Original Article

The altered amplitudes of temporomandibular joint vibrations during swallowing in oral cancer patients with oronasal communication before and after obturator rehabilitation: a pilot study

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Abstract

Purpose: *This study investigated the association between obturator rehabilitation and the amplitude of temporomandibular joint (TMJ) vibration during swallowing in oral cancer patients with oronasal communication.*

Materials and methods: *Oral cancer patients treated with obturator rehabilitation to close an oronasal fistula following tumor excision were enrolled in this study. Each of the patients was asked to swallow three times independently without and with the obturator in place, while electrosonography (ESG) (K7 sonography; Myotronic Inc.) was used to record the amplitude of TMJ vibration. Statistical analysis was performed using IBM SPSS Statistics, version 20.0, with the results compared using the Wilcoxon signed-rank test and $P<0.05$ considered to indicate a statistically significant difference.*

Results: *Ten patients with oronasal communication, including three females and seven males, participated in this study. Their mean age was 39.4 years old (range: 32 to 63 years old). Their average amplitude (Avg) values of TMJ vibration were 76.81 ± 0.52 and 77.93 ± 0.91 when wearing and not wearing an obturator, respectively. According to these results, utilizing an obturator to close the oronasal communication significantly impacted the amplitude of TMJ vibration during swallowing in these oral cancer patients ($P < 0.005$).*

Conclusion: *Compared to oral cancer patients with oronasal communication who have not received obturator reconstruction, such patients fitted with an obturator might have significantly different TMJ movements during deglutition. Relatedly, future studies could compare the physical swallowing patterns of patients with an intact palate before tumor excision to those of the same patients after obturator reconstruction to determine what differences, if any, there are.*

Key words: Obturator, Oronasal communication, Swallowing, TMJ vibration

Introduction

The surgical extirpation of a maxillary cancerous area often results in oronasal communication. The maxillary defect usually significantly impacts post-treatment oral functions[1], including intake, swallowing, pronunciation, and chewing ability[2]. Deglutition is a complicated function controlled by multiple oral muscles and structures, such as the maxilla, mandible, tongue, dental components, temporomandibular joints (TMJ), and masticatory muscles[3]. The TMJs are involved in the actions of mouth opening, closing, and mastication in the oral stages of swallowing patterns. A previous study indicated that TMJ disorder (TMD) has negative impacts on the swallowing function[4]. However, previous studies have rarely tracked the trajectory of the TMJs during swallowing, because the movement of the TMJs during swallowing is very slight and thus difficult to record.

It is necessary to seal any oronasal communication to accelerate food bolus transfer from the oral cavity to the pharynx[5]. The use of an obturator to close a maxillary defect can not only close the oronasal communication but can also rehabilitate the swallowing function and decrease the swallowing time. In the past, the recovery of oral function after obturator reconstruction was typically investigated by surveying the subjective responses of patients through questionnaires, whereas the actual changes to deglutition patterns due to the sealing of oronasal communications have been less investigated.

The vibrations of the TMJ can be used to represent different joint conditions[6]. There are many sounds that are emitted during TMJ movement, especially when there are some internal derangements of the joint[7]. Past studies have reported that the average amplitude of such sounds is higher in subjects with at least one symptom or sign of TMD[8]. Previous studies have further found that the presence of a peak-shaped track in electrosonography (ESG) results has high specificity in detecting articular disc displacement with reduction[9,10],while still another previous study utilized the kinematics of the mandible and the condyles to determine the actual movement paths and positions of the mandible and condyles during the process of swallowing[11]. Hence, this study utilized TMJ vibration sounds to determine mandibular movements during deglutition. More specifically, we tried to estimate the altered amplitudes of TMJ vibrations during deglutition to represent the changes in swallowing patterns of patients with oronasal communication when fitted with and not fitted with an obturator. This study preliminarily utilized TMJ vibration sounds to determine the changes in swallowing patterns after obturator rehabilitation.

The purpose of this study was to compare the TMJ movements during swallowing in patients with oronasal communication when wearing or not wearing an obturator.

Material and methods

A total of ten people participated in this pilot study, including three females and seven males. Their mean age was 39.4 years old (range: 32 to 63 years old). All of the subjects had undergone chemotherapy and radiotherapy after tumor excision from 2017 to 2019. The patients all suffered from oronasal communication after their surgeries and thus received obturator reconstruction. Because missing teeth may affect oral functions, only subjects with fully intact dentition were included in the study, while participation was further limited only to those with a Class III Aramany Classification of maxillary defect[12]. All the subjects received obturator rehabilitation to close their oronasal communications, and they all had clear consciousness and were able to perform swallowing following instructions. Any individuals with stroke history, temporomandibular disorder, neuromuscular disease, or any symptoms of dysphagia were excluded from this study. The TMJ sounds during swallowing were evaluated by ESG (K7 sonography; Myotronic Inc.). This equipment was used to determine the sounds of TMJ vibrations. It is composed of a headset that holds highly sensitive vibration transducers over each TMJ and simultaneously captures bilateral tissue vibrations resulting from joint sounds. The sounds of TMJ vibrations are accompanied with mandibular movements, and provide valuable information for assessing TMJ functions. Utilizing ESG to detect TMJ vibrations during swallowing is a non-invasive form of evaluation (Fig.1).

