Snoring: recent developments

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Despite limited evidence validating its efficacy, surgery to overcome snoring is commonly undertaken. This article looks at the development of snoring surgery to present day, highlighting its limitations and outlining current methods being used to target the surgery more effectively.

Snoring is a very common human malady (Fairbanks and Fujita, 1987). Estimates of prevalence of habitual snoring range from 24 to 50% for men (Katsantonis et al, 1988; Woodhead et al, 1991; Maniglia, 1993) and from 14 to 30% for women (Fairbanks and Fujita, 1987; Ah-See et al, 1998).

Snoring noise, or stertorous sleep-related breathing, is generated by the vibration of anatomical structures of the upper aerodigestive tract during sleep. Sleep results in a relative muscular hypotonia of the upper airway, resulting in segmental collapse, which is maximal when airflow is least. An inspiratory force has to be generated in order to overcome this airway collapse. It is the resulting airflow, in which more upstream structures vibrate, which generates the noise of snoring. Which structure actually vibrates depends on many factors, few of which are well understood. Most commonly, the soft palate is assumed to be the primary noise generator, although other structures, such as tongue base, epiglottis or lax pharyngeal mucosa, may also vibrate to a greater or lesser extent, in any one individual.

Snoring is a symptom of sleep-related breathing dysfunction, which is usually considered as a continuum, with 'uncomplicated' snoring at one extreme and obstructive sleep apnoea syndrome (OSAS) at the other (Lugaresi et al, 1978; Issa and Sullivan, 1984). Snoring is worse in men than in women, and is known to worsen with age, obesity, alcohol ingestion and nasal obstruction (Fairbanks et al, 1990; Stradling and Crosby, 1991).

In its simplest form snoring results in considerable social disability, contributing to relationship disharmony, marriage breakdown, social ostracism, and even murder (Edilberto et al, 1989). In addition, apparent uncomplicated snoring has been implicated in the aetiology of more sinister morbidity, most notably hypertension, ischaemic heart disease and cerebrovascular accident as well as increased morbidity and mortality from road traffic and work-related accidents (Koskenvuo et al, 1985, 1987; Partinen and Palomaki, 1985; Haraldsson et al, 1995). OSAS is a serious medical condition, which if not treated may result in physical and/or psychological morbidity or even death (Guilleminault et al, 1976; Tilkian et al, 1977; Clark, 1979; Kales et al, 1985a,b; Hung et al, 1990; Bédard et al, 1991; Fletcher, 1995).

It is not sufficient to treat OSAS sufferers as snorers (Krespi et al, 1994). With this in mind, although surgery has been used to treat OSAS, it will not be considered further in this review. It is most common for physicians with an interest in sleep medicine to treat OSAS sufferers with a nasal continuous positive airway pressure appliance (Wright and Dye, 1995).

ASSESSMENT OF SNORERS

Snorers are typically referred to otolaryngologists or respiratory physicians with an interest in snoring and sleep-related breathing disorders.

On initial assessment, particular care is taken to elicit evidence of any medical complications of OSAS. Depending on the history and examination findings, one of several screening procedures may be invoked. For individuals with a low index of suspicion of OSAS, an overnight pulse oximetry will suffice. However, if the index of suspicion is high then a formal polysomnography is performed.

Nasal obstruction, collar size, body mass index, and alcohol and cigarette consumption are also documented as they have all been implicated in snoring severity (Stradling and

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Crosby, 1991; Hoijer et al, 1992; Braver et al, 1995; Koay et al, 1995; Wenzel et al, 1997; Ah-See et al, 1998).

TREATMENT OF SIMPLE SNORERS

Conservative

Surgery is not the only means by which reduction of snoring can be achieved. Several conservative methods have been shown to be effective. These include weight reduction, reduction of alcohol intake and treatment of coincident nasal obstruction (Stradling and Crosby, 1991; Hoijer et al, 1992; Woodhead and Allen, 1994; Braver et al, 1995; Wenzel et al, 1997). Attendance to these will have significant effects on the reduction of snoring and should be attempted before consideration of any surgical remedy. It should be emphasized that if any of these factors remain untreated the chances of surgical success will be compromised.

