Palatal augmentation prostheses in individuals treated for head and neck cancer: Effects on speech and oral transport

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Abstract

Background: Negative side effects affecting articulation and oral transport are common after treatment for head and neck cancer (HNC). The aim of this study was to assess the effects on speech and patient-reported experience of palatal augmentation prostheses (PAP) in this patient group.

Methods: Twenty consecutive patients who had received a PAP were included. We performed a blinded randomized listener assessment of recordings of the patients’ speech with and without the PAP. Patient-reported experiences were collected from medical records.

Results: The listener assessment showed that production of velar sounds improved significantly for 12 of 19 patients; 12 of 19 patients also reported easier or better speech with the PAP. All six patients treated for tongue cancer reported speech improvement. Seven of 20 patients reported better transport of food or saliva.

Conclusion: A PAP can help patients treated for HNC to more precisely articulated velar consonants and can benefit oral transport.

KEYWORDS
articulation disorder, head and neck cancer, oral cancer, oral transport, speech assessment

1 INTRODUCTION

The oral cavity and the oropharynx are the most common sites of head and neck cancer (HNC). In Sweden, an average of 450 persons per year are diagnosed with oral cancer and 410 with oropharyngeal cancer. Cancer of the tongue dominates cancers in the oral cavity, while the tonsils and the tongue base are the most common tumor sites in the oropharynx. A recent review concluded that there is a growing incidence worldwide of oral and oropharynx cancer among young people (defined as younger than 45 years old), of which the etiology and pathogenesis are not clear.

Patients who have undergone treatment for oral or oropharyngeal cancer with surgery and/or radiotherapy often suffer from a range of different side effects. Oral complications such as limited mouth opening (trismus) and impairment of the tongue can result in mastication problems, reduced control of drink or saliva (drooling), and difficulties in articulation. The size and location of the primary tumor are important factors for the outcome of oral motor function. The worst functional consequences are seen in patients who receive postoperative radiation, as some patients develop radiation fibrosis that decreases the flexibility and range of tongue movements. Those who have less extensive treatment with surgery...
alone show the best functional posttreatment results.\textsuperscript{5} Patients who only receive chemoradiotherapy against oral or oropharyngeal cancer often experience decreased range of motion of the tongue and other radiated tissues, risking deterioration of both swallowing and speech production, due to radiation fibrosis and/or degeneration of the innervation of the tongue.\textsuperscript{6,7} Others undergo major surgery to remove parts of the tongue and may receive transplanted tissue that sometimes results in abnormal movement patterns and lack of sensory function, and in some cases the surgery may cause nerve damage that impact on the tongue function.\textsuperscript{8}

The tongue plays an essential role in articulation and, during normal speech, moves rapidly between the different articulatory positions. Tongue-to-palate contact is important for several consonants, especially plosives. The tongue also shapes the oral and pharyngeal cavities for different vowel sounds.

After treatment for HNC, the range of movement of the tongue can be so limited that articulation of certain speech sounds cannot be achieved. This is often the fact with the velar plosives /k/ or /g/, where tongue contact with the palate is needed for clear articulation. Sometimes also the plosives /d/ or /t/, produced with the tip of the tongue, are affected.\textsuperscript{9} With the lack of contact, or if the contact is too weak, the speech sound is distorted and plosives can sound more like fricatives such as “sch” or “ch” or like a vowel. This may affect speech intelligibility.

Patients who have an impaired ability to move the tongue, and may lack parts of it, can have difficulties both in preparing food and in propelling food, drink, or saliva back to the pharynx. Often the ability to spit out saliva (if there is a lack of pharyngeal swallow function) or transport saliva to the pharynx is impaired. The uncontrolled drooling is often described by patients as a great negative inconvenience in their social lives. Many patients are dependent on some alternative method to obtain adequate nutrition, for example, feeding through a nasogastric (NG) tube or a percutaneous endoscopic gastrostomy (PEG) tube.\textsuperscript{10,11}

