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MISCELLANEOUS

Comparison of two surgical suture techniques in uvulopalatopharyngoplasty and expansion sphincter pharyngoplasty

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Abstract

Background Uvulopalatopharyngoplasty (UPPP) and expansion sphincter pharyngoplasty (ESP) are two standard surgical procedures for treatment of snoring and sleep apnea. In a prospective clinical trial, we compared a standard simple interrupted suture technique for closure of the tonsillar pillars with a running locked suture.

Methods Each suture technique was randomly assigned either to the left or the right tonsillar pillars in 28 patients. During the first week, patients were daily checked for suture dehiscence and again on days 10 and 21, the end of followup. Time to perform the sutures was measured intraoperative and surgical complications were recorded.

Results During followup, suture dehiscence was observed in 15/28 interrupted and 16/28 running sutures ($p > 0.5$). If a dehiscence occurred during the observation period, the median day of dehiscence was 10 (1 and 3 quartile: 5.75 and 17) days for the interrupted suture and 10 (5–11) days for the running locked suture technique ($p > 0.05$). The mean (± SD) surgical time for the interrupted suture was 5.2 ± 1.9 and 3.5 ± 1.8 min for the running locked suture ($p < 0.001$). Postoperative bleedings occurred in 4/28 running sutures and 2/28 interrupted sutures.

Conclusion The running locked suture technique is an equally safe and time saving way of wound closure in UPPP and ESP.

Keywords OSA · Snoring · Wound dehiscence · Tonsillectomy · Secondary bleeding · AHI

Introduction

The rationale of palatal surgery in the management of sleep-disordered breathing is to alleviate retropalatal obstructions during sleep. Palatal flutter is the major cause for non-apnoeic snoring. Palatal surgery removes redundant soft tissue of the palate and lateral pharyngeal walls and repositions them to a more anterior position [1, 2]. It is efficient in the treatment of retropalatal and oropharyngeal obstruction. Uvulopalatopharyngoplasty (UPPP) is the most widely performed surgical procedure to reduce palatal collapse and vibration [3]. It was first described by 1964 by Ikematsu for the treatment of snoring and in 1981 for the treatment of OSA by Fujita et al. [4, 5]. Earlier surgical approaches were invasive leading to significant morbidity and complications, such as nasopharyngeal stenosis or velopharyngeal insufficiency [4–6]. The more conservative technique described by Fujita and coauthors is equally efficient, but associated with less complications [7]. The Fujita technique is the most common UPPP technique applied in German-speaking countries [6]. A second major surgical treatment option for OSA or snoring which addresses the collapse of the lateral pharyngeal wall is expansion sphincter pharyngoplasty (ESP) introduced by Pang and Woodson [8]. This surgical technique reduces lateral pharyngeal wall collapse by isolating the palatopharyngeus muscle. The muscle is left with its posterior surface partially attached to the posterior horizontal superior pharyngeal constrictor muscles. Sufficient muscle has to be isolated to mobilize the muscle and to allow suturing of the muscle with a Vicryl suture. A superolateral incision is made on the anterior pillar arch bilaterally, identifying the arching fibres of the palatoglossus muscles. The palatopharyngeus muscle is then attached superolaterally

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close to the hamulus pterygoideus with a Vicryl 2-0 suture [9, 10] through a submucous tunnel.

Closure of the tonsillar pillar is part of both techniques. It is commonly performed with simple interrupted sutures with a resorbable suture. Sutures are usually placed 1–1.5 cm apart [3]. The use of running locked sutures may be easier to perform and less time consuming, because fewer knots are needed. In a prospective clinical study, we aimed to assess the efficacy and efficiency of these two suture techniques by comparing the incidence of suture dehiscence, surgical time needed to perform the sutures and the incidence of bleeding complications.

Methods

Between October 2015 and November 2016, 28 patients treated with UPPP or ESP at the Department of Otorhinolaryngology, Head and Neck Surgery, Medical University of Innsbruck, were consecutively included in this prospective clinical trial. In random laterality, the tonsillar pillars were approximated on one side with an interrupted suture and on the opposite side with a running suture. Outcome parameters were incidence of suture dehiscence within an observation period of 21 days postoperatively, time needed to perform the suture in minutes and incidence of postoperative complications according to the Clavien–Dindo classification [11].