Methylmethacrylate mandibular advancement prostheses (*Figure 1*) are increasingly used to good effect (Schmidt-Nowara et al, 1995; Stradling et al, 1998). They consist of an upper and lower dental bite plate fixed together. The mechanics are such that when the bite plates are in position on the upper and lower teeth, the force transmitted from one to the other promotes protrusion of the mandible. They are used during sleep and serve to pull the tongue forward resulting in an increased oro- and hypo-pharyngeal diameter, thereby relieving airway constriction, which is the underlying cause of the snoring.

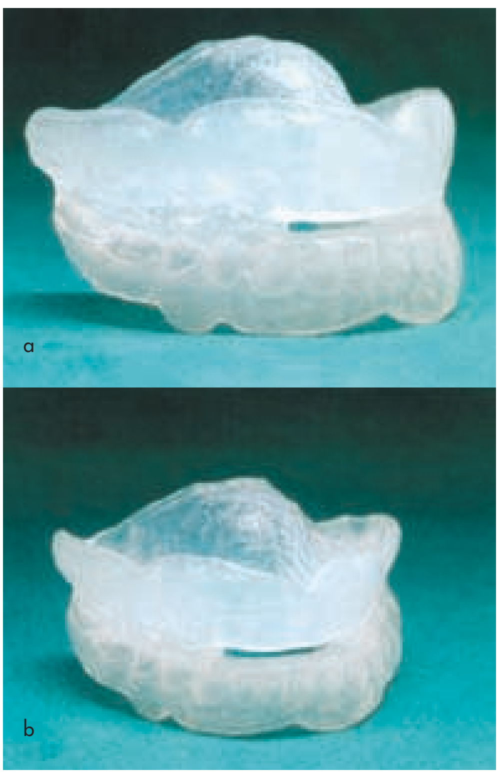

Figure 1. Methylmethacrylate mandibular advancement prostheses.

Surgical

Uvulopalatopharyngoplasty (UPPP): This operation was pioneered in 1964 by Ikematsu and introduced to the west by Fujita et al, in 1981, as a surgical remedy for OSAS (*Figure 2*).

The procedure includes a tonsillectomy, or de-epithelization of the tonsillar fossae if tonsillectomy has already been performed, followed by

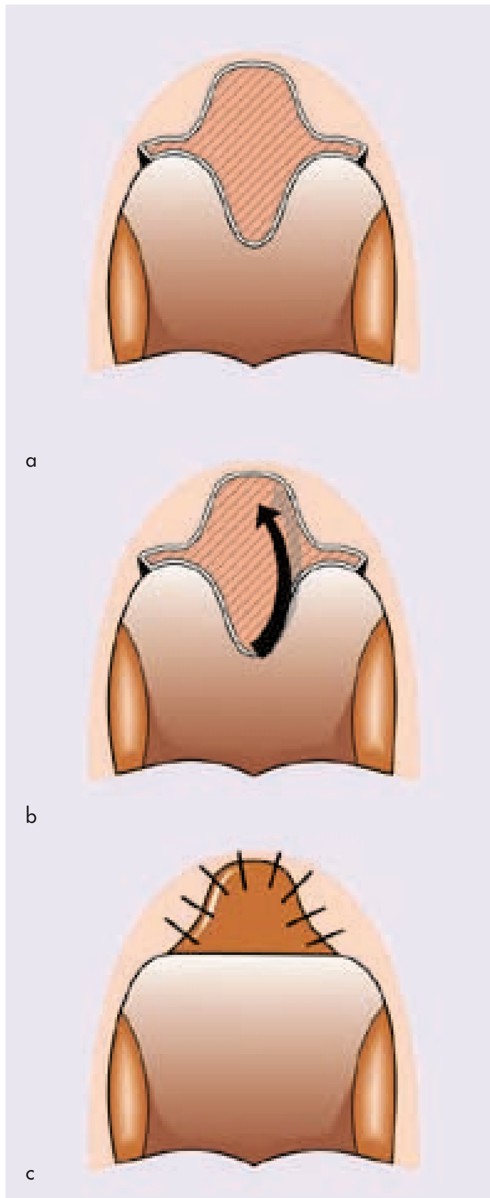

Figure 2. Uvulopalatopharyngoplasty. a. Tonsillectomy. b. Excision of uvula and rim of soft palate. c. Apposition of mucosal edges.

suture apposition of the denuded anterior and posterior faucial pillars and excision of 1–2 cm of the soft palate including the uvula.

