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Health-Related Quality of Life in Maxillectomy Patients Rehabilitated with Obturator Prostheses: A Literature Review

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Abstract

The prosthetic rehabilitation of the maxillectomy defect is important to restore oral functions and facial contours as well as to improve patients' health-related quality of life (HRQOL). This literature review aims to assess the HRQOL of maxillectomy patients rehabilitated with obturator prostheses and their determinants as well as to identify the most commonly used HRQOL measures. A literature search has been performed using PubMed, EMBASE, and Google Scholar to identify studies published before October 10, 2016. Twenty-three studies were identified. Most studies are cross-sectional. The most frequently used HRQOL measures were the Obturator Functioning Scale and the University of Washington Quality of Life scale version 4. Studies showed that postoperative radiation therapy, residual dentition, obturator functioning, impairment of ingestion, speech, appearance, the extent of therapy, and pain were important factors affecting patients' HRQOL. This review provides valuable information for clinicians and researchers in determining patients' needs, selecting HRQOL measure, planning future studies, as well as planning and developing comprehensive prosthetic rehabilitation programs. Well-designed clinical, multicenter, longitudinal studies with a larger sample are needed to evaluate the impacts of different reconstruction and retention methods as well as several determinants including sociodemographic, clinical, and psychological on patients' HRQOL.

Keywords: maxillectomy patients, health-related quality of life, obturator prosthesis, obturator functioning

1. Introduction

As a patient reported outcome, the assessment and monitoring of the health-related quality of life (HRQOL) in patients with head and neck cancer play a critical role in the treatment of decision-making process and developing treatment protocols as well as providing supportive care [1, 2].

Globally, cancer burden are increased due to population growth, aging, and an increasing prevalence of risk factors such as smoking, obesity, and dietary patterns [3].

Oral cavity cancer is the most common type of head and neck cancer [4]. Despite significant advances in its treatments, oral cancer has a poor prognosis and a low survival rate [5].

The Global Burden of Disease Study [6] reported that the global burden of periodontal disease, oral cancer, and dental caries increased markedly by an average of 45.6% from 1990 to 2010. Oral cancer is the eighth most common cancer worldwide. When compared with high-income countries, oral cancer is common in low-income countries [7]. In 2012, lip, oral cavity, and pharyngeal cancers were responsible for 529,500 incident cases and 292,300 deaths, accounting for approximately 3.8% of all cases and 3.6% of cancer deaths. Maxillary cancer is a rare tumor with increased mortality and 10% of all oral cancers occur in the oral cavity subsites of the upper gingiva and hard palate [8].

Oral cancer and its treatment have a direct impact on patients' physical, psychological, and social well-being. After resection of maxillofacial tumor, these patients experience orofacial functional changes and social and emotional issues that can have significant negative effects on their HRQOL and obturator functioning. The prosthetic rehabilitation of the maxillectomy defect is important to restore oral functions and facial contours as well as to improve HRQOL of patients. Following maxillectomy, patients experience severe problems in oral functioning, including speech, swallowing, mastication, and orofacial esthetics, all of which consequently affect their HRQOL and well-being. Therefore, prosthetic rehabilitation by the multidisciplinary team is a critical element to restore both oral function and facial form [9].

Maxillary defects after tumor resection can be reconstructed by using an obturator prosthesis or by a surgical reconstruction according to the extent of the maxillectomy defect and the need for radiation therapy [9, 10]. Although there is no consensus regarding the more effective treatment option, obturator prosthesis is the most widely used noninvasive approach and the recommended treatment modality to restore the patient's oral functions, aesthetics, and resocialization in the management of maxillary defects [10–15] because it provides a quick and adequate prosthetic rehabilitation in older patients, patients with a high morbidity rate, and patients with an unfavorable life expectancy [11]. Obturator rehabilitation is an equivalent reconstructive option for improving HRQOL and reducing complications in patients undergoing total or extended maxillectomy for advanced malignancy [16]. The comprehensive oral rehabilitation management is crucial for improving survival and oral functions in patients with advanced-stage disease and large defect which are treated by combination therapy, including preoperative irradiation, chemotherapy, surgery, and immediate reconstruction.

Besides clinical parameters, the subjective assessment by patients gives more information about patients' needs, expectations, and treatment effectiveness. To assess the HRQOL, many HRQOL instruments have been used by researchers, which are categorized into five groups: patient performance questionnaires, generic quality of life questionnaires, generic cancer questionnaires, head and neck cancer questionnaires, and head and neck functional questionnaires [17]. However, most studies used different questionnaires and study design to measure patients' HRQOL which hinders the ability to make direct comparison among studies. In addition, the existing studies reported several factors affecting patients' HRQOL and obturator functioning. Recent systematic review on the HRQOL of patients with maxillary defects who had undergone restoration with obturator protheses and/or free tissue reported that prospective, blinded, randomized, multicenter studies with standardized methods are needed to reach definitive conclusions about the best method and the related factors with these treatment options [18].

