The prevalence of Passavant’s ridge in patients with velopharyngeal insufficiency in a Taiwan Chinese population

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Abstract  Background/purpose: The Passavant’s ridge can be utilized as a guide landmark during obturator prosthesis fabrication, but there were no studies concerning about the prevalence of the ridge in East Asia region. The purpose of this study was to evaluate the occurrence of Passavant’s ridge in patients with velopharyngeal insufficiency in a Taiwan Chinese population.

Materials and methods: It’s a retrospective study that 91 patients with velopharyngeal insufficiency who received a obturator prosthesis during the period from 1992 to 2016 in Taichung Veterans General Hospital (TCVGH, Taiwan) were included. The Passavant’s ridge was directly identified under intraoral examination during phonation (group 1) and gagging (group 2) action by two examiners. The results in these two groups were compared using McNemar test. Associations between the presence of the ridge and categorical variables (gender, etiology and defect area) were also analyzed using the chi-square test or Fisher’s exact test. (α = 0.05)

Results: Passavant’s ridge was observed during phonation in 72 patients (79.1%) and during gagging in 83 patients (91.2%), which showed a statistically difference (p < 0.05). The relationship between the presence of the ridge and categorical variables (gender, etiology and defect area) were evaluated but no statistically significant correlation was found (p > 0.05).

Conclusion: A high prevalence of Passavant’s ridge either in phonation and gagging action was identified in patients with velopharyngeal insufficiency in a Taiwan Chinese population. In addition, the occurrence of Passavant’s ridge was significantly higher during gagging action than during phonation.

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Introduction

The intact velopharyngeal mechanism is responsible for regulating oral and nasal cavity airflow, ensuring the adequate function of speech, respiration, and swallowing.1 Due to some different irresistible reasons, if the mechanism becomes impaired, which is generally termed velopharyngeal dysfunction, it could be further classified into velopharyngeal incompetence and velopharyngeal insufficiency. Velopharyngeal incompetence refers to patients with abnormal neurophysiology, and velopharyngeal insufficiency is caused by abnormal anatomy, which is referred to as congenital or acquired anatomic defect of soft palate.2 In patients with velopharyngeal insufficiency, the anatomic defect will cause the disruption in velopharyngeal mechanism, and hypernasality and decreased intelligibility during speaking may be the result. In those cases with velopharyngeal insufficiency, obturator prosthesis is designed to re-establish structural integrity, separating oropharynx and nasopharynx, to provide acceptable speech and prevent food/liquid leakage.

However, obturator fabrication may be challenging because of the complexity of anatomy and physiology of velopharyngeal portion. The obturator bulb is extended to the defect; and is functional molded to provide surface contact for the remaining musculature of the velopharyngeal mechanism during activities such as speech and swallowing.2 Moreover, the location of the obturator bulb should also be carefully considered, the superior margin should not be extended above the muscular activity level, and the inferior margin should not be extended beyond the lower level of muscular activity, either.1 If the inferior extension was so low, interference of tongue movements and improper articulations of speech may results.3,4 The inferior margin of obturator prosthesis is usually determined as the extension of palatal plane, and therefore, the Passavant’s ridge, which was thought to be an area of posterior pharyngeal wall with greatest muscular activity,5 can be served as a guide if it is able to identify and locate.1(Fig. 1).

Passavant’s ridge was first described in 1863 by a German surgeon Gustav Passavant, who described the existence of a transverse forward projection on the posterior pharyngeal wall during speech in cleft-palate patients and concluded that the ridge was an essential structure for normal velopharyngeal closure.1,6 The concept has engendered a lot of controversy for many years, and now it was widely agreed that the ridge is not existed in all population or necessary for velopharyngeal closure. Since Passavant’s ridge could be served as a guide for determination the inferior margin of obturator prosthesis, the observation of the ridge during treatment is required. In previous studies, the prevalence of Passavant’s ridge showed inconsistent results, ranged from 5% to 83%,6–9 and there were no studies concerning about the population in East Asia region had been published. Most of the investigators focused on evaluation the occurrence of the ridge during phonation and swallowing using radiography or nasopharyngoscopy. However, the construction of a well fitted obturator for patients with soft palate anatomic defects, direct oral examination may be an easier and effective way for identification and evaluation the occurrence of Passavant’s ridge, without exposing the patient to radiation or causing discomfort during the radiographic examination. Since Passavant’s ridge does not occurs on all sounds during phonation, and the size may varied with different sounds,10,11 Swallowing is a more consistent physiological behavior compared to speech, that will induce a more forceful velopharyngeal closure12,13 and, therefore, the ridge may be more easily to be observed. In addition, gagging sharing the same velopharyngeal pattern with swallowing,14 and we generally utilize mouth mirror to elicit gag reflex to observe the presence of ridge with mouth opening.

