# The effectiveness of different surgical techniques in the treatment of obstructive sleep apnea syndrome.

## Clinical and polysomnographic outcomes

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**The effectiveness of different surgical techniques in the treatment of obstructive sleep apnea syndrome. Clinical and polysomnographic outcomes**

AIM: *The aim of this study is to emphasiz technique in the treatment ofe the importance of DISE in the* treatment of *OSAS and to evaluate the effectiviness of surgical treatment methods in patients who have undergone OSAS Surgery.*
MATERIAL AND METHODS: *Patients with OSAS were evaluated using preoperative and postoperative Epworth Sleepiness Scale results and preoperative and postoperative sixth month polysomnography (PSG) results. All patients had a DISE preoperatively to assess the upper airway and to decide the surgical approach.*
RESULTS: *There were 44 men (78.6%) and 12 women (21.4%) included in the study. According to the preoperative the Apnea-hypopnea index (AHI), 19 (33.9%) patients were mild OSAS, 19 (33.9%) were severe OSAS and 18 (32.2%) were moderate OSAS. According to the postoperative AHI, 24 (42.9%) patients had only simple snoring. Postoperatively there were 20 (35.7%) mild OSAS, 7 (12.5%) moderate OSAS and (8.9%) severe OSAS detected. When comparing preoperative and postoperative AHI, the greatest decrease was observed in the combined oropharynx and tongue base surgery group.*
CONCLUSIONS: *OSAS is a disease caused by multiple levels of obstruction. The results of this study show a small, statistically significant reduction in the AHI after combined oropharynx and tongue base surgery.*

KEY WORDS: Drug Induced Sleep Endoscopy, Obstructive Sleep Apnea Syndroma, Polysomnography

### Introduction

Obstructive Sleep Apnea Syndroma (OSAS) is the most common form of sleep disordered breathing. This highly prevalant condition is described as repetitive pharyngeal collapse during sleep, leading to fragmanted sleep [1]. If untreated; OSAS causes cerebrovasculer events, cardiovasculer disease, diabetes mellitus and cognitive impairments [2]. Studies showed OSAS increased mortality due to all this causes. Also OSAS is associated with increased motor vehicle accidents caused by excessive sleepiness [3].

The most common risk factors of OSAS include obesity, male sex and advancing age [4]. Patients mostly report snoring, waking up with a choking sensation, witnessed apnoeas and excessive daytime sleepiness [5]. The most useful test for OSAS is polysomnography in a laboratory and primary outcome measure in test is apnoea-hypopnoea index [6].
Continuous Positive Airway Pressure (CPAP) is highly effective treatment. And recomended as most succesfull therapy method. Although CPAP is considered first therapy and highly effective therapy method, some patients refuse or can't tolerate CPAP. And leaving patients and clinicians in search of other effective treatments [7].
Surgical treatments can be recommend in some cases. Surgery for OSAS aim o enlarge and stabilize the upper airway and as mentined before may provide an option for patients in whom conventional medical treatment had failed [8].
However, there have been few randomized trials evaluating the benefits and complications of these surgical

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procedures. Studies mostly have tested surgical approach at a single level of the upper airway and in highly select patients groups were included [9,10]. In this study we aimed to compare the outcomes and to assess the effectiveness of different surgical tecniques with subjective and objective parametres including polysomnography results.

## Material and Methods

### Study Design and Setting

Patients who underwent surgery for OSAS between July 2014 to June 2019 were evaluated with clinical characteristics, preoperative and postoperative Epworth Sleepiness Scale, preoperative and postoperative 6th month polysomnography results. In order to evaluate the recovery results of the patients in the long term, polysomnography test was performed at the 6th postoperative month. Throid function tests and echocardiographic examinations of the patients were evaluated in the preoperative period. All patients had Drug Induceed Sleep Endoscopy (DISE) preoperatively to assess the upper airway and to decide the surgical approach. The drug used during DISE is propofol as it has less side effects. The sleep levels of the patients were followed up with a bispectral index device. In the physical examination, the obstruction levels of the patients were examined with the Muller Maneuver. However, The surgical treatment choice of the patients was evaluated primarily according to DISE findings. The patients underwent nasal, oropharynx and tongue base surgery. Septoplasty, turbinate reduction as nasal surgery; anterior palatoplasty, partial uvulectomy, lateral pharyngoplasty, soft palate radiofrequency, expansion sphincter pharyngoplasty as oropharyngeal surgery; radiofrequency and tongue base excision as tongue base surgery was performed.

