ABSTRACT

Background: Over the last few years, there has been an increase in oncologic morbidity in the maxillofacial region. A significant increase in cases of cancer of the maxilla has been established. As a result of the surgical treatment of maxillary tumours, the barrier between the oral and nasal cavity is broken, which leads to serious speech disorders.

Aim: The purpose of the literature review is to analyse data from different studies on the changes in speech after maxillectomy and the opportunities for its restoration with different types of dentures.

Discussion: The opportunities for treatment of patients with maxillary defects include surgical restoration or obturator, as there are contradictory data on what are the optimal means of restoring speech. The predominant opinion is that the choice of treatment method depends on the size and the location of the defects, with most authors considering obturators the optimal means of treatment. Their role in the normalisation of speech function by restoring the barrier between the oral and nasal cavity is indisputably proven. Immediate prosthetics have been found to provide faster and easier recovery of speech. To preserve the achieved results, a three-stage method of treatment with surgical, temporary and definitive obturator is recommended, which restores not only speech but also normal articulation.

Conclusion: Surgical treatment of cancer of the upper jaw causes defects differing in size, which seriously disturbs speech function. Depending on the size and location of the defect, specific prosthetic treatment methods are used, with different types of dentures being produced.

Keywords: cancer of the upper jaw, maxillary resection, speech, obturator, tumor,

BACKGROUND

The literature, there are relatively few studies on the changes in speech after maxillary resection and the opportunities for its restoration with prosthetic treatment methods. Most of them show that despite the successes of modern surgery, prosthetic constructions remain the main treatment method [1, 2]. The predominant opinion is that they need to be produced immediately after resection. A study of 41 patients aged 20–73 proves that immediate prosthetics are the leading factor contributing to the rapid recovery of speech [2]. In order to preserve the achieved treatment results, it is necessary to rebase the immediate denture during the first 2-3 months after the surgery until the definitive completion of the healing process and the production of the definitive obturator. In this case, the use of a speech intelligibility test indicates 94,10% speech intelligibility after immediate prosthetics, 95,60% on the 20th day after surgery and 95,97% after the definitive prosthetics. The important role of immediate prosthetics is also confirmed by other studies, according to which restoration of the preoperative shape of the palate and dentition facilitates speech [3]. In order to preserve this shape and carry out fast modification of the surgical obturator, some authors use a method consisting of the addition of acrylic teeth, which improves the articulation and aesthetics of the patients [4]. Considering the importance of immediate prosthetics for the recovery of a patient’s speech and social activity, most authors agree that the production of a surgical obturator should become the standard of care for the patient [5].

Most studies examine speech impairments after maxillectomy as a part of the overall change in the quality of life of the patients. Above all, the degree of damage and the possibilities of recovery during the various stages of prosthetic rehabilitation is monitored. In such a study, Dholam et al. [6] analyse the speech changes in 30 patients during the stages of treatment with surgical, immediate and definitive obturator, comparing the data obtained with those before surgery. Assessment is done using the EORTC QLQ-C30, EORTC QLQ-H & N35 questionnaires and acoustic speech software that assesses intensity, frequency, vibration and maximum phonation time. The results of the study show a significant improvement in intensity, vibration and maximum phonation time over the
course of treatment. The leading role of prosthetic treat-
ment for the recovery of speech and its close relationship
with patients’ quality of life is proven. The authors be-
lieve that preoperative speech analysis enables subsequent
evaluation of the effect of the treatment and directs the
treating specialist to the optimal prosthetic method for the
specific case.

OBJECTIVE
The purpose of the literature review is to analyse
data from different studies on the changes in speech after
maxillectomy and the opportunities for its restoration with
different types of prosthetic constructions.

LITERATURE SURVEY
Literary data show that impaired speech function is
a major problem in patients with maxillectomy. Some stud-
ies establish that speech intelligibility after resection is
61% and increases to 94% after treatment with a definitive
obturator in which there is also an improvement in nasality
from 5.8 to 1.6 (on a 7-point rating scale) [7]. Such results
are also reported by a study by the National prevention
program of the USA, which found 57.5% speech intelligi-
bility and 5.3 nasality (on a 13-point rating scale) after
resection and 95.6% and 0.66 after prosthetic treatment
[8]. The effectiveness and role of prosthetics in the nor-
malisation of speech after maxillectomy is also proven by
the studies of Umino et al. [9] carried out in 54 patients
with definitive obturators. The registered values are sig-
ificantly lower compared to other studies - 35.7% ± 22.7%
before and 84.9% ± 12.7% after the treatment, but the three-
fold increase gives the authors reason to define prosthetic
treatment as the optimal means to restore speech. Impro-
vement in speech intelligibility was also reported in a retro-
spective study of 73 patients with the questionnaires of
head and neck cancer (PSS-HN) of the University of Wash-
ington (UWQOL) and the obturator rating scale (OFS). The
results obtained show 87% speech intelligibility after the
treatment, which according to patients, is a leading factor
in improving their quality of life [10].

