

# Tongue base suspension technique in obstructive sleep apnea: personal experience

## *Ruolo della sospensione linguale nel trattamento chirurgico della sindrome delle apnee ostruttive nel sonno: nostra esperienza*

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### Key words

Obstructive sleep apnea • Multilevel obstruction • Tongue base suspension

### Parole chiave

OSAS • Ostruzione multilivello • Sospensione linguale

### Summary

Tongue suspension with Kit Repose<sup>TM</sup> is a surgical mini-invasive end-oral technique used in treatment of rear tongue obstruction. The base of the tongue is anchored with a non-reabsorbable suture, held in place with a titanium screw, to the mandible in correspondence to the geni apophysis of the mandible; this loop should prevent the tongue, during sleep, from dropping backwards, favoured also by gravity and hypotonicity of the genioglossus muscle. Aim of this report is to focus on the results of our experience in 15 patients presenting obstructive sleep apnea submitted to uvulopalatopharyngoplasty associated with tongue suspension, using the Kit Response bone screw system (Influent Inc., San Francisco, CA, USA). Mean age of patients was 50.5 years (range 36-66), with mean RDI (apnoea/hypopnea index) of 44.47 (range 23-63) and mean body mass index of 28.27 (range 22.6-34.4). Scrupulous clinical evaluation, including endoscopy and cephalometry, revealed a pharyngeal obstruction both retro palatal and retro lingual. Clinical and polysomnographic examinations were carried out 4-6 months after surgery. Patients were considered responders if the RDI had decreased by 50% and below 20, with disappearance of subjective symptoms (snoring, daytime sleepiness). Polysomnographic examination showed, overall, good results with mean reduction of RDI from 44.5 to 24.2 (45% reduction); albeit, only 6 cases could be considered surgically successful; 4 cases (26.6%) showed improvement whereas the remaining 5 (33.4%) failed to present any significant change in RDI. Even if the technique was, indeed, mini-invasive, rapidly performed and lacked significant complications, the results were not, in our opinion, encouraging, bearing in mind the high cost of the kit and limited stability of the results over time. Better results can be obtained by advancement of the genioglossus associated with hyoid suspension, whereas, of the mini-invasive techniques, promising outcomes would appear feasible with reduction of volume at the base of the tongue, using radiofrequency.

### Riassunto

*La tecnica della sospensione linguale con Kit Repose è una metodica chirurgica endorale mini-invasiva per il trattamento dell'ostruzione retrolinguale: essa comporta l'ancoraggio della base linguale alla mandibola per mezzo di un'ansa di filo non riassorbibile fissata con una vite in titanio in corrispondenza dell'apofisi geni della mandibola; tale ansa deve limitare, durante il sonno, la caduta posteriore della lingua favorita dalla gravità e dalla ipotonicità del muscolo genioglossa. Scopo di questo studio è quello di riportare i risultati della nostra esperienza relativa ad un gruppo di 15 pazienti affetti da sindrome delle apnee ostruttive nel sonno, sottoposti ad intervento chirurgico combinato di uvulopalatofaringoplastica e sospensione linguale (utilizzando il Kit Repose<sup>TM</sup> bone screw system – Influent Inc., San Francisco, CA, USA). L'età media dei pazienti era di 50,5 anni (range 36-66) con RDI (indice di apnea/ipopnea) medio di 44,47 (range 23-63) e BMI (indice di massa corporea) medio di 28,27 (range 22,6-34,4). Un'accurata valutazione clinica, endoscopica e cefalometrica documentava la presenza di ostruzione faringea sia retropalatale che retrolinguale. A distanza di 4-6 mesi dall'intervento è stato effettuato un controllo sia clinico che polisomnografico: sono stati considerati responders i pazienti che presentavano un indice dell'RDI ridotto del 50% e al di sotto di 20 ed una scomparsa dei sintomi soggettivi (russamento, sonnolenza diurna). Il controllo polisomnografico ha dimostrato complessivamente un buon risultato con una riduzione dell'RDI medio da 44,5 a 24,2 (riduzione del 45%); tuttavia solo 6 casi (40%) potevano essere considerati successi chirurgici; 4 casi (26,6%) risultavano migliorati mentre nei rimanenti 5 (33,4%) non si è avuta una significativa variazione dell'RDI. Sebbene la tecnica si sia dimostrata miniinvasiva, di veloce esecuzione e non gravata da significative complicanze, i risultati non sono a nostro giudizio incoraggianti tenuto anche conto del costo elevato del kit e della limitata stabilità nel tempo dei risultati. Risultati migliori sono ottenibili con l'avanzamento genioglossa in associazione alla sospensione ioidea, mentre tra le tecniche mini-invasive, buone prospettive sembrano aprirsi per la riduzione volumetrica della base linguale mediante uso di radiofrequenze.*