### Participants and Eligibility Criteria

The study included 56 patients. The patients older than 18 years of age who diagnosed with OSAS and underwent surgery in Ankara University Department of Otorhinolaryngology were included in the study. All patients had preopertive and postoperative 6th month polysomnography results. All patients data were evaluated retrospectively. Patients whose mediacal information could not be accessed and whose postoperative polysomnography or ESS findings were not available were excluded from the study.

### Polysomnography

All patients had one-night sleep laboratory polysomnographic evaluations in the same settings before and after surgery. Apnea was defined as a ≥ 90% decrease in airflow for ≥ 10 seconds relative to basal amplitude. Hypopnea was defined as a ≥ 50% decrease in the airflow amplitude relative to baseline value lasting ≥ 10 seconds with the presence of arousal or oxygen desaturation of ≥ 4%. Patients with AHIs of ≥ 5 and < 15 were considered to have mild OSAS, those with AHIs of ≥ 15 and < 30 were considered to have moderate OSAS, and those with AHIs of ≥ 30 were considered to have severe OSAS (per American Academy of Sleep Medicine criteria).

### Drug Induceed Sleep Endoscopy

A DISE was performed as a matter routine on each patient in supine position in an operation room by an experienced ENT specialist. Monitored by electrocardiography and pulse oximetry, sleep was induced by slow intravenous titration of small boluses of propofol starting with 0.01 mg per kg body weight. After every 5-10 min, propofol was added until the patient fell asleep deeply enough based on bispectral index monitoring . The endoscope was inserted transnasally and positioned on different levels of the upper airway observing and documenting [1] location (velum including soft palate and tonsils, tongue base, epiglottis) [2], mechanism (anterior-posterior, concentric, laterolateral)[3], intensity (vibration, collapse, collapse and vibration) and [4] time point of obstruction during breathing cycle (inspiration, expiration), applying to every compromise or obstruction of the airway which impaired breathing under sedation.

### Statistically Analysis

The statistical analyses were done with IBM Statistical Package for the Social Sciences software for Mac version 25.0 (IBM SPSS Corp.; Armonk, NY, USA). Results are expressed as numbers and percentages for categorical and as mean +/- standard deviation for quantitative variebles. The distribution of normality of AHI, success rate was evaluated by Kolmogorov- Smirnov Test and it wasobserved that these variables were not normally distrubuted. Preoperative and postoperative AHI comparison for each surgical method was made separately with the Wilcoxon Test. The effect size was found after dividing the square root of the patient number for each surgeon procedure, the z value obtained as a result of the Wilcoxon test. According to Cohenin criteria, the effect size was evaluated as 0.1= small, 0.30 = medium, 0.50 and above as high. The realitionship between the surgical method and the success rates of the surgical method was evaluated with the Kruskall Wallis Test. The realitionship between preoperative AHI and BMI was evaluated by Spearmen correlation analysis. The mean and standard deviations

of preoperative and postoperative AHI were presented seperately for each surgical method. Statistical significance level was identified as 0.05.

### Ethics Committee Approval

Ethics committee approval was received for this study from the Institutional Review Board of Ankara University School of Medicine (Approval Date: September 16, 2020; Approval Number: I8-515-20).

## Results

There were 44 men (78,6%) and 12 women (21,4%). The age of patients ranged from 24 to 73 years, with an average age of 47,5 years. The most presenting symptoms were sleep apnea and snoring in 37 (66%), snoring in 17 (30,4%) and witnessed sleep apnea in 2 (3,6%) cases. The body mass index (BMI) levels ranged from 18.25 to 39.84 (mean 29.63). According to BMI index, 25 (44.6 %) patients were overwight, 25 ( 44.6 %) patients were obese, 5 (8,9 %) patients were normal and 1 (1.8 %) patient was thin. The mean preoperative Epworth Sleepiness Scale was 9,7 and postoperative Epworth Sleepiness Scale was 4,6.