The palatal augmentation prosthesis (PAP) was developed in order to improve these individuals' ability to articulate and swallow. The PAP is an oral prosthesis with an augmentation that lowers the palate. It is placed on the hard palate and attached to the teeth by clasps. The augmentation is made with a functional impression to shape the palatal vault to the remaining tissue of the tongue. The first study describing a PAP was by Cantor et al in 1969,\textsuperscript{12} followed by several studies in the 1980s and 1990s describing the possibility of enhancing articulation and swallowing after HNC treatment.\textsuperscript{9,13-18} Marunick and Tselios (2004) evaluated nine studies performed on individuals who had received a PAP. The studies investigated the benefits of a PAP for both swallowing and articulation. In total, 36 of 42 individuals improved swallowing and 32 of 37 improved speech. Even though these studies lacked standardized objective measurements, according to Marunick and Tselios, they supported the functional efficacy of a PAP.\textsuperscript{17} de Cavalloto-Theles, Sennes and Gielow concluded that the PAP improved the intelligibility of spontaneous speech and syllables for patients who underwent glossectomy.\textsuperscript{18} There are very few studies that include more than 10 patients and many are single case presentations. No previous studies have reported the patients' experience of the PAP.

Since 1992, the oral motor team (OMT), a collaboration between dentists at the Special Dental Care unit and speech-language pathologists (SLPs) at the department of Otorhinolaryngology at Sahlgrenska University Hospital (SU) in Gothenburg, Sweden, have been assessing patients regularly, trying to find ways to improve tongue or lip function to allow improved speech outcomes and ability to eat and drink. During recent years, the OMT designed around 20 PAPs for patients who had severe negative side effects after treatment of HNC. The aim of this study was to assess the patient-reported experience and effects on speech of a PAP in patients suffering from negative side effects after treatment for HNC that impaired articulation and oral transport of saliva, food, and drink.

The specific research questions were:

1. Do the patients report any improvement of function in oral transport or eating and swallowing when they use the PAP?
2. Do the patients report any speech benefits when they use the PAP?
3. Does the location of the primary tumor indicate which patient group benefits the most from a PAP?
4. How do blinded raters assess the patients' articulation of velar (k, g) and dental (t, d, s) speech sounds as well as their overall clarity of the speech with and without the PAP?
5. Do patients' experiences of speech with a PAP correlate with the results of the blinded listener rating of its effect on speech?

2 | MATERIALS AND METHODS

The study was approved by the Regional Ethical Review Board, Gothenburg, 170727, dnr 576-17 and was performed in accordance with the Declaration of Helsinki.
2.1 | Test subjects

We initially included 22 consecutive patients from the OMT between 2009 and 2017 who had been treated for any kind of HNC and had received a PAP for treatment of side effects including impaired articulation, eating difficulties, or drooling.

2.2 | Tumor sites, treatment and side effects

To obtain an overview of the types of tumor sites, the treatment given and its side effects, such as osteoradionecrosis and difficulties in eating and speaking, information from medical records at the Special Dentist Care and the department of Otorhinolaryngology at SU was analyzed. The Functional Oral Intake Scale (FOIS) was used to categorize the patients' documented ability to eat.

2.3 | Preparation of the PAP

In order to make the PAP, an oral impression in alginate was made at the first visit to allow the production of plaster casts of the upper and lower jaw. The dental technician made an acrylic plate with two to three pairs of ball clasps to hold the plate as firmly as possible. At the second visit, an impression was made using elastic material with the plate in the mouth of the patient. During the setting of the material, approximately 90 seconds, the patient was asked to repeat words and sentences from a commonly used Swedish dysarthria test, containing speech sounds that require contact with the palate, such as /k/, /g/, /t/, and /d/. A few other words were sometimes added to suit each patient and their specific articulation difficulties. The patient was also asked to dry-swallow so that the maximal ability of the tongue could show in the impression. The procedure was continued until contact with the remaining tongue tissue was visible in the impression and detectable in the patient’s speech. The technician replaced the impression material with acrylic. Dependent on the amount of tongue tissue left, the device could be very thick (Figure 1) or rather thin (Figure 2). For some patients, adjustments were made if the plate interfered in such a way that the pronunciation of certain sounds became worse. For example, during the production process, the dentist and SLP carefully monitored /s/, which is sensitive to small changes in the oral cavity, so that the PAP would interfere with production of /s/ as little as possible, or make the /s/ better. The whole process was entirely individualized and often took two to three visits to the clinic before the PAP had reached its optimal shape to be of use to the patient. The dentist who made the PAPs had over 30 years of experience with making dentures and had been collaborating with SLPs for 26 years.