Use of the technique to cure uncomplicated snoring increased over the following decade. Although UPPP has been shown to reduce snoring in most patients (Blair Simmonds et al, 1984; Sharp et al, 1990; Koay et al, 1995), it became apparent with time that there were significant and unacceptable complications. These included nasal regurgitation, nasopharyngeal stenosis, hypernasal voice and even death (Croft and Golding-Wood, 1990; Fairbanks, 1990).

Palatoplasty procedures: In an attempt to overcome the radical nature of UPPP, its complications and uncertain outcome, a variety of techniques that were limited to the soft palate were devised. These are all based on the supposition that palatal flutter is one of the most important sound generator mechanisms of snore production. Therefore, reducing palatal flutter or vibration should, in theory, reduce the level of snoring. These techniques are designed either to reduce the length of, or to stiffen, the soft palate.

Palatal stiffening techniques: In the early 1990s, Ellis et al proposed a radical change in strategy for the treatment of uncomplicated snoring by the introduction of palatal stiffening. Their technique used a laser to remove a central longitudinal strip of mucosa from the oral surface of the soft palate and uvula. Subsequent healing by fibrosis resulted in the required stiffening of the soft palate and, at least in the short term, a reduction of snoring noise (Ellis et al, 1993; Ellis, 1994).

Many different techniques have been developed since. These include diathermy-assisted uvulopalatoplasty (DAUP) (Yardley et al, 1997), laser palatoplasty plus excision of the uvula (Morar et al, 1995; Ingrams et al, 1996) (*Figure 3*), and simple soft palate cautery (Mair and Day, 1996).

Palatal shortening techniques: *Laser-assisted uvulopalatoplasty*: Kamami described laser-assisted uvulopalatoplasty (LAUP) (*Figure 4*) (Kamami, 1990) and the procedure has been widely used since (Carenfelt, 1991; Krespi and Pearlman, 1995; Wareing and Mitchell, 1996; Ikeda et al, 1997).

This technique involves sequential removal of soft palate, lateral to the base of the uvula, resulting in the formation of bilateral 'Kamami trenches'. Formation of the trenches leads to a relative elongation of the uvula, which, although spared, is shortened as the trenches are elongated. In order to prevent excess removal of palatal tissue and to allow assessment of effectiveness,

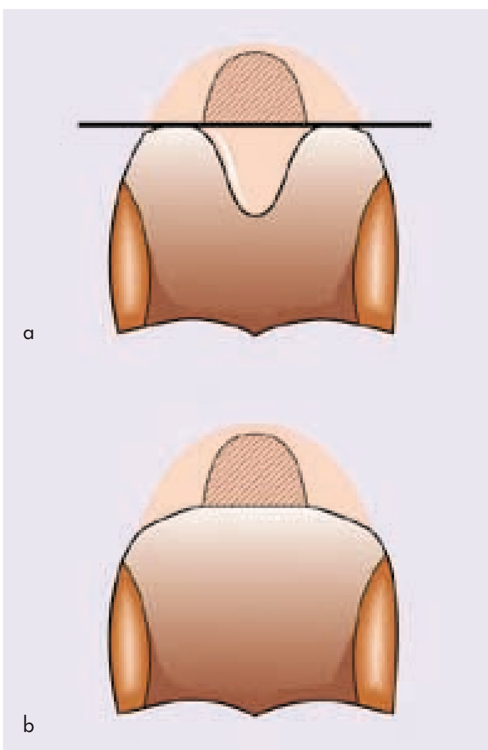

Figure 3. Palatoplasty plus uvulectomy. a. Mucosal flap excised from soft palate. b. Uvulectomy.

