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Original Article

OSAHS obstructive plane localization: comparative study between ag200 and friedman classification

Xi Chen, Jianjun Sun, Wei Yuan, Jinrang Li

Department of Otolaryngology-Head and Neck Surgery, Navy General Hospital, Beijing 100048, China

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Abstract: Objective: To compare AG200 (Sleep Monitoring Obstructive Locator, Apneagraphy) and the result of Friedman classification and evaluate the accuracy of the two testing methods on OSAHS obstructive localization diagnosis. Methods: 77 patients who were undergoing a treatment in the hospital, with Obstructive sleep apnea hypopnea syndrome (OSAHS) diagnosed by Polysomnography, were selected. Those patients were monitored by ArthroCare AG200 for their upper airway-esophageal pressure. Friedman classification, tongue height scale (Friedman tongue position, FTP), tonsil scale and classification between constituent ratio of upper obstruction ≥70% and constituent ratio of lower obstruction ≥70% were recorded before analyzing the relations of obstructive planes measured by Friedman classification and AG. Result: Friedman clinical classification didn't include type IV patients (no patients had BMI ≥40, or had obvious jaw deformity); the comparison between each other within a group showed that the number of type III patients was apparently larger than that of Friedman type I ($U=4.689$, $P<0.05$); A common rule was that as the scale of Friedman classification and FTP increases, the lower obstructive constituent ratio also increases. AG systematic analysis showed that 66.23% (51/77) patients mainly complained of upper obstruction, i.e. upper obstructive constituent ratio ≥70% while 12.99% (10/77) patients mainly complained of lower obstruction, i.e. lower obstructive constituent ratio ≥70%). No obvious difference was detected if classified by tonsil size. If patients were classified by upper obstructive constituent ratio ≥70% and lower obstructive constituent ratio ≥70%, the condition of the patients, FTP and the size of the tonsil showed no significant difference ($P>0.05$). Conclusion: Friedman classification method is easy to operate and to some extent, it can predict the site of obstructive plane, though the result is not always accurate because the result from Friedman classification of some patients was not consistent with that measured by nasopharyngo-fiberoscope and CT scan. Measuring the upper airway-esophageal pressure by AG200 system is the only localizing diagnosis method now to find the dynamic changes of all obstructive sites during the whole night as it can acquire the rough constituent ratio of obstructive plane and complement the shortcomings of physics examination and imaging tests. But it can only provide the location of the lowest plane instead of the accurate cause of obstruction and whether there is another obstruction above the existed obstruction at the same time. Clinically, patients, especially those who are considering surgeries like UPPP should combine different examination methods before the surgery so as to complement their advantages and improve the accuracy of localizing obstructive plane before deciding a proper surgery plan for a successful surgery, thus patients can recover as soon as possible.

Keywords: Obstructive sleep apnea hypopnea syndrome, upper airway pressure measurement, friedman classification

Introduction

Obstructive sleep apnea hypopnea syndrome (Obstructive sleep apnea hypopnea syndrome, OSAHS) manifests clinically as snore during sleep, sometimes accompanied by apnea, shallow breath, and night hypoxemia off and on. Its cause is complicated and its pathological state hasn't been fully clarified. The upper airway stenosis is usually treated by clinical surgery [1]. To ensure that the patient is consistent to the indication of the surgery as well as to prove the accuracy and effectiveness, a pre-operational test is needed to find the severity of the patient's OSAHS and the obstructive condition and location [2]. The tests include imaging tests like MRI, CT scan, X-ray craniofacial measurement and nasopharyngo-fiberoscope, etc. [3]. CT scan can provide a fast observation of the patient's stenosis plane, but the observing time