2.4 | Procedure

A quantitative evaluation of the participants' speech with and without their PAP was performed using blinded randomized listener evaluation. Audiovisual material from recordings performed at clinical follow-ups was used. In the audiovisual recordings, the patients read sentences from the Swedish dysarthria test. A few additional sentences containing velar sounds were added. No spontaneous speech was used in the listener evaluation because it was lacking in several of the recordings.

Ten of the audiovisual recordings were filmed with an analogue film camera (Sony Model DCR-TRV900E),
and nine were filmed with a digital camera (Sony-HDR-PJ810E). To facilitate listener evaluation, the analog films were digitalized.

The recording with the PAP in place was preferably selected from the time when the patient had been using the device for at least 1 month or the device had reached its optimal shape for the patient’s needs. In one case, the recording made at the first fitting of the device was used because of a lack of follow-up related to the patient’s worsened health status. Two recordings for each patient were selected, one with the device and one without. The recordings with and without the PAP were recorded at the same clinical follow-up session in 17 of 19 cases. They were randomized and called A and B. Each film was 2-4 minutes long.

### 2.4.1 Listener assessment

The listener assessments were performed by three speech-language pathologists (SLPs). Headphones AKG K271 MkII were used and the audiovisual recordings were played using Windows Media Player on a Hewlett-Packard computer.

The SLPs evaluated the patients’ ability to pronounce dental and velar plosives and the fricative /s/, and assessed the overall clarity of the speech by performing a pairwise comparison of the speech in the two different recordings for each patient. They judged the speech according to a 3-point assessment scale. The speech and speech sounds were evaluated as “A sounds best,” “no difference,” or “B sounds best.” The median of the results from the three listeners was used. In the few cases when the three SLPs chose three different alternatives, the alternative “no difference” was used.

For intra-rater reliability, 30% of the recordings were assessed twice by each SLP, reliability was calculated as the percent exact agreement; listener 1 had 96%, listener 2 75%, and listener 3 58%. To assess inter-rater reliability, the results from the three SLPs were compared and expressed as a percentage of the total number of instances in which two of the three listeners agreed; this value was 93%. In addition, the percentage of exact agreement between each pair of listeners was calculated. The percent of exact agreement between listeners 1 and 2 was 64%, between listeners 2 and 3 63%, and between listeners 1 and 3 53%. The mean value of agreement between the three was 60%.

### 2.4.2 Patient experience

Self-reported experiences after using the device were collected from the patients’ medical records and analyzed in terms of frequencies and percentage. The standard procedure in clinic was to ask the patient to evaluate the benefit of the PAP and to decide, in collaboration with the patient, if there was a need to adjust the PAP to optimize the function or if it was of no use for the patient. Therefore, the medical records were quite detailed in describing what the patients reported. No specific question protocol was used.

The records were reviewed and the patient experience noted after the patient had used the PAP, preferably for 1 month but sometimes longer if the fitting of the PAP took several visits to the clinic.

The data were categorized and digitalized. Three categories were analyzed: (a) patient-reported speech experience with the PAP (better, sometimes better and sometimes worse, or worse); (b) patient-reported experience with drooling or oral transport of food or drink with the PAP (whether use at meals/helps oral transport, or not); and (c) patient-reported frequency of using the device (all day, part of the day, or not at all).

### 2.5 Statistical analyses

The data collected were digitized and analyzed with IBM SPSS Statistics v24. The frequencies of listener assessment and the demographic data were analyzed using descriptive statistics and compared in cross-tabulations. The significance of an effect of a PAP on speech was tested using the Wilcoxon signed rank test since the 3-point scale for the listener assessment was regarded as a crude ordinal scale.

The correlation between the overall clarity of speech and velar sounds, as assessed by the SLPs and the patient-reported experience of speech, was tested using the Spearman rank correlation coefficient. Three subjects for whom no patient-experience evaluation was available were excluded and correlation was analyzed for the remaining 16 subjects. The analysis was made by correlating the listener assessment scales (1, best with a PAP; 2, no difference; 3, worse with a PAP) with the patient-reported grading (1, speech better/easier with a PAP; 2, some sounds better, some sounds worse; 3, speech worse with a PAP).

