Original Article / Çalışma - Araştırma

Can the Müller maneuver detect multilevel obstruction of the upper airway in patients with obstructive sleep apnea syndrome?

Obstrüktif uyku apneli hastalarda Müller manevrasıyla üst hava yolunun çoklu seviyeli tıkanıklıkları tespit edebilir mi?

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Objectives: Our aim is to figure out the role of Müller maneuver (MM) to detect the level of upper airway obstruction and the severity of obstructive sleep apnea syndrome (OSAS).

Patients and Methods: In this study, polysomnographies were made after the routine otorhinolaryngological examination including MM in patients admitted with OSAS suspicion in Ankara Oncology Training and Research Hospital's Department of Otorhinolaryngology, Sleep Medicine Policlinic. Two-hundred and twenty-one OSAS patients (142 males, 179 females; mean age 47.63 years; range 18 to 82 years) were included to the study.

Results: There weren't any significant correlation among apnea hypopnea index (AHI) results and body mass index (BMI), tonsil size and obstruction severity due to MM ($p>0.05$). Müller maneuver scores are positively correlated to the Epworth sleepiness scale (EPSS) scores ($r=0.213$ and $p<0.001$). Epworth sleepiness scale scores are found to be correlated to BMI and neck circumference ($p<0.05$). Level of the airway obstruction doesn't affects the EPSS scores ($p=0.235$). Also EPSS scores are not affected from uni or multilevel obstruction ($p=0.088$).

Conclusion: The severity of the MM score is not correlated to the severity of OSAS according to AHI results, but it is found to be correlated to EPSS. Vibrating tissues caused local and systemic inflammation in OSAS patients. The correlation between EPSS and MM scores can be explained by this inflammatory process. Further prospective studies have to be done in this field. Müller maneuver in an awake patient might reflect the levels of the obstruction in sleep conditions even though insufficient for figuring out the severity of OSAS.

Key Words: Müller maneuver; obstructive sleep apnea syndrome; uvulopalatopharyngoplasty; videoendoscopy.

Amaç: Müller manevrası (MM)'nın obstrüktif uyku apne sendromu (OUAS)'nun şiddeti ve üst hava yolundaki tıkanıklık seviyesinin tespitindeki rolü ortaya kondu.

Hastalar ve Yöntemler: Ankara Onkoloji Eğitim ve Araştırma Hastanesi, Kulak Burun Boğaz, uyku ve horlama polikliniğinde, OUAS şüphesiyle başvuran MM'de dahil olmak üzere rutin kulak burun boğaz muayenelerini takiben polisomnografi yapıldı. Çalışmaya 221 OUAS'li hasta (142 erkek, 179 kadın; ort. yaş; 46.63 yıl; dağılım 17-82 yıl) dahil edildi.

Bulgular: Apne hipopne indeksi (AHİ) sonuçları ile vücut kitle indeksi (VKİ), tonsil büyüklüğü ve MM'de tespit edilen tıkanıklık şiddeti arasında anlamlı fark bulunamadı ($p>0.05$). Müller manevrası sonuçları ile Epworth uykululuk skalası (EPUS) arasında anlamlı fark tespit edildi ($r=0.213$ ve $p<0.001$). Epworth uykululuk skalası sonuçları, VKİ ve boyun çevresi ölçüm sonuçlarıyla ilişkili bulundu ($p<0.05$). Tıkanıklık seviyesinin EPUS sonucuna etkisi görülmedi ($p=0.235$). Tıkanıklığın tek ya da birkaç seviyeli oluşunun da EPUS'ye etkisi tespit edilmedi ($p=0.088$).

Sonuç: Müller manevrasıyla tespit edilen tıkanıklık şiddeti AHİ sonuçlarına göre OUAS şiddetiyle bağlantılı bulunmamasına rağmen EPUS ile bağlantılı bulundu. Epworth uykululuk skalası ile MM arasındaki bu ilişkinin, OUAS hastalarında oluşan yumuşak damak ve etraf dokulardaki lokal enflamasyona ve OUAS'nin sistemik enflamatuvar etkisine bağlı olabileceği düşünüldü. Bu bağlantıyı araştırmak için daha kapsamlı çalışmalar yapılmalıdır. Müller manevrası, OUAS şiddeti hakkında güvenilir bilgi sağlamasa da üst hava yolundaki darlık seviyelerinin tespitinde faydalı bir yöntemdir.

