


Long-term results of a modified expansion sphincter pharyngoplasty for sleep-disordered breathing

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Received: 27 July 2016 / Accepted: 18 November 2016 / Published online: 1 December 2016
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Abstract Our aim was to evaluate the long-term objective and subjective results of a modified expansion sphincter pharyngoplasty (ESP) technique in patients with sleep-disordered breathing. Single center prospective study of 35 patients underwent an ESP as a primary surgical treatment between June 2012 and September 2015 at the hospital AZ Sint-Jan Bruges-Ostend. Patients were divided into non-OSAS and OSAS (AHI >5). Primary outcome parameters were the Epworth Sleeping Scale (ESS, reduction and score less than 10) and the Visual Analogue Score of snoring (VAS, assessed by partner) evaluated at 3 months and 1 year. In addition, the OSAS group underwent a polysomnography after 6 months to calculate the Apneu-Hypopneu Index (AHI) change. Secondary outcome parameters were possible complications and morbidity rate. The overall Epworth Sleepiness Scale showed a steady total reduction of, respectively, 42 and 48% at the two timepoints. All patients had a post-operative score of less than ten points. The Visual Analogue Score improved in 92% of the patients; of these, the snoring was reduced in 86% and disappeared in 6%. In the OSAS group, we noticed a reduction in AHI of more than 50 in 53% of the patients. A considerable reduction was found in the severe OSAS group, where we found a mean pre-operative average AHI of 41.3/h that was reduced 6 months after the operation to 17.4/h. There were no severe complications or increased morbidity rate observed. This first long-term study shows that the modified ESP seems to be a safe and promising technique in palatal surgery for patients with sleep-disordered breathing. Surgical effectiveness is

sustained after 1 year, both in OSAS as in snoring pathology. The technique seems as approachable for the basic ENT surgeon as the uvulopalatopharyngoplasty.

Keywords Sleep-disordered breathing · Obstructive sleep apnea · Surgical treatment · Expansion pharyngoplasty · Uvulopalatopharyngoplasty

Introduction

Sleep-disordered breathing (SDB) is a wide clinical identity that can range from socially disruptive snoring to severe obstructive sleep apnea syndrome (OSAS), associated with cardiovascular and metabolic health risks as well as cognitive impairment. Given the increased prevalence of SDB, owing to the increased prevalence of obesity, SDB has become a growing medical, social, and economic problem [1–3].

There is an ongoing development of different treatment options for sleep-disordered breathing, including surgery. Surgical treatment modifies the upper airway depending on the site of vibration and collapse. The uvulopalatopharyngoplasty (UPPP) first described in the early 1950s by Dr Ikematsu for snoring and in 1981 by Fujita for OSAS remains the most performed technique if the site of obstruction is located at the soft palate. However, long-term results are even in experienced hands often discouraging. In a sophisticated volumetric analysis of the upper airway soft-tissue structures with magnetic resonance imaging between control and OSAS patients, Schwab et al. found a significantly increased risk of sleep apnea in case of larger volume of the tongue, lateral pharyngeal walls, and total soft tissue [4].

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Taking into account the import role of the lateral pharyngeal wall and, more precisely, the increased collapsibility in patient with SDB, and Pang and Woodsen introduced the ESP as a promising new palatal technique [4, 5].

The aim of this article is first to look at the efficiency of the modified ESP in all types of SDB, including snoring, daytime somnolence, and OSAS. Second, we evaluate the long-term results of objective as well as subjective parameters, the morbidity, and complications.

Materials and methods

We performed a prospective study between June 2012 and September 2015 at the department of Otorhinolaryngology, Head and Neck Surgery of the Sint-Jan Hospital in Bruges.

All patients with sleep-disordered breathing underwent a standard basic clinical examination with evaluation of the general parameters (BMI), nasal cavity and nasopharynx (septal deviation, turbinate hypertrophy, nasal polyps, adenoid hypertrophy), oral cavity, and oropharynx (webbing, uvula size, tonsil size, malampati, macroglossia, retrognathia, lateral pharyngeal wall), hypopharynx and larynx (post-epiglottis space, pre-epiglottis space, Muller's maneuver). The impact of the SDB on the quality of life was evaluated with the Epworth Sleepiness Scale (ESS) and Visual Analogue Score (VAS).