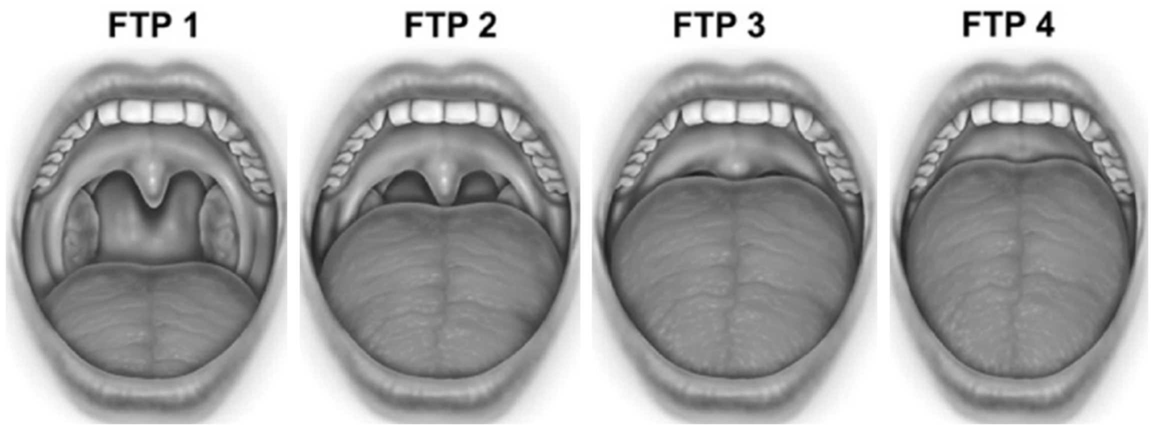

Figure 1. Tongue height scale (Friedman tongue position, FTP).

Table 1. Records of the patients' obstructive classification

classification	Friedman classification				FTP classification			
	I	II	III	IV	1	2	3	4
case number	14	18	45	0	5	24	47	1
upper obstruction dominance (case)	9	10	11	-	5	11	10	-
lower obstruction dominance (case)	5	8	34	-	0	13	37	-
obstruction times (times)	(204±35.35)	(208.64±53.25)	(155.17±35.35)	-	(208.4±53.12)	(65.41±17.87)	(67.53±18.31)	-
mixed obstructive cases (cases)	7	13	32	-	4	17	30	-
central obstructive cases (cases)	2	8	11	-	2	4	15	-
minimum oxygen (%)	(70.86±18.36)	(61.20±15.60)	(64.40±16.30)	-	(71.8±18.02)	(73.08±18.87)	(71.43±18.36)	-

is short and it needs the patient's conscious cooperation, thus it has its own limitation [4]. By contrast, AG system provides a long-time dynamic observation of upper airway-esophageal measurement. Patients can be monitored for the whole night by placing micro pressure sensors and temperature sensors of the AG system at nasopharynx, mid-esophagus, tongue back and palate back for their times of different apnea hypopnea, total times of obstruction, times of upper and lower obstruction, oxyhemoglobin saturation and so on [5]. As a simpler and more direct method, Friedman classification can also predict the prognosis of the surgery. In this study, the hospital observed and compared the accuracy of the two methods in OSAHS obstructive plane localization.

Methods

General materials

77 patients treated in our hospital for obstructive sleep apnea hypopnea syndrome (OSAHS) were selected. All patients were male, with age ranging from 18 to 68 (39.8±10.2 on average), body mass index (BMI) from23.25 to 42.4 kg/m^2 (23.8±8.6 on average). They received two methods of testing classification, i.e. ArthroCare AG200 system for their upper airway-esophageal pressure and recording of Friedman classification, tongue height scale (Friedman tongue position, FTP), tonsil scale and classification between constituent ratio of upper obstruction ≥70% and constituent ratio of lower obstruction ≥70%. Then the relation of obstructive planes measured by Friedman classification and AG was analyzed.