The participants were asked to swallow three times independently when not wearing an obturator. The final data was represented as the average of the three values. The patients all

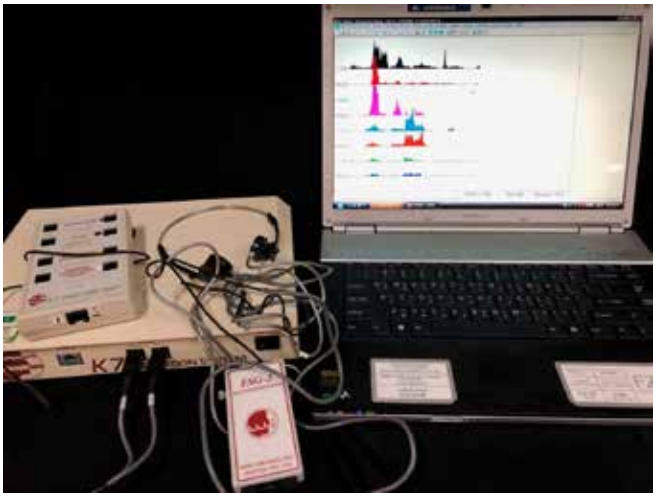

Figure 1. ESG (K7 sonography; Myotronic Inc.) composites made with a lightweight headset that holds highly sensitive vibration transducers over each TMJ, enabling the simultaneous, bilateral capture of tissue vibrations resulting from joint sounds.

received an interim obturator over six months after their excision wound had become stable, and all the obturator rehabilitations were performed by the same prosthodontist. After the permanent obturators had been delivered and used for over three months and a clinician had ensured that the patients had adapted well to their obturator, the ESG assessment was performed again with all the subjects when they were wearing their obturators. To relieve the xerostomia resulting from having undergone radiotherapy, all the participants were asked to drink water before swallowing. The amplitudes of the TMJ vibration sounds during deglutition were thus ultimately recorded using ESG when the patients were both wearing and not wearing their obturators.

Comparisons of the results for the subjects when wearing and not wearing obturators were made using the Wilcoxon signed-rank test. The analyses were performed using IBM SPSS Statistics, version 20.0, and $P < 0.05$ was considered to be statistically significant.

Results

The average amplitudes of TMJ vibrations in the participants when wearing and not wearing an obturator were 76.81 ± 0.52 and 77.93 ± 0.91, respectively. The difference in the average amplitudes when wearing and not wearing obturators was significant ($P < 0.001$) (Table 1).

Table 1. Comparison of the average amplitudes of TMJ vibrations during swallowing before and after obturator rehabilitation by Wilcoxon signed-rank test.

N=10	Before (Mean±SD)	After (Mean±SD)	*P*-value
Avg	77.93±0.91	76.81±0.52	0.000**

Note: Before = Before obturator rehabilitation, After = After obturator rehabilitation, Avg = the average amplitude of TMJ sounds. ** $P < 0.001$.

Discussion

A previous study indicated that obturator rehabilitation, which is a reliable treatment modality, can reduce nasal regurgitation, hypernasal speech, and the time of swallowing, in addition to improving speech, articulation, deglutition, and mastication[13]. The results in this study showed that the average amplitudes of TMJ sounds were significantly different when the subjects wore their obturators as compared to when they were not wearing them. From this result, it can be inferred that obturator reconstruction might change the TMJ movements during swallowing in those with oronasal communication in comparison to those with oronasal communication who have not had obturator reconstruction. However, this study still could not prove that obturator reconstruction is able to effectively improve swallowing patterns because the amplitudes of the TMJ vibrations during deglutition before oral surgery in subjects who had intact soft and hard palates were not estimated. Otherwise, the participants were all restricted to individuals with Aramany Class III maxillary defects because such patients can utilize their tongues to seal any oronasal communication during swallowing, and this restriction may have caused bias in the results. That said, the mandibular trajectory in a swallowing pattern might be changed after obturator reconstruction, and based on the findings of this study, it would be interesting to measure the amplitudes of TMJ sounds during swallowing before tumor excision, as such measurements might be regarded as a reference for the recovery of swallowing function after obturator reconstruction. In future studies, the

enrolled subjects should thus include patients with various Aramany Classifications of maxillary defect to increase the realism of said studies.

This retrospective pilot study had some limitations, such as a small sample size. However, while the sample size was small, future investigations can still use the findings of this study as a reference for further discussions. Another limitation, meanwhile, was that the initial swallowing patterns and TMJ movements before tumor excision were not recorded. That said, the pre-surgical records of TMJ vibrations during swallowing could be used for comparison to confirm the inference of this study. In clinics, oral function evaluations are typically restricted to subjective estimations, but whether the amplitudes of TMJ vibrations can be regarded as a reference to evaluate the swallowing function in the future is worthy of further discussion.

Conclusion

The results of this study suggest that patients with oronasal communication who have undergone obturator reconstruction have significantly different amplitudes of TMJ vibration during swallowing compared to those with oronasal communication without obturators, with the TMJ movements during deglutition being greatly altered after obturator rehabilitation. Relatedly, it would be of interest to investigate whether the amplitudes of TMJ sounds during deglutition can be considered as physiological references indicating the recovery of the swallowing function in oral cancer patients with oronasal communication. To perform such an investigation, larger sample sizes and recordings of the initial statuses of the swallowing patterns of patients are needed in future research.

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Conflicts of interest

None.

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