

# THE EFFICACY OF HYOIDOTHYROPEXY IN MANAGEMENT OF MODERATE AND SEVERE OBSTRUCTIVE SLEEP APNEA

By

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## ABSTRACT

**Background:** Snoring and obstructive sleep apnea (OSA) are major and important health problems with increasing rate of recording and achieving more attention. The wide spread availability of polysomnography and sleep lab makes the diagnosis of OSA easier and straight forward. Hyoidothyropexy is a type of skeletal surgeries which considered a part of phase I surgery targeted to the hypopharyngeal area

**Objective:** Evaluation of the efficacy of hyoidothyropexy in patients with moderate and severe Obstructive Sleep Apnea (OSA)

**Material and methods:** Nineteen patients were included in the study after taking their consent. They all underwent full history taking, and clinical examination with measurement of body mass index (BMI). Daytime sleepiness was measured using the Epworth Sleepiness Scale (ESS). The site of obstruction was determined via the upper airway endoscopy and Mueller maneuver and sleep endoscopy. The diagnosis and severity were assessed by overnight sleep study, i.e polysomnography (PSG). Patients were divided into moderate OSA (group A - 8 patients), and severe OSA (group B - 11 patients). Post-operative reevaluation after 6 months was done by ESS and PSG. Preoperative and postoperative data were compared regarding ESS, and overnight sleep study PSG findings; (AHI), (SI), average SpO<sub>2</sub> (%). Also demographic data and BMI were reviewed.

**Results:** The difference between the pre- and postoperative means of AHI, SI, ESS and average SpO<sub>2</sub> % was of statistically significance in both groups. The cure rate in group A and B after hyoidothyropexy was 71.4 % and 61.4% respectively, but the main postoperative AHI was > 10 in group (B).

**Conclusion:** Hyoidothyropexy was an effective method in surgical treatment of moderate OSA with cure rate of 71.4% and significant reduction of AHI. While, in severe OSA it was better to be combined in multilevel surgery because the main AHI remained above 10 in most of the cases.

**Keywords:** Obstructive sleep apnea, hyoidothyropexy, hyoid suspension.

## INTRODUCTION

Obstructive sleep apnea (OSA) is a condition characterized by recurring episodes of increase in upper airway resistance and decreased airflow due to upper airway collapse or narrowing during sleep (*Marin et al., 2005*).

The “gold standard” for the diagnosis of OSA is full polysomnography (PSG), which provides detailed information on sleep state and respiratory and gas exchange abnormalities, in addition to a range of other variables including body position, heart rate and rhythm, and

muscle tone and contraction (*McNicholas, 2008*).

Several procedures may be used to increase upper airway patency or to decrease its collapsibility, anywhere from the nasal cavity down to the hypopharynx, including the neck and the maxillo-mandibular complex. These procedures are often combined as part of a multiple procedures instead of an isolated procedure (*Certal et al., 2013*). These surgical procedures were developed to treat airway obstruction, with one being the hyoid suspension, which addresses hypopharyngeal constriction (*Hormann and Baisch, 2007*).

The present work was a trial to evaluate the efficacy of hyoidthyropexy in treatment of patients with moderate and severe obstructive sleep apnea (OSA).

## MATERIAL AND METHODS

This study was conducted in Bab Al-Shareia University Hospital, during the period from 2013-2015. The total number of the patients encountered in this study was 19 patients after taking their consent. Excluded patients who were with obvious disease in the nose causing obstruction as severe nasal septal deviation, nasal polyposis or nasal mass or those with congenital facial deformity, central sleep apnea, neuromuscular disorder or muscular dystrophies diseases or with a diagnosed level of obstruction away from the retrolingual (hypopharyngeal) area.

Patients with moderate obstructive sleep apnea were collected in group A (8 patients), while 11 patients with severe sleep apnea were collected in group (B).