Patients' inclusive criteria

(1) Patients who were diagnosed with obstructive sleep apnea hypopnea syndrome (OSAHS) by Polysomnography (PSG);

(2) Patients who could receive the whole-night monitoring by AG system;

(3) Patients without hypothyroidism, laryngospasm, neuromuscular disorders, paralysis, central sleeping apnea hypopnea syndrome, etc.;

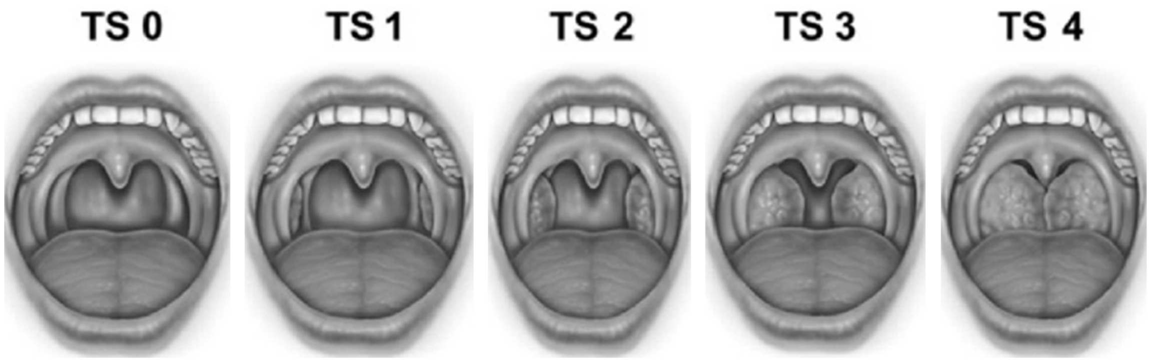

Figure 2. Tonsil scale (Friedman tongue position, FTP).

Table 2. Records of the classification of patients' tonsil size and different AG tests' results

classification	classification by tonsil size				
	0	1	2	3	4
case number	1	10	44	19	3
upper obstruction dominance (case)	1	10	7	7	0
lower obstruction dominance (case)	0	0	37	12	3
obstruction times (times)	-	(158.9±40.23)	(161.83±40.96)	(216.23±54.88)	(27.67±7.02)
mixed obstructive cases (cases)	-	8	37	10	1
central obstructive cases (cases)	-	2	15	3	2
minimum oxygen (%)	-	(26.5±6.93)	(61.64±16.21)	(52.68±13.57)	(70.67±18.17)

(4) The study was approved by Hospital Ethics Committee and patients knew about the study before signing the informed consent.

Testing methods

Upper airway-esophageal Monitoring method: To test by ArthroCare AG200 system. AG system is composed of five parts: main engine, tube components for measuring the pressure, SaO_2 components, data acquisition card and software analysis system. When patients were sitting, placing a tube through the nose cavity and four sensors (two micro-pressure sensors P0 and P2, and two temperature sensors T0 and T1) at mid-esophagus, pharynx oralis at the lower free edge of the palate, back of the tongue and choana. When metal mark of the pressure tube reached the top of the free edge of the palate, the sensors reached every target sites. Fix the pressure measuring tube around the nose before connecting it and the blood oxygen wire with the main engine and fixing the latter on the upper abdomen. Measure the air passing the nose and the mouth and monitor the pressure changes on different planes and esophagus during sleeping hours to learn about the obstruction sites and the constituent ratio of the upper to lower plane obstruction.

Friedman classification method

To avoid the clinical classification bias caused by different testers' standards, the testing method was practiced by one physician involved in the research. During the test, the patient should open his mouth as large as possible to expose the tongue body naturally. The tongue should not stick out of the mouth or near the articulation area and the test should be repeated for several times to make sure that the physician can observe the relation between the tongue body and the palate to give an accurate classification. The patients were classified into I~IV types according to the tongue height scale (Friedman tongue position, FTP), tonsil scale and classification between constituent ratio of upper obstruction ≥70% and constituent ratio of lower obstruction ≥70%. In the Friedman clinical classification of type IV, BMI ≥40, or it accompanied a obvious jaw deformity, so there was no IV patient.