According to the preoperative Apnea-Hypopnea İndixes (AHI), 19 (33.9%) patients were mild followed by 19 (33.9%) were severe, and 18 (32.2%) were moderate OSAS.

According to the postoperative AHI; 24 (42.9%) patients had only simple snoring. Postoperatively there were 20 (35.7%) mild, 7 (12.5%) moderate, 5 (8.9%) severe OSAS detected (Table I).

When to compare preoperative and postoperative AHI, the most decrease was observed in combined oropharynx and tongue base surgery group (Table II).

Nasal and oropharyngeal surgery was performed in 21 patients (37.5%), nasal surgery in 17 (30.4%), oropharyngeal surgery in 8 (14.3%), oropharyngeal-tongue base surgery in 6 (10.7%), and oropharynx, nasal and tongue base surgery in 4 (7.1%) (Fig. 1).

In postoperative AHI, we detected that 77.4% reduction in the patients who underwent oropharynx and tongue base surgery, 75.9 % reduction in those who underwent only oropharynx surgery, 61% reduction in those who underwent oropharynx and nasal surgery, 56.4 % reduction in those who underwent nasal and tongue base surgery and 45.9 % reduction in those who underwent isolated nasal surgery (Fig. 2).

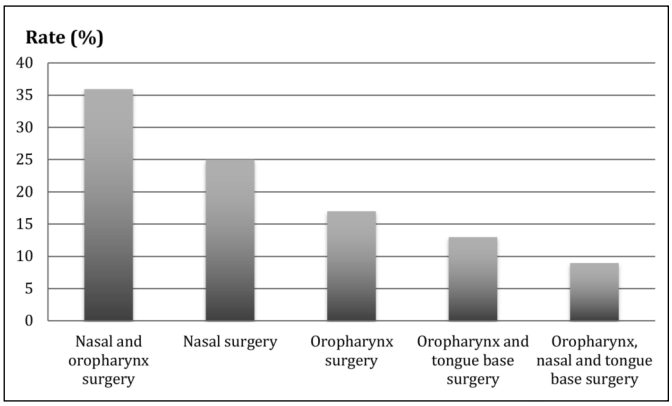


Fig. 1: Surgical Techniques in Treatment of OSAS.

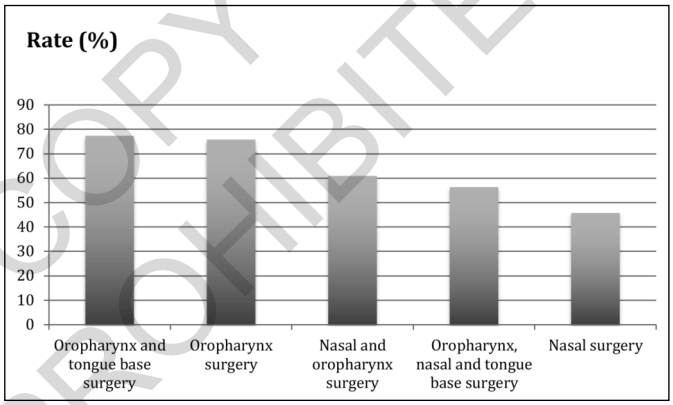


Fig. 2: Reduction rates of apnea hypopnea index after surgery.