Any patient complaining from snoring, sleep apnea, and/or sleep disturbance were

subjected to full history taking, complete clinical examination and measurement of body mass index (BMI). It was calculated according to the next formula:  $BMI = \frac{Weight}{Height^2}$ . Patients were classified in relation to their BMI as follows: Underweight: 16.0 to 18.5, normal: 18.5 to 25, overweight: 25 to 30, moderately obese: 30 to 35, severely obese: 35 to 40 and very severely obese: over 40. Endoscopic examination using flexible fiberoptic endoscope, Muller's maneuver and sleep endoscopy were also done. Daytime sleepiness was measured using the epworth sleepiness scale (ESS) (*Johns, 1991*).

The site of obstruction was best determined via the Muller's maneuver and upper airway endoscopy. Upper airway endoscopy was performed to determine the site of OSA while the patient was supine. The Muller's maneuver was performed while the patient was upright with a closed mouth and pinched nose with maximum inspiration.

Overnight sleep was studied by polysomnography to assess apnea/ hypopnea index (AHI), snoring index (SI) and average SpO<sub>2</sub> (%).

The degree of OSA was categorized as either mild (AHI: 5 to 14), moderate (15 to 29), or severe ( $\geq 30$ ). The snoring index (SI) was defined as (total time with snoring  $>90$  dB/estimated total sleep time)  $\times 100$  (*Karatayl? and Demireller, 2012*).

Hyoidthyropexy was done to the patients of both groups to evaluate its efficacy in treating OSA. Reevaluation after 6 months was done for all patients by ESS and PSG.

Statistical analysis of the data: Statistics were done by computer using SPSS data editor Software, version 16.0. The tests used were:

1. X mean, SD standard deviation: to measure the central tendency of data and the distribution of data around the mean.
2. Student's t-test: for testing statistical significant difference between means of two samples.

Data were considered significant when  $p < 0.05$ .

### RESULTS

Eight patients were diagnosed as moderate obstructive sleep apnea in group (A) out of 19 (42%), 3 out of 8 were

females (37.5%) and 5 were males (62.5%) with male to females ratio 1.8: 1. The mean age of patients in this group was 50.5. Their BMI distribution was one with normal weight (12.5%), two with overweight (25%), three with moderately severe obesity (37.5%), one with severe obese (12.5%), and one with very severe obese (12.5%). The BMI Mean  $\pm$  SD was  $32.2 \pm 9.08$ . In group (B), all patients were males. The mean age of patients in this group was  $48.1 \pm 6.25$ . Their BMI was distributed as follow: moderately severe obesity 5 patients (45.5%), one patient with severe obesity (9%), 5 patients with very severe obesity (45.5%). The differences between both groups regarding the age and the BMI were statistically significant (Table 1).

**Table (1):** Mean  $\pm$  SD of the age and BMI of the studied groups.

Parameters Statistics	Age		BMI (kg/m <sup>2</sup> )	
	Group A	Group B	Group A	Group B
MEAN $\pm$ SD	48.1 $\pm$ 6.25	50.5 $\pm$ 5.31	38.6 $\pm$ 3.2	32.2 $\pm$ 9.08
t test	41.083		11.063	
P value	0.15		0.05	

In group (A), one patient (12.5%) was considered not sleepy, 2 patients (25%) were considered sleepy and 5 patients (62.5%) were considered very sleepy. The Mean  $\pm$  SD of ESS was  $18 \pm 7.03$ . AHI Mean  $\pm$  SD was  $23.05 \pm 4.98$ . Snoring index Mean  $\pm$  SD was  $29.1 \pm 6.6$ , while the average SpO<sub>2</sub> (%) Mean  $\pm$  SD was  $88.1 \pm 6.2$ . Postoperatively, ESS Mean  $\pm$  SD was  $4.6 \pm 3.24$ , and all patients considered not sleepy. The Mean  $\pm$  SD of AHI changed to  $6.6 \pm 5.52$ . Also, the Mean  $\pm$  SD of snoring index changed to  $3.4 \pm 0.69$ . The Mean  $\pm$  SD of average SpO<sub>2</sub> (%) postoperatively was  $95 \pm 1.19$ .