### 3 RESULTS

#### 3.1 Test subjects

Two of the subjects were subsequently excluded: one did not complete the fitting and, thus, never used the device, and recordings were not available for the other. One participant from the tongue cancer group was given the device only because of eating problems and not to improve speech production. No evaluation of this
| P | Tumor site | TNM classification | Type of surgery | Radiation | Year of diagnosis | Speech | FOIS 1-7 |
|---|------------|-------------------|-----------------|-----------|------------------|--------|----------|
| 1 | Tongue    | T3N0M0            | Hemiglossectomy + RN + mandible resection + fibula transplant | External + brachy | 1998 | Indistinct, no TC in velar sounds | 2 |
| 2 | Tongue    | T3N0M0            | Part tongue + tongue base + mandible resection | External + brachy | 2006 | Severely impaired speech | 2 |
| 3 | Floor of mouth | T3N0M0 | Hemiglossectomy + mandible resection + pectoralis flap | External + brachy | 2005 | Impaired dental sounds | 2 |
| 4 | Tongue    | -                 | Mandible resection | External + brachy | 2006 | Indistinct overall | 4 |
| 5 | Tonsil    | T2N0M0            | Tonsillectomy + tongue base + part tongue | External | 2012 | Indistinct, no TC in velar sounds | 2 |
| 6 | Tongue base | -                 | RN               | External + brachy | 1990 | Indistinct, nasal | 5 |
| 7 | Oropharyngeal + tongue | T3N2M0 | Hemiglossectomy + RN | External | 2011 | Impaired velar sounds | 1 |
| 8 | Tongue base | T1N2M0          | No surgery       | External + brachy | 2008 | Impaired velar sounds | 1 |
| 9 | Parapharyngeal schwannoma | - | Hypoglossal nerve palsy due to surgery | None | 2012 | Impaired velar and dental sounds | 6 |
| 10 | Tongue base + floor of mouth | T4N2M0 | No surgery | External + brachy | 2012 | Impaired velar sounds | 2 |
| 11 | Tongue base | T4N2M0          | Partial laryngectomy | External + brachy | 2012 | Impaired velar sounds | 3 |
| 12 | Tonsil    | T1N2M0            | Mandible resection + pectoralis flap + RN | External + brachy | 1994 | Impaired velar sounds | 2 |
| 13 | Tongue    | T2N0M0            | Tongue resection + floor of mouth + RN | External | 2006 | Indistinct, no TC velar sounds | 5 |
| 14 | Tongue    | T1N0M0            | Tongue resection + floor of mouth + mandible resection | External + brachy | 1996 | Severely impaired, no TC | 5 |
| 15 | Tonsil    | T3N2M0            | No surgery       | External + brachy | 1997 | No TC in velar sounds | 5 |
| 16 | Floor of mouth | T1N0M0 | Box resection + mandible resection | External | 2015 | Indistinct overall, has TC, gets tired | 2 |
| 17 | Tonsil    | T2N2M0            | Tonsillectomy + mandible resection + pectoralis flap | External + brachy | 1997 | No TC in velar sounds | 2 |

(Continues)
patient’s speech was performed, but the patient’s experience of the device was included in the study. Therefore, the total number of participants was 20 regarding eating and drinking, 19 of whom were also evaluated concerning speech. The participants included 11 men and 9 women, aged 47 to 81 years (mean age 63.2 years).

### 3.2 Tumor sites, treatment and side effects

The primary tumor sites were distributed as follows: seven in the tongue, five in the tongue base, five in the tonsils, two in the floor of the mouth, and one patient was treated for a parapharyngeal schwannoma. Sixteen patients had undergone surgery. All but one patient had received radiation therapy; five received external radiation and 14 had received both external radiation and brachytherapy. Nine of the patients had undergone mandibulectomy because of osteoradionecrosis. The patients who had not undergone surgery (patients with tonsil and tongue base tumors) had severe radiation fibrosis in the tongue which in each case, to a different amount, manifested in tongue atrophy and decreased ability to move the tongue both in speech and oral transport. The one patient with parapharyngeal schwannoma had hypoglossal palsy in the tongue due to surgery. For the patients who had undergone surgery, unfortunately the percentage of remaining tongue tissue was not possible to estimate, based on the information in the medical records. The patient demographics are described in Table 1. Age and sex are excluded to avoid identification. Nine participants could eat by oral intake and 11 had a PEG or an NG tube. Of the participants with PEG/NG tubes, two could not eat at all by mouth, eight were tube-dependent with minimal oral intake, and one was tube-dependent but had consistent oral intake. Of the nine that were able to feed totally by mouth, two could eat food of a single consistency, five could eat multiple food consistencies with special preparation, and two had a totally normal intake but had to avoid certain foods. Over half of the participant group reported in a questionnaire completed at their first visit that they were negatively affected in their social life with regard to both speaking and eating.