This review provides an outline of existing literature on HRQOL of maxillectomy patients rehabilitated with obturator protheses. Additionally, it provides valuable information for clinicians and researchers in determining patients' needs, selecting an existing validated measure, planning future studies, as well as planning and developing comprehensive prosthetic rehabilitation programs.

The aim of this literature review was to assess the HRQOL in maxillectomy patients rehabilitated with obturator protheses and its determinants as well as to identify the most commonly used HRQOL measures.

2. Methods

A literature search has been performed in PubMed, EMBASE, and Google Scholar to identify studies published in the period July 1996–October 10, 2016. The following keywords such as maxillectomy patients, palatal obturators, patient satisfaction, HRQOL, and obturator function in diverse combinations with MeSH search were used to identify all relevant studies. In addition, the reference lists of these manuscripts and all included chapters were checked for eligible articles.

3. Selection criteria

3.1. Inclusion criteria

Titles and abstracts were screened by the author, according to the following inclusion criterion: studies published in English; quantitative studies; study sample consisted of maxillectomy patients who had undergone restoration with obturator protheses; studies published in the period July 1996–October 10, 2016; studies used at least one validated HRQOL measure; studies reported determinants related to HRQOL and patient satisfaction; and studies compared HRQOL outcomes of patients who had undergone maxillectomy followed by different prosthetic modalities.

3.2. Exclusion criteria

Case reports or case series, qualitative studies, studies used self-reported HRQOL factors, validation studies, systematic reviews, unpublished theses, and dissertations were excluded.

3.3. Data extraction

Data were extracted on study design, characteristics of participants, outcome measure(s), and findings.

4. Findings

Screening of the titles and abstracts resulted in a selection of 23 articles. Of the 23 selected studies, 13 were retrospective cross-sectional studies, 1 was case-control study, 4 were experimental studies, and 5 were cohort studies.

4.1. Study characteristics

Of the 23 studies included in this review were conducted in the United States ($n = 4$), China ($n = 4$), Pakistan ($n = 3$), UK ($n = 2$), the Netherlands ($n = 2$), Denmark ($n = 1$), Germany ($n = 2$), Egypt ($n = 1$), Brazil ($n = 1$), India ($n = 1$), and Canada ($n = 2$).

Sample sizes of the studies varied widely, between 8 and 73 participants. Selected characteristics of the 23 studies are presented in **Table 1**.

4.2. Measurement of HRQOL

The most frequently used HRQOL measures were the Obturator Functioning Scale (OFS) ($n = 14$) and the University of Washington Quality of Life scale version 4 (UW-QoLv4) ($n = 6$). Twelve studies used more than one instrument to measure HRQOL and only three studies used an oral health-related quality of life measure. Five studies used only one measure, namely, OFS. Five studies used a head and neck cancer-specific measure besides a generic measure.

The most frequently used head and neck cancer-specific instruments were: the European Organization for Research and Treatment of Cancer general form (EORTC C-30), head-neck specific version (EORTC HN35), the UW-QoLv4, the Performance Status Scale for Head and Neck Cancer Patients (PSS-HN), the OFS, the Swallowing Quality Of Life (SWAL-QOL), and the Eastern Cooperative Oncology Group performance score (ECOG).

Only two region-specific HRQOL measures [The Disabilities of the Arm, Shoulder and Hand (DASH) and the American Academy of Orthopedic Surgeons (AOSS) Hip and Knee Questionnaire] were used in combination with a head and neck cancer function-specific HRQOL measure [19]. Only one study used a questionnaire which is originally developed for DOESAK (a German, Austrian, and Swiss cooperative group on tumors of the maxillofacial region) in combination with head and neck cancer specific measures [14].

Author (year)/ country	Title	Study design	Patient information	HRQOL	General results
Chen et al. (2016)/ China [28]	Quality of Life in Patients After Maxillectomy and Placement of Prosthetic Obturator	Retrospective cross-sectional study	N = 29 (16 male, 13 female); mean age = 48.8 years; 29 OP	UWQOLv4 OFS	Postoperative radiotherapy was the strongest variable affecting HRQOL in patients with maxillectomy and prosthetic obturator reconstruction. The size of the defect affected the obturator function.
Chen et al. (2016)/ China [25]	Function of obturator prosthesis after maxillectomy and prosthetic obturator rehabilitation	Retrospective cohort study (10 years)	N = 28 (19 male, 9 female); mean age = 62.05 years; 9 COP 11 AOP 8 MOP	OFS	Obturator prosthesis improves oral function of maxillectomy patients; the retention of the obturator prosthesis enhanced by the addition of attachments showed more benefits in oral function. There was significant difference in functions such as speech, swallowing and chewing among these three sub-groups.
Breeze et al. (2016)/ England [12]	Health-related quality of life after maxillectomy: obturator rehabilitation compared with flap reconstruction	A prospective study two-group pretest-posttest design	N = 39 (22 male, 17 female); mean age = 64 ± 7 years; 18 flap reconstruction 21 OP	UWQOLv4	There was a significant decrease in HRQOL after treatment compared with before, but there was no significant difference in the effects of these treatment methods on HRQOL. Obturators remain an important option for rehabilitation in selected patients in addition to reconstruction with a flap. The size of the vertical defect and the use of postoperative radiotherapy had no adverse effect on HRQOL.
Wang et al. (2016)/ China [27]	Functional outcome and quality of life after a maxillectomy: a comparison between an implant supported obturator and implant supported fixed prostheses in a free vascularized flap	Comparative cross-sectional study	N = 38 (23 male, 15 female); 18 implant supported OP (mean age of 56.2 years) 20 vascularized free flap transfer with implant supported fixed prostheses (mean age 45.6 years)	OFS EORTC HN 35 MHI	There is no difference in oral function between these patient groups. Patients wearing obturator had poorer mental health than did patients with fixed prostheses.