In group (B), 4 patients (36.3%) were sleepy and 7 patients (63.7%) were very sleepy with Mean  $\pm$  SD of  $19.7 \pm 3.2$ . The Mean  $\pm$  SD of AHI was  $42 \pm 6.1$ . Snoring index Mean  $\pm$  SD was  $18.2 \pm 2.5$ , while the Mean  $\pm$  SD of average SpO<sub>2</sub> (%) was  $89.4 \pm 4.3$ . Postoperatively, ESS Mean  $\pm$  SD was  $11.2 \pm 2.7$ , and 3 patients (27.2%) considered not sleepy and 8 patients (72.8%) was sleepy. The Mean  $\pm$  SD of AHI was  $16.2 \pm 5.2$ . Also, the Mean  $\pm$  SD of snoring index changed to  $7.4 \pm 2.2$ . The Mean  $\pm$  SD of average SpO<sub>2</sub> (%) was  $95.8 \pm 1.4$ .

Regarding the complications, 2 cases (very severe obese) developed neck seroma which resolved within 3 weeks

after the surgery. Also, postoperative dysphagia developed in one case and resolved within 2 days.

**Table (2):** Mean  $\pm$  SD of preoperative and postoperative findings in studied groups.

Parameters Statistics	ESS				AHI				SI				Average SpO2 (%)			
	A		B		A		B		A		B		A		B	
	PREOP	POSTOP	PREOP	POSTOP	PREOP	POSTOP	PREOP	POSTOP	PREOP	POSTOP	PREOP	POSTOP	PREOP	POSTOP	PREOP	POSTOP
M $\pm$ SD	18 $\pm$ 7.03	4.6 $\pm$ 3.24	19.7 $\pm$ 3.2	11.2 $\pm$ 2.7	23.05 $\pm$ 4.98	6.6 $\pm$ 5.5	42 $\pm$ 6.1	16.2 $\pm$ 5.2	29.1 $\pm$ 6.6	3.4 $\pm$ 0.69	18.2 $\pm$ 2.5	7.4 $\pm$ 2.2	88.1 $\pm$ 6.28	95 $\pm$ 1.19	89. $\pm$ 4.36	95.8 $\pm$ 1.43
t test	6.409		7.223		7.742		14.780		4.002		7.684		2.778		4.336	
P value	0.004		0.001		0.001		0.003		0.005		0.001		0.027		0.001	

## DISCUSSION

Surgical treatments for OSA aimed to relieve the obstruction by increasing the surface area of the airway to bypass the pharyngeal airway, or to remove a specific pathological lesion (*Sundaram et al., 2005*).

The goal of skeletal surgery for the treatment of OSA is to alleviate pharyngeal obstruction by moving osseous structures forward and thereby advancing attached soft tissue structures to improve the airway during sleep. This skeletal expansion targets the retrolingual space of the pharynx (*Meslemani and Lamont, 2011*).

In this study, males were more frequently affected by OSA. In group A, 62.5% of the patients were males with male to female ratio 1.8: 1, while in group B all patients were males. The mean age of patients in group (A) and (B) was 50.5 and 48.1 respectively.

The Wisconsin sleep cohort study determined the prevalence of sleep apnea among middle-aged women as 9% and among men 24% (*Lee et al., 2008*). Also, *Canzi et al. (2013)* found a higher rate of

OSA among men. The mean of the age of their patients was 50.7. *Chung et al. (2008)* estimated the incidence of moderately OSA as 11.4% and 4.7% of men and women respectively.

The difference in incidence of moderate and severe OSA between the current study and the previously mentioned studies could be explained by the fact that this incidence is measured over the surgical population which is usually different from the general population.

Obesity with all its degree is highly frequent among the patients within the current study. The mean BMI of both groups elevated and the difference between both groups regarding the BMI was statistically significant. These findings explained why obesity was considered as an important general risk factor for OSA.

Apart from a significant male gender predominance, an elevated AHI is significantly associated with age is which is also more prevalent in obese individuals (*Chung et al., 2008*).

*Jaradat and Rahhal (2015)* found that obesity is intimately associated with OSA. The majority of obese patients have some

degree of OSA, and the majority of patients with OSA are obese. Increasing BMI, neck circumference and waist to-hip ratio are all associated with increased prevalence of OSA. So a body mass index (BMI) over 25 and/or a neck size over 16 inches puts an individual at risk for sleep apnea. Also, *Chung et al. (2008)* found that AHI is significantly more prevalent in obese individuals. *Young et al. (2005)* found that logistic regression points to BMI as the strongest independently significant predictor of having OSA in older adults.