### 3.3 Patient experience

Nine of the 20 participants (45%) reported that they used the device all day, seven (35%) reported usage part of the day, and four (20%) reported no usage.

Twelve of the 19 participants (63%) reported easier or better speech outcomes with the device, two (10.5%) reported that some sounds sounded better while others...
sounded worse, and two (10.5%) reported worse speech. For three participants (15.8%), it was not possible to evaluate patient-reported effects on speech or oral transport because the patients did not use the device between follow-up visits or did not attend the follow-up.

Seven of 20 participants (35%) reported benefits of the PAP for oral transport and use at mealtimes, while 10 (50%) reported that the device was taken out during mealtimes and that they did not benefit from the device in terms of oral transport. Three participants could not be evaluated because they did not use the device between follow-up visits or did not attend the follow-up.

Comparison of the patient-reported experience with oral transport of saliva or food and the ability to eat food of different consistencies as graded by FOIS showed that four of eight patients who had no to minimal intake by mouth (FOIS 1-2) still reported benefits with the PAP. The four patients all described that it was easier to transport the saliva, back to the pharynx or forward to spit, when wearing the PAP. Three patients who had tube supplements and consistent oral intake or total oral intake of food of a single consistency (FOIS 3-4) reported no help from the device, while three of six patients who had a total oral intake of multiple consistencies or a total oral intake but had to avoid specific foods (FOIS 5-6) reported benefit from the PAP (Figure 3). Three patients could not be evaluated. Of note, the three participants not evaluated for patient-reported effects on speech differed from those not evaluated for patient-reported effects on oral transport.

Analysis of the associations between tumor site and patient-reported benefits of the PAP showed that all six participants treated for tongue cancer who received the PAP for articulation difficulties reported benefits of the PAP regarding speech, and four of seven treated for tongue cancer reported benefits regarding eating/oral transport. Of the participants treated for tonsil cancer, three of five reported benefits with speech. The patients with tongue-base tumors reported no benefits with eating/oral transport and were heterogeneous with regard to speech results (Figures 4 and 5). However, these sample sizes were too small to allow formal statistical analysis.

**FIGURE 3** FOIS and patient-described benefits with oral transport. FOIS 1: no oral intake, FOIS 2: tube-dependent, minimal oral intake, FOIS 3: tube-dependent, consistent oral intake, FOIS 4: total oral diet of a single consistency, FOIS 5: total oral diet with multiple consistencies, require special preparation, FOIS 6: total oral diet, must avoid specific food. (No patient was graded as FOIS 7: total oral diet, no restriction.) FOIS, Functional Oral Intake Scale

**FIGURE 4** Patient-reported benefits by speech and tumor site. PAP, palatal augmentation prostheses

**FIGURE 5** Patient-reported use of palatal augmentation prostheses at meals/oral transport by tumor site
### Table 2: The results of the listener assessment

| Speech sound | Best with PAP | No difference | Best without PAP |
|--------------|---------------|---------------|------------------|
| Velar        | 12            | 63.2%         | 6               | 31.6%           | 1               | 5.3% |
| Dental       | 3             | 15.8%         | 14              | 73.7%           | 2               | 10.5% |
| S sound      | 2             | 10.5%         | 13              | 68.4%           | 4               | 21.1% |
| Overall clarity | 9           | 47.4%         | 7               | 36.8%           | 3               | 15.8% |

Abbreviation: PAP, palatal augmentation prostheses.

#### 3.4 Listener assessment

The results of the listener assessment showed that for overall speech clarity, nine of 19 participants (47.4%) were assessed as better with the PAP, three (15.8%) sounded better without the PAP, and for seven (36%), no difference was heard (Table 2).

There was a statistically significant effect of the PAP on improving articulation of velar sounds ($z = -3.051, P = .002$). No significant effect of the PAP was detected on the other speech sounds.

