ORIGINAL ARTICLE
SLEEP MEDICINE AND SURGERY
DOI: 10.5152/B-ENT.2023.231362

Patient-Reported Outcomes of Barbed Reposition Pharyngoplasty in Unilevel Palatal Snoring: A Prospective Pilot Study

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Cite this article as: Parys Q, Claerhout M, Verfaillie J, Serry P. Patient-reported outcomes of barbed reposition pharyngoplasty in unilevel palatal snoring: A prospective pilot study. B-ENT. 2024;20(1):1-6.

ABSTRACT

Objective: This prospective study aimed to evaluate the benefit of barbed reposition pharyngoplasty in the management of patients presenting with isolated unilevel palatal snoring, regardless of the presence of obstructive sleep apnea (OSA).

Methods: Barbed reposition pharyngoplasty was performed in 16 patients with confirmed unilevel palatal snoring observed during drug-induced sleep endoscopy. Patient-reported snoring questionnaires were taken before surgery and at 2 weeks, 6 weeks, and 6 months after surgery. Additionally, postoperative data, including pain scores, duration of hospitalization, and complication types and rates, were reported.

Results: The mean snoring intensity dropped significantly from 8.1 ± 2.0 preoperatively to 3.5 ± 2.1 after 6 months ($P < .001$). The mean preoperative and postoperative snoring severity were 7.0 ± 1.5 and 3.1 ± 1.7, respectively ($P < .001$). The mean snoring score decreased from 8.5 ± 1.5 to 3.6 ± 2.0 ($P < .001$). The Epworth Sleepiness Scale scores decreased from 6.7 ± 4.2 to 4.9 ± 5.0, but this reduction did not reach significance ($P = .087$). Mean pain scores reached a peak at 6.4 ± 1.8 on day 4. The average hospitalization period was 1.06 ± 0.25. Thread extrusion occurred in 5 patients (31.3%) with no clear effect on the outcome measures.

Conclusion: Barbed reposition pharyngoplasty is an effective surgical treatment option for patients with unilevel palatal snoring, and indications for palatal surgery should not be limited to OSA. Future studies assessing objective outcome measures and longer follow-up periods are needed to validate our findings.

Clinical Trial registration number: NCT05643352

Keywords: Snoring, sleep-disordered breathing, pharyngoplasty, palatal surgery, barbed wire

Introduction

Snoring and obstructive sleep apnea (OSA) belong to the spectrum of abnormal respiratory patterns during sleep termed sleep-disordered breathing (SDB). Snoring is caused by increased upper airway resistance leading to turbulent airflow and soft tissue vibration. Habitual snoring, which is defined as the presence of loud snoring at least 3 nights a week, affects an estimated 44% of males and 28% of females and poses a pronounced social burden on patients and their partners.[1] Moreover, segmented sleep, observed in habitual snorers, is associated with disorders including obesity, diabetes, and cardiovascular diseases.[2]

Treatment options for snoring are abundant and determined by the level and complexity of airway collapse. Surgical procedures are alternatives to conservative approaches if they are not tolerated or fail. The objective is to reduce upper airway obstruction by enlarging the pharyngeal lumen. Over the last decades, many surgical procedures have been described, from classical uvulopalatopharyngoplasty to lateral pharyngoplasty techniques. This shift in surgical approach resulted from an increased understanding of lateral pharyngeal wall collapse in snoring and OSA.[1,3] Techniques addressing the lateral pharyngeal wall include expansion sphincter pharyngoplasty,[4] functional expansion pharyngoplasty,[5] and relocation pharyngoplasty. The latter was developed by Li and

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Received: June 7, 2023 **Revision Requested:** July 18, 2023 **Last Revision Received:** August 8, 2023 **Accepted:** August 16, 2023
Publication Date: November 3, 2023
Available online at www.b-ent.be

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Lee[h6] and later modified by Vicini,[7] who termed this procedure barbed reposition pharyngoplasty (BRP). The term "barbed" refers to the use of knotless bidirectional resorbable sutures, previously introduced into pharyngeal surgery by Mantovani et al,[8] and "reposition" alludes to the displacement of the palatopharyngeal muscle in a more lateral and anterior position.