## Introduction

Obstructive sleep apnea (OSA) syndrome, a complex disease of multifactorial origin, is characterised by the presence of repeated episodes of airway obstruction at pharyngeal level during sleep<sup>1</sup>. Repeated obstructive events throughout the night cause changes in the sleep pattern which, in turn, leads to daytime sleepiness, lack of concentration and memory, as well as hypoxigenation- resulting in blood hypertension and increased risk of cardiovascular events<sup>2,3</sup>.

Whilst the pathogenesis of the obstructive phenomenon remains to be fully elucidated, it is generally accepted that morphological changes (micrognathia, macrogloxy, hypertrophy of the tonsils, lengthening of the soft palate) determine a reduction in calibre of the epilaryngeal airways<sup>4-6</sup>; these anatomic anomalies, in predisposed subjects, affect, over time, functional deterioration of the dilated muscles of the pharynx<sup>7</sup>. At hypopharyngeal level, anomalies of the hyoid-lingual complex with rear position and the vertical position of the tongue or frank macrogloxy (frequent, particularly in obese patients) play an important role in the development of obstructive apnoea. This is supported by the finding that >50% of OSA patients present retro-lingual collapse<sup>8</sup>, and that, in severe OSA, pharyngeal obstruction is almost always due to tongue abnormalities<sup>9</sup>.

These findings would explain why, since the mid 1980's, once the therapeutic limits of uvulopalatopharyngoplasty (UPPP) alone had been established, also in those patients who, at endoscopy and cephalometry, presented prevalently oropharyngeal obstruction, numerous surgical techniques have been proposed to effectively overcome, retro-lingual obstruction.

These procedures tend to produce, with various approaches, an increase in the retro-lingual air space during sleep, or through reduction in the volume of the tongue base (laser midline glossectomy, lingualplasty, lingual tonsillectomy, reduction of the volume with radiofrequency)<sup>10-13</sup> or by applying tension to the walls delimiting the hypopharyngeal arial lumen (hyoid suspension, genioglossus advancement)<sup>14</sup>; these are invasive procedures, not without risk of severe complications and which may, in some cases, require a temporary tracheostomy.

De Rowe et al.<sup>15</sup> recently proposed a mini-invasive technique for the treatment of retrolingual obstruction based upon the use of the Kit Repose™ bone screw system (Influent Inc., San Francisco, CA, USA). This is an endoral technique in which suspension of the base of the tongue to the mandible is effected by means of a non-absorbable suture loop anchored to a titanium self-tapping screw inserted, with the aid of a disposable drill, in correspondence to the geni apophysis of the mandible; aim of this loop is to

prevent the tongue, during sleep, from falling backwards, being aided by gravity and hypotonicity of the genioglossus muscle (Fig. 1).

Aim of the present report is to describe our experience in the use of this surgical technique which we have performed in association with UPPP.

## Patients and methods

Between January 2000 and December 2001, 15 male patients presenting with OSAs have been submitted to UPPP associated with tongue suspension, using Kit Repose™ bone screw system.

The following investigations were carried out, in all patients, prior to surgery: 1) ORL physical examination with classification of the obstructive oropharyngeal pattern according to the modified Mallampati classification and staging of tonsil volume from 0 to 4<sup>16</sup>; 2) teleradiographic examination of the skull to determine cephalometric measurements according to the Stanford protocol<sup>17</sup> (SNA, SNB, PNS-P, PAS, MPH); 3) fibroscopy of the upper digestive-airways with Muller manoeuvre: the examination was performed with a flexible fibroscope with the patient in the supine position; the Muller manoeuvre is performed at retro-palatal and retro-lingual level; 4) evaluation of nasal respiratory function with active anterior rhinomanometry; 5) night polysomnography, performed using an outpatient technique (Embletta, Polymesam) and use of a questionnaire to determine the degree of daytime sleepiness [Epworth Sleepiness Scale (ESS)]. The main anthropomorphic and polysomnographic features of all patients are shown in Table I.