Table 1. (continued).

Author (year)/ country	Title	Study design	Patient information	HRQOL	General results
Gotfredsen and Abdullah (2015)/ Denmark [21]	Oral prosthetic rehabilitation with and without implants after radiation therapy and ablative surgery	Quasi Experimental Designs One group before after study	N = 51 (35 male, 16 female); mean age= 66 years; 10 OP 16 fixed prosthesis 5 fixed combined with removable prostheses 30 had only removable prostheses	OHIP-49	After oral rehabilitation with fixed and removable dental prosthesis, a significant improvement in oral health related quality of life was found in all patients. The oral rehabilitation resulted in better appearance and chewing function. No significant effect between fixed versus removable prostheses and no significant effect of implant on the OHIP-score were found.
Salem et al. (2015)/ Egypt [20]	Evaluation of Zygomatic implant retained obturator in rehabilitation of partial palato-maxillectomy patients	A prospective comparative study	N = 8 (5 female, 3 male); age range 20 to 58 years conventional OP Implant retained OP	OHIP 14	For the abutment teeth, there was no statistically significant difference in gingival index, tooth mobility, and bone level between these patients groups. The implant retained obturator highly improved the masticatory function and oral health-related quality of life in comparison to conventional obturator.
Seignemartin et al. (2015)/Brazil [26]	Understandability of Speech Predicts Quality of Life Among Maxillectomy Patients Restored With Obturator Prosthesis	Retrospective cross- sectional study	N = 73 (37 male, 36 female); mean age= 62.2 years; 52 total upper OP and 21 upper partial OP	PSS-HN UWQOLv4 OFS	The understandability of speech was the only predictor of HRQOL Classification of the defect, eating in public, and understandability of speech were predictors of worse obturator functioning. Patients wearing partial removable prostheses had better HRQOL than those with total removable prostheses. There were no statistical associations of age, gender, maxillary teeth status, and tumor stage with total HRQOL and OFS scores.
Murphy et al. (2015)/USA [16]	Quality of life factors and survival after total or extended maxillectomy for sinonasal malignancies	Retrospective cohort study	N = 25 (12 male, 13 female); mean age= 67.8 years; 13 free flap 11 OP 1 regional flap	ECOG performance score	The inevitable morbidity could be deemed acceptable by patients. Obturator rehabilitation was found to be an equivalent reconstructive option in these patients in terms of the HRQOL factors and complications.

Table 1. (continued).

Author (year)/country	Title	Study design	Patient information	HRQOL	General results
Hussain et al. (2014)/Pakistan [22]	Quality of life in oral cancer patients after provision of maxillary obturators	Before-after study One group Pretest, Posttest	N = 32 (25 male, 7 female); age range of 15–74 years 32 OP	OHIP-14	After provision of obturators, there was significantly improvement in oral health quality of life in these patients, especially in speech, mastication and self-confidence.
Khan et al./Pakistan [35]	Subjective assessment of obturator functioning in patients with hemimaxillectomy	Cross-sectional study	N = 50 (37 male, 13 female); mean age = 41.7 years. 50 OP	OFS	Obturator prosthesis provides better functioning in speech and esthetics but it is not very efficient in terms of mastication and swallowing.
Jiao et al. (2014)/China [23]	Rehabilitation of maxillectomy defects with obturator prostheses fabricated using computer-aided design and rapid prototyping: a pilot study	Quasi Experimental Designs	N = 11 (7 male, 4 female); age range 25–68 years.	OFS	These methods improve oral function and social acceptance. It has shown significant clinical value, especially for use in developing countries.
Chigurupati et al. (2013)/USA [32]	Quality of life after maxillectomy and prosthetic obturator rehabilitation	Retrospective, cross-sectional study	N = 23 (14 male, 9 female); mean age = 61 years	UWQOLv4 OFS MHI	Postoperative radiation therapy was the most important predictors of HRQOL in patients with maxillectomy and prosthetic obturator reconstruction. Further multicenter trials with large sample size are needed to identify how factors affecting HRQOL of patients after maxillectomy might influence the choice of reconstruction.
Kumar et al. (2013)/India [13]	Assessment of the quality of life in maxillectomy patients: a longitudinal study	A longitudinal study Before after treatment	N = 30 (20 male, 10 female); mean age=46.83 years	EORTC QLQ-H &N 35v1	Obturator prosthesis is a highly positive and non-invasive approach to improve patients' HRQOL. A statistically significant improvement was found in some functions such as problems in swallowing solid food, problem in opening mouth wide, trouble in eating, difficulty in eating food in front of family and other people, problem in enjoying food, difficulty in conversation to people and on the telephone, problem in making social contacts with friends, trouble in making public appearance and difficulty in making physical contacts with others.