The focus of studies involving pharyngoplasty has been primarily on OSA, and the success rate of each technique is mainly determined by the degree of apnea–hypopnea index (AHI) reduction. Change in snoring intensity is usually considered a secondary outcome measure, and results are reported for patients with predominantly moderate to severe OSA.[9] Data on the benefit of palatal surgery in non-apneic patients with isolated unilevel palatal snoring are lacking. Therefore, with this present study, we aim to investigate whether BRP is a valuable surgical treatment option for snoring in patients with unilevel retropalatal collapse who do not experience hypersomnolence or have severe OSA (AHI < 30 per hour).

Methods

This prospective study was conducted at the Otolaryngology, Head and Neck Surgery Department of AZ Delta, Roeselare in Belgium. The study protocol was approved by the Ethics Committee of AZ Delta and registered on *ClinicalTrials.gov*. This study was approved by Ethics Committee of AZ Delta (Approval No: 18059, Date: July 23, 2018). All consecutive patients meeting the inclusion criteria stated later were asked to participate in this study. Sample size calculation was performed prior to the inclusion stage. A total of 16 patients with bothersome snoring enrolled between January 1, 2019 and December 31, 2021. All patients signed a written informed consent prior to inclusion in the study.

Patients Workup

The standardized diagnostic workup of patients presenting with complaints of snoring at our center was published in a previous paper.[10] This workup includes polysomnography (PSG), drug-induced sleep endoscopy (DISE), and skull radiography. Every case is subsequently discussed in a multidisciplinary meeting in the presence of at least one otorhinolaryngologist, maxillofacial surgeon, orthodontist, and pulmonologist. The purpose of this meeting is to allow for personalized treatment planning, and as such, a consensus is found as to what treatment option meets the patient's needs best.

Main Points

- Barbed reposition pharyngoplasty (BRP) is an effective surgical treatment option for the management of unilevel palatal snoring.
- Unilevel palatal snoring is a potential indication for BRP, regardless of the presence of obstructive sleep apnea or hypersomnolence.
- Objective outcome measures and longer follow-up periods are needed to validate our findings.

Inclusion Criteria

Patients with complaints of snoring having single-level retropalatal collapse observed during DISE. Both concentric and anteroposterior patterns of palatal collapse were included.

Exclusion Criteria

Patients with severe OSA are defined as having an obstructive AHI (OAHI) ≥ 30 per hour. Obese patients with a body mass index (BMI) ≥ 30 kg/m^2. Patients with multilevel airway collapse observed during DISE and patients under 18 years of age.

Outcome Measures

For all subjects, the following data were recorded before surgery: age, gender, BMI, history of tonsillectomy, and preoperative OAHI. Four questionnaires were filled out by the patient and their bed partner before surgery and at 2 weeks, 6 weeks, and 6 months post-surgery. These questionnaires consisted of symptom scores, including "the snoring intensity" from 0 (no snoring) to 10 (partner sleeps separately due to snoring), "the snoring severity" (frequency, duration, and loudness of snoring),[11] and "the snoring score," which is a global score of snoring on a visual analog scale (VAS). Questionnaires are provided in the supplementary material section. Local restrictions in the reimbursement of PSG made it impossible to routinely repeat this examination after surgery. Obstructive AHI could therefore not be adopted as an outcome measure, and the Epworth Sleepiness Scale (ESS)[12] was used instead to assess change in daytime sleepiness as a secondary outcome measure. Additionally, time to patient discharge, postoperative pain, and postoperative complication type and rate were registered per patient.