Anahtar Sözcükler: Müller manevrası; obstrüktif uyku apne sendromu; uvulopalatofarengoplasti; videoendoskopi.

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Obstructive sleep apnea syndrome (OSAS) is a public health problem which affects almost 2-4% of the middle aged population.[1,2] The treatment options for OSAS are surgery and the use of a nasal continuous airway pressure device. Obstructive sleep apnea syndrome surgery is much more effective when it is done with a multilevel approach because OSAS patients tend to have multilevel upper airway obstructions, especially in severe forms of the disease. To plan the sites of multilevel surgery, we have to evaluate patients very carefully by physical examination and flexible endoscopic nasopharyngolaryngoscopy with Müller maneuver (MM). Using nasopharyngoscopy during the application of intrathoracic pressure, the MM is frequently employed to establish the site of upper airway obstruction. While the maneuver is noninvasive, cost-effective, reproducible and not physician-dependent, the reliability of the MM remains controversial. There are strong concerns about the use of the maneuver to reflect the site of the obstruction as it is not done during sleep. However, the MM is still being used for predicting the obstructed sites. It has been shown that while MM results are not dependent on the performer, it still remains a subjective test.[3]

The MM was first described by Borowiecki and Sassin for the preoperative assessment of OSAS patients.[4] The idea of the maneuver is to mimic the obstruction in the upper airway during sleep. Forced inspiratory effort against an obstructed airway under fiberoptic endoscopic visualization is initiated for the maneuver. During the maneuver, collapse of the walls visualized by endoscopy is recorded.

We compared the recorded data of the MM and the apnea-hypopnea index (AHI), one of the key parameters used in the diagnosis of OSAS, to explore whether the physical findings (tonsil hyperthrophy, Mallampati score) observed during the MM could predict the severity and the level of obstruction.

PATIENTS AND METHODS

Institutional review board approval for the study protocol and appropriate informed consents were obtained from the 221 patients accepted to the study group. Routine evaluations were done for the suspected OSAS patients in the Ankara Oncology Training and Research Hospital's Department of Otorhinolaryngology, Sleep Medicine Policlinic before the patient was referred for polysomnography (PSG). The demographic data including age, sex, weight and height were taken into consideration. All patients underwent a thorough history and physical examination (tonsil size, Mallampati score, posterior plicate or uvular web) were recorded and the Turkish version of the Epworth Sleepiness Scale (EPSS) questionnaire was completed. The EPSS score was obtained using standardized questions in which patients rated, on a scale of 0 to 3, their likelihood of dozing in eight situations, for an overall score which ranged from 0 to 24. The EPSS was performed to differentiate OSAS from primary snoring.[5]

Polysomnography

An all-night monitored, comprehensive sleep study was performed using a computerized polygraph (Sagura/Leonardo EEG & PSG, Germany) to monitor electroencephalogram (C3-A2, C4-A1), left and right electrooculogram, electrocardiogram, chin and anterior tibialis electromyogram, abdominal and thoracic movement by inductive plethysmograph, nasal oral airflow, oxygen saturation by pulse oximetry (SaO_2), and throat sonogram. Hypopnea was measured by a thermistor that was placed in the path of airflow from the nose to mouth. Apnea was defined as cessation of breathing for at least 10 seconds. Hypopnea was a decreased effort to breathe at least 50% less than the baseline and with at least a 4% decrease in SaO_2. The AHI was calculated as the sum of total events (apneas and hypopneas) per hour. All patients were studied in the same sleep laboratory facility.

Müller maneuver

The MM was performed with the patient in the sitting position after topical nasal anesthesia was achieved with 4% lidocaine and 0.5% ephedrine spray. A flexible nasopharyngoscope (Olympus ENF, type P3, Lake Success, NY) was inserted through the anesthetized nasal cavity to the lower oropharynx. The collapse of the soft palate level (anteroposterior or lateromedial collapse) and hypopharynx [lateral pharyngeal walls and the base of tongue (BOT)] was assessed during a maximal inspiratory effort against a closed mouth and sealed nose (reverse Valsalva). The nasopharyngoscope was withdrawn to a level which was just cephalad to Passavant's ridge. Collapse of the soft palate (PAL) was again assessed during a maximal inspiratory effort against a closed mouth and sealed nose. The obstruction of the regions that collapsed with the MM, when the patients were awake and in a sitting

Table 1. The results of Müller maneuver (grade I-IV) and number of patients

Müller maneuver grade	n	%
Grade I	33	14.9
Grade II	68	30.8
Grade III	76	34.4
Grade IV	44	19.9

position, was evaluated in a semi-quantitative fashion: no obstruction (0), up to 25% obstruction (1), 50% (2), 75% (3) and 100% obstruction (4).