Table 1. (continued).

Author (year)/ country	Title	Study design	Patient information	HRQOL	General results
Kreeft et al. (2012)/ Netherlands [31]	Oral function after maxillectomy and reconstruction with an obturator	Retrospective cohort study	N = 32 (13 male, 19 female); mean age=49 years 32 OB	EORTC-H&N 35 OFS	Size of the maxillectomy defect did not significantly influence functional outcome, but adjuvant radiotherapy resulted in worse mouth opening and self-reported oral and swallowing problems. Residual dentition had a significant effect on both mastication and HRQOL.
Depprich et al. (2011)/Germany [14]	Evaluation of the quality of life of patients with maxillofacial defects after prosthodontics therapy with obturator prostheses	Cross-sectional study	N = 31 (14 male, 17 female); mean age=67.6 years; 31 OB	DOESAK EORTC QLQ- H&N35 OFS	Obturator functioning, impairment of ingestion, speech, appearance, the extent of therapy, and the existence of pain had significant impact on the HRQOL. Orofacial rehabilitation of patients with maxillofacial defects using obturator prostheses is an appropriate treatment modality. To improve the situation of patients prior to and after maxillectomy sufficient information about the treatment, adequate psychological care and speech therapy should be provided.
Riaz and Warriach (2010)/Pakistan [15]	Quality of life in patients with obturator prostheses	Cross-sectional study	30 (19 male, 11 female); mean age=57.6 years; 30 OB	UW-QOLv4 OFS	Obturator functioning, impairment of ingestion, speech and appearance, the extent of therapy, and the existence of pain had significant impact on the HRQOL. Orofacial rehabilitation using obturator prostheses is an appropriate treatment modality. To improve the situation of patients prior to and after maxillectomy sufficient information about the treatment, adequate psychological care and speech therapy should be provided.
Lethaus et al. (2010)/Netherlands [11]	Surgical and prosthetic reconsiderations in patients with maxillectomy	Retrospective cohort study	11 (6 male, 5 female); mean age=60 years; a computer-aided design/computer-aided manufacturing designed prosthesis	OFS	Obturator prosthesis fabricated with CAD/ CAM techniques improves oral function and social acceptance.

Table 1. (continued).

Author (year)/country	Title	Study design	Patient information	HRQOL	General results
Irish et al. (2009)/Canada [33]	Quality of life in patients with maxillectomy prostheses	Cross-sectional study	N = 42 (12 male, 30 female); mean age=60.7 years; 42 OB	OFS MHI IES IIRS CES-D	Leakage when swallowing foods was the most frequently reported problem. Difficulty with speech and eating resulted in an increase in avoidance of social life. The surgical approach had a significant effect on the OFS, IES, and MHI subscales. Good obturator function is associated with a better HRQOL.
Hertrampf et al. (2004)/Germany [34]	Quality of life of patients with maxillofacial defects after treatment for malignancy	Case-control study	Patients with defects who received prosthetic treatment (<i>n</i> = 17, mean age 61.7 years); Persons affected with a nonmalignant condition (control; <i>n</i> = 17, mean age 53.4 years) German population reference data (<i>n</i> = 2028)	EORTC QLQ-C30 EORTC-H&N 35	Tumor patients did not significantly differ from nontumor patients in terms of the total HRQOL. Tumor patients had worse scores in role functioning, speech, mouth opening, and dry mouth, as well as pain and swallowing. In comparison with the reference data of the German population, tumor patients had more deficits regarding role functioning, dyspnea, financial difficulties, fatigue, insomnia, and appetite. Tumor patients rated the diagnosis as the most stressful event and reported that the family was most instrumental in the recovery process. Patients with maxillofacial defects suffer from many symptoms and problems, even after prosthodontic treatment. These patients need psychologic care at the time of diagnosis and after completion of the prosthodontic treatment, therapy options for pain or speech problems should be offered.

Table 1. (continued).