Surgical Technique

All the procedures were performed by the same senior surgeon (PS) under general anesthesia, with the use of a nasotracheal intubation tube. Patients are positioned in the supine reverse Trendelenburg position with the neck in hyperextension. The surgical steps of BRP are described in detail in the manuscript of Vicini[7] and are identical for both sides. First, a tonsillectomy is performed with careful preservation of the surrounding palatopharyngeus and palatoglossus muscles as well as the mucosa of the pharyngeal pillars. Before proceeding further, the posterior nasal spine, the pterygoid hamulus, and the pterygomandibular raphe are marked as landmarks. A triangular-shaped wedge of mucosa and palatoglossus muscle is removed at the cranial end of the anterior tonsil pillar to widen the oropharyngeal inlet at the superior border. Then, using a pinpoint (Colorado®) monopolar diathermy, a partial release incision is made in the caudal part of the palatopharyngeus muscle. The relocation itself is realized by a single barbed suture, bidirectional polydioxanone-absorbable monofilament. One needle is introduced in the palate at the posterior nasal spine and passed laterally toward the hamulus of the pterygoid. The needle is subsequently re-inserted close to the point of exit, passed around the pterygomandibular raphe, and pulled through the tonsillectomy bed and then the upper part of the palatopharyngeus muscle. While maintaining traction on the suture, the needle is then placed through the posterior pillar, back through the tonsillectomy bed, and suspended around the raphe. This step is repeated 2 more times while progressively expanding towards the lower pole of the muscle. Finally,

Figure 1. Surgical steps in barbed reposition pharyngoplasty. (A) View after tonsillectomy with the marking of the landmarks (1) posterior nasal spine, (2) pterygoid hamulus, (3) pterygomandibular raphe; (B) Shaded area: excised triangular-shaped wedge of mucosa and palatoglossus muscle; black sickle: inferior release of the palatopharyngeus muscle; (C) Path of the continuous suture: starting from the posterior nasal spine, around the pterygoid hamulus, suspending the posterior pillar to the pterygomandibular raphe; (D) Final position after suturing the tonsillar bed with individual sutures and performing partial uvulectomy.

the thread comes out at the raphe, and a small stitch in the opposite direction is made to prevent loosening. Traction is put on the suture while holding the palate down, and the suture is cut near the mucosa. We made subtle modifications to this technique: (a) instead of Stratafix® 0, we used Stratafix® 2-0 as the knotless barbed suture; (b) all patients received a partial uvulectomy regardless of uvula size; and (c) at the end of the procedure, the mucosa of the tonsil is sutured over the exposed palatopharyngeal muscle with individual Vicryl® sutures. Figure 1 gives an overview of the different steps of this technique.

Postoperative Instructions

Patients are admitted for an overnight hospital stay after surgery; however, patients were not discharged until the pain was controlled with oral analgesia and adequate oral intake was possible. In consultation with colleagues in the department of anesthesiology, a peri- and postoperative pain protocol was composed (provided in the supplementary material section).

Statistical Analysis

Statistical Analysis was performed using IBM Statistical Package for the Social Sciences version 28.0 (IBM SPSS Corp.; Armonk, NY, USA). A paired Wilcoxon signed-rank test was applied to compare the results of pre-operative and post-operative snoring questionnaires. The same test was performed on ESS results. Data are mean ± standard deviation unless otherwise stated and values were rounded to one decimal place. Significance was attributed to *P* values below .05 and appropriate adjustments were made for multiple comparisons.

Results

In total, 16 patients (11 males, 5 females) were included with a mean age of 40.0 ± 8.9 (range 28-55), a mean BMI of 27.8 kg/m^2 ± 2.7 (range 20.3-29.7), and a mean OAHI at baseline of 14.3 ± 9.1 (range 1.3-29.5). Only 1 patient had a history of tonsillectomy. The snoring intensity dropped significantly from 8.1 ± 2.0 (range 4-10; out of 10 points) preoperatively to 3.5 ± 2.1 (range 0-7) after 6 months ($P < .001$) (Figure 2). The severity of snoring was reduced by 3.9 points, starting at 7.0 ± 1.5 out of 9 (range 5-9) and dropping to 3.1 ± 1.7 (range 0-6) postoperatively ($P < .001$). The mean snoring score measured 8.5 ± 1.5 out of 10 preoperatively (range 5-10) and equally declined to 3.6 ± 2.0 (range 0-8) at the end of the follow-up, with a significant reduction of 4.9 points ($P < .001$). We observed a change in the mean ESS score from 6.7 ± 4.2 out of 24 (range 1-14) to 4.9 ± 5.0 (range 1-8); however, this finding was not significant ($P = .087$). The evolution of these scores over time is shown in Table 1, and individual changes in snoring intensity are shown in Figure 3.

