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Original Article

Predictors of uvulopalatopharyngoplasty success in the treatment of obstructive sleep apnea syndrome

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ABSTRACT

Objective: Uvulopalatopharyngoplasty (UPPP) has been described as an option for treating obstructive sleep apnea syndrome (OSAS), with variable success rates. The main purpose of our study was to correlate UPPP success to craniofacial bony structure and orofacial muscles function.
Methods: Clinical variables, including body mass index (BMI), age, and preoperative apnea-hypopnea index (AHI); cephalometric measurements of the craniofacial region and hyoid bone position; and muscle function variables including clinical protocol and tongue strength measures were evaluated in 54 patients who underwent UPPP in the last 7 years. The measurements were related to the success or failure of UPPP based on the results of preoperative and postoperative polysomnography (PSG).
Results: The variables BMI, preoperative AHI, and cephalometric measurements showed no influence on surgical success. The clinical muscle protocol also was similar between groups. However, the muscle strength of the anterior portion of the tongue was significantly greater in the group that showed surgical success compared to those with surgical failure.
Conclusion: OSAS is a multifactorial disease and diagnostic symptom assessments should be individualized. In addition, special attention should be given to functional muscle alterations of the airways, as they might influence the evolution of the disease.

1. Introduction

Obstructive sleep apnea syndrome (OSAS) is characterized by recurrent episodes of airway obstruction during sleep, which usually is associated with sleep fragmentation and decreased oxygen saturation [1]. Clinical diagnosis associated with ancillary tests characterizes OSAS [2]. Currently polysomnography (PSG) is the gold standard to diagnose OSAS and to stratify its degree of severity [1]. Adult patients are diagnosed as having OSAS when there are more than 5 apneas or hypopneas per hour of sleep associated with symptoms of daytime sleepiness [1].

Several medical and surgical treatments have been reported to treat OSAS, with variable rates of success. Among medical options, the most established treatment is continuous positive airway pressure; other reported medical treatments are weight loss, positional treatment, avoidance of alcohol and neural system depressor substances, and intraoral devices. Reported surgical treatments include maxillomandibular advancement nasal surgeries, genioglossus and hyoid advancements, palatal procedures (i.e., uvulopalatopharyngoplasty [UPPP]), and tongue reduction surgeries.

UPPP has been widely used as a surgical treatment of OSAS since it was first described by Fujita et al. [3] in 1981, with clinical improvement evidently reported by both patients and otolaryngologists. Because clinical improvement is important, this treatment became the most practiced procedure performed by ear, nose, and throat surgeons. The most commonly observed side effects for this surgery are difficulty in swallowing, nasal regurgitation, and taste and voice disturbances [4]. Life-threatening complications have been reported in 1–2% of UPPP procedures [5,6]. Additionally objective analyses using PSG have shown that the overall rate of success after the procedures is 40.7% [7] and today UPPP is becoming progressively less indicated [6]. One possible explanation is the existence of multiple sites of airway collapse hindering

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the treatment of the disease, especially in the surgically treated one [8].

Several factors have been reported to influence the success of UPPP, including the body mass index (BMI), the severity of apnea, and the anatomy of the oropharyngeal region encompassing soft tissue characteristics and deformities in the facial bone structure. It is now known that some characteristics, such as skeletal disorders, morbid obesity, and severe change on soft tissue in the oropharyngeal region are related to a poor prognosis [2]. Friedman et al. [9] correlated UPPP findings with those of physical examination and concluded that cranial and skeletal disorders and morbid obesity (BMI $\geqslant$ 40 kg/m^2) are indicative of a poor prognosis for surgical procedures exclusively involving soft tissue. Those two factors currently are considered specific contraindications for UPPP. However, there have been few studies correlating a poor prognosis of UPPP with nonsyndromic skeletal or orofacial muscle changes.

Millman et al. [10] reported a UPPP success rate of 27% and 50%, respectively, in patients with and without micrognathia based on lateral cephalometry. However, Rintala et al. [11] found no correlation between micrognathia and the rate of UPPP success. Millman et al. [10] also correlated UPPP success with the distance from the hyoid bone to the mandibular plane and reported that the rate reached up to 70% in patients in whom the distance was less than 20 mm, which significantly contrasts with the success rate of 20.6% in those in whom the distance was greater than 20 mm.

The test of choice for the evaluation of the bone structures in OSAS patients is cephalometry [11,12], as it establishes the standards for values such as the linear and angular measures of facial bones, facial patterns, position of the hyoid bone, tongue base dimensions, and posterior airway measures [9,13]. Cephalometry is easy to perform, has good reproducibility, uses low-dose radiation, and is a low-cost procedure. Therefore, it is indicated in patients with apnea, as it provides information that helps to define the most appropriate treatment strategy for each patient [12,14]. Airway collapsibility in OSAS also could be related to the alteration of muscle tones during sleep, especially of the dilator muscles of the pharynx [15]. Disturbances in the activity of dilator muscles, especially the genioglossus and tensor palatine muscles, could represent a marker of OSAS [15,16].