Author (year)/ country	Title	Study design	Patient information	HRQOL	General results
Rieger et al. (2003)/ Canada [29]	Maxillary obturators: the relationship between patient satisfaction and speech outcome	Cross – sectional	N = 20(12 female, 8 male); mean age 55 years 20 OP	OFS	The poorer aeromechanical speech were associated with the avoidance of social events, whereas lower speech intelligibility outcomes were related to worse speech function on the OFS. Background patient characteristics such as gender, degree of resection, type of prosthesis retention, history of orbital exenteration, history of radiation therapy, and the wearing time of definitive obturator are most important determinants of functional speech functions and patient satisfaction.
Rogers et al. (2003)/ England [24]	Health-related quality of life after maxillectomy: a comparison between prosthetic obturation and free flap	Cross sectional study	N = 28 (18 male, 10 female); mean age = 64 years; 10 OB 18 SR	UW-QOL EORTC QLQ C30 -EORTC HN 35 HAD	No significant differences were identified between obturator and free flap groups. Obturator patients were more concerned about their appearance, more aware of their upper teeth, more self-conscious, less satisfied with their upper dentures, and less satisfied with function. They had more pain and soreness in their mouths.
Genden et al. (2003)/USA [19]	Comparison of functional and quality-of-life outcomes in patients with and without palatomaxillary reconstruction: a preliminary report	Comparative cross sectional	N = 8 (5 male, 3 female); mean age=42 years; 4 OB with a tissue-borne prosthetic obturator; 4 vascularized bone- containing free flap	DASH AAOS Hip and Knee Questionnaire SWALQOL	Patients with free flap had higher scores on mastication and speech than those with a prosthetic obturator. Compared with their prosthetic counterparts, flap patients enjoyed a better HRQOL without incurring significant donor site morbidity. Although free flaps requires a second operative site, this method can provide better functional and HRQOL outcomes than prosthetic obturator.

Table 1. (continued).

Author (year)/ country	Title	Study design	Patient information	HRQOL	General results
Kornblith et al. (1996)/USA [30]	Quality of life of maxillectomy patients using an obturator prosthesis	Retrospective cross-sectional	N = 47 (31 male, 16 female); mean age = 59.5 years; 47 OP	OFS, PAIS, MHI, IES, Family Functioning Scale, Perceived Negative Socioeconomic Impact of Cancer Index	Obturator functioning are associated with better adjustment and an improvement in pronouncing words, chewing and swallowing food, and voice quality after surgery. The most important predictors of obturator functioning were the extent of resection of their soft palate (one third or less) and hard palate (one fourth or less). Well-functioning obturator is important for improving the HRQOL of maxillectomy patients.

Note: OP, obturators; COP, conventional retained obturator prosthesis; AOP, enhanced retentive obturator prosthesis with stud attachment; MOP, enhanced retentive obturator prosthesis with magnetic attachment; HRQOL, health-related quality of life; UWQOLv4, the University of Washington Quality of Life scale version 4; OFS, the Obturator Functioning Scale; EORTC QLQ-C30, the European Organization for Research and Treatment of Cancer general form; EORTC HN 35, the European Organization for Research and Treatment of Cancer general form, head-neck specific version; MHI, the Mental Health Inventory; OHIP-49, the 49 items of the Oral Health Impact Profile; OHIP 14, the short version OHIP; PSS-HN, the Performance Status Scale for Head and Neck Cancer Patients; ECOG (the Eastern Cooperative Oncology Group) performance score; DOESAK, a German, Austrian and Swiss cooperative group on tumors of the maxillofacial region; IES, Impact of Events Scale; IIRS, Illness Intrusiveness Ratings Scale; CES-D, Centre for Epidemiologic Studies Depression Scale; HAD, Hospital Anxiety Depression; DASH, The Disabilities of the Arm, Shoulder and Hand; AAOS (American Academy of Orthopaedic Surgeons) Hip and Knee Questionnaire; SWALQOL, the Swallowing Quality of Life; PAIS, the Psychosocial Adjustment to Illness Scale.

Table 1. Characteristics of selected studies.

The used general quality of life measures were: Mental Health Inventory (MHI; $n = 4$), Impact of Events Scale (IES; $n = 2$), Illness Intrusiveness Ratings Scale (IIRS; $n = 1$), Centre for Epidemiologic Studies Depression Scale (CES-D; $n = 1$), the Psychosocial Adjustment to Illness Scale (PAIS; $n = 1$), the Family Function Scale ($n = 1$), the Perceived Negative Socioeconomic Impact Index ($n = 1$), and the Hospital Anxiety and Depression Scale (HAD; $n = 1$).

There are only three studies using an oral health-related quality of life [20–22]. Of the three studies identified, one used the forty-nine items of the Oral Health Impact Profile (OHIP-49), and two used the short version OHIP-14.

Two studies evaluated the effects of different technologies used in manufacturing individualized obturators on patients' HRQOL [11, 23], three compared the HRQOL after maxillectomy between obturators and flaps [12, 16, 24], and three compared patients' HRQOL who used obturator prosthesis with different retention mechanism [20, 21, 25], one compared the HRQOL between patients with an upper denture obturator and upper partial obturator [26], and one evaluated the differences in obturator functioning and HRQOL between patients with implant-supported obturators and implant-supported fixed prostheses in free vascularized flaps [27].

4.3. Studies on the effects of different technologies used for manufacturing individualized obturators

Studies about comparing different technologies used for manufacturing individualized obturators showed that the computer-aided design with rapid prototyping technology is an alternative and feasible method for manufacturing individualized obturators for patients after maxillary resection [23]. In other study, the treatment protocol which incorporates the use of standard dental implants in combination with a computer-aided design/computer-aided manufacturing showed good functional and social outcomes [11].