Studies by Sullivan et al. [7] indicate that the loca-
tion and size of the defect are deciding factors for the de-
gree of speech impairment. The most severe are the cases
with resection of the soft palate in which prosthetic treat-
ment is difficult or impossible and the recovery of speech
extremely difficult [11]. This is the reason some authors
use mainly surgical methods of treatment for these types
of defects and prosthetics only in cases of refusal or con-
traindications for surgery [12]. Digital planning of the
surgery provides predictability of the size and location of
the defect as well as the expected changes in speech [13].

Literary data indicate close dependence between pa-

tients’ speech and quality of life. A study by the Univer-
sity of California in 43 patients with obturators shows that
speech improvement leads to the restoration of social con-

tacts and confidence. The University of Washington Ques-
tionnaires (UWQOL), Obturator Functioning Scale (OFS)
and Mental Health Scale (MHI) showed 92% satisfaction
after the end of treatment and mean values of 77.3% for

UWQOL, 72% for OFS and 4.5 for MHI in the course of
rehabilitation [14]. It is significantly more difficult to re-
cover the speech of radiotherapy patients who have xeros-
tomia and impaired speech intelligibility [15]. Another
problem is numbness of the upper lip, which makes pa-

tients’ articulation and phonetics difficult [16]. However,
the most serious and frequent complication after radio-
therapy is trismus, which makes not only speech but also
treatment difficult [17].

Studies indicate that speech is an important crite-

rion for treatment satisfaction, which is the reason why
speech recovery is the main goal of prosthetics. This, ac-

cording to most authors, necessitates a three-stage treat-
ment methodology with a surgical, temporary and defini-
tive obturator [18]. Chaubai et al. [19] offer a systematic
approach for restoring speech that includes the produc-
tion of an immediate obturator in the first 2-3 weeks after
the surgery, temporary until the sixth month and a defini-
tive obturator after completion of healing processes in the
defect. It is accepted that restoring speech with a surgical
obturator is the most difficult and complex [2]. There are
different views on the optimal terms for its production,
with the prevailing opinion being that immediate
prosthetics has a great number of advantages compared to
deferred treatment [20].

A main problem for the recovery of speech after max-
ilary resection is the healing process in the defect, which
requires continuous rebasing to ensure the pressurisation
of the obturator [21]. The aim is to create a stable barrier
between the oral and nasal cavity, the purpose of which is
to prevent air transfer and to normalise speech. Some au-

tors use methods which preserve the preliminary shape of
the palate, which facilitates adaptation and sound forma-
tion [22]. The production of a temporary obturator is nec-

cessary in cases when the healing process leads to substan-
tial changes in the prosthetic field, and a correction of the
surgical obturator is not possible [23]. Different methods
for the production of temporary obturators exist, and it is
accepted that those preserving the preoperative shape of
the palate and the teeth provide optimal speech recovery
[24]. It is proven that these methods allow regulation of
the depth of the obturating part, which decreases nasal
speech and improves breathing [25]. Prosthetic treatment
during this intermediate stage of treatment with a tempo-
rary obturator is connected with plenty of difficulties and
problems, which result from the dynamics of the healing
processes and a reason. It is assumed that its duration is
until about the sixth month after the operation, and in or-
der to maintain normal speech during this period, about
12-14 clinical visits are required [26].

Definitive and lasting speech restoration is imple-
mented with the definitive obturator, which is the final stage
of prosthetic rehabilitation of patients with maxillary resec-
tion. This requires correct planning and construction of the
type and shape of the obturator, consistent with the main
prosthetic principles and the characteristics of the clinical
case [27]. Particular attention is given to the factors that can
influence the retention and stability of the obturator, as this
is a major element in the recovery of speech [28].
According to some studies, the size and location of the defect, as well as the presence of teeth, determine the degree of speech impairment and the possibilities of its recovery [2, 15]. Tripathi et al. [29] found a relationship between the inner diameter of the maxillary defect, resonant frequency and effectiveness of the obturator in reducing nasal speech. Their study in 29 patients with defects of the hard palate (Aramany class I and II) that have used an obturator for more than 3 months proves better effectiveness and improvement of nasal speech in smaller maxillary defects. Other data indicate that the stage of speech restoration also depends on the type of materials which are used in the fabrication of the obturator [3, 4]. Most authors believe that the use of acrylic resin allows for achieving stable support and relatively good retention of the obturator, which improves speech [30]. Other authors prefer light-curing resin, emphasising the advantages connected with the opportunity for easy and fast processing, the lack of residual monomer and the low porosity [31]. Direct shaping and corrections in the defect allow unproblematic modification and transformation of the different types of obturators until optimal speech recovery is achieved. Studies show that using light-curing resin reduces the weight of the obturator by 25%, which also improves phonetics [32].