Second, a polysomnography was performed to rule out OSAS. Patients who met the criteria for CPAP convention (AHI >20/h), were first encouraged to try CPAP. Patients without OSAS or intolerance for CPAP underwent an evaluation by a DISE to reveal the site of vibration and collapse. Only when these examinations revealed retro-palatal collapse, superior lateral pharyngeal collapse and redundant pharyngeal tissues, palatal surgery was indicated. Patients with multilevel pathology and the need for multilevel surgery were excluded from this study. In case of a significant reduction in vibration and collapse by chin-lift during DISE, preferably maxillo-mandibular advancement (MMA) or osteotomies were recommended.

After the operation, all patients were seen at a post-operative meeting 1 and 3 weeks and 3 months after the operation. At the last consultation, a complete clinical examination, including Muller's maneuver, was performed and the effect of the operation was measured with the ESS and VAS score. All patients with an AHI >5/h underwent a polysomnography 6 months after the procedure. By telephone contact, the ESS and VAS were evaluated 1 year after the surgery.

We only included those patients without previous surgery, no combined surgical techniques and those with a follow-up of more than 1 year. In total, 35 patients were

included. There were 29 men and 6 females with a mean age of 45.46 years and a mean BMI of 28.94 kg/cm².

Surgical technique

The procedure is performed under general anesthesia with the patient in supine position and the head in hyperextension. A Mueller Davis mouth gag is used to expose the oropharynx. The operation starts with a bilateral tonsillectomy by unipolar and bipolar cauterization when tonsils are still present. By doing this, it is important to leave as much as possible of the muscle fibers in situ (Fig. 1). Afterwards, the m. palatopharyngeus on both sites is dissected, with care taken to leave enough of its attachments posteriorly (Fig. 2). After horizontal transection of this muscle inferiorly, a tunnel is made from the apex of the fossa tonsillar to the hamulus pterygoideus by blunt dissection (Fig. 3). The m. palatopharyngeus is rotated and lifted anterolatero-superiorly with fixation of its inferior muscle bulk to the hamulus by Vicryl 2-0 (Fig. 4). By rotating and leaving part of the fibrous attachment to the superior pharyngeal constrictor muscle, an adequate tensions, anterior replacement of the soft palate, and thereby a three-dimensional widening of the retro-palatal lumen are created. The last step is a closure with Vicryl 2-0 of the anterior and posterior tonsillar pillars.

In contrast with Pang, a complete or partial uvulectomy is not routinely performed but only in patients with a long (>1.5 cm) or large (>1 cm) uvula. We do not make superolateral incisions on the soft palate and thereby do not attach the m. palatopharyngeus to the arching fibers of the soft palate. In contrast by blunt dissection, our m. palatopharyngeus is attached at the hamulus pterygoideus, such as described in the Functional Expansion Pharyngoplasty by Sorrenti [6].