Inclusion criteria comprised informed consent, age between 18 and 70 and prior outpatient respiratory polygraphy or polysomnography. Indications for surgery included snoring or obstructive sleep apnea with a respiratory disturbance index (RDI) < 30 or RDI > 30 with failure of CPAP treatment and BMI < 40. Moreover, an American Society of Anaesthesiologists (ASA)-Score I–III was required for inclusion. Exclusion criteria comprised AHI > 30/h and no prior use of CPAP, age < 18 and > 70, ASA IV and any other general contraindication against elective surgery. A positive vote of the Ethics Committee of the Medical University of Innsbruck (AN2014-0268) was obtained.

All patients underwent a standard basic clinical examination with evaluation of BMI, daytime sleepiness and endoscopy of the nasal cavity and nasopharynx, oral cavity, and oropharynx, hypopharynx and larynx. AHI was assessed with outpatient polygraphy or polysomnography. The surgical procedure started with drug-induced sleep endoscopy (DISE) to reveal the site of tissue vibration and collapse. Depending if DISE revealed palatal collapse or lateral pharyngeal collapse, UPPP or ESP was performed. After surgery, patients were hospitalized for 5 days for pain management and inpatient surveillance. They were controlled every day for the first 5 days for wound dehiscence, infections or signs of bleeding. All patients were routinely controlled after 9–11 days, 2 and 3 weeks postoperatively in our outpatient department.

Surgical technique

All surgical procedures were performed by two surgeons (T.B.S; B.B) under general anaesthesia with the patient in supine position and the head in hyperextension. A McIvor mouth gag was used to expose the oropharynx. The operation started with a bilateral tonsillectomy by cold dissection when tonsils were still present. We used the modification of the standard UPPP suggested by Fujita in 1984. Redundant velar tissues from the free margin of the soft palate, tonsillar pillars and uvula were excised without resecting muscles of the velum.

In ESP, palatopharyngeus muscles on both sides were dissected. After horizontal transection of this muscle inferiorly, a tunnel was made from the apex of the fossa tonsillaris by blunt dissection. The palatopharyngeus muscles were rotated and lifted through this tunnel superolateral with fixation of its inferior muscle bulk near the hamulus pterygoideus by Vicryl 2-0 (Fig. 1) [8].

As final step of both surgical techniques, the tonsillar pillars were apposed with Vicryl 2-0. In every patient, one side was closed with a routine interrupted suture, the other side with a running locked suture (Fig. 2). Which side was treated with which technique was randomized for each patient by tossing a coin. Both suture techniques were performed in each patient (paired samples). The

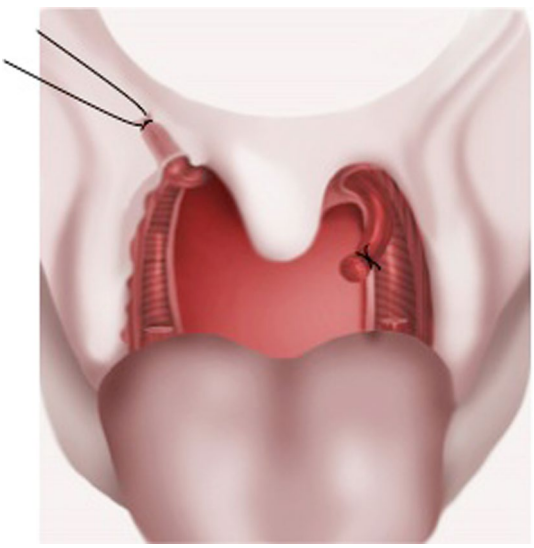

Fig. 1 Expansion sphincter pharyngoplasty reduces lateral pharyngeal wall collapse by isolation and rotation of the palatopharyngeal muscle. After horizontal transection of this muscle, a tunnel is made superolaterally from the apex of the tonsillar fossa by blunt dissection. The muscle is attached near the hamulus pterygoideus with a Vicryl 2-0 suture