In this retrospective study, the prevalence and occurrence of Passavant’s ridge in patients with velopharyngeal insufficiency (including those patient with congenital or acquired anatomic defects) during speech and gag reflex was evaluated with direct oral examination, and we hypothesized that the occurrence of the ridge was higher while gagging because of more consistent and forceful muscular activity induction. The association between patient’s factors such as gender, etiology, defect area and the occurrence of the ridge was also evaluated.

Materials and methods

Patients with velopharyngeal insufficiency who were prepared to receive obturator prosthesis during the period from 1992 to 2016 at the Department of Stomatology in Taichung Veterans General Hospital (TCVGH, Taiwan) were included in this retrospective study and the research protocol was approved by the ethical committee of TCVGH. All the patients were recognized having total or partial soft palate defects with or without hard palate defects. All studied cases included unrepaired congenital clefts or acquired surgical defects that surgical resection was received at least three months postoperatively. Those individuals with previous surgical reconstruction and incomplete documentation in clinical examinations were excluded from the study. Finally, a total of 91 patients, 74 were male and 17 were females, that matched the requirements were evaluated in the study. The ages of the patients ranged from 25 to 81 years old, with a mean age of 53.8 years.

Figure 1 Patients with unrepaired soft palate defect demonstrating Passavant’s ridge, which can serves as a guide for inferior margin of obturator prosthesis (arrow).
Data based concerning the patient’s medical and dental record including the performance of Passavant’s ridge during phonation and gag reflex, the gender, the etiology of defect, and the area of soft palate defect were also recorded and analyzed.

At the first appointment for obturator prosthesis fabrication, Passavant’s ridge was identified and verified using direct intra-oral observation with a mouth mirror by two examiners together to reach a consensus. Since the examined patients did not accept surgical repair, the defect right back to the uvula and pharyngeal wall could be easily examined and observed. Patients were required to perform speech and gagging for accurately evaluation. The sequence of examination is listed as the following.

1) Speech activity test: patient phoned a brief “Ah” repeatedly (Fig. 2A).
2) Gag activity test: examiner used a mouth mirror to touch the posterior pharyngeal wall to elicit the reflex (Fig. 2B).

A localized well-defined anterior projection from the posterior pharyngeal wall would be recorded as positive, indicating the existence of the Passavant’s ridge (Fig. 2A and B). No movement or generalized forward movement of posterior pharyngeal wall, which is not a discrete movement, would be recorded as negative, indicating the absence of the ridge (Fig. 3). The results are both agreed by two examiners and recorded.

The etiology of soft palate defects was recorded and classified as congenital or acquired defects. The defect area of soft palate was also recorded and classified as total, median and lateral resection based on the recommendation of Aramany and Myers at 1978.14

Periodic follow up was arranged at 1 week, and 1, 3, 6 months after obturator prosthesis delivery, and every 6 months thereafter. The performance of Passavant’s ridge was re-evaluated and recorded when the patient came back for a routine check-up. However, the appointment after obturator delivery for routinely check up is not mandatory, only a few patients came back regularly.

Recorded data were organized for group comparison and analyzed, using the Statistical Package for the Social Sciences (IBM SPSS version 22.0; International Business Machines Corp). In purpose to compare the results between the speech group and the gagging group, McNemar test was used. All the data were checked for normal distribution and deviation (Kolmogorov–Smirnov and Shapiro–Wilk normality tests). The association between the presence of Passavant’s ridge and categorical variables (gender, etiology and defect area) were also analyzed using the chi-square test for association and Fisher’s exact test depending on the samples of categories. Statistical significance was defined as $P < 0.05$.