## Discussion

OSAS is a chronic and mostly age-related disease. OSAS can be treated with non-surgical and surgical procedures. Treatment options can be listed as follows: weight loss treatment, positional treatment, Continues Positive Airway Pressure, mandibuler advencement splint and surgery treatment [11]. Continues Positive Airway Pressure is the first line and gold standard treatment for OSAS. The American Academy of Sleep Medicine describes CPAP as the standard for the management of mild obstructive sleep apnea [12]. The most important advantage of CPAP therapy is that it may affect all levels in the upper airway. Which will help treatment for patients both with multilevel and single level airway obstruction. The most important disadvantage is that patients having discomfort that made them not to use it regularly. Acceptance of the device and poor compliance with Continues Positive Airway Pressure are the main problems patients had with this therapy. Surgery is an alternative treatement to those patients who can not toleratede Continues Positive Airway Pressure therapy. Among various surgery, palatal surgery is the most common surgical procedures to treat to snoring and OSAS [13]. Different interventions aimed at multiple airway levels have been applied for airway collapse.

In the study, the body mass index (BMI) of 25 patients

TABLE I - *Preoperative and postoperative OSAS classification*

| | Snoring | Light grade OSAS | Mild grade OSAS | Severe grade OSAS |
|---|---|---|---|---|
| Preoperative | 0 | 19 /33.9 % | 18/ 32.2 % | 19/ 33.9% |
| Postoperative | 24/ 42.9 % | 20 / 35.7 % | 7/ 12.5 % | 5 / 8.9% |

TABLE II - *Preoperative and postoperative AHI evaluation according to surgical treatment modalities*

| Surgery Type | N | | Preoperative AHI | Postoperative AHI |
|---|---|---|---|---|
| Oropharynx | 8 | Mean | 40.0875 | 9.7625 |
| | | Median | 40.3500 | 9.4000 |
| | | Std. Deviation | 25.87296 | 7.34379 |
| | | Minimum | 8.10 | 1.60 |
| | | Maximum | 74.00 | 21.10 |
| | | | | p = 0.012 |
| Nasal | 17 | Mean | 21.6765 | 12.8941 |
| | | Median | 17.6000 | 8.4000 |
| | | Std. Deviation | 17.44482 | 17.23269 |
| | | Minimum | .70 | .50 |
| | | Maximum | 68.00 | 65.70 |
| | | | | p = 0.001 |
| Nasal and Oropharynx Surgery | 21 | Mean | 27.5048 | 11.6476 |
| | | Median | 22.3000 | 5.1000 |
| | | Std. Deviation | 25.22280 | 16.93486 |
| | | Minimum | .30 | .00 |
| | | Maximum | 89.20 | 65.00 |
| | | | | p = 0.001 |
| Oropharynx and Tongue base surgery | 6 | Mean | 32.6833 | 6.5167 |
| | | Median | 25.1500 | 1.8000 |
| | | Std. Deviation | 22.46788 | 9.08414 |
| | | Minimum | 13.40 | .00 |
| | | Maximum | 70.00 | 21.60 |
| | | | | p = 0.046 |
| Oropharynx, nasal and tongue base surgery | 4 | Mean | 29.3750 | 14.9750 |
| | | Median | 13.4000 | 6.5000 |
| | | Std. Deviation | 39.38565 | 20.95302 |
| | | Minimum | 2.90 | 1.00 |
| | | Maximum | 87.80 | 45.90 |
| | | | | p = 0.465 |



was 30 and above. 9 of these patients had severe OSAS and did not benefit from CPAP teratment. These patients were first consulted to the endocrine department and dietitian clinic in the preoperative period. Despite this, patients whose complaints did not improve were evaluetad in terms of suitability for surgical treatment.

Thyroid function tests of OSAS patients were evaluated in the preoperative period. Patients with abnormal thyroid function tests were not included in the study and were evaluated for other examinations. There are a number of studies examining the relationship between OSAS, hipothyroidism and thyroid cancers. Throid cancer is the most common endocrine malignancy and its incidince is increasing [14]. Some studies have suggested that OSA is related to the occurrence of malignancies, whereas, others have indicated that it is not significantly related [15].

The mean Epworth sleepiness scale (ESS) of the patients in the study was 9.7 in the preoperatif period. This quastionnare relies on self reported patient symptoms, asking ' How likely are you to doze off or fall asleep?' in a set of 8 hypothetical situatians. This tes has provided mixed results in the detection of OSAS [16]. An ESS score of 10 is most often considered to be the upper limit of normal, though more recent work has shown that a lower score may be associated abnormal daytime sleepiness [17,18].