As per protocol, all patients were admitted for an overnight hospital stay. Only 1 patient (6.3%) needed a longer, 2-night, hospitalization because of uncontrolled pain and lack of oral intake. The main postoperative complaint was pain with a peak at day 4 postoperatively (mean VAS for pain of 6.4 ± 1.8, range 3-9). The evolution of mean VAS scores for pain is depicted in Figure 4. Three patients (18.8%) were readmitted to the hospital in the first week after surgery, 2 (12.5%) presented with postoperative pain needing intravenous analgesia, one of whom received antibiotics due to clinical and biochemical suspicion of postoperative infection. The third patient was readmitted because of postoperative hemorrhage needing transfer to the operating room. Dysphagia was also frequently reported; however, the large majority of patients had resumed their normal diet at the 2-week control appointment. Medication-related complications such as nausea and constipation were reported in 4 patients (25.0%). Foreign body sensation was a common complaint during the first weeks after surgery. A total of 5 patients (31.3%) had a barb suture loop showing through the palatal mucosa which had to be cut out in an outpatient setting. We did not notice a difference in outcome in this group of patients compared to others.

Discussion

This prospective study was the first of its kind to analyze the effect of BRP in non-obese, non-apneic patients complaining of snoring on account of isolated retro-palatal obstruction. In these patients, we demonstrated that BRP had a significantly positive impact on self-reported snoring. After correction for multiple comparisons, the results remain significant. Across the snoring-related questionnaires, the most apparent change occurred in the first 2 weeks after surgery, and the effect increased thereafter, persisting throughout the entire follow-up period of 6 months. Since we did not correct the postoperative outcomes for BMI, the expected postoperative weight loss could have been a confounding factor affecting these early results. Nevertheless, it is reasonable to assume that patients' body weight will have recovered by week 6 and certainly after 6 months, demonstrating that the observed beneficial effect is mainly realized by the procedure. Mean snoring scores did not drop to 0. This means snoring still occurred in most subjects