**Results**

A total of 91 patients with velopharyngeal insufficiency without previous surgical repair that were prepared and arranged for an obturator prosthesis treatment were included and analyzed in the present study. Of those samples, 81 subjects were categorized as acquired surgical defect, and 10 subjects with congenital cleft defects. In those soft palate defect subgroup, 54 subjects were found to have total resection of soft palate defects, 9 subjects had median resection of soft palate defects, and 28 subjects had lateral soft palate defects. All the data were recorded and are shown in Table 1. During obturator prosthesis fabrication, the presence of Passavant’s ridge was identified during patient phoned “ah” and gag reflex; a well-defined localized ridge would be recorded as positive. On the contrary, the absence of ridge would be

**Figure 2** (A) Patient phoned a brief “Ah”, an obvious localized anterior projection could be observed by direct oral view (arrow). (B) A significant localized anterior projection could be observed by eliciting the gag reflex with a mouth mirror to touch the posterior pharyngeal wall (arrow).

**Figure 3** There is no significant well-defined localized anterior projection from posterior pharyngeal wall during phonation could be observed.
recorded as negative. Overall, the results demonstrated that Passavant’s ridge was present in 72 patients (79.1%) during phonation, and 83 patients (91.2%) during gagging action. This was a markedly difference and showed a statistical significance. In subgroup analysis, a significantly higher occurrence of Passavant’s ridge during gagging action than during phonation was also found in males, in patients with acquired defect, and in those with total soft palate defect.

Finally, a comparative analysis of the phonation and gagging action groups was conducted, which included all subgroups if gender, etiology, and area of defect were found to be related to the presence of Passavant’s ridge, but the results did not reveal any statistical significance (Tables 2 and 3).

**Discussion**

The retrospective study was undertaken to evaluate the occurrence of Passavant’s ridge in patients with velopharyngeal insufficiency during speech and gagging action before obturator prosthesis fabrication. The effects of gender, etiology, and area of defect were also analyzed. The results demonstrated a high prevalence of the ridge in patients with velopharyngeal insufficiency by direct intraoral examination.

In this study, 79.1% of patients exhibited the Passavant’s ridge during phonation, which was similar to the results of the study by Casey and Emrich (1988). They found 82.75% of subjects demonstrated Passavant’s ridge during phonation. However, the prevalence rate was much higher compared with some previous studies. The different evaluation methods employed and different population included of those studies would be the main reasons to conclude the different results. In the majority of past studies, the velopharyngeal function was usually evaluated using radiographic technique with or without nasopharyngoscopy, while we observed the presence of Passavant’s ridge directly by intraoral examination. This method of evaluation and observation enables the examiner accurately observe the localized projection from the posterior pharyngeal wall which may be difficult and uncertain using radiography, particularly without the aid of a contrast agent. In addition, it is necessary to avoid the risk of radiation exposure for the studied subjects. Moreover, radiography or nasopharyngoscopy may be especially challenging if the patients are uncooperative. In this case, the direct intraoral examination allows for a more precise and accurate assessment.

### Table 1

| N | Phonation | Gag reflex | P-value<sup>a</sup> |
|---|-----------|------------|-------------------|
|   | Positive | Negative | Positive | Negative |
| Gender | Male | 74 | 57 (77%) | 17 (23%) | 66 (89.2%) | 8 (10.8%) | <0.05 |
| Female | 17 | 15 (88.2%) | 2 (11.8%) | 17 (100%) | 0 (0%) | -- |
| Etiology | Congenital | 10 | 9 (90%) | 1 (10%) | 10 (100%) | 0 (0%) | -- |
| Acquired | 81 | 63 (77.8%) | 18 (22.2%) | 73 (90.1%) | 8 (9.9%) | <0.05 |
| Soft palate defect | Total | 54 | 42 (77.8%) | 12 (22.2%) | 50 (92.6%) | 4 (7.4%) | <0.05 |
| Median | 9 | 9 (100%) | 0 (0%) | 9 (100%) | 0 (0%) | -- |
| Lateral | 28 | 21 (75%) | 7 (25%) | 24 (85.7%) | 4 (14.3%) | 0.250 |
| Total | 91 | 72 (79.1%) | 19 (20.9%) | 83 (91.2%) | 8 (8.8%) | <0.05 |

<sup>a</sup> Comparison of occurrence of Passavant’s ridge between patients performing phonation and gag reflex by McNemar test.