In the current study, pathological ESS was estimated as 87.5% in group (A) with mean of 18, while in group (B) all patients were suffering from hypersomnolence with ESS mean of 19.7. Postoperatively, ESS in group (A) and (B) changed to 4.6 and 11.2 respectively which were of high statistical significant value. All patients of group (A) considered not sleepy, while in group (B) only 27.2% considered not sleepy. These findings are consistent with that obtained by *Baisch et al. (2006)* and *Canzi et al. (2013)*.

In the present work, the mean AHI in group (A) before the surgery was 23.05 which changed to 6.6 postoperatively. This improvement (71.4%) was considered as significant surgical success because the improvement was above 50% (objective index of success), and the main AHI was < 10. In group (B), the mean of AHI before the surgery was 42 which changed to 16.2 postoperatively. This improvement (61.4%) cannot be considered as significant surgical success because the main postoperative AHI was > 10. *Sher et al. (1996)* stated that success defined as 50% improvement in respira-

tory disturbance index (RDI) to a final absolute value below 20, or the apnea index (AI) to below 10.

The results of the current study were consistence with that obtained by *Baisch et al. (2006)* who have achieved a success rate of 59.7% in their patients. However, *Bowden et al., (2005)* concluded that hyoid suspension does not provide results equivalent to those reported for genioglossus advancement or multiseession tongue radiofrequency. A lower success rate is documented by *Murat (2010)* who concludes that hyoid myotomy and suspension success rates are low when used alone, roughly 50%.

The variation in AHI results between these publications and the results of the current work may be attributed to a number of factors such as the difference in the interpretation of the observations as well as individual variability of a single-night recording of polysomnography, scoring variability between polysomnography technologists and sleep laboratories due to different scoring criteria.

In the current study, the average SpO<sub>2</sub> (%) significantly increased postoperatively in group (A), and group (B). This is consistence with the study of *Baisch et al. (2006)*.

In this study, the mean of snoring index preoperatively in group (A) was 29.1 which decreased significantly in postoperative period to 3.4, while in group (B), the mean of snoring index pre and postoperatively were 18.2 and 7.4 respectively. The difference between the snoring index pre and postoperatively was of statistical significance. The rate of reduction of snoring index in group (A) was 88.3 % while that of group (B) was

59.3%. In both groups there were great associations between the increase of snoring index and the severity of OSA as assessed by AHI.

This observation corresponds to the data obtained by *Wilson et al. 1999*. A very significant difference was noted between snoring index in patients with and without sleep apnea. BMI and gender were significantly related to all sound intensity levels. The BMI had a positive significant association with snoring sound intensity levels. Men have significantly louder snorers than women. The relationship between snoring sound intensity levels and the BMI was statistically significant after controlling for gender.

*Maimon and Hanly (2010)* recorded snoring in a large series of patients submitted to polysomnography. They stated that the mean snoring intensity increased linearly with the severity of OSA. Snoring was louder in men than women, in patients with BMI >30 kg/m<sup>2</sup>, neck circumference >40 cm, and while in the supine position and during non-REM sleep stage (*Oliveira et al., 2011*).

## CONCLUSION

Hyoidthyropexy (hyoid suspension) was an effective method in surgical treatment of moderate OSA with a cure rate of 71.4% and significant reduction of AHI, while in severe OSA it was better to be combined in multilevel surgery because the main AHI remained above 10 in most of the cases. Patients with severe OSA have an incomplete cure if they were treated by this technique especially those with high BMI. It may be due to the presence of hidden multilevel obstruction

in such patients. They should be treated with hyoidthyropexy as a part of multilevel procedures. Surgical treatment options should be individualized and should specifically target the areas of obstruction that present in each patient.

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### محمد عبد الرحمن شمس الدين

قسم الأذن و الأتف والحنجرة - كلية طب الأزهر

**خلفية البحث:** يعتبر الشخير وتوقف التنفس أثناء النوم مشكلة صحية كبيرة وخطيرة واسعة الإنتشار وتستحق المزيد من الإهتمام. كما أن توافر دراسة النوم و مختبرات النوم تجعل تشخيص توقف التنفس أثناء النوم أكثر سهولة. وتعتبر جراحة تثبيت العظم اللامي مع الغضروف الدرقي نوع من العمليات الجراحية التي تستهدف منطقة البلعوم السفلي التي تستخدم في علاج هذا المرض.