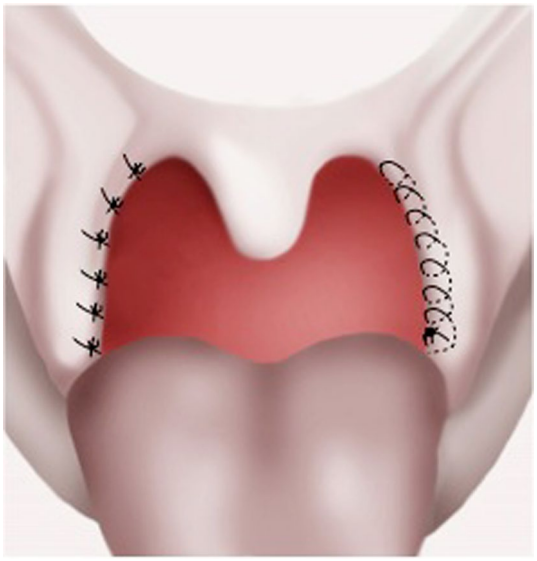

Fig. 2 We used the modification of the standard UPPP suggested by Fujita in 1984. Redundant velar tissues from the free margin of the soft palate, tonsillar pillars and uvula were excised without reducing the muscles of the velum. The tonsillar pillars were apposed with Vicryl 2-0 in UPPP and ESP. In every patient, one side was closed with a routine interrupted suture, the other side with a running locked suture

time needed for each suture was measured by the scrub nurse.

All patients received single-shot antibiotics with amoxicillin/clavulanate 2.2 g intravenously 30 min before surgery. Postoperative pain management on day 1–day 5 was standardized in three steps. All patients received paracetamol 4 × 1 g + naproxen 2 × 500 mg as step I medication. If the patient rated pain on a pain scale (0 = no pain; 10 = maximum conceivable pain) higher than 3, the treatment level was increased one step. Step II medication consisted of step I, plus additional modified-release hydromorphone 2 × 2 mg. For step III pain medication, 2 × 4 mg hydromorphone added. Correspondingly, if the pain was scored below 4, pain medication was decreased one step [12].

Data analysis

Interval data were presented as mean ± standard deviation (SD) unless indicated otherwise and tested with the paired samples *t* test. Categorical data were analysed with the McNemar test. Statistical analysis was performed using SPSS 22 (IBM Corporation, Armonk, NY, USA).

Results

In 2015 and 2016, 28 patients were enrolled in this study. 7 out of 28 patients were female. UPPP was the most common performed type of palatal surgery (19/28). In 26/28 patients, surgery started with tonsillectomy, in 2 patients, tonsils had already been removed. The running locked suture was performed in 17/28 patients at the left side. Two of the participating patients did not show up to the 10-day postoperative control but to the 3-week control.

Suture dehiscence

A suture dehiscence was seen in more than half of all tonsillar pillars within 3 weeks (55%). A suture dehiscence was observed in 15 interrupted sutures and in 16 running locked sutures ($p > 0.5$). In patients with dehiscence, the day of suture dehiscence did not differ between both suture techniques. If a dehiscence occurred during the observation period, the median day of dehiscence was 10 (1. and 3. quartile: 5.75 and 17) days for the interrupted suture and 10 (5 to 11) days for the running locked suture technique ($p > 0.05$). Of the running locked sutures, 75% were dehiscent on day 11, whereas 75% of the single button sutures were dehiscent on day 17.

Time requirement

The surgical time needed for tonsillar pillar suture differed significantly between both suture techniques. The mean duration was 5.2 ± 1.9 min for the interrupted suture technique and 3.5 ± 1.8 min for the continuous suture technique ($p < 0.001$).

Surgical complications

There were no major surgical complications, corresponding to a Clavien–Dindo Classification Score II-V, observed in the patient cohort. Clavien–Dindo Classification Score I complications were seen in six patients and were without exceptions secondary bleedings [11]. A light secondary bleeding according to a grade A–C described by Sarny et al. in 2011 was observed in five patients, which was effectively treated with electro cautery or conservative therapy [13]. Two of the bleedings happened on the single button suture side, four on the running locked suture side. One patient had a bleeding on both sides. The suture technique had no significant influence of the rate of secondary bleeding ($p > 0.3$). No other surgical complications

such as wound infections, nasal regurgitation or stenosis were observed.