### Table 2

| Phonation | Total (n=91) | Positive (n=72) | Negative (n=19) | p value |
|-----------|-------------|----------------|----------------|---------|
| Gende<sup>a</sup> | n | % | n | % | n | % |
| Male | 74 | (81.3%) | 57 | (79.2%) | 17 | (89.5%) | 0.509 |
| Female | 17 | (18.7%) | 15 | (20.8%) | 2 | (10.5%) |
| Etiology<sup>a</sup> | n | % | n | % | n | % |
| Congenital | 10 | (11.0%) | 9 | (12.5%) | 1 | (5.3%) | 0.682 |
| Acquired | 81 | (89.0%) | 63 | (88%) | 18 | (94.7%) |
| Soft palate defects | Total | n | % | n | % | n | % | 0.256 |
| Median | 9 | (9.9%) | 9 | (13%) | 0 | (0%) |
| Lateral | 28 | (30.8%) | 21 | (29%) | 7 | (36.8%) |

Chi-square test.<br><sup>a</sup> Fisher’s exact test. Mann-Whitney test.
Passavant’s ridge in velopharyngeal insufficiency patients

Table 3  The association between the presence of Passavant’s ridge during gagging stimulation and categorical variables (gender, etiology and defect area) were analyzed.

|                      | Total (n=91) | Positive (n=83) | Negative (n=8) | p value |
|----------------------|--------------|----------------|---------------|---------|
| Gender^a             |              |                |               |         |
| Male                 | 74 (81.3%)   | 66 (79.5%)     | 8 (100%)      | 0.344   |
| Female               | 17 (18.7%)   | 17 (20.5%)     | 0 (0%)        |         |
| Etiology^a           |              |                |               | 0.591   |
| Congenital           | 10 (11.0%)   | 10 (12.0%)     | 0 (0%)        |         |
| Acquired             | 81 (89.0%)   | 73 (88.0%)     | 8 (100%)      |         |
| Soft palate defects  |              |                |               | 0.359   |
| Total                | 54 (59.3%)   | 50 (60.2%)     | 4 (50%)       |         |
| Median               | 9 (9.9%)     | 9 (10.8%)      | 0 (0%)        |         |
| Lateral              | 28 (30.8%)   | 24 (28.9%)     | 4 (50%)       |         |

Chi-square test.
^a  Fisher’s exact test. Mann-Whitney test.

retrospective study, all the patients were unrepaired anatomic defects due to congenital or acquired causes, so that we could directly observed the ridge easily.

The results showed that 91.2% of patients perform the Passavant’s ridge during gagging, which support our hypothesis that the occurrence during gagging is higher than during phonation. The difference reach the statistical significance. Passavant’s ridge can be a reference area to guide the reconstruction of the inferior margin of obturator prosthesis. Therefore, an evaluation of the ridge during treatment cannot be overlooked. According to previous studies, the performance of the ridge varied with different vowels production, \(^{10,15}\) and the appearance may be inconsistent. When the examiners compare the function of speech, pharynx contraction is found to be more forceful and consistent during swallowing. \(^{13}\) Since gagging and swallowing sharing the same pattern of velopharyngeal closure, \(^{12}\) gag reflex elicitation may be a more accurate and easier way to observe the ridge by a direct intraoral examination. In the present study, the results showed that 12.1% of patients do not demonstrated the ridge during phonation, while the ridge is elicited during gagging stimulation. So that, if the presence of Passavant’s ridge is to be evaluated, different stimulation method is recommended.

In the subgroup analysis, the prevalence of the Passavant’s ridge during gagging was still higher than those observed during phonation, and in the subgroups of male gender, acquired defect, and total soft palate defect, there was statistical significance mentioned. Of those 28 patients with lateral soft palate defect, 85.7% exhibited the ridge during gagging, that was obviously higher than during phonation (75%), but the results was not statistically significant. It might be related to the small sample size in this study.