Although polysomnography is the gold standard for diagnosis of OSAS, it cannot actually detect level and degree of obtruction. It is important to determine causes of obstruction. So, different imaging modalities are used for assessment of patient with OSAS. Computed tomography scan has a role in the assessment of the patients, but it is associated with radiation exposure.

Cephalometry can assess craniofacial abnormalities, but it is limited value in the evaluation of soft tissue structures. Magnetic resonance imaging (MRI) can help for

the determination anatomy of pharyngeal airway and craniofacial abnormalities [19]. Dynamic MRI can obtain rapid images that are temporally spaced a short time apart. It can show dynamic changing of the upper airway, thereby allowing visualition of the changing shape and configuration of the airway during respiration [20]. The major limitations of MR imaging are as follows: long examination time, noisy scanning, claustrophobic effects experienced by many people while in the gantry tube, and high cost. The lack of a comfortable sleep environment also limits the ability to use MR imaging during sleep [21].

Drug induced sleep endoscopy (DISE) was described by Croft and Pringle in 1991 [22]. The level and degree of upper airway obstruction during sleep is evaluated with an endoscope. For this reason, it is thought that it may be useful in the decision of treatment options. The most important factor affecting the success of surgical treatment in OSAS is the correct determination of the obstruction of the obstruction site. The airway can also be evaluated with fiberoptic flexible endoscopy to identify the obstruction site. DISE allows evaluation of the upper airway during sleep with an endoscope. For this reason, it is beneficial in the decision of surgical treatment options [23,24].

Surgeries were done more likely to improve symptoms instead of cure of the disease. Surgical management of snoring and obstructive sleep apnea is indicated when a surgically correctable abnormality is believed to be the source of the problem [13]. Different surgery modalities aimed at multiple airway levels have been applied for airway collaps. Surgeries can be classified as nasal, oropharynx, tongue base surgery and maxillomandibular advancement according to anatomic location of the collaps. Nasal surgeries which we performed mostly are septoplasty, turbinate reduction, functional endoscopic sinüs surgery and nasal valve surgery. Oropharynx surgeries are UPPP, lateral pharyngoplasty, tonsillectomy and expansion sphincter pharyngoplasty. Tongue surgeries are radiofrequency tongue ablation and reduction. Our data indicates surgeries targeting oropharynx and tongue base have to be expected more successful outcomes [25,26].

The most common surgical treatment for OSAS is uvulopalatopharyngoplasty (UPPP), where the aim is to open an stabilize the oropharyngeal and velopharyngeal inlets [27]. Evidence shows that palatal surgery significantly alleviates OSA-related symptoms and reduces the risk of major complications but rarely normalizes AHI [27]. In our study, we saw that the most performed surgical group was UPPP. We haven't seen complications in any patient in the postoperative period and so we believe that patient satisfication and reliability are high. Another major site of upper airway collapse is the posterior tongue. And narrowing at this level is corraleted with apnea- hypopnea index (AHI) in the supine position [26]. Surgery to tongue obstruction appears to improve surgical outcomes in the treatment of OSAS [27,28]. In our study, we found the highest decrease in AHI in patients with combined oropharynx and tongue base surgery. So we think that tongue base surgery should be combined with other surgical procedures in appropriate indicatins. Another type of surgery for airway collapse is nasal surgery. A few studies showed that AHI could be significantly improved postoperatively by isolated nasal surgery [29]. Multiple airway levels, including the nose, have been implicated as possible areas of obstruction leading to downstream airway collaps, thus implicating the nose as a possible site for intervention. İsolated nasal surgery for patients with nasal obstruction and OSAS led to improvements in Epworth Sleepiness Scale and AHI [30]. But in most cases of OSAS airway collapse occurs at multiple levels. So surgeons prefer the multilevel surgery designation within the upper airway. In our study, isolated nasal surgery was performed in 17 (30.4%) patients and postoperative AHI values of these patients decreased. An average of 45.9% decrease in the AHI was detected in those who underwent isolated nasal surgery and it was evaluated statistically significant. However, as many studies, we think that OSAS patients have multiple levels of obstruction in the upper airway.