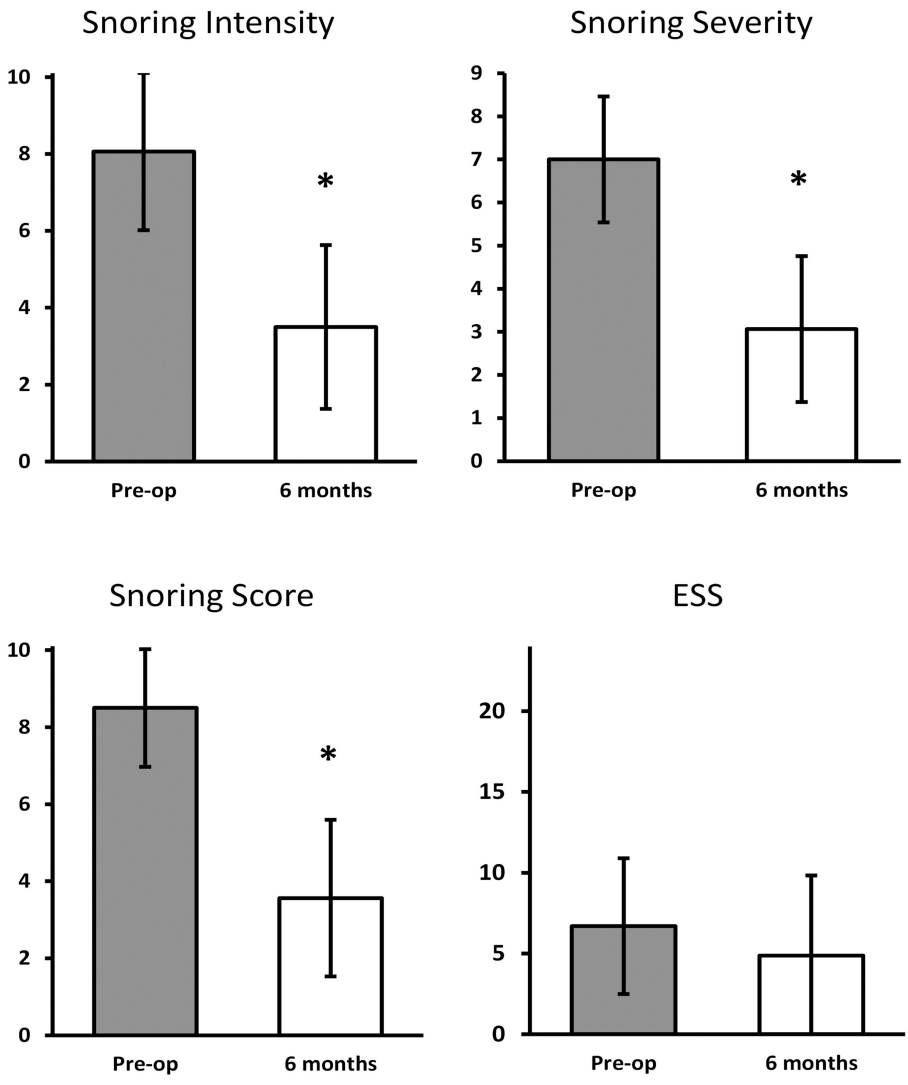

Figure 2. Postoperative outcomes. Self-reported scores preoperatively (gray) compared to scores after 6 months (white). Data are expressed as means ± SD (*P < .001).

after 6 months. However, in all patients, snoring diminished in either loudness, frequency, or both, reducing the associated social burden. We refrained from comparing outcomes between subgroups presenting with anteroposterior and concentric palatal collapse, as there was a skewed distribution among these subgroups and the number of study participants

Table 1. Postoperative Outcomes During the Entire Follow-up Period

	Preoperative	2 Weeks	6 Weeks	6 Months
Snoring intensity	8.06 ± 2.05	4,13 ± 2.90**	3,69 ± 2.52†	3,50 ± 2.13†
Snoring severity	7.00 ± 1.46	4.00 ± 1.86†	3.25 ± 1.88†	3.06 ± 1.69†
Snoring score	8.50 ± 1.53	4.50 ± 2.37†	3.63 ± 2.22†	3.56 ± 2.03†
ESS	6.69 ± 4.21	4.81 ± 3.08*	4.44 ± 2.97*	4.88 ± 4.95

Self-reported outcomes at the various scheduled postoperative control appointments. Data are expressed as means ± SD. ESS, Epworth Sleepiness Scale. *P < .05; **P < .01; †P < .001 compared to preoperative mean score.

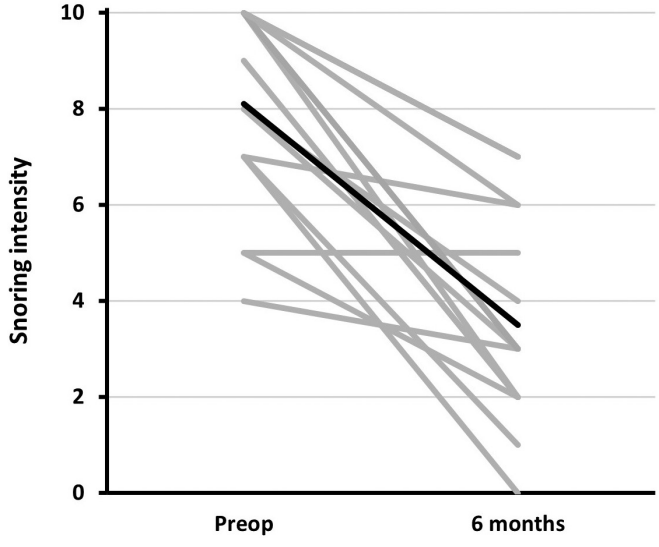

Figure 3. Individual changes in snoring intensity. Comparing individual snoring intensity results before and at 6 months after surgery. Every subject is represented with a gray line. The black line represents the mean.