Other factors that influence speech are the type and shape of the obturator. Most authors accept that the lightened construction of hollow obturators creates a prerequisite for better phonetics [33]. These views are confirmed by the studies of Kumar et al. [34] in 10 patients with Aramany I and II class defects, which show insignificant changes in articulation and nasal speech six weeks after the treatment with hollow obturators. An important role in phonetics is played by the height of the obturating part and its positioning in the defect. According to some data, high lateral and low mesial walls provide optimal speech restoration [35]. Other authors recommend a maximum height of the lateral walls for the reduction of nasal speech [36]. However, some studies indicate that speech normalisation is only possible with low walls of the obturator [37]. A comparative study to determine the optimal obturator height shows 94.24% speech intelligibility at the height of 10 mm, 91.2% at 5 mm and 90.5% at 15 mm, with measured values of 45.04% ± 5.86% before treatment [38].

The shape and depth of the palatal arch play an important role in the restoration of speech, which requires the use of treatment methods, allowing preservation of the preoperative shape of the palate. In some cases, this is possible only with two-piece prefabricated obturators in which the replacing obturating part is removable and fixed with magnets to the obturator plate [39]. This allows the production of lower arches for eating and higher for speech, which can be replaced depending on the needs of the patient. However, the described methodology is not widely used in practice due to the inconvenience of replacing the arches, despite the reported increase in speech intelligibility from 19% before to 74% after the treatment.

A major problem in speech restoration in patients with maxillary resection is the weight and size of the prosthesis, because of which most authors use hollow obturators [40]. Some authors use soft resin for better pressurisation of the defect and for improving phonetics [41]. Other authors prefer silicon materials, which provide easy placement of the obturator in the defect with the opportunity for faster rebasing in conformity with the phonetics of the patient [42]. According to some data, their use is only possible in small defects [43]. In cases of larger defects, combined obturators, with a plastic plate and a silicon obturating part providing pressurisation of the defect, are made [44]. The studies of Ramasamy and Chandra [45] indicate that adding silicon material to the acrylic obturators provides a tight fit in the defect and improves speech function. The data indicate that silicon materials improve not only phonetics but also masticatory function and aesthetics, leading to improvement of the patient’s psyche [46].

In some cases, speech restoration is very difficult because of the size of the defect. This makes treatment with classic methods impossible and requires two-piece obturators, the plate and replacing part of which are assembled in the mouth. Their application is particularly useful in patients with trismus and after radiotherapy. Most often, magnets fixed in each of the parts of the obturator are used for linking [47]. Some authors use this treatment approach in relatively rare cases of total maxillectomy [48]. Others accept that correct articulation in big maxillary defects is only possible with hollow obturators [49].

Depending on the size and anatomical characteristics of the defects, sometimes the retention and stabilisation of the obturators is possible only with implants, which provides tight pressurisation of the defect and optimal speech restoration [50]. In some cases, mini dental implants are used, and in others, classic implants are fixed to preserved areas of the jaw [51]. The clinical experience of Vosselman et al. [52] shows that for large defects, the placement of zygoma implants is the only treatment option. An important condition for achieving positive results is their correct planning and positioning in the defect [53]. Depending on the location of the defect, it is sometimes necessary to combine zygoma and classic implants [54]. In the rare cases of total maxillectomy, it is necessary to combine surgical and prosthetic treatment methods with the use of pterygoid implants [16]. In the case of defects with a large bone loss, it is impossible to carry out prosthetic treatment, which necessitates a bone transplant [55].

Several studies on the impact and role of implants on speech recovery after maxillectomy have been described in the literature. Dholam et al. [56] trace the treatment of 12 such patients with the standardised questionnaire of the European Organisation of Research and cancer treatment QLQ-C30 and Speech Software (Tiger DRS Inc), where they found improved vocal resonance and intonation as well as the opportunity for stronger and continuous speech. Although in 37% of patients with radiotherapy, osseointegration was unsuccessful 18 months post-treatment, the authors believe that the use of implants allows anatomical, functional and aesthetic recovery. The data are also confirmed by another study showing improvement in gestural and mimic efficiency, articulation and breathing [1].
Very often, surgical treatment of maxillary tumours affects the surrounding soft tissues, the nose and the eyes of the patient. The extensive defects created in the middle floor of the face require a multidisciplinary treatment approach with the participation of different specialists. Studies indicate that due to a lack of maxillofacial prosthetics specialists, such cooperation is possible only in 65% of the cases, which leads surgeons to carry out only surgical treatment in 19% of the cases [57]. In cases of the terminal stage of a disease or due to the impossibility of carrying out plastic restoration, the only opportunity for speech restoration are prosthetic treatment methods [58, 59].