Apnea-hypopnea index can be considered as the primary criterion in determining the effectiveness of these surgeries performed in patients with OSAS. In our study, we found the highest decrease in AHI in patients with combined oropharynx and tongue base surgery. We also think that isolated nasal surgery significantly reduces the AHI in selected patients. The success rates of surgical methods used in appropriate cases in the literature vary between 41-90 % [31-32].

Another issue will be patient selection for different approaches. As studies showed DISE is an safe and effective method to determine the level of obstruction in upper airway. According to our data all patients who will receive surgery for OSAS needs to get DISE examination either under loca lor general anesthesia. DISE can point out problems that causes apnea and affect our surgical plan.

Usually postoperative PSG were not done routinely but despite lack of symptoms objective evaluation is neccessary to know for certain that patients don't at a risk of OSAS complications anymore.

## Conclusions

The results of this study show a small, statistically significant reduction in the AHI after combined oropharynx and tongue base surgery. Because OSAS is a disease caused by multiple levels of obstruction, combined oropharynx and tongue base surgery may have role in improving OSAS symptoms in appropiate cases. Postoperative evaluation with PSG is crucial and must be done to be sure patients safety and determine effectiveness.

## Riassunto

Lo scopo di questo studio è di sottolineare l'importanza della DISE nel trattamento dell'OSAS e valutare l'efficacia dei metodi di trattamento chirurgico nei pazienti che hanno subito un intervento chirurgico OSAS.
Sono stati valutati 56 pazienti con OSAS utilizzando i risultati della scala di sonnolenza di Epworth preoperatoria e postoperatoria e i risultati della polisonnografia del sesto mese (PSG) preoperatoria e postoperatoria. Tutti i pazienti sono stati sottoposti a DISE prima dell'intervento per valutare le vie aeree superiori e decidere l'approccio chirurgico.
I pazienti inclusi nello studio sono stati 44 uomini (78,6%) e 12 donne (21,4%). Secondo l'indice di apnea-ipopnea (AHI) preoperatorio, 19 (33,9%) pazienti presentavano OSAS lieve, 19 (33,9%) OSAS grave e 18 (32,2%) OSAS moderata. Secondo l'AHI postoperatorio, 24 (42,9%) pazienti avevano solo russamento semplice. Dopo l'intervento sono state rilevate 20 OSAS lievi (35,7%), 7 OSAS moderate (12,5%) e OSAS gravi (8,9%). Confrontando l'AHI preoperatoria e postoperatoria, la diminuzione maggiore è stata osservata nel gruppo di chirurgia combinata dell'orofaringe e della base della lingua.
Conclusioni: L'OSAS è una malattia causata da più livelli di ostruzione. I risultati di questo studio mostrano una piccola riduzione statisticamente significativa dell'AHI dopo chirurgia combinata dell'orofaringe e della base della lingua.