**الهدف من البحث:** تقييم فعالية جراحة تثبيت العظم اللامي مع الغضروف الدرقي في المرضى الذين يعانون من إنقطاع النفس الإنسدادي المتوسط والشديد أثناء النوم.

**المرضى وطرق البحث:** تم إدراج المرضى في الدراسة بعد أخذ الموافقة علي إدراجهم في البحث. و قد تم أخذ التاريخ المرضي والفحص السريري الكامل وقياس مؤشر كتلة الجسم . و قد تم قياس قابلية النعاس خلال النهار بإستخدام مقياس إبورث. و تم تحديد موقع الإنسداد عن طريق منظار المجرى الهواء العلوي و إجراء مولر و منظار مجرى الهواء العلوي أثناء النوم . (مع استبعاد المرضى الذين لا يعانون من إنسداد في منطقة ما خلف اللسان ومنطقة البلعوم السفلي). وقد تم التشخيص و تقييم شدة المرض عن طريق دراسة النوم. و تم ذلك في المرضى الذين يعانون من توقف التنفس المتوسط أثناء النوم في مجموعة أ (8 مرضي) و المرضى الذين يعانون من توقف التنفس الشديد في مجموعة ب (11 مريضاً). وقد تم تقييم المرضى بعد 6 أشهر ومقارنة نتائج قياس قابلية النعاس خلال النهار بإستخدام مقياس إبورث و مؤشر توقف التنفس ، ومؤشر الشخير، ومتوسط نسبة تشبع الأكسجين قبل الجراحة وبعده العملية الجراحية، كما تم إستعراض البيانات الديموجرافية للمرضى ومؤشر كتلة الجسم ثم قياس العلاقات الإحصائية بين النتائج.

**النتائج:** لوحظ إنخفاض متوسط قياس قابلية النعاس خلال النهار بإستخدام مقياس إبورث في مرضي المجموعة (أ) بعد الجراحة. كما إنخفض متوسط مؤشر توقف التنفس ، ومؤشر الشخير، ومتوسط نسبة تشبع الأكسجين بعد الجراحة . كما لوحظ إنخفاض متوسط قياس قابلية النعاس خلال النهار بإستخدام مقياس إبورث في مرضي المجموعة (ب) بعد العمل الجراحي. و قد وجد أن متوسط مؤشر توقف التنفس ومؤشر الشخير ومتوسط نسبة تشبع الأكسجين قد إنخفض بعد العمل الجراحي و كان الفارق بين هذه النتائج في ما قبل وما بعد التدخل الجراحي ذو درجة عالية من الدلالة الإحصائية في كلا المجموعتين. و كان معدل الشفاء في المجموعة (أ) و (ب) بعد جراحة تثبيت العظم اللامي مع الغضروف الدرقي 71.4 % و 61.4% على التوالي ، ولكن وجد أن متوسط مؤشر توقف التنفس بعد الجراحة مازال أعلي من 10 في المجموعة (ب).

**الاستنتاج:** جراحة تثبيت العظم اللامي مع الغضروف الدرقي في المرضى الذين يعانون من الإنقطاع الإنسدادي المتوسط للنفس أثناء النوم بسبب وجود إنسداد في منطقه ما خلف اللسان ومنطقة البلعوم السفلي هي طريقة فعالة في العلاج مع نسبة شفاء تصل إلى 71.4%. وإنخفاض كبير في متوسط مؤشر توقف التنفس بعد الجراحة، بينما في المرضى الذين يعانون من الإنقطاع الإنسدادي الشديد للنفس أثناء النوم فمن الأفضل إستخدام جراحة تثبيت العظم اللامي مع الغضروف الدرقي كجزء من جراحة متعددة المستويات حيث إن متوسط مؤشر توقف التنفس بعد الجراحة مازال أعلي من 10 في معظم الحالات.