The MM score was compared with the AHI as a way of exploring the ability of the MM to predict the severity of OSAS, with the hypothesis that a greater degree of anatomical obstruction correlated with a more severe sleep apnea. The AHI is commonly used to classify the severity of sleep apnea into the following categories: An AHI of zero to five indicates that there is no clinically significant sleep apnea; an AHI of five to 20 is considered as mild sleep apnea; an AHI of 20 to 40 is a moderate sleep apnea; and an AHI of 40 is a severe sleep apnea.

We performed the MM on all patients scheduled for sleep PSG, even if not all of them would be offered surgery as a treatment option. The aim was to compare the severity and the level of obstruction in OSAS with MM results.

RESULTS

Two hundred and twenty one patients who had snoring complaints were admitted to our sleep medicine polyclinic for polysomnography in our sleep laboratory. The mean body mass index (BMI) of the study group was 29.41, the mean neck circumference of the patients was 39.14 cm, the mean AHI result was 18.33, the mean MM obstruction severity was 2.59 and the mean EPSS result was 14.14.

The patients who tended to have posterior plicate web had statistically significant higher AHI results than the patients who did not have a web (p=0.03). The web formation did not affect the EPSS scores (p=0.065). Mallampati scores were not correlated with neither the EPSS scores nor the AHI results (p=0.116). Multilevel hypopharyngeal obstructions caused statistically significant higher EPSS scores than the patients who had unilevel obstruction (p=0.036). Hypopharyngeal multilevel obstruction also caused statistically significant higher AHI scores (p=0.023).

Table 2. The number of airway obstructions types (unilevel or multilevel)

	n	%
Unilevel airway obstruction	138	62.4
Multilevel airway obstruction	83	37.6
Total	221	100

Based on the MM, most of the patients [104 (47.1%) of 221] had obstruction at the soft palate level, 33 (14.9%) had hypopharyngeal obstruction and 84 (38%) had obstruction at both levels. It was possible to classify the obstructions into unilevel and multilevel. The results of Müller maneuver (grade I-IV) and number of patients are summarized in Table 1. According to the most recent classification of obstruction types; 138 patients (62.4%) had unilevel and 83 patients (37.6%) had multilevel obstruction (Table 2).

There was no statistical correlation among AHI results and BMI, tonsil size and obstruction severity due to MM (p>0.05). Apnea-hypopnea index results positively correlated with neck circumference and ESS scores (p<0.001). Apnea-hypopnea index results and the MM obstruction severity scores were not correlated (p>0.05). Subjects who tended to have multilevel obstruction had higher AHI results than those who had unilevel obstruction (p=0.021). However, level of obstruction was not correlated with AHI results (p=0.065). The MM scores were positively correlated with the EPSS scores (r=0.213 and p< 0.001). The ESS scores correlated with BMI and neck circumference (p<0.05). The level of the obstruction did not affect the EPSS scores (p=0.235), and the EPSS scores were likewise not affected by unilevel nor multilevel obstruction (p=0.088).

We found no statistically significant correlation between MM scores and AHI results (Table 3). There was a statistically significant correlation between MM and EPSS scores (p=0.016; Table 4).

DISCUSSION

The upper airway collapse during sleep that results in sleep-disordered breathing often occurs at multiple levels and therefore requires multilevel surgical management. The efficacy of surgical treatment for OSAS should be improved with refinement of preoperative assessment techniques that appropriately target the level of surgery to

Table 3. Relation with Müller maneuver scores and apnea hypopnea index results

Müller maneuver score	n	Mean AHI result
1	33	14.43
2	68	17.13
3	76	18.18
4	44	23.4
Total	221	18.33

AHI: Apnea hypopnea index.