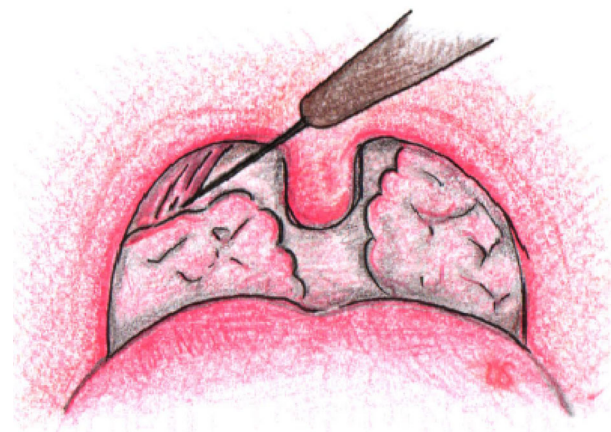


Fig. 1 Tonsillectomy

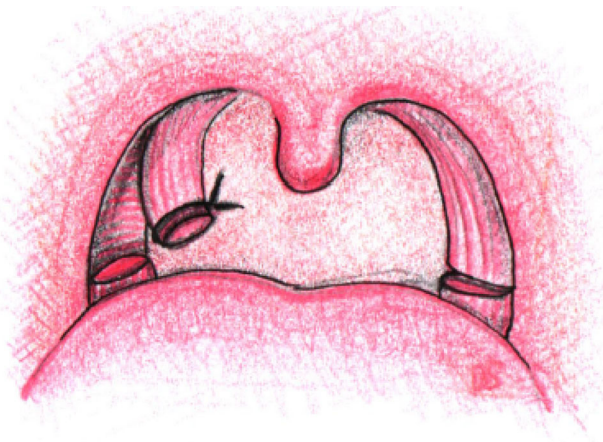


Fig. 2 Dissection m. palatopharyngeus

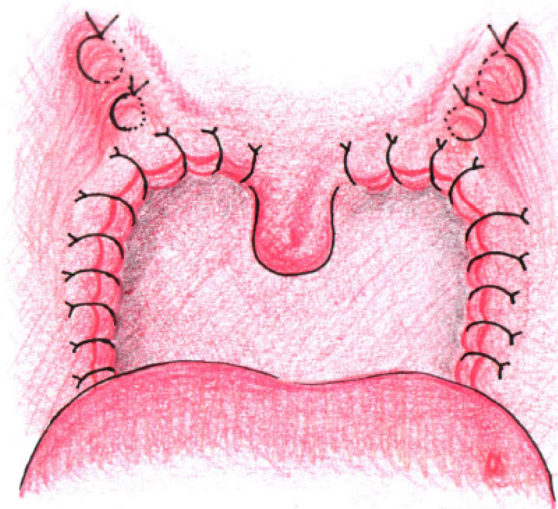


Fig. 4 Rotation and fixation of m. palatopharyngeus to hamulus. Closure of the anterior and posterior tonsillar pillars

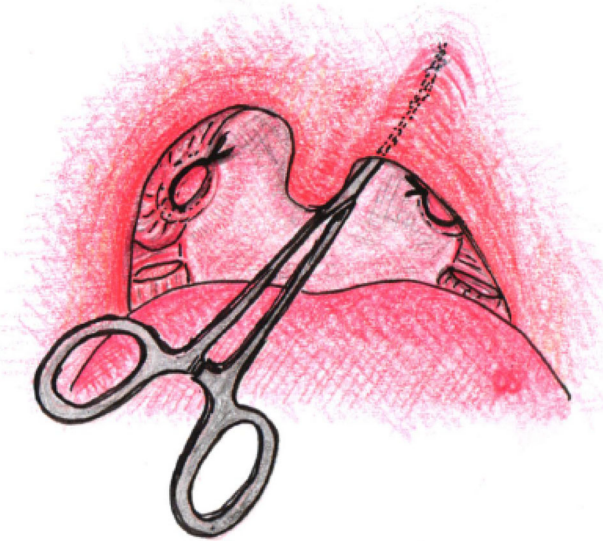


Fig. 3 Tunnel from apex fossa tonsilaris to hamulus pterygoideus

All patients stayed overnight and most patients could be discharged on the first post-operative day. They were giving adequate analgesia (Paracetamol, NSAID, Tramadol), prophylactic systemic broad spectrum antibiotics for 1 week, methylprednisolone (reduction schedule for 15 days, 5 days 32 mg, 5 days 16 mg, and 5 days 8 mg), and local antiseptic mouth gargle. We advised all patients to consume adequate cold oral fluid hydration and a soft diet in the first week.

Results

The 35 enrolled patients were divided into two groups. Patients with an AHI <5/h (simple snoring, daytime somnolence) were classified as non-OSAS ($n = 16$), the other as OSAS ($n = 19$). The last group was further subdivided

into mild (AHI 5–15/h), moderate (AHI 15–30/h), and severe (AHI >30/h).