Outcome

Subjective improvement of snoring was reported by 19/28 patients. If bilateral dehiscence occurred, 11/12 patients reported snoring improvement and if at least one or both sutures were not dehiscent, 8/14 reported snoring improvement ($p = 0.08$). Preoperative AHI had no influence on self-reported improvement of symptoms ($p = 0.7$). Also, self-reported improvement did not depend on preoperative body mass index (BMI) ($p = 0.8$), however, severely adipose patients with a BMI > 40 had been excluded from the study. Nearly half of the patients (12/28) were treated with UPPP/ESP for primary snoring with an AHI < 5. Consequently, postoperative AHI were only available in eight patients (Table 1), because primary snorers were not controlled with outpatient polygraphy postoperatively. A functional success was defined as an AHI reduction of 50% or below 20/h [8], which was observed in 7/8 patients (Table 1).

Discussion

Snoring is one of the most obvious clinical signs of obstructive sleep apnea but can be an impairment by itself. The incidence of snoring is increasing with age and BMI and is reported to be 45% in male and 30% in female above 65 [14]. The reported prevalence of OSA has increased over time, in part due to increasing rates of obesity. The overall population prevalence ranges from 9 to 38% and is higher in men [15]. Surgical treatment of snoring and OSA include UPPP and ESP. These techniques remove redundant soft tissue of the palate and lateral pharyngeal walls and reposition them to a more anterior position [1, 2]. They are efficient in treating retropalatal and oropharyngeal obstruction and reduce palatal flutter which is the major cause for non-apnoeic snoring [3].

Suture approximation of the anterior and posterior tonsillar pillars is part of both surgical procedures. The apposition suture of the anterior and posterior tonsillar pillars increases the anterior–posterior diameter of the pharyngeal cavity [3]. It is unclear, if this interpillar suture is essential for a good clinical outcome [16]. Wu and coauthors question the utility of interpillar sutures because it endures tension on the wound edges. Moreover, the tonsillar fossa may become a dead space increasing risk of tissue swelling and inflammatory reactions [16].

Suture dehiscence of interpillar sutures is frequently observed. The aim of this study was to investigate the frequency of suture dehiscence in interrupted sutures and running-locked sutures. In a prospective surgical trial, patients received one interpillar suture technique on one side and the other technique on the opposite side. Sides were assigned randomly. Suture dehiscence was observed in 15/28 interrupted and 16/28 running sutures ($p > 0.5$). This is in line with a recent study, where dehiscence of the interpillar suture was observed in 11/24 patients [16]. There was no difference in suture dehiscence rates between both suture techniques ($p = 0.8$). Time interval from surgery to suture dehiscence did not differ as well. The mean day of dehiscence was day 10 ± 5 for running locked sutures; the mean day of dehiscence was day 11 ± 6 for single button sutures ($p = 0.5$).

Wound dehiscence may occur if sutures pull through the wound edges, by knot slippage, or by early suture break down. Other causes of early wound dehiscence include poor wound healing due to age, systemic diseases such as diabetes mellitus, obesity or Ehler–Danlos syndrome, poor knotting of the stitches or trauma to the wound after surgery [17]. Due to tension on wound edges following approximation of anterior and posterior pillars, suture pull through was expected to occur frequently. It was assumed that suture pull through could be reduced with continuous sutures, because the force on wound edges is more evenly distributed. This apprehension was not supported by the results of this study. There was no difference in wound dehiscence in both suture techniques. Technical

Table 1 Summary of characteristics and surgical outcome of patients with OSA

Patient	Age	Sex	BMI	OP	AHI pre	AHI post
1	36	M	28	UPPP	14	1
3	40	M	38	UPPP	10	2
8	30	M	27	ESP	12	4
9	30	M	29	ESP	76[a]	70
15	43	M	26	ESP	10	1
20	27	F	26	UPPP	35	15
21	35	F	21	UPPP	20	5

[a]This patients was treated with UPPP because of CPAP therapy failure. UPPP was indicated prior to implantation of upper airway stimulation therapy (Inspire Medical Systems, Inc.)