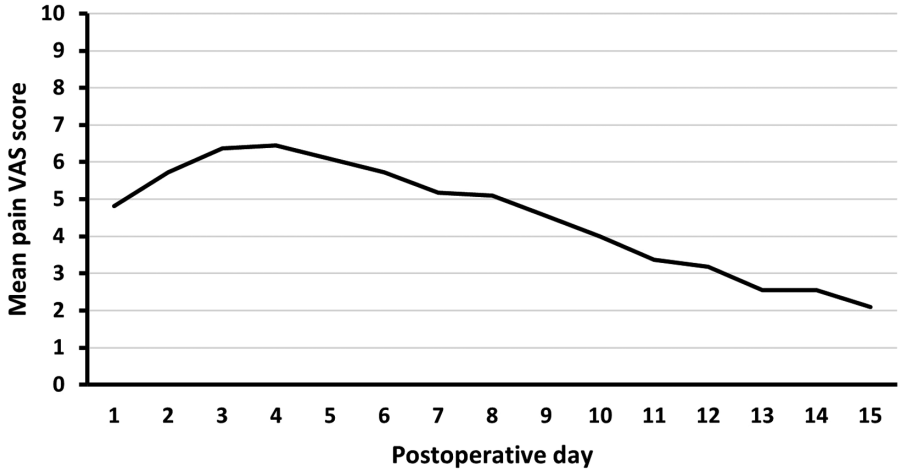

Figure 4. Postoperative pain. Postoperative visual analog scale pain score during the first 15 days after surgery. Data are expressed as means.

was limited. For the same reason, we did not analyze outcomes based on whether patients had a history of tonsillectomy. Epworth Sleepiness Scale scores did not significantly decrease in our patients, which was to be expected because patients were not included based on the presence of hypersomnolence and pre-operative ESS scores were relatively low.

Compared to other pharyngoplasty techniques, BRP is considered to be less invasive due to minimal dissection of the pharyngeal muscle, allowing faster recovery of postoperative pain and dysphagia.[13-15] We, however, noticed elevated pain scores postoperatively despite extensive pain management. Day 4 after surgery marked the peak of discomfort. This finding was not reported in a previous study,[7] though no duration of hospitalization was reported in this manuscript. Another notable cause of postoperative discomfort is thread extrusion. Almost a third of our patients experienced this minor complication. Cutting the surfaced suture loop alleviates the resulting soreness with no apparent impact on the result of surgery.[14] No significant long-term complications were observed, both in our patients and in previous reports.[16]

Some small alterations were made to the surgical technique as first described by Vicini.[7] A partial uvulectomy was performed since patients with elongated uvula tend to experience less benefit from BRP. Additionally, mucosal sutures were used to cover the palatopharyngeal muscle, further widening the oropharyngeal inlet. It was not the intention of the authors or the purpose of this paper to compare the technique to the original procedure or other procedures. In contrast, other authors have modified the technique and published their results alongside the results of conventional BRP. The rationale of Babademez et al[17] for this was that conventional BRP insufficiently stabilizes the midportion of the soft palate; hence, an additional suture is passed through the base of the uvula toward the opposite tonsillectomy bed, from where the procedure on the contralateral side is started in the opposite direction.[17] This modified procedure did not significantly outperform BRP with regard to ESS score, snoring VAS, and AHI changes, albeit a greater reduction of these scores was seen in the experimental group.

A major limitation of this study is the use of subjective, patient-reported scoring systems. Since PSG is only reimbursed every 2 years in Belgium, it was impractical to use objective outcome measures like "time of snoring" and "loudness of snoring," which are routinely recorded during PSG. For the same reason, AHI was not determined postoperatively. Nevertheless, the subjective scoring systems are arguably as relevant as they take into account the social burden of snoring. Another limitation is the period of follow-up. Although 6 months is routinely used as the time of follow-up in OSA studies,[9,16] long-term effects of surgery beyond this timeframe were not assessed.

In this prospective pilot study, we demonstrate that BRP is an effective surgical treatment option for unilevel palatal snoring. Self-reported questionnaires were used to evaluate the benefit of this procedure, and favorable results concerning snoring and its associated social burden were observed. Consequently, we argue that indications for BRP should not be limited to OSA since non-apneic patients presenting with retro-palatal snoring can equally benefit from this surgery. To ensure success, careful patient selection with sleep endoscopy is essential. Future studies should focus on objective outcome measures to validate our findings. Finally, to assess the durability of the procedure, studies with long-term follow-up periods are needed.
Availability of data and materialThe datasets and additional documents analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics Committee Approval: This study was approved by Ethics Committee of AZ Delta (Approval No: 18059, Date: July 23, 2018).