4.4. Studies on the effects of different retention mechanism

Studies on the effects of different retention mechanism on patients' HRQOL reported that the retention of the obturator prosthesis enhanced by the addition of attachments showed some improvements in oral function such as speech, swallowing, and chewing. Patients treated with an enhanced retentive obturator prosthesis with stud attachment reported higher scores in the domains of speech and swallowing than patients treated with conventional and magnetic retentive prosthesis. Patients who were treated with an enhanced retentive obturator prosthesis with stud attachment and with an enhanced retentive obturator prosthesis with magnetic attachment had better scores in "swallowing-leakage with solid" and "chewing/eating" domains of HRQOL than patients with a conventional retained obturator prosthesis. The large one-side defect and gender were found to be important factor for enhancing retention and improving patient's confidence and esthetics [25].

Study on the evaluation of zygomatic implant retained obturator in rehabilitation of partial palato-maxillectomy patients showed that rehabilitation of maxillectomy patients with conventional or implant retained obturator had significant improvement in the functional impairment, psychological disability, and social disability domains of the oral health-related

quality of life in comparison to patients without obturator. Significant improvements were found in patients' oral health-related quality of life as well as their masticatory function after converting the conventional obturator to implant retained obturator. For the abutment teeth, there was no statistically significant difference in some clinical parameters such as gingival index, tooth mobility, and bone level between conventional obturator and implant retained obturator [20].

Another study [21] conducted on patients treated with radiation therapy and/or ablative surgery reported a significant improvement in appearance and chewing function after oral rehabilitation with fixed and removable dental prosthesis. In this study, no significant effect between fixed versus removable prostheses and no significant effect of implant on the oral health-related quality of life of patients were found. Seignemartin et al. [26] reported that patients wearing partial removable prostheses had higher HRQOL than those with total removable prostheses.

4.5. Studies comparing the obturator replacement with free flap

There are a small number of studies comparing the HRQOL of patients wearing obturator prostheses with those who underwent free flap reconstruction. The cross-sectional study by Rogers et al. [24] found no statistically significant difference in HRQOL between these groups, but obturator patients were more concerned about their appearance, more aware of their upper teeth, more self-conscious, less satisfied with their upper dentures, less satisfied with function, and they reported more pain and soreness in their mouths. Similarly, Wang et al. [27] found no differences in HRQOL and oral functioning between patients with implant-supported obturators and implant-supported fixed prostheses in free vascularized flaps after a maxillectomy but obturator patients had worse mental health than those with fixed prostheses. Consistent with these findings, Breeze et al. [12] found no significant difference in the effects of these treatments on patients' HRQOL.

In contrast, another cross-sectional study reported that palatamaxillary reconstruction with vascularized bone-containing free flaps may improve the functional and HRQOL outcomes relative to defect-matched patients rehabilitated with a prosthetic obturator although this method requires a second operative site [19].

In a 5-year retrospective cohort study [16], obturator placement was found to be an equivalent reconstructive option with respect to the HRQOL factors and complications, because inevitable morbidity caused by the disfiguring effects of maxillectomy (total or extended) could be deemed acceptable by these patients. In another longitudinal study conducted by Breeze et al. [12] reported similar findings. They found no significant difference in the effects of these treatment options on patients' HRQOL.

4.6. Studies assessing obturator functioning among patients wearing an obturator prosthesis

There were 11 cross-sectional studies that examined the HRQOL among patients wearing an obturator prosthesis. Existing studies showed that obturator functioning is associated with

the size of defect [26, 28, 29], the extent of resection in the soft palate and hard palate [30], the grade of impairment of speech [14, 29], ingestion [14], eating in public, and understandability of speech [26]. Some studies reported conflicting results with regards to the impact of defect size [14, 31]. Depprich et al. [14] reported that the prosthesis form, the former wearing of dentures, and the existence of maxillary teeth or dental implants had no significant effects on the obturator functioning. Kreeft et al. [31] reported that obturator functioning is not related to the history of adjuvant radiotherapy and the presence of residual dentition. Rieger et al. [29] reported that background patient characteristics such as gender, type of prosthesis retention, history of orbital exenteration, history of radiation therapy, and the wearing time of the definitive obturator are important predictors of obturator functioning and satisfaction. Seignemartin et al. [26] found no statistical associations of age, salivary flow, tooth in the maxilla, and tumor stage with obturator function.

4.7. Studies assessing HRQOL among patients wearing an obturator prosthesis

Studies of maxillectomy patients rehabilitated with obturator prostheses reported that post-operative radiotherapy [26, 28, 31, 32], the size of defect [26], the degree of hyposalivation [15, 26], understandability of speech [26], functioning of the obturator prosthesis [14, 15, 30, 33], impairment of ingestion, speech, and appearance [14, 15], the extent of therapy [14, 15], the existence of pain [14, 15, 24, 34], the type of surgery [33], and residual dentition [31] had significant impacts on patients' HRQOL. Some studies have reported conflicting results. Depprich et al. [14] found that the classification of maxillary defects and the type of surgery (transoral vs. transfacial) had no significant influence on HRQOL. Seignemartin et al. [26] found no statistical associations of salivary flow, tooth in the maxilla, and tumor stage with the HRQOL. Breeze et al. [12] reported that there are no adverse effects of both the size of the vertical defect and postoperative radiotherapy on HRQOL.