refinements such as multilayer closure of tonsillar pillars [18] may prevent wound dehiscence more effectively than the mono-layer closure we used. Suture dehiscence in this study group was mainly a consequence of suture breakdown and not of knot slippage or suture pull through the wound edges. Suture materials may also influence dehiscence rate. We used Vicryl® (polyglactin 910), an absorbable, polyfil suture with a mean absorption time of 56–70 days (Ethicon, Johnson & Johnson Medical Products Ltd., Vienna, Austria) in all patients. The speed of suture degradation caused by hydrolysis depends not only on suture materials but also on tissue temperature and pH [19–22]. Saliva and different types of oral diet such as cow milk products enhance Vicryl® suture degradation [23]. Systemic diseases such as poorly controlled diabetes mellitus and cardiovascular disease may be associated with oral inflammatory conditions and can enhance suture degradation [24]. However, both suture techniques were performed in the same patient by the same surgeon to exclude bias due to patient factors such as diet, oral hygiene, composition of saliva, wound healing ability or surgical skills as confounders.

Despite lasting only a short part of the whole inpatient process, operating room care usually takes highest costs [25]. In the United States, each minute of operating theatre time has been estimated to be worth $22–$80 [26]. In the UK, median operating theatre running costs are £16 per minute (range £12–£20 per min) [27, 28]. Running locked suture techniques needed less time to close tonsillar pillars than single button sutures, saving costs and patient burden. Continuous suture technique simplified the closure of the tonsillar pillar for the surgeon because it allows the scrub nurse to hold the thread upward and pull the velum anteriorly so that it can be easier reached by the surgeon.

During the observation period, grade A (patient reported without current bleeding) and B (minor bleeding not requiring surgical intervention) posttonsillectomy haemorrhages according to Sarny and Stammberger were observed in 5/28 patients. A haemorrhage requiring surgical intervention under general anaesthesia according to a grade C after Sarny and Stammberger was observed in three patients [13]. This is in line with previous reports [12]. Suture approximation of the anterior and posterior tonsillar pillars was reported to protect from postoperative haemorrhage. Aksoy and co-authors analysed the incidence of secondary haemorrhage in a retrospective study including 404 patients who either underwent tonsillectomy or submucosal UPPP with multilayer closure of the pillars [18]. They found a significant lower incidence of secondary haemorrhage requiring surgical intervention in the UPPP patients (1.45 vs. 5.05%) and concluded that closure of the tonsillar pillar protects from haemorrhage after tonsillectomy. In this study, we observed a similar rate of secondary bleeding as in a previous tonsillectomy study without interpillar sutures. There was no association between suture dehiscence and secondary bleeding ($p = 0.6$).

Although not a primary aim of this study, it was of interest, if dehiscence of the anterior and posterior tonsillar pillars interferes with outcome. An improvement of self-reported snoring was observed in 19/28 patients. There was no significant association between improvement of snoring and suture dehiscence, but surprisingly a tendency towards better snoring outcome in patients with bilateral dehiscence ($p = 0.08$). Postoperative AHI was accessible in seven patients as half of them were primary snorers (12/28) or lost to followup. Surgical success according to the criteria suggested by Pang and co-authors [8] was observed in 7/8 patients. Because of the low number of available postoperative AHI data, a conclusive statement of the effect of suture dehiscence on postoperative AHI could not be made, but 6 of these 8 patients had at least unilateral dehiscence on day 21 (Table 1). Wu et al. reported good surgical success rates in a majority of patients (15/24) despite a dehiscence in nearly half of the patients. Surgical success was defined according to the criteria suggested by Pang and co-authors as well as improvement of subjective symptoms such as daytime sleepiness. Surgical success rates did not differ in the conventional UPPP group and in the group without apposition suture of the tonsillar pillar ($p = 0.54$) [16].

Furthermore according to patients self-reports, they were more distracted from the suture remnants of the running suture after dehiscence because of the long piece of suture hanging loosely in their pharynx, which can cause foreign body sensation and gag reflexes. But as this long suture piece could be more easily extracted by the surgeon during control visits, than a few loosely hanging knots, it was not leading to major patient discomfort in our experience.

Conclusion

Running locked sutures are equally safe and effective as interrupted sutures for wound closure in UPPP and ESP. Advantages are shorter surgical time and easier handling. Postoperative suture dehiscence of tonsillar pillars did not interfere with outcome.

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Compliance with ethical standards

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee (Ethics Committee of the Medical University

of Innsbruck, AN2014-0268) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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

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

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