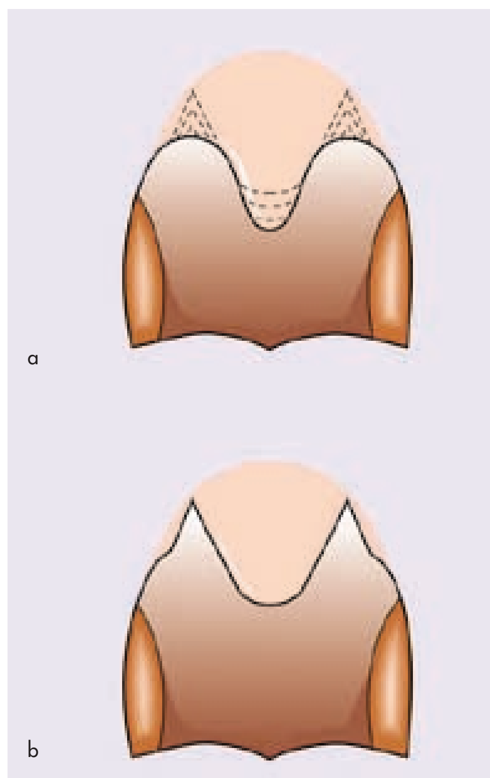

Figure 4. Laser-assisted uvulopalatopharyngoplasty. a. Sequential excision of soft palate 'trenches'. b. Sequential shortening of uvula.

patients were required to undergo several procedures, separated by a 4–6-week interval, with only a small strip of palate vaporized at each visit. Each procedure was carried out using local infiltration of anaesthesia in the 'office' setting. Kamami reported a success rate comparable with UPPP, with a marked decrease in postoperative complications. He did concede, however, that the requirement for repeated procedures was a significant drawback to the technique.

Uvulopalatal elevation palatoplasty: In this technique, a laser is used to excise a mucosal strip from the oral surface of the soft palate and uvula (*Figure 5*). Lateral palatal incisions release the soft palate allowing the uvula flap to be reflected anteriorly on to the denuded oral surface of the soft palate. It is secured with vicryl sutures. Covering the raw area of the soft palate minimizes postoperative pain and discomfort (Wilde and Swift, 1995).

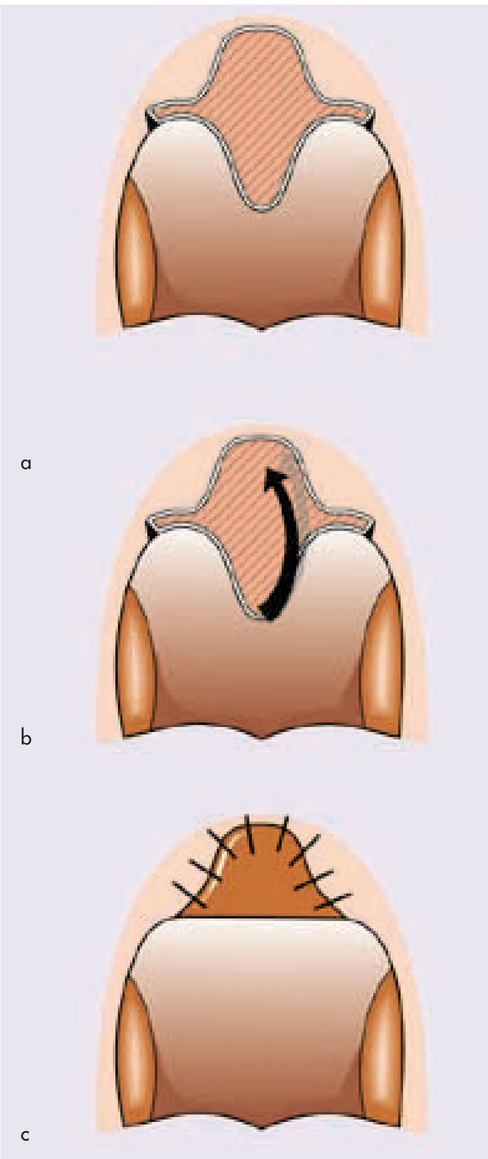

Figure 5. Flap palatoplasty. a. Lateral releasing incisions, and mucosal strip from soft palate and uvula. b. Uvula flap anteverted onto soft palate. c. Flap secured with vicryl.

Whichever technique is used, palatoplasty surgery does confer several advantages over UPPP. The results are good, at least in the short term; there are minimal voice changes, as well as decreased nasal regurgitation and nasopharyngeal stenosis (Kamami, 1990; Ellis et al, 1993; Krespi and Pearlman, 1995; Morar et al, 1995; Mair and Day, 1996; Ingrams et al, 1996; Clarke et al, 1998).

The technique does, however, appear to result in significant early postoperative pain (Clarke et al, 1998) and there is an attendant initial failure rate of 7–22% (Ikeda et al, 1997).