There are conflicting findings concerning demographic characteristics. Some researchers reported that gender [15] and the level of education [14] were associated with HRQOL, while others did not find any relationships between these variables and patients' HRQOL [14, 15, 26, 33]. No significant association was found between HRQOL and age [14, 15, 26].

4.8. The self-reported problems among patients wearing an obturator prosthesis

In general, the most common problems reported by patients wearing an obturator prosthesis include: leakage when swallowing foods, impairment of speech, chewing, swallowing, and pain [14, 30, 33, 35]. Difficulties in pronouncing words, chewing and swallowing food, and voice changes after surgery were found to be related with worse adjustment [30].

The longitudinal study conducted by Kumar et al. [13] reported that there was a significant increase in some items scores of the EORTC QLQ-H&N35 after treatment compared with before (e.g., problems in swallowing solid food, opening mouth, eating, enjoying food, conversation with people, talking over the telephone, making social and physical contacts with friends and others). These findings are consistent with previous cross-sectional studies conducted by Depprich et al. [14], Irish et al. [33], and Kornblith et al. [30].

Another longitudinal study using the OHIP-14 showed that there was significant improvement in speech, mastication, and self-confidence domains of oral health-related quality of life in maxillectomy patients after prosthodontic rehabilitation [22].

5. Discussion

In recent years, there has been a growing interest in evaluating HRQOL and patient satisfaction as patient-reported outcome measures among maxillectomy patients rehabilitated with obturator protheses.

Patients who underwent radiotherapy due to oral cavity cancer showed worse oral health-related quality of life than patients with other tumor sites and the population average. In head and cancer patients, tumor site is a more important factor affecting HRQOL than the number of remaining teeth or type of prosthesis [36].

Only, one study compared the HRQOL in maxillectomy patients with that of the general population. Compared to nontumor patients, tumor patients showed a significant decrease in oral functions such as speech, mouth opening, dry mouth, pain, and swallowing. Comparison with the reference data of the German population, tumor patients experienced some problems regarding role functioning, dyspnea, and financial difficulties [34].

Due to additional radiotherapy and chemotherapy, maxillectomy patients with advanced malignancy and large defect size tend to have more fear of the future and to be depressed because they are at a higher risk of relapse and survival [15]. It is known that patients' HRQOL depends on the extent and location of the resection, the types of cancer treatment, patients' coping strategies besides the functionality of dentures, and the type of rehabilitation [37].

In general, the most common problems reported by patients wearing an obturator prosthesis were leakage when swallowing foods, impairment of speech, chewing, swallowing, and pain [14, 30, 33, 35]. Prosthodontic rehabilitation using maxillary obturator improves speech, mastication, esthetics, swallowing, and self-confidence [22, 30, 35]. In these patients, difficulties with speech, eating, and swallowing may lead to avoid social life [13–15, 26, 29, 33]. Obturator functioning are associated with better psychosocial adjustment and improvement in pronouncing words, chewing and swallowing food, and voice quality after surgery [30].

Even after prosthodontic treatment, these patients suffered from psychological, functional, or behavioral problems [26, 27, 30, 33, 34]. After assessing the information about patient-related clinical factors, needs, and personality, comprehensive oral health rehabilitation including psychological care, speech therapy, and pain management should be given by the multidisciplinary team for improving patients' HRQOL [14, 15, 19, 21, 26, 29–31, 33, 34].

Obturator prosthesis improves oral function of patients after surgery. The retention of the obturator prosthesis enhanced by the addition of attachments may provide more benefits in oral function [25]. Implant retained obturator showed significant improvement over

conventional obturator in the social and psychological aspects of HRQOL of these patients because additional retention provides the opportunity to prevent obturator movement during speech [20].

To date, there are few studies comparing obturators to free flap reconstructions of maxillectomy defects [12, 16, 19, 21, 24, 27]. Some studies reported that there was no significant difference in HRQOL after treatment between flaps and obturators [12, 21, 24], whereas others reported a significant difference in the functional and HRQOL outcomes between these patients [19, 27]. In the future, large multicenter studies are needed to compare the effects of different types of flaps and alternative reconstruction methods (i.e., stem cells) on patients' HRQOL [12, 14, 15, 19]. Large prospective and longitudinal studies are needed to compare the HRQOL of patients wearing obturator prostheses with those who underwent free flap reconstruction and to understand the effects of functional factors and patient-perceived symptoms on the selection of appropriate treatment [24, 29]. In addition, large and multicenter trials are required to identify the factors affecting HRQOL after maxillectomy which might influence the choice of reconstruction [26, 32].

Only two studies examined the effects of different technologies used in manufacturing individualized obturators on patients' HRQOL. These studies suggest the integration of the combination of three-dimensional (3-D) technology, implant insertion, and resection into treatment protocol for improving patients' HRQOL and obturator functioning, especially in developing countries, because obturator prosthesis fabricated with CAD/CAM techniques or rapid prototyping improves oral function and social acceptance as well as reduce the treatment cost, time, and effort [11, 23]. Future studies using additional assessment for the classification of maxillary defect and soft palate junction are needed to evaluate the validity of these methods.