Our primary outcome parameter was the ESS (Fig. 5), which showed a stable total reduction of, respectively, 42 and 48% at the two time points. In the non-OSAS group, the mean pre-operative score was 10.44 points which diminished to, respectively, 6.31 and 4.69 points at 3 months and 1 year. In the OSAS group, there was a mean reduction from 10.42 points to 5.79 and 5.89 points. Daytime somnolence is defined as a score ≥ 10 at the ESS.

In the Visual Analogue Score of snoring, we found a significant reduction (Fig. 6). After 3 months, the mean reduction for both groups was 63% as after 1 year it was 55%. According to their partners, after 1 year, the snoring disappeared in 6%, while the majority (86%) mentioned a reduction in frequency as well as in the loudness of snoring. In two patient (6%), the snoring stayed equal and one patient experienced an increment (Fig. 7).

All patients from the OSAS group underwent a polysomnography 6 months after the operation, four patients refused (Fig. 8). In the mild group, there was a reduction of 22% (AHI 9.4/h pre-op, AHI 7.3/h post-op), in the moderate of 31% (AHI 21.2/h pre-op, AHI 14.5/h post-op) and the greatest reduction, 58% (AHI 41.3/h pre-op, AHI 17.4/h post-op), was counted in the severe group. In total 53% of the OSAS, patients had a reduction of >50% in apnea-hypopnea index. In Belgium, CPAP is refunded from AHI ≥ 20 /h as cause of potential health risks. Post-operatively, the mean AHI of each group was less than 20/h.

We had two post-operative bleedings without the need for a surgical intervention. There were no cases of infections. The most serious post-operative complaint was pain

Fig. 5 Epworth Sleepiness Scale

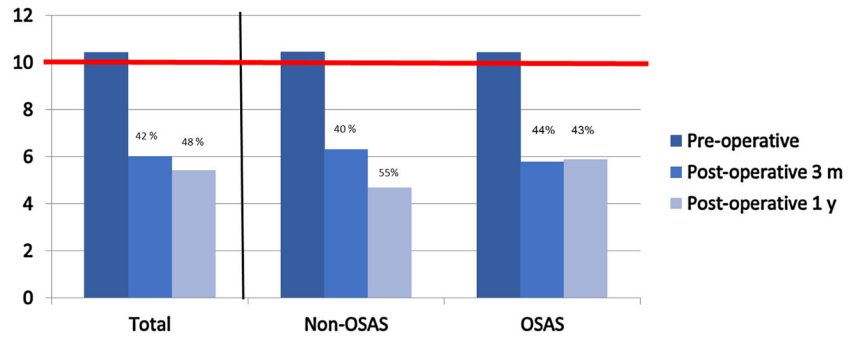


Fig. 6 Visual analogue score of snoring

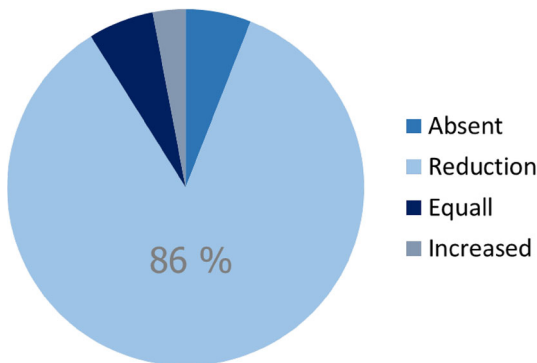
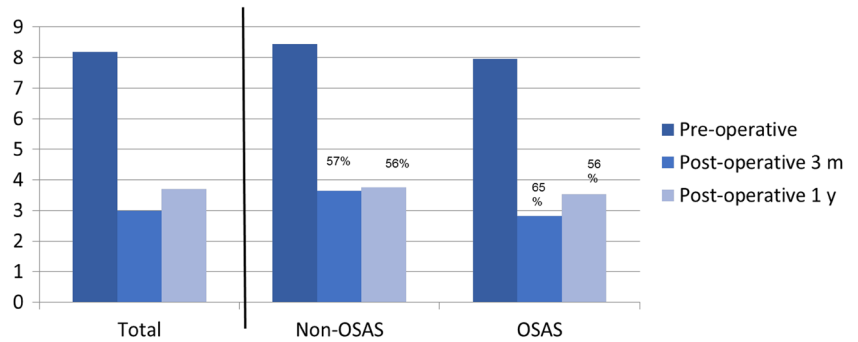