Primary failure of the procedure occurs because palatal flutter may not be the major mechanism of sound production in each individual. Therefore, negating palatal flutter in such individuals is unlikely to remedy their snoring.

Considerable effort is currently being applied in an attempt to target palatal procedures more precisely, avoiding unnecessary surgery in up to 25% of snorers seeking help.

TARGETING PALATAL SURGERY

Several techniques have been used in an attempt to identify the major snoring sound-generator mechanism in any one individual. These include:

- Imaging
- The Müller manoeuvre
- Sedation (sleep) nasendoscopy
- Acoustic analysis.

Imaging

Fluoroscopic techniques, computerized tomography scanning and magnetic resonance imaging have been used in attempts to identify structures involved in snore generation with only limited success (Shepard and Thawley, 1989; Ryan et al, 1991; Jäger et al, 1998). Practicability and excess radiation exposure prove the major limitations.

Müller manoeuvre

This was first described by Borowiecki and Sassin in 1983, and later modified by Sher et al in 1985. The Müller manoeuvre, which is performed in the outpatient clinic, involves forced inspiration against closed nasal and oral airways (i.e. the opposite of a Valsalva manoeuvre). Flexible nasendoscopy allows direct visualization of the extent of airway collapse at the different levels during the manoeuvre. The extent of collapse at the velopharynx, relative to collapse at the oropharyngeal level, is used to predict surgical outcome. However, the technique has been shown to be inferior to other techniques, such as sleep nasendoscopy (Pringle and Croft, 1991), and is now rarely used in isolation to select individuals for snoring surgery (Boot et al, 1997).

Sedation (sleep) nasendoscopy

First described by Croft and Pringle in 1991, and later simplified by Camilleri and colleagues in 1995, the procedure requires the sedation of the patient. Once snoring is achieved a nasendoscope is used in an attempt to visualize the vibrating structures contributing to the snoring sound. It would be expected that only patients in whom soft palate flutter dominates would benefit from a palatoplasty procedure.

The technique has two major flaws. First, it is unlikely that sedation-induced sleep correlates well with natural sleep. Therefore, the respective mechanisms of snoring may have little in common. Second, there is currently no standardized protocol for sedation. This results in wide variation from individual to individual, between sequential studies on the same individual, and between centres (Camilleri et al, 1995; Quinn et al, 1995; Marais, 1998; Takeda, 1998). Studies standardizing the sedation protocol, allowing assessment of the predictive efficacy of the technique while using acoustic analysis of the snoring sound as an objective measurement of surgical outcome, are currently ongoing.

Acoustic analysis

Since the early 1990s, interest in the acoustic analysis of the snoring sound has developed. Acoustic techniques have been used in an effort to create theoretical models of snoring sound production (Gavriely and Jensen, 1993; Beck et al, 1995). Additionally, snoring sound has been used to diagnose OSAS (Perez-Padilla et al, 1993; McCombe et al, 1995; Fiz et al, 1996) as an objective outcome measurement of snoring surgery (Prichard et al, 1995; Smithson et al, 1995; Walker et al, 1996), and in an attempt to differentiate the underlying mechanism of sound generation (Weingarten and Raviv, 1995; Quinn et al, 1996). To date, although showing great promise, these techniques have had only limited success.

The ultimate goal is the identification of the acoustic characteristics of palatal flutter. It would then be possible to screen the individual's natural snoring pattern for the relative composition of palatal flutter, providing a measurable index that can be used to predict surgical outcome.

CONCLUSIONS

Although snoring surgery is widely undertaken in this country, many fundamental questions still need to be answered. Better methods of targeting the surgery need to be developed as an initial failure rate of 20–30% is unacceptable. Acoustic analysis of the snoring sound appears the most promising strategy at present.

Despite a plethora of surgical techniques, very few, if any, have been rigorously validated, especially in the long term. There is an urgent need for well designed, randomized, controlled, clinical trials, with objective outcome measures and long-term follow up. Only after these have been completed will it prove possible to assess the true worth of snoring surgery. **HM**

KEY POINTS

- Surgery to overcome snoring is now widespread in the Western world.
- Many different techniques have been developed.
- Few if any have been fully validated, especially in the long term.
- Much current research attempts to develop methods to target snoring surgery more effectively.

Conflict of interest: none.

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