Diagnosis criteria

Deciding criteria for the obstructive sites [6]: Obstructive sites can be divided into upper obstruction and lower obstruction. The former is mainly in the palate back area, which includes

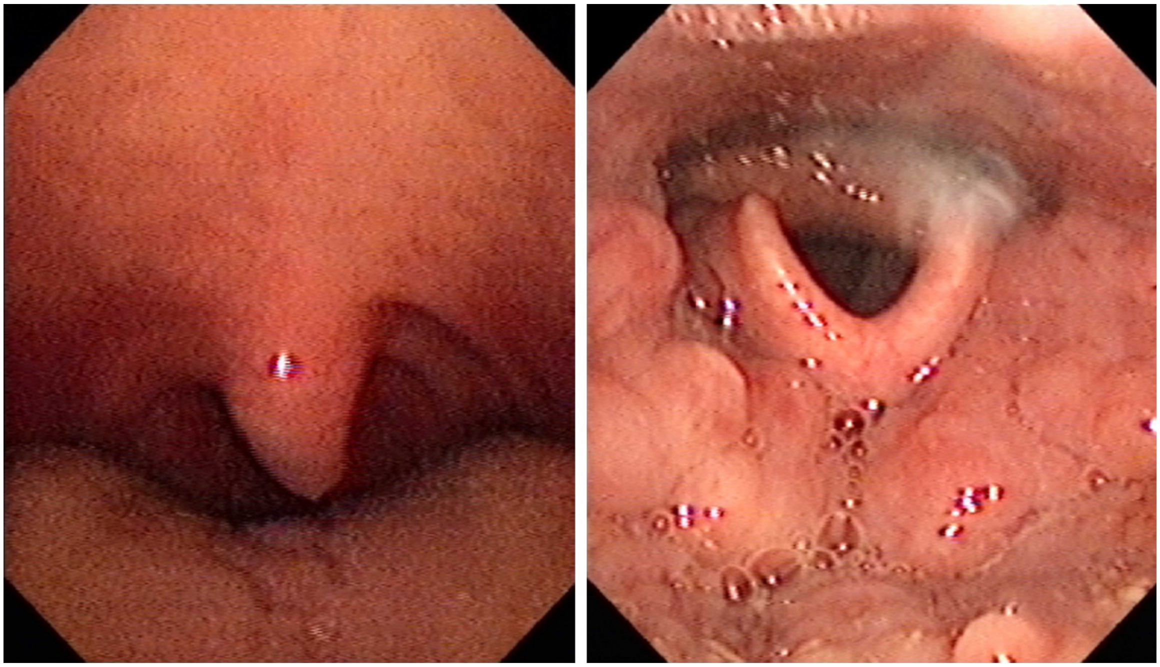

Figure 3. Yu surname patients with FTP was classified into type II, but fiber laryngoscopy showed patients with tongue lymphatic tissue is obvious hyperplasia and pressing part of epiglottis.

palate back area, nasopharynx and nose cavity, i.e. the part above the P2 sensor. The latter is mainly in the tongue back area, including tongue back area as well as the pharynx and larynx, i.e. the part below the P2 sensor. During the normal breath, the sensor shows a negative value in the upper airway of the thoracic cavity. When the obstructive plane is inhibited, the rules are as follows: the fluctuation range of the upper sensor decreases to below 50% of the basic value or even disappear and pressure fluctuation range of the lower sensor gets more obvious. So a conclusion was drawn that when the upper obstruction occurs, the obstructive plane is above the two sensors, therefore the fluctuation of the two micro sensors are similar; when the lower obstruction occurs, the obstructive plane is between the two sensors, therefore the fluctuation range of the P2 which is below is larger, and it may be more than one half of P0. The researchers also need to count the ratio of upper obstruction and lower obstruction at night, the former = upper obstruction times/total obstruction times ×100%, the latter = lower obstruction times/ total obstruction times ×100%.