In the post-operative period, patients were monitored, in bed, by means of pulsioximetry for 24 hours. A nasopharyngeal tube was also introduced to improve clearance of the upper airways also in the event of marked palatal oedema<sup>18</sup>.

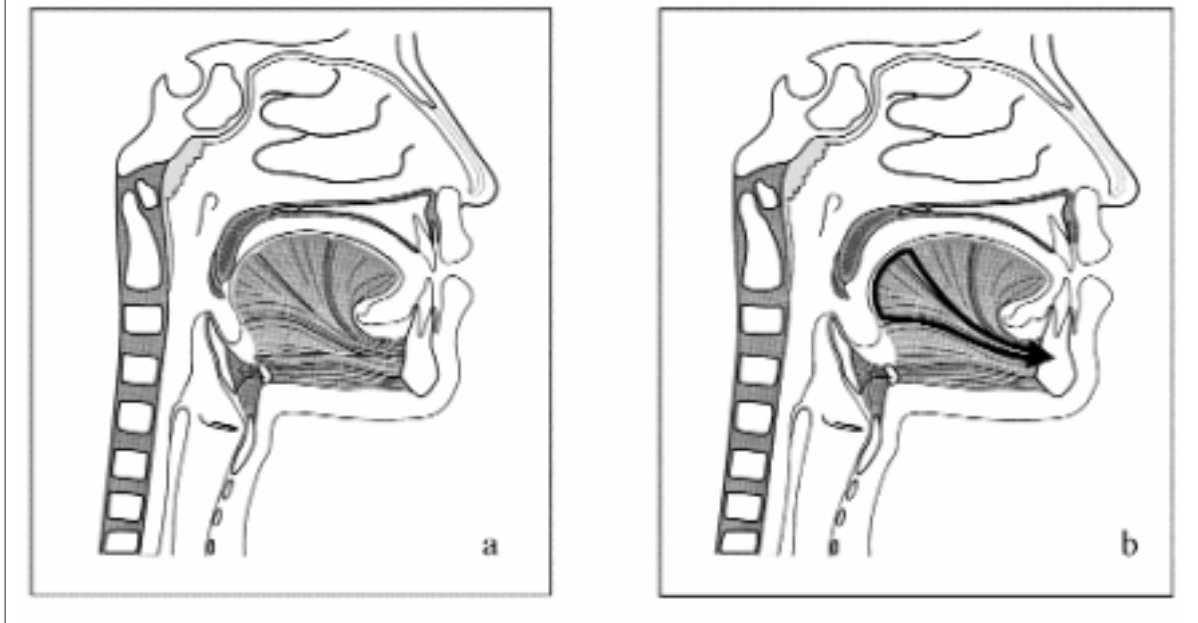
Approximately 3 months after surgery, endoscopic and radiological examinations (teleradiography of the skull in lateral projection) were carried out in all patients; on this occasion, patients and their partners were asked to complete a questionnaire in order to evaluate subjective results of the treatment procedure, including also ESS.

A repeat polysomnographic examination was carried out 4-6 months after surgery. Successful outcome of surgery was established according to the following criteria: RDI reduced by 50% or less than 20; disappearance of subjective symptoms (sleepiness, snoring).

Statistically significant differences between morphometric and polysomnographic parameters were evaluated using a t-test for paired data in responders and non-responders.

UPPP was always associated with tonsillectomy ac-

Fig. 1. Diagram shows tongue suspension technique with repose kit: a) before surgery; b) after surgery



according to Fairbanks' technique<sup>19</sup> in order to achieve a rectangular profile of the palate with a considerable and stable increase in the transversal and antero-posterior diameters of the oropharyngeal air lumen. Tongue suspension was always performed by the same surgeon; the suture passing through the tongue was fixed in such a way as to obtain considerable depression of the base of the tongue (Fig. 1).