Fig. 7 Visual analogue score of snoring after 1 year

despite adequate pain medications, and 59% of the patients scored their pain on the VAS as more than 7.

Four patients mentioned temporary nasal reflux, while two patients had persisted symptoms at the post-operative appointment 3 months after the operation. At this time point, three patients experienced more mucus production, ten patients had a globus sensation, and eight patients observed a change in taste. After 1 year, there were still two patients with increased mucus production: only one patient with persistent globus sensation and another with long lasting taste alterations. None of our patients suffered from long-term velopharyngeal insufficiency (Table 1).

Fig. 8 Apnea-hypopnea index

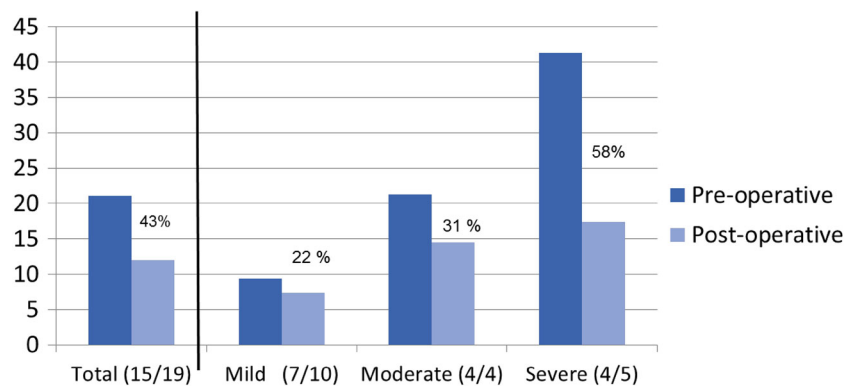


Table 1 Morbidity

	3 months (%)	1 year (%)
Globus	34	2.8
Taste	26	2.8
Mucus	9	5.7
Velopharyngeal insufficiency	11	0

Global patients' satisfaction of the operation after 1 year was 86% but only 80% would consider to do the operation over again. The major reason was the severe post-operative pain.

Discussion

There is a high need for adequate treatment options with satisfactory long-term results given the increased prevalence of SDB. It is important to find, between the many treatment possibilities and more precisely in oropharyngeal surgery, the most performant technique. In a recent systematic review and meta-analysis of five studies, the ESP has been shown to have significantly better clinical and statistical outcomes compared to UPPP for moderate and severe OSAS patients [7].

Comparison of our ESP results to those published in the literature is difficult. This is the first study that included all patients with SDB, while other studies only investigated patients with severe OSAS. Pang and Woodson had a group of 23 patients, and the mean AHI improved from 44.2 to 12.0/h [4] and counted for a reduction of 59%. The modified technique of Sorrenti showed in a group of 85 patients, a reduction in mean AHI from 33.3 to 11.7/h [5] equals a reduction of 64%. We had five patients with severe OSAS, only four underwent a PSG after 3 months, and the mean AHI decreased from 41.3 to 17.4/h. We found a comparable reduction of 58%, and limited factor is the small population in this subgroup. Reduction was less in the mild and moderate OSAS groups, but more importantly, the mean AHI post-operatively for all groups was less than 20/h.