Diagnosis standard for apnea: Diagnosis standard of apnea is no air passing the nose or mouth for more than 10 seconds, which can be divided into three types: central apnea, obstructive apnea and mixed apnea. The obstructive apnea causes an increasing negative value of airway pressure showed by the two micro sensors. An abrupt drop of the negative value means breath back to normal. The central apnea makes the pressure fluctuation of the two sensors disappear. The mixed apnea causes the airway negative value disappears before increasing to normal at 5 seconds or above. The two sensors show the same changes during hypopnea as obstructive apnea, when the breathing air reduces to less than 50% of the normal and lasts more than 10 seconds, with the oxyhemoglobin saturation reducing over 4%.

Statistics method

SPSS 16. 0 statistical package was applied to carry out the statistical analysis and One. Sample Kolmogomv-Smimov Test was applied to check the data's normality. Normally distributed data was represented by $\overline{x}$±s and analyzed by ANOVA one-way variance; skewed distributed data was represented by median [25 quantile; 75 quantile] (M[P25; P75]), analyzed

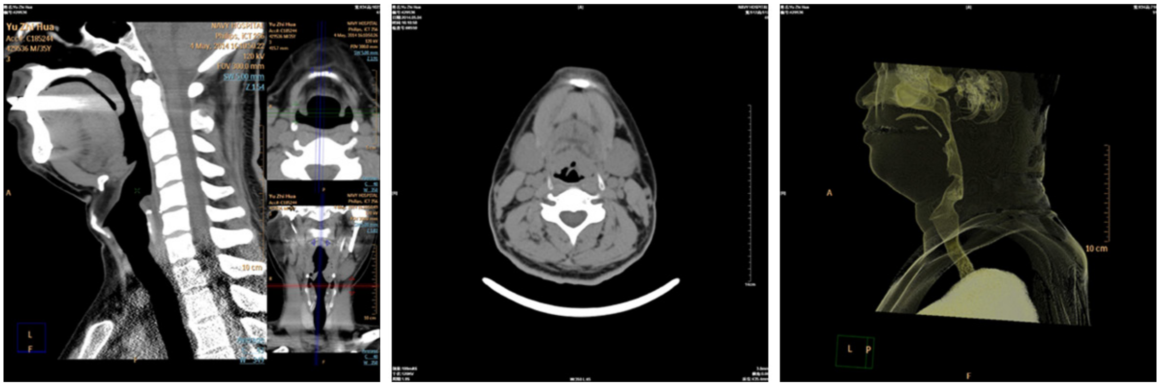

Figure 4. Yu surname patients with head and neck CT scan showed there are retrolingual obstruction.

by Kmskalwalli rank-sum test and tested by Mann-Whitney U.

Results

Comparison of different items between Friedman classification and AG system

Record the obstructive type judged by Friedman classification (**Figure 1**) and AG before analyzing the relations between them two. (1) AG system showed that the upper obstructive dominance (upper obstruction ≥70%) and the lower obstructive dominance (lower obstruction ≥70%) account for 66.23% (51/77) and 12.99% (10/77) respectively. (2) Friedman clinical classification can be divided into type I~IV. In the classification, there were 14 type I cases, 18 type II cases and 45 type III cases. It was required that in type IV, BMI ≥40 or accompany an obvious jaw deformity, so there was no type IV in the study. A comparison of every two of them showed that Friedman type III was obviously higher that of Friedman type I (U=4.689, P<0.05) and as the level of the type got higher, the number also increased. (3) According to the tongue height scale, i.e. FTP classification method, there were four types: I~IV, of which 5 belonged to type I, 47 belonged to type II, 24 belonged to type III and only 1 belonged to type IV. The FTP type III was apparently higher than FTP type I (U=5.017, P<0.05). (4) A study of the result showed that according to Friedman clinical classification and FTP scale classification, the increase of the scale also brought about the rise of lower obstructive constituent ratio. The patients classified between upper obstruction ≥70% and lower obstruction ≥70% presented no significant difference in the severity of their disease and FTP (P>0.05) (**Table 1**).

The classification of tonsil size and the records of different AG testing results

AG system showed that the upper obstructive dominance (upper obstruction ≥70%) and the lower obstructive dominance (lower obstruction ≥70%) account for 66.23% (51/77) and 12.99% (10/77) respectively. According to size of tonsil, they were divided into five types: 0~4 (**Figure 2**), with 1 case, 10 cases, 44 cases, 19 cases and 3 cases respectively. There amount of different types showed no significant difference (P>0.05) (**Table 2**).