There were 11 cross-sectional studies that examined the HRQOL among patients using an obturator prosthesis. Studies using multivariate analysis method reported that the most important factors affecting HRQOL in patients using obturator prosthesis were the postoperative radiotherapy [28, 32], understandability of speech [26], obturator functioning, impairment of ingestion, appearance, the extent of therapy, the existence of pain [15], and residual dentition [31]. The most frequently reported factors regarding obturator functioning were defect size [28], surgical approach [33], postoperative radiotherapy, and premorbid dentition [25]. More longitudinal studies are needed to evaluate temporal changes in HRQOL and obturator functioning because most studies used cross-sectional design. These studies may provide valuable information about the likely effects of the various phases of illness, treatment, and rehabilitation on patients' HRQOL.

The most frequently used head and neck-specific HRQOL measures were the OFS [11, 14, 15, 20, 23, 25–27, 29, 30–33, 35] and the UW-QoLv4 [12, 15, 24, 26, 28, 32]. The OFS subsite-specific questionnaire has been most frequently used in studies of maxillectomy patients wearing obturator prosthesis. Although this measure may be used by clinicians to identify the patients who are likely to have a poor HRQOL for improving the outcomes of prosthodontic rehabilitation [33], more studies are needed to assess the clinical utility of the OFS as a screening measure.

There are only three studies using oral health-related quality of life [20–22]. Although oral health-related quality of life measures has been used mainly in studies evaluating different

oral rehabilitation treatment modalities, the validity of these measure may be questioned in head and neck patients with a compromised functional status for assessing the effect of oral rehabilitation on HRQOL [21]. Comparison studies showed that the OHIP-49 was a better method for measuring the impact of treatment, whereas the individual systematic interview method was more appropriate for gaining detailed information for decision making than the OHIP-49 [38]. Most HRQOL instruments do not capture all relevant determinants [39]. Thus, combined HRQOL measures (head and neck cancer specific and general) were used in five studies [24, 27, 30, 32, 33]. Some studies reported that patients adjusted favorably after maxillectomy and rehabilitation with obturator prostheses [15, 30].

The life contexts and psychosocial factors are most important determinants of HRQOL [21, 24, 27, 30, 32, 33]. Thus, future studies should examine the impacts of the personal resources and life context-related factors such as having a loving family, socioeconomic advantages, absence of psychologically independent stressful life events, and social support on these patients' HRQOL.

It is known that many generic, cancer-specific, and head and neck cancer-specific measures have overlapping content. Researchers and clinicians should consider the factors such as study objectives, research question, study sample, instrument properties, content/HRQOL domains, disease subsite, treatment, the pitfalls, and benefits of combining measures, and the time frame of the questions when selecting HRQOL instrument [17, 39].

There are conflicting findings concerning demographic characteristics [14, 15, 26, 32, 33]. Considering the findings and suggestions of these previous studies, future studies should be planned to assess the impacts of patients' sociodemographic and clinical factors on HRQOL and obturator functioning.

There were a relatively small number of studies that used the additional clinical test such as nasometry, salivary flow test, chewing performance, and mixing ability test [19, 20, 26, 29, 31]. Using both clinical and patients' subjective evaluation may provide a better judgment for prosthodontic management of these patients [31]. More attention should be paid by clinicians for integrated use of clinical tests together with HRQOL instruments in clinical practice. More studies are needed to assess the associations between functional status and HRQOL outcomes for successful prosthodontic management in these patients.

The most commonly used classification system for maxillary defects is the Brown classification in these studies [12, 14, 15, 25, 26, 28, 31, 32]. Further comparative studies are needed to evaluate the effects of different classification systems of defect size (such as Armany and Okay) on patients' HRQOL.

Studies on HRQOL in maxillectomy patients rehabilitated with obturator prostheses had small sample size because maxillary cancer is a rare tumor with increased mortality. In these studies, different study design and HRQOL measures were used. Because of these reasons, comparisons across studies were difficult. To date, there is no gold standard method for measuring head and neck cancer patients' HRQOL. By reviewing existing HRQOL measures, HRQOL studies, and its results, I hope this review provides an opportunity to improve future HRQOL studies in maxillectomy patients rehabilitated with obturator prostheses maxillectomy.

6. Conclusion

The main findings of this review revealed that the obturator prosthesis had a significant influence on patients' HRQOL and functioning. Studies showed that postoperative radiation therapy, residual dentition, functioning of the obturator prosthesis, impairment of ingestion, speech, appearance, the extent of therapy, and the existence of pain were important factors affecting patients' HRQOL. This review provides valuable information for clinicians and researchers in determining patients' needs, selecting an existing validated measure, planning future studies, as well as in planning and developing comprehensive prosthetic rehabilitation programs. Well-designed clinical, multicenter, longitudinal studies are necessary to evaluate the impacts of different reconstruction and retention methods on patients' HRQOL. There is further need for multicenter and comprehensive studies with a larger sample to identify several determinants including sociodemographic, clinical, and psychological that may affect patients' HRQOL and satisfaction.

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