The velar sounds improved with the PAP in 12 of the 19 patients (63.2%). One of 19 (5.3%) was assessed as best without the PAP in place, and for six of 19 (31.6%), no difference was heard with or without the PAP in place.

With regard to dental sounds, three of 19 individuals (15.8%) were assessed as sounding better with the PAP, two (10.5%) sounded better without the PAP, and for 14 (73.7%), no difference was heard.

The /s/ sound was assessed as better with the PAP in two of 19 participants (10.5%), better without the PAP in four (15%), and no difference in 13 (68.4%).

Analysis of the associations between the speech assessments and tumor site showed that five of the nine patients assessed as “sounds best with the PAP” for overall clarity of speech were from the tongue cancer group. The remaining four had different tumor sites.

#### 3.5 Agreement between listener assessments and patients’ views

Eight of the nine participants who were assessed by the SLPs as “better with the PAP” for overall clarity of speech also evaluated their own speech as being “better/easier with the PAP”. Four subjects who were assessed by the SLPs as displaying “no difference” in the overall clarity of speech when using the PAP self-reported that “speech was easier/better with the PAP.” There was a strong correlation between SLP assessment of overall speech clarity and patient-reported experience ($r_s = 0.726, P = .001$). Comparison of the patient-reported experience and the listener assessment of velar sounds indicated that 10 of 12 patients who experienced that “speech is better/easier with the PAP” were evaluated by SLPs as “sounds best with PAP”. The correlation between the assessment of velar sounds and patient experience of overall speech improvement was found to be significant and moderate-to-large ($r_s = 0.524, P = .04$).

### 4 Discussion

#### 4.1 Speech

This study confirmed the results of previous studies showing that a PAP can help patients achieve a more precise articulation of speech, particularly when it comes to velar sounds in which contact between the palate and tongue is of importance. However, in this study, the PAP had a lower likelihood to generate detectable changes to the dental plosives or the /s/ sound. The /s/ sound is known to sometimes be distorted by a PAP, and, thus, is carefully listened to and adjusted when the device is being constructed; therefore, the lack of change in /s/ articulation with a PAP was a positive finding.

A total of 12 patients described their speech as “easier/better” with the PAP, and there was good agreement between the patients’ experience and the SLPs’ judgment of the overall clarity of speech. This result indicates the strength of the blinded listener assessment and is also an indication that the information in the medical records reliably described the patient-reported effects.

Four patients rated speech “easier/better” with the PAP, but the SLP listeners rated their overall speech clarity as the same with and without the PAP. It is notable that many of the patients initially had very distorted speech after surgery and had undergone many different interventions (see Table 1). Many patients require a great deal of effort to make themselves understood after HNC treatment. The use of a PAP appears to make speaking less of an effort for some patients, even if the outcome does not always differ markedly for the listener. It is possible that the use of a PAP by patients with a severe impairment after HNC treatment can affect their well-being and quality of life. This was not assessed in this...
study but is an important question to investigate in future studies.

The fact that no spontaneous speech by patients was available for analysis might have contributed to the difficulty in detecting a difference for some patients between speech with or without the PAP. In our clinical experience, there is a difference between when the patient tries his/her best to articulate a specific test sentence and when the patient is speaking spontaneously at his/her own pace. This issue also needs further investigation. It should be considered whether including spontaneous speech in the clinical documentation before and after using a PAP should become standard procedure.

The three listeners differed when it came to intrarater reliability which is a weakness of the study. Also the comparison between the three listeners assessment in percentage was moderate. It is a known fact that listener ratings are difficult to perform with high intra- and interrater reliability, but still auditory-perceptual assessment methods are considered the “gold standard” for assessing dysarthria. The 3-point assessment scale was crude and possibly the statistical analyses would have been more able to differentiate variations in the speech if a more fine-grained scale had been available. However, this might not have resulted in a higher reliability, as rating distorted speech and detecting small differences in the mid-range of the scale can be hard. In future studies, such methodological issues need to be carefully considered.

The case series results in this study suggest that patients who have undergone treatment for cancer of the tongue may be the group who benefit the most from a PAP. However, the results also indicate that patients who have undergone treatment for tonsil cancer can benefit from a PAP when it comes to articulation. It is important to acknowledge the fact that patients who have only undergone radiotherapy or have had surgery that did not include the tongue still can have articulation difficulties due to radiation fibrosis or nerve damage and may also benefit from a PAP.