Discussion

Obstructive sleep apnea hypopnea syndrome (Obstructive sleep apnea hypopnea syndrome, OSAHS) patients experience repeated apnea for more than 30 times at night during sleep [7]. (Apnea means no air passing nose or mouth for 10 or over 10 seconds during sleep). Apnea causes a series of changes of the human bodies, including drowsiness in the day, severe damage to cardiocerebral vascular system and harm the human body. Apnea can be divided into three types: central apnea, obstructive apnea and mixed apnea according to the history of disease and pathogenesis [8]. In the treatment methods, the improved UPPP has become an acknowledged effective method. PSG, as a golden standard for diagnosis, is often used to verify OSAHS and evaluate the severity before surgery, but it cannot predict the obstructive plane. So clinically, AG system is used to measure the upper airway-esophageal pressure by systematic micro pressure sensors, in which the change of data was shown and used to measure the obstructive plane, in this way the patients' whole-night sleeping structures were monitored without affecting their sleep [9]. While the upper airway-esophagus measurement of AG system can measure obstructive plane without disturbance, the anatomical structure of the obstructive plane cannot be identified, so it has its restrictions.

The research of Friedman and other scholars showed that classifying the patients by the tongue height scale, size of tonsil and BMI can help the doctors to decide the surgery plan and predict the effect of surgery, in this way a successful surgery is more likely to be realized. The data proved the reliability of the conclusion as the successful rate increased after type II and type III patients in Friedman classification applying the combination of tongue root radiofrequency ablation and UPPP method. Compared with AG system which can monitor the patients for the whole night, Friedman classification also has its own limitations. For example, it needs the patients' cooperation, cannot accurately measure the obstructive plane and cannot decide which type the obstruction is [4]. In this study, AG system showed that the patients with upper obstruction constituent ratio ≥70% occupied 66.23% (51/77) while those with lower obstruction constituent ratio ≥70% occupied 12.99 (10/77); In Friedman classification and FTP scale classification, as the scales increased, the lower obstruction constituent ratio also increased. Comparisons between each other in Friedman classification showed that the number of patients with type I was obviously smaller than that with type III ($U=4.689$, $P<0.05$) and the same occurred in FTP classification, ($U=5.017$, $P<0.05$); Classified by the size of tonsil, no obvious difference was shown between different groups; In groups classified between upper obstruction ≥70% and lower obstruction ≥70%, the comparison of the patients' condition, FTP and size of tonsil showed no significant difference ($P>0.05$). In conclusion, Friedman classification is easy to carry out and can, to some extent, predict the obstructive plane, but when it comes to a detailed patient, it's a different story. For example, a patient whose surname is Yu was classified into type II in TFP (**Figure 3**) and gave no consideration to the tongue root as an obstructive site. But the fiber laryngoscope (**Figure 3**) and CT scan (**Figure 4**) showed that the tongue root was obstructed and AG test showed that the plane obstruction of tongue root accounted for 70%, which was inconsistent with Friedman classification. So clinically, patients, especially those who are considering about the surgeries, should apply multi-method tests to improve the accuracy of localizing the obstructive plane. Upper airway pressure measuring system is the only method currently that can give a localizing diagnosis of the whole-night changes of obstructive sites and a rough constituent ratio of obstructive plane, in this way, the shortcomings of the traditional physics tests and imaging tests are complemented [10]. Regardless of its advantages, its disadvantages are that it can only provide the location of the lowest obstructive plane, so more testing methods are needed to find the cause of this obstruction and whether there are more obstructions above this one at the same time [11].

Disclosure of conflict of interest

None.

Address correspondence to: Xi Chen, Department of Otolaryngology-Head and Neck Surgery, Navy General Hospital, Beijing 100048, China. E-mail: xichen_ohns@163.com

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