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – M.C., P.S.; Design – M.C., P.S.; Supervision – P.S.; Resources – Q.P., M.C., P.S.; Materials – Q.P., M.C., P.S.; Data Collection and/or Processing – Q.P., M.C.; Analysis and/or Interpretation – Q.P., M.C.; Literature Search – Q.P., M.C., P.S.; Writing – Q.P.; Critical Review – Q.P., M.C., J.V., P.S.

Declaration of Interests: The authors have no conflict of interest to declare.

Funding: The authors declared that this study has received no financial support.

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Supplementary Information

Supplementary information

Snoring questionnaires (translated from Dutch).

1. Snoring intensity

Use the following scale and circle the number that best describes the intensity of your snoring, possibly as indicated by your bed partner.

0: No snoring at all.
1-3: Soft snoring, no influence on your bed partner's sleep.
4-6: Snoring loudly, hinders bed partner.
7-9: Snoring very loudly, hinders people in the vicinity.
10: Bed partner goes to sleep in another room.

0	1	2	3	4	5	6	7	8	9	10
no	soft			loud			Very loud			Sleep separately

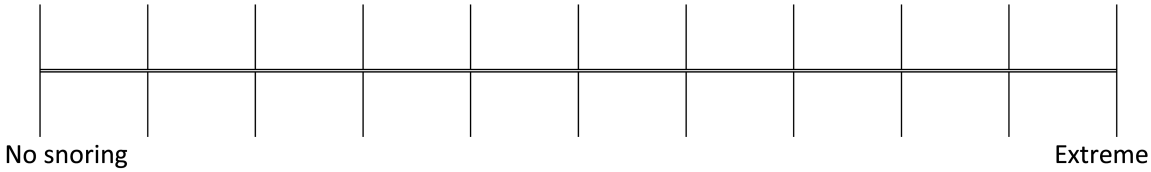
2. Snoring severity

Please complete this question together with your bed partner.
Check the box according to the severity of the snoring.

How often do you snore?	○ Rarely or never ○ Some nights (<50%) ○ Most nights (>50%) ○ Every night
How long do you snore?	○ Rarely or never ○ Small part (<50%) of the night ○ Large part (>50%) of the night ○ All night
How audible is snoring? (when the door is closed)	○ Rarely audible ○ Audible in the same room ○ Audible in the adjacent room ○ Can be heard downstairs/in the hall

3. Snoring score

Please indicate the severity of snoring (overall) with a cross on the bar below.



No snoring Extreme

4. Epworth Sleepiness Scale (ESS)

Use the following scale to choose the most appropriate number for each situation:

0 = would never doze
1 = slight chance of dozing
2 = moderate chance of dozing
3 = high chance of dozing

Sitting and reading	0	1	2	3
Watching TV	0	1	2	3
Sitting still in a public place (e.g. a theatre, a cinema or a meeting)	0	1	2	3
As a passenger in a car for an hour without a break	0	1	2	3
Lying down to rest in the afternoon when the circumstances allow	0	1	2	3
Sitting and talking to someone	0	1	2	3
Sitting quietly after lunch without having drunk alcohol	0	1	2	3
In a car or bus while stopped for a few minutes in traffic	0	1	2	3

Post-operative pain protocol

- Week 1
  - Step 1: Paracetamol 1 gram max. 4x/day
  - Step 2: Ibuprofen 600mg max. 3x/day (if pain persists after step 1)
  - Step 3: Oxycodone sustained release pill 5mg max. 2x/day (if pain persists after step 1 and 2)
  - Step 4: Oxycodone 5mg max. 3x/day (if pain persists after step 1, 2 and 3)
- Week 2:
  - Step 1: Paracetamol 1 gram max. 4x/day
  - Step 2: Ibuprofen 600mg max. 3x/day (if pain persists after step 1)
  - Step 3: Tramadol 50mg max. 3x/day (if pain persists after step 1 and 2)
- Supportive medication
  - Alizapride 50mg max. 3x/day in case of nausea and/or on step 3 or 4 in week 1
  - Laxoberon 10 drops max. 2x/day in case of constipation and/or on step 3 or 4 in week 1
  - Pantoprazole 40mg 1x/day 30min. before breakfast