Speech recovery in patients with defects of the soft palate, where the inability to close the palatal valve impairs sound formation, is very difficult [60]. Studies show that shaping the distal section of the prosthesis is essential for speech restoration [61]. Three types of obturators are used, depending on the location of the defect - “hinge” type, in which the obturating part is connected by a hinge to the plate, horizontal obturator, which is fixed on the level of the palate and during function contacts with the pharyngeal musculature and “meatus” obturator, which is extended in the pharyngeal region and is used in major defects of the palate. Fluoroscopic and nasoendoscopic studies show the best recovery of speech and masticatory function with the use of a horizontal (fixed) obturator [62]. According to Bohle et al. [63], a main factor for speech intelligibility in patients with defects of the soft palate is the position of the obturator towards the anterior tubercle of the first cervical vertebra.

Studies indicate that there is no protocol for speech restoration in defects of the soft palate, which is why some authors propose an algorithm for treatment with surgical and prosthetic methods [64]. However, in most cases, prosthetic methods of restoration are preferred, which allow rapid and effective overcoming of palatal insufficiency [65]. To achieve optimal results, the use of instrumental visualisation methods such as nasoendoscopy is recommended, which allow proper adjustment and fixation of the obturator [66].

The development of modern technologies such as CAD-CAM and 3D-printing led to the creation of new treatment methods providing for better speech restoration [67]. The results of the application of these treatment methods show 93% speech satisfaction 6 months after surgery [68]. Digital methods are also applicable in cases requiring duplication of an existing obturator when a new three-dimensional model of plastic is made by scanning with computer tomography [69].

Control examinations play an important role in maintaining normal speech function and correct articulation. It is recommended that the prosthesis be evaluated every 2 weeks during the first 3 months of treatment, then every 3 months for the next 3 years and annually thereafter [29]. Studies prove that the application of prosthetic adhesives improves sound articulation and speech intelligibility [70].

DISCUSSION

Treatment options for patients with maxillary defects include surgical restoration or obturating prostheses, with conflicting data as to which is the optimal means of speech restoration. Systematic database review in Medline, PubMed and Web of Science shows that most authors consider speech recovery as part of the overall assessment of the quality of life (QoL) after obturator treatment and/or tissue transfer. Results show that the most frequently used indicator for assessment of the quality of life, and accordingly the speech, is the questionnaire of the University of Washington (UW-QOL). According to some data, the two treatment options have no considerable difference in speech and quality of life. According to others, the quality of life of patients with obturators is comparable to or even better than in other chronic illnesses.

Studies indicate that the most common types of defects are class IIa and IIb, which allow successful speech restoration with prosthetic methods of treatment. The prevailing opinion is that the choice of treatment method depends on the size and localisation of the defect and the presence of teeth. It is accepted that open obturators provide better phonetics, independently of the height of the replacing part and speech in defects of the soft palate is the hardest to restore.

Despite the lack of agreement on the question of what is the optimal method of treatment, the prevailing opinion is that prosthetics provides faster and easier recovery of damaged functions, especially in cases with large defects. Immediate prosthetics have been found to provide faster and easier recovery of speech. To preserve the achieved results, a three-stage treatment methodology with a surgical, temporary and definitive obturator is recommended, which ensures not only the successful restoration of speech but also normal articulation. Auditory and spectral analysis studies indicate that this treatment approach reduces nasal speech and creates a correct speech stereotype. Some studies have found an interesting relationship between the degree of speech recovery, the intellectual abilities of the patient and the will to solve the problem. There is consensus that the involvement of a speech therapist during each stage of treatment facilitates speech recovery.

Analysis of literature data indicates the need for further studies on the advantages and disadvantages of prosthetic and surgical treatment methods in terms of speech improvement after maxillectomy.

CONCLUSIONS

Surgical treatment of cancer of the upper jaw causes defects differing in size, which seriously disturb speech function. Depending on the size and location of the defect, specific prosthetic treatment methods are used, with different types of prosthetic constructions being produced. Their correct planning and construction allows successful speech recovery, which is the main purpose of the treatment after maxillectomy.
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