Gender, etiology, and soft palate defect area were also analyzed and showed no significant correlation with the presence of the ridge whenever during phonation or gag reflex. These results was in agreement with Di Ninno et al. (2012), \(^{16}\) who concluded that the velopharyngeal closure pattern was not correlation with age, gender, or cleft type. However, McKerns & Bzoch (1970) suggested that a difference might exist in velopharyngeal valving with respect to gender\(^{17}\) because males having a greater velar length and higher elevation height. But they focused mainly on the orientation of the velum, not the movement of the pharyngeal wall.

Although the exact role of Passavant’s ridge in velopharyngeal closure and speech function is controversial, its clinical application in the design of obturator prosthesis has been recognized. During the processes of assessment for fabrication of obturator prosthesis, Passavant’s ridge can be used as a reference area to guide and demarcate the inferior margin of the speech bulb. According to the classification of velopharyngeal closure, \(^{8,18}\) the presence of the ridge is only related to velopharyngeal circular pattern, representing the movements of the lateral and posterior pharyngeal wall both involved in closure. The treatment outcome of obturator prosthesis may be enhanced with any residual movement of velopharyngeal complex, allowing a space between the prosthesis and tissue for nasal breathing and nasal sound production, that also provided the effective obturation during the performance of a given function.\(^{1,19}\) In the present study, a detectable ridge during phonation was observed in 79.1% and an observable ridge in 91.2% of those subjects during gagging. It is, therefore, demonstrated that most of the patients with velopharyngeal insufficiency may have chance to achieve an adequate speech with obturator prosthesis treatment.

However, the responsible mechanism for the formation of Passavant’s ridge is still controversial. Many studies have been postulated that the formation of the ridge is primarily related to a compensatory mechanism due to the alteration of velopharyngeal function, \(^{7,20,21}\) Croft et al. (1981) evaluated the distribution of velopharyngeal closure pattern, and the results showed that the coronal pattern was most frequently observed; however, there was a wider distribution of other patterns in subjects with a clefts.\(^{8}\) Warren (1986) also reported that 57% of unrepaired cleft palate subjects had the ridge, which was higher in occurrence than that found in the normal subjects.\(^{22}\) The prevalence of Passavant’s ridge was higher in subjects with velopharyngeal dysfunction, but evidences to support a compensatory factor related to the formation of the ridge was still
lacking. In the present study, four studied subjects had no detectable ridge at the first examination during phonation and gagging, but the ridge was developed after obturator prosthesis was applied one year later. It was indicated that the pattern of velopharyngeal closure and performance of the Passavant’s ridge may change following muscle activity. Therefore, regularly follow-up of obturator prosthesis and adjustment is recommended.

In the present study, we did not evaluate or classify the pattern of velopharyngeal closure during prosthetic treatment for two reasons. First, the description of different patterns may be misleading as the pattern may vary over time especially during different functions. Second, an atypical pattern may have existed. The intensity of the ridge in the present study was not evaluated either, owing to difficulty in defining and classifying the degree of intensity; as well as the possibility that it may vary with different functional activities among individuals.

There are some limitations in the present study. The Passavant’s ridge before and after surgical treatment in patients with acquired surgical defect do not evaluated, and the evaluation of the performance of the ridge for each patient after obturator prosthesis delivery do no completed either. Because of many patients are lost during the follow-up period, a comparison of these data will certainly provide some valuable results. Furthermore, the speech function of the studied patients have not been assessed by a speech pathologist, the relationship between treatment outcome and the performance of Passavant’s ridge are not able to evaluate and discuss. Further clinical studies may help to elucidate the exact mechanism of the Passavant’s ridge.

In this retrospective study, the results showed a high prevalence of the ridge in patients with velopharyngeal insufficiency in a Taiwan Chinese population, with a rate of 79.1% during speech and 91.2% while gagging, suggesting that we could use the ridge as a guide for inferior margin while fabricating obturator prosthesis for patients with velopharyngeal insufficiency most of the time, and according to our results, eliciting gag reflex would be a easier and more consistent way to observe the ridge.

Conflicts of interest

None.

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