In a systematic review and meta-analysis of Sleep published in 2010 consisting of 14 papers on UPPP, the mean reduction in AHI following UPPP was 33%. The AHI at baseline was 40.3/h while post-operative residual AHI remained elevated, averaging 29.8/h [8]. For many years, we believed that the collapse and vibration in the pharynx of patients with SDB were caused by a structural narrow lumen due to redundant pharyngeal tissue. All the surgical techniques, such as the UPPP, consisted, therefore, of enlarging the pharyngeal lumen by reducing volume.

These techniques had their effect especially in patients with large tonsils. The success rate of the traditional UPPP in Friedman stage I patients was 80.6%, whether stage II patients had a success rate of 37.9%, and stage III patients had a success rate of 8.1% [9]. Latest studies showed, next to the structural narrowing, the co-existence of an even more important functional impairment of the pharynx. It is the lateral pharyngeal wall and, more precisely, the increased collapsibility that is the dominant anatomic factor in apneic subjects [4]. These findings explain the documented success of the ESP over the UPPP.

None of the published ESP studies investigated the success of the ESP in patients with simply snoring or daytime somnolence (non-OSAS group). In this group, snoring scores and scores on the ESS are promising with a 86% reduction in the frequency and loudness of snoring and a mean post-operative score on the ESS less than 10.

It is said that the results of the UPPP deteriorate after a certain time period due to excessive post-operative scarring leading to a narrowing of the pharyngeal lumen [10]. Our 1 year results ESS and VAS were found to be stable in both groups. Global patient's satisfaction is still high after 1 year (86%).

It is documented that the ESP produce high post-operative pain levels. Although Vicini showed in his retrospective review that pain and globus sensation was even inferior to UPPP [11]. Near 60% of our patients scored their pain on the VAS as more than 7 and the major reason for not doing the operation again was the high post-operative pain. There are minimal invasive soft palatal procedures that can be performed under local anesthesia, such as the Laser-Assisted Uvulopalatoplasty (LAUP), Radiofrequency-Assisted Uvulopalatoplasty (RAUP), and the Cautery-Assisted Palatal Stiffening Operation (CAPSO). Since these interventions are limited to the mucosa, and do not involve a tonsillectomy, they could reduce the risk of post-operative bleeding, stenosis, and high pain levels. However, already in 2001, the LAUP showed in a review of the literature to have disappointing results and high rates of globus sensation [12]. Moreover, the post-operative pain was reported similar or even more severe compared to the UPPP [13].

There is evidence that RAUP is an intervention causing less post-operative pain and adverse effects than other techniques on the palatum, but results regarding snoring and AHI reduction are questionable. Both techniques involve also multiple surgical sessions to remove redundant palatal tissue [14]. Finally, the CAPSO has post-operative pain levels and an AHI reduction comparable with UPPP [15]. Importantly, a limitation of all this minimal invasive techniques is the necessary condition of a small tonsil size.

The ESP has, besides the high scores of post-operative pain, further low complication and morbidity rates. The ESP is found to be a safe and well-tolerated technique which is easy to learn, fast, and without the need for special equipment. We feel that the ESP is as approachable for the basic ENT surgeon as the UPPP or other minimal invasive palatal procedures.

A possible bias of the good and promising results is our rigorous selection of patients in this study. For satisfactory long-term success rates of a surgical technique, a good patient selection by clinical and drug-induced sleep endoscopic evaluation of the upper airway to identifying the site of vibration and collapse is important [16, 17]. As mentioned earlier only in case of isolated pathology at the velum and the oropharyngeal lateral walls, an ESP was suggested. Second, in case of a significant reduction in vibration and collapse by chin-lift during DISE, preferably maxillo-mandibular advancement (MMA) or osteotomies were recommended. Further studies will have to indicate to role of ESP in multilevel surgery for OSAS and snoring.

Conclusion

The expansion sphincter pharyngoplasty is efficient for all patients with sleep-disordered breathing ranging from simple snoring to severe OSAS. The technique has a long-term patient's satisfaction and low morbidity. Essential to obtain these results is a good patient. We feel that this technique is as feasible for the basic ENT surgeon as the UPPP or other minimal invasive palatal procedures.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Informed consent Informed consent was obtained from all individual participants included in the study.

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