However, other authors have also deemed a marginal bone loss higher than 1.5 mm to 2 mm in the first year to be acceptable.44 In the present review, four studies analyzed this parameter, reporting marginal bone loss between 0.2 mm and 1 mm, which could be considered satisfactory.19–21,26

However, these data must be carefully reviewed, since they were provided by studies with heterogeneity and with different follow-ups for the data and studies.

### Treatment Complications
The surgical complications found in the present study were similar to those mentioned in previous studies that involved the placement of dental and zygomatic implants in patients with no maxillary defects.37,46–49

In relation to prosthodontic complications associated with implant-supported palatal obturators, the most common were screw loosening and prosthesis mobility. The most common retentive mechanism used in this review was bars and clips, which is in accordance with previous studies on implant-supported overdentures.15,39–41,50–52 Although no systematic review compared telescopic crowns to bar overdentures, Zou et al.53 did not find any differences between the two groups and concluded that the telescopic crown prostheses required more maintenance.

The data must be interpreted carefully because of the heterogeneity and lack of detail.

### Patient Satisfaction and QoL
Regarding patient satisfaction, implant-supported palatal obturators may provide better prosthesis retention and may increase patient satisfaction.11 Until now, no studies have compared patient satisfaction between conventional palatal obturators and implant-supported obturators. Unless standardized questionnaires were used, the heterogeneity between studies prevented comparison of their results.

Nevertheless, all authors reported an improvement in comparison to their previous condition before

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**Table 5 Prosthodontic Data and Complications**

<table>
<thead>
<tr>
<th>Author</th>
<th>Follow-up, y</th>
<th>Prosthodontic data</th>
<th>Prosthodontic complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roumanas et al.19</td>
<td>10</td>
<td>Extracoronal resilient attachment, Hader bar, Brånemark ball system</td>
<td>NM</td>
</tr>
<tr>
<td>Laine et al.20</td>
<td>1–8</td>
<td>Milled or prefabricated bar to provide support and retention to the prosthesis; Clips or CEKA attachments to attach the obturator to the implant bar</td>
<td>1 patient did not adapt to the obturator prosthesis, so the prosthesis design was changed to a fixed implant-supported prosthesis.</td>
</tr>
<tr>
<td>Fukuda et al.21</td>
<td>1–6</td>
<td>Milled bar attachment</td>
<td>NM</td>
</tr>
<tr>
<td>Schmidt et al.22</td>
<td>2–3</td>
<td>Bar removable obturator</td>
<td>NM</td>
</tr>
<tr>
<td>Boyes-Varley et al.23</td>
<td>8</td>
<td>Cast structure</td>
<td>2% screw fracture, 7% prosthesis fracture, 9% screw loosening, 7%, prosthesis mobility.</td>
</tr>
<tr>
<td>Landes et al.24</td>
<td>1–8.5</td>
<td>12 telescopic overdentures, 2 bar-clip overdentures, 1 telescopic partial denture with braces to remaining teeth (galvanized, zirconia, high gold alloy, chromium-cobalt-molybdenum)</td>
<td>4 required a new prosthesis, 2 bars replaced by telescopic abutments (due to implant removal)</td>
</tr>
<tr>
<td>Katsoulis et al.25</td>
<td>1–5</td>
<td>4 implant overdentures with obturators, 4 bar overdentures, 1 ball overdenture obturator</td>
<td>NM</td>
</tr>
<tr>
<td>Huang et al.26</td>
<td>6</td>
<td>18 patients (implant-supported fixed prostheses)</td>
<td>Screw loosening, prosthesis modification</td>
</tr>
<tr>
<td>El-Sayed et al.27</td>
<td>3</td>
<td>Ball abutments</td>
<td>NM</td>
</tr>
<tr>
<td>Wang et al.28</td>
<td>8</td>
<td>8 magnet attachments, 2 locators, 2 ball, 2 combination</td>
<td>NM</td>
</tr>
</tbody>
</table>

NM = not mentioned.
rehabilitation in patient oral health–related QoL while using implant-supported palatal obturators.\textsuperscript{1,19,21,25–28} This finding is in accordance with the studies on implant-supported overdentures, which indicate that the satisfaction and oral health–related QoL of the rehabilitated edentulous patients were improved in comparison to their previous situation (Table 4).\textsuperscript{54,55} It was not possible to reach common conclusions because the studies used different QoL questionnaires.

**Implications for Research**

Substantial underreporting was noted for several important aspects in these types of patients. The main limitation of the present study is the heterogeneity among the studies’ methodologies in terms of the type of study, patient follow-up, and oral health–related QoL and patient satisfaction assessments. There is no established protocol when it comes to rehabilitating the maxillary defect patient with palatal obturators, accounting for the difficulty in treatment outcome analysis.

The current evidence reveals an important knowledge gap when it comes to the outcomes of implant-supported prosthetic rehabilitation in patients with maxillary defects. To the present authors’ knowledge, this is the only systematic review to analyze the literature on implant-supported palatal obturators related to these variables.

Until now, there has been only one systematic review on the oral rehabilitation of maxillary defects.\textsuperscript{33} While that review focused on which treatments provide the best functional and esthetic outcomes, as well as on the influence of radiotherapy, it did not consider implants for their subsequent prosthodontic rehabilitation.

The language chosen to carry out this review was English because it was the common language among the reviewers. While some authors agree that the English language is sufficient for systematic reviews, it has also been suggested that the use of other languages may widen the scope of possible studies to be included.\textsuperscript{17}

Further high-quality research is needed, and standard protocols for treating and rehabilitating these patients should be defined based on the outcomes of this systematic review.

**CONCLUSIONS**

Considering the previous information and all the limitations of this systematic review, it can be concluded that:

- Acceptable clinical results can be expected with implant-supported prosthodontic rehabilitation, including palatal obturators, in maxillary defect patients. The implant survival rates found ranged between 85% and 92% and between 69.2% and 100% in partially and fully edentulous patients, respectively. The lower survival rates were reported in studies involving patients with radiotherapy and implants placed in compromised sites.
- Although several studies reported that palatal obturators improve patient oral health–related QoL, they did not use the same questionnaires and therefore were not comparable.
- Considering the clinical outcomes (survival rate, implant and prosthodontic complications, and QoL) of implant-supported palatal obturators reported in the literature, it can be concluded that this type of rehabilitation represents an acceptable treatment option for maxillary defect patients.
- Rehabilitation using implants in patients who may require adjuvant reconstructive surgery and/or chemo-radiotherapy is a safe therapeutic alternative, bearing in mind the potential for a higher percentage of implant loss.
- Further controlled studies with a focus on the outcomes of this rehabilitation are recommended.

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**REFERENCES**