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**Commento e Commentary**

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Ad oggi, la risoluzione terapeutica delle apnee notturne ed il miglioramento della sintomatologia correlata (inclusi i disturbi cardio-circolatori e pneumologici) è un problema aperto in rapporto alla compliance del paziente alle possibile terapie mediche effettuabili. La terapia chirurgica può in questo contesto rappresentare una valida opzione.
La roncochirurgia ha subito una notevole evoluzione grazie ai progressi compiuti nella conoscenza dei meccanismi che portano al collabimento delle alte vie aeree durante il sonno, nella capacità di valutare il grado di severità della sintomatologia e nella diagnostica endoscopica; tutto ciò ha portato allo sviluppo di numerose tecniche chirurgiche che interessano i vari livelli sede di ostruzione. Nonostante esistano numerosi studi che valutano l'efficacia delle singole tecniche, sono limitati gli studi randomizzati che ne analizzano l'approccio combinato. Questo tipo di studi contribuisce alla formulazione di precisi algoritmi decisionali con lo scopo di aiutare nella identificazione dei possibili candidati alla chirurgia e nella selezione delle tecniche chirurgiche da adottare.
L'identificazione della gravità della malattia e delle alterazioni anatomo-funzionali che ne stanno alla base è un presupposto indispensabile per la scelta delle strategie terapeutiche. A tale proposito la Sleep Endoscopy consente di acquisire informazioni indispensabili per la pianificazione chirurgica: il successo della procedura dipende infatti dall'accurata selezione del paziente, dalla versatilità dell'approccio chirurgico e della combinazione di tecniche "tailored" per il singolo paziente.
Sicuramente la durata del follow-up e la a scelta di una valutazione polisonnografica post-operatoria è un punto di forza di questo studio ed uno strumento essenziale per determinare l'efficacia del trattamento; bisogna infatti considerare che i risultati di questa chirurgia sono difficilmente valutabili in quanto i parametri da considerare non sono direttamente correlati con il solo risultato anatomico ottenuto.
Il limite della bassa numerosità campionaria potrebbe comportare conclusioni non generalizzabili alla più ampia popolazione OSAS per cui sono necessarie ulteriori ricerche per confermare questi risultati e per comprendere l'utilità clinica, l'efficacia a lungo termine e la sicurezza della chirurgia multilivello delle vie aeree superiori. Questi risultati tuttavia confermano indubbiamente l'importanza di una corretta valutazione endoscopica pre-operatoria.
Infine, nonostante un confronto tra tecniche chirurgiche sia al momento valido oggetto di studio sarebbe altresì interessante confrontare i risultati in termini di riduzione dell'AHI nei pazienti sottoposti al trattamento chirurgico con i risultati ottenibili in un gruppo di controllo sottoposto a trattamento medico (in particolare con la CPAP), anche in funzione di età e BMI, che sappiamo essere indispensabili determinanti per gli outcome terapeutici.

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*To date, the therapeutic resolution of sleep apnea and the improvement of related symptoms (including cardio-circulatory and pneumological disorders) is an open problem in relation to the patient's compliance with possible medical therapies. Surgical therapy can represent a valid option in this context.*
*Roncosurgery has undergone a notable evolution thanks to the progress made in the knowledge of the mechanisms that lead to the collapse of the upper airways during sleep, in the ability to assess the degree of severity of symptoms and in endoscopic diagnostics; all this has led to the development of numerous surgical techniques that affect the various levels of obstruction. Although there are numerous studies that evaluate the effectiveness of individual techniques, there are limited randomized studies that analyze the combined approach. This type of study contributes to the formulation of precise decision-making algorithms with the aim of helping in the identification of possible candidates for surgery and in the selection of surgical techniques to be adopted.*
*The identification of the severity of the disease and the anatomical-functional alterations underlying is an indispensable prerequisite for the choice of therapeutic strategies. In this regard, the Sleep Endoscopy allows you to acquire essential information for surgical planning: the success of the procedure depends on the careful selection of the patient, the versatility of the surgical approach and the combination of "tailored" techniques for the individual patient.*
*Surely the duration of the follow-up and the choice of a post-operative polysomnographic evaluation is a strength of this study and an essential tool for determining the effectiveness of the treatment; it must in fact be considered that the results of this surgery are difficult to evaluate since the parameters to be considered are not directly correlated with the anatomical result obtained only.*
*The limit of low sample size could lead to conclusions that cannot be generalized to the larger OSAS population and therefore further research is needed to confirm these results and to understand the clinical utility, long-term efficacy and safety of multilevel upper airway surgery. However, these results undoubtedly confirm the importance of a correct pre-operative endoscopic evaluation.*
*Finally, although a comparison between surgical techniques is currently a valid object of study, it would also be interesting to compare the results in terms of AHI reduction in patients undergoing surgical treatment with the results obtainable in a control group undergoing medical treatment (in particular with CPAP), also as a function of age and BMI, which we know are essential determinants for therapeutic outcomes.*