Table 4. Relation with Müller maneuver scores and Epworth sleepiness scale results

Müller maneuver score	n	Mean EPSS scores
1	33	12.18
2	68	13.48
3	76	14.38
4	44	16.22
Total	221	14.14

EPSS: Epworth sleepiness scale.

the site of anatomical airway collapse. Numerous methods have been used to predict the location of upper airway obstruction. These methods include physical examinations; manometry, radiography, (including computed tomography, fluoroscopy, cephalometry); and various endoscopic examination procedures, such as MM. An ideal test would be predictive of the site or sites of upper airway resistance and would also be noninvasive, cost-effective, and reproducible. The MM was first described by Borowiecki and Sassin for the preoperative assessment of OSAS patients.[3]

Nasopharyngoscopy with MM (forced inspiration against a closed mouth and occluded nose), not only permits direct observation of the pharynx, but by increasing negative intraluminal pressure, has also been posited to mimic the dynamic changes that are seen in OSAS, and bears a predictive value for the outcome of multilevel OSAS surgery.[5-8] In our study, the preoperative assessments were done to determine the levels of obstruction in the upper airway of OSAS patients. In comparison to AHI results, it seems that theMM is not a reliable technique for predicting OSAS severity, but endoscopic (fiberoptic nasopharyngolaryngoscopy) evaluation of the obstruction levels is helpful for predicting the levels which need surgical treatment. Also MM scores are surprisingly found not to be correlated with AHI results but with ESS scores. Thong et al.[9] found a correlation between the EPSS score and anteroposterior pharyngeal wall collapse at the level of the soft palate during MM in their study (r=0.3, p=0.02). Our result parallels Thong's study; however, we did not focus on the exact level of the obstruction in correlation with the EPSS scores. Perhaps this relation can be explained by the vibrating tissues of OSAS patients causing local and systemic inflammation.[10,11] It has been demonstrated that the MM allows the physician to pinpoint the sites of pharyngeal narrowing, which has been found to be primarily located not only in the rhinopharynx, especially in the retropalatal area, but also in the retrolingual area of the oro-pharynx and the hypopharynx which is the region of minimal collapse.[12,13] Moreover, there are indications that an increase in the AHI (AHI, or the total number of apnea episodes per hour of sleep) is associated with the severity of OSAS.[14]

Methods performed during wakefulness are preferred for their simplicity, but do not provide as much information as those performed during sleep. In previous years, the MM was believed to replicate obstructive events which occurred during sleep and therefore provide a satisfactory assessment of the dynamics of obstruction of the upper airway.[15] The probable reason for the low predictive value of the MM is the attempt to close both airways, nasal and oral, during the maneuver. Another cause for the low predictive value of the MM on OSAS could be the initial airway collapse at its narrowest or most relaxed segment. In addition, the muscular tone of the upper airway differs during wakefulness and sleep.[7] Zonato et al.[16] reported a statistically significant correlation between AHI and BMI ($p<0.000$), which modified Mallampati classification ($p=0.002$). However, in our study we could not find a significant correlation between AHI and BMI, which modified Mallampati scores ($p>0.05$).

In the previous studies the MM was found to have a low predictive value in assessing candidates for uvulopalatopharyngoplasty (UPPP). Because UPPP was the only widely accepted surgical treatment of OSAS, even the hypopharyngeal obstructions were mistreated. However, UPPP is not being used as much as in the past. The new treatment concept is multilevel surgery for the multilevel obstructed OSAS patients. Radiofrequency ablation techniques can also be part of the multilevel approach.[17] These

new surgical approaches lead us to consider this simple technique in preoperative assessments.[18]

Further studies should be done for post operative MM results of the patients who underwent multilevel surgery for OSAS.

In our study we have found that the MM is not a reliable method for predicting the severity of OSAS for preoperative evaluations, but it still might be helpful to define the levels of obstruction. It was also found to be correlated with the EPSS scores. The severity of the MM score is not correlated with o the severity of OSAS, according to AHI results, but it is due to ESS. The correlation with the EPSS and MM scores could be the result of vibrating tissues in OSAS patients, which have been shown to cause local and systemic inflammation. Further prospective studies should be done in this field. The use of the MM in an alert patient may reflect the levels of the obstruction in sleep conditions even though it may be insufficient for determining the severity of OSAS.

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