### 4.2 Oral intake reported by participants

Seven of 20 participants (35%) self-reported a positive effect of PAP on oral transport and its use at mealtime, while 10 patients reported that the PAP was no use/no help with oral transport, and three patients could not be evaluated. The participants that reported positive effects appeared to be distributed evenly between patients with (n = 4) or without (n = 3) a PEG/NG tube. The analysis of the reported effect of the PAP on oral transport compared with the FOIS grading showed that several of the patients who reported that the device helped with oral transport actually had no or minimal oral intake. This verifies our clinical experience that patients who use a PAP report less drooling because of easier oral transport of saliva to the pharynx. All patients who had undergone treatment for tongue cancer (n = 6) reported better/easier speech, and four of seven reported that the use of PAP at meals helped with oral transport. Three of five patients treated for tonsil cancer reported better/easier speech using the PAP, and two of four reported that the use of the PAP at meals helped with oral transport. Although the number of patients was small, these results indicate that a PAP can be of help to other patient groups than those treated for tongue cancer. Previous studies that mainly comprised patients treated with glossectomy do report an effect of a PAP on the ability to swallow.

Davis et al reported fewer dry swallows, less oral residue, and less aspiration because the patient did not have to tilt their head backwards to propel the liquid to the pharynx. This needs to be assessed further. This study focused primarily on speech outcome and used no objective measure to evaluate swallowing.

The retrospective design of this study, collecting patient-reported data from medical records rather than by direct clinical interview, is not the strongest scientific design. In addition, the number of study subjects was small, meaning that the subgroup analyses in particular were qualitative and preliminary. Each patient group included in this study contained a small number of patients because only patients with the most negative treatment side effects regarding speech and nutrition were referred to the OMT. However, the total number of participants was greater than those in previous studies.

This group of patients is often neglected when it comes to rehabilitation of side effects such as impaired speech, drooling, and eating problems resulting from the cancer treatment. Many patients are probably never offered assessment or contact with an SLP or an OMT. Thus, there is a risk that patients who could benefit from treatment with a PAP are missed. This highlights the need for a different approach to rehabilitation for this group of patients. It is essential that there is a specified chain of care for rehabilitation after treatment of HNC, and of utmost importance that there is a team approach to the patients’ needs and difficulties. This should involve not only collaboration between ENT doctors, oncologists, and SLPs, but also a team working with the specialist dentistry care and maxillofacial surgeons. The team approach is also beneficial to allow the different professionals to exchange knowledge and discuss the best possible treatment. This might increase the patients’ quality of life, which has been shown to be poor for this
To broaden the scope of this study and to investigate whether the PAP influences the patients' quality of life, it would be of interest to include measures such as EORTC QLQ-H&N 35, which is designed specifically for patients with HNC, in further studies. Spontaneous remarks made by some patients indicate that there is such an effect, but it was not measured in the present study.

Recent research has shown a gap in the evidence for interventions by SLPs following partial glossectomy and the commonly used range-of-motion exercises are being questioned. Further research on interventions and rehabilitation of patients who have undergone treatment for HNC is essential. A majority of the subjects in this study were treated for their cancer several years ago, and only one had a free flap reconstruction of the tongue, a procedure that has become more common in recent years. Few studies have evaluated the relationship between the method of reconstruction, that is, flap reconstruction vs primary closure, and the outcomes regarding postoperative swallowing and speech, and this needs further study.

This study highlights the importance of having clinical routines using objective methods to record and document the speech and swallowing abilities of patients both at the start of treatment and at follow-up visits to be able to determine whether the treatment given is beneficial for the patient and to support the best evidence-based treatment.

5 | CONCLUSION

The results of this case series are consistent with those of previous research showing that a PAP can help some patients articulate more precisely, in particular for velar sounds. Patient-reported experience showed that 12 of 19 patients experienced better/easier speech with the PAP and 7 of 20 reported that it was used at meals/helped with oral transport. All six patients who had undergone treatment for tongue cancer reported better/easier speech with the PAP, as did three of five patients who had undergone treatment for tonsil cancer. The other subgroups were too small to evaluate. We find that the use of a PAP improves speech for several patients and also facilitates oral transport of food and saliva for some patients in the HNC population.

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CONFLICT OF INTEREST

The authors indicated no potential conflict of interest.

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