After evaluating measurements of muscle activity of the dilator muscles of the pharynx in apneic patients, Mezzanotte et al. [17] suggested that the neuromuscular mechanism plays an important role in airway collapsibility during sleep. In addition, Guimarães et al. [18] demonstrated an improvement in the results of apnea-hypopnea index (AHI) after 3 months of myofunctional therapy, which underscores the importance of the orofacial muscles in OSAS. However, there is little evidence regarding the correlation between predictors of success of palatal surgery and pharyngeal dilator muscle activity. Therefore, the aim of our study was to determine if the success of UPPP is related to changes in orofacial muscles or in cephalometric measurements in nonobese patients.

2. Materials and methods

The study was approved by the Research Ethics Committee of the Clinics Hospital of School of Medicine of Ribeirão Preto, University of São Paulo, Brazil (Process No. 1235/2010). In accordance with the outpatient clinical protocol, all patients with sleep-disordered breathing underwent PSG and were clinically evaluated by a multidisciplinary team, including an otolaryngologist and a neurologist prior to being considered candidates for UPPP. As part of the routine evaluation, all of the patients underwent anthropometric assessment, physical examination, and fiber optic endoscopy added by Müller maneuver. Patients considered adequate candidates for UPPP were those with Friedman stage I or II [9], no craniofacial abnormalities, a BMI less than 40 kg/m^2, and tonsils graded 2–4.

All the UPPP procedures were performed by a resident student and were always assisted by only two senior professors (FCPV and DSK). The technique was systemized between the professors and included tonsillectomy, a lateral incision in superior and lateral border of the palatoglossus muscle, followed by suture between the palatoglossus and palatopharyngeal muscles. Partial uvulectomy was performed with cautery followed by suturing of its borders.

From all the patients who underwent UPPP for the treatment of OSAS in the last 7 years, 54 were included in the study because their medical records were complete. These patients were then invited to participate in our study by mail or by telephone. The anthropometric data (e.g., BMI, Friedman stage) and preoperative AHI were obtained from the medical records.

2.1. Polysomnographic evaluation

The patients underwent PSG examinations, and all of the PSGs, both prior and after the surgical procedure, were nocturnal and were performed in the Sleep Laboratory within the hospital using BioLogic equipment (BioLogic Vision, Inc. Natus, San Carlos, CA, USA) from the Neurophysiology Department. Parameters were acquired, including electroencephalogram, electrocardiogram, electrooculogram, chin and inferior limbs electromiogram, pulse oximeter, thoracic and abdominal effort register, and oronasal flow. All of the technical parameters used were in accordance with the 2007 *American Academy of Sleep Medicine Manual*, using 4B criteria to diagnose respiratory events (i.e., if there was a drop of >50% of baseline nasal pressure excursions lasting more than 10 s or associated to a >3% desaturation from pre-event baseline, or if the event was associated with arousal) [19]. The neurologists responsible for scoring the PSGs were aware if the examinations were performed before or after the operation. The period between the preoperative PSG and the surgery was an average of 3 months. The mean period between surgery and postoperative PSG was 18.7 months.

Pre- and postoperative PSG results were compared to determine surgical success. Only patients who presented a reduction greater than 50% in the AHI and also a postoperative AHI lower than 5 were considered in the UPPP success group (group 1), whereas those who did not meet these criteria were collectively designated the UPPP failure group (group 2). The professionals responsible for the myofunctional and cephalometric assessments (a speech-language pathologist and an orthodontist, respectively) were blinded to the group assignments. These two evaluations were only performed at the postoperative evaluation on an average of 18 months after surgery.

2.2. Myofunctional assessment

Initially the patients were clinically assessed with the orofacial myofunctional evaluation with scores protocol proposed by Felício and Ferreira [20]. This protocol was recently validated [21] and highlights facial symmetry, appearance or posture and mobility of the lips, tongue, cheeks, and soft palate, as well as respiration, mastication, and deglutition.

After clinical evaluation, all of the patients were evaluated for maximal isometric tongue strength (MITS) [22] using a dynamometer (force transducer) model DDK/M (Kratos Equipamentos Industriais, São Paulo, Brazil), as shown in Fig. 1A–C. The results were recorded in kilogram-force and were converted to N (International System of Units): 1 kilogram-force = 9.8066 N. This examination was recently validated [23]. The MITS was determined for two