For hypopharyngeal stabilisation, choice of the tongue suspension procedure, as opposed to genioglossus advancement + hyoid suspension, was made according to the following criteria: presence of a 'moderate' retro-lingual obstruction revealed at rhinopharyngoscopic examination with the Muller manoeuvre (2+/3+ with pattern of antero-posterior collapse), absence of frank macroglossia evaluated according to the modified Mallampati classification, and cephalometric examination (PAS, MP-H), absence of a significant mandible retrusion (SNB >77°), presence of contraindications of an odontostomatologic type (edentulia, severe gum disease) to genioglossus advancement.

## Results

Mean age of the patients was 50.5 years (range 36-66) with a mean RDI of 44.47 (range 23-63) and a mean BMI of 28.27 (range 22.6-34.4). The mean

ESS value was 11.2 (range 7-14). All patients were found to have both retro-palatal and retro-lingual obstruction (type II obstruction according to the classification of Fujita)<sup>20</sup>.

In 4 cases, impaired nasal respiratory function was also present: these patients were submitted to septoplasty and/or decongestion of the turbinates, 2 months after surgical treatment.

None of the patients presented any significant respiratory impairment or any significant complications related to the surgical procedure, in the immediate post-operative period. Prophylactic antibiotic treatment was given for 6 days. Post-operative pain, which was slightly more marked than that related to UPPP alone, was successfully treated with non-steroidal anti-inflammatory drugs (NSAIDs); none of the patients complained of marked dysphagia (semi-liquid diet for the first 3-4 days with complete return to normal eating per os within 5-6 days). Mean hospitalisation was 3.4 days (range 2-5).

Endoscopy and cephalometry revealed, in all patients, good stabilisation of the surgical outcomes.

Subjective results also appeared to be satisfactory: indeed, in 12 cases (80%), the patients and their partners reported a marked decrease in snoring and apnoea, an improvement in the quality of sleep with less daytime sleepiness (ESS=6.6, range 5-9); furthermore, no swallowing disorders or speech difficulties were reported.

Table I. Patients features.

Pt	Age (yrs)	Sex	Preoperative data						Postoperative data								
			BMI	Pas	Tonsillar volume <sup>*</sup>	Muller rp <sup>†</sup>	Degree of macroglossia <sup>‡</sup>	Muller rl <sup>§</sup>	RDI	saO <sub>2</sub> min	ESS	BMI	Pas	RDI	saO <sub>2</sub> min	ESS	
BS	51	m	23.8	7	1	2	2	2	2	23	81%	9	23.8	8	22	90%	6
LS	55	m	22.6	7	0	2	2	2	2	26	85%	12	22.6	8	2	91%	5
PO	64	m	30.7	7	0	2	2	3	3	26	86%	7	30.9	7	36	88%	6
MS	43	m	26.4	10	1	2	2	3	2	34	87%	13	26.0	11	30	86%	5
BA	57	m	27.4	9	1	2	2	2	3	35	86%	9	27.4	11	16	88%	6
NF	45	m	29.6	11	1	2	2	3	2	39	85%	11	29.6	11	26	85%	5
GC	49	m	28.3	7	1	2	2	3	2	36	77%	10	26.9	9	20	89%	7
MP	41	m	33.5	9	3	3	3	3	3	43	75%	10	33.5	12	7	86%	8
CE	66	m	27.3	7	1	2	2	2	2	44	74%	14	27.3	9	52	90%	8
LM	65	m	25.5	8	2	4	3	3	3	55	80%	11	25.8	8	14	85%	5
MA	46	m	28.7	10	2	3	2	2	2	56	79%	13	29.0	10	26	84%	6
DN	36	m	28.0	11	3	4	2	2	2	62	72%	11	27.7	10	15	77%	7
RS	37	m	34.4	10	2	4	4	3	3	62	74%	13	35.2	12	7	73%	8
ML	63	m	30.8	9	2	4	4	3	3	63	72%	12	30.1	10	60	78%	8
CG	40	m	27.0	12	2	2	2	2	3	63	73%	14	27.0	12	31	83%	9

\* Grade 0: tonsillectomy scar

Grade 1: intrapillar tonsils

Grade 2: tonsils approaching the anterior pillar

Grade 3: tonsils occupy 3/4 of pharyngeal space

Grade 4: tonsils obstructing the aero-digestive tract

† (modified Mallampati classification)

Grade 1: tonsils, pillars and soft palate are not clearly visible

Grade 2: uvula, pillars and superior pole, all visible

Grade 3: only part of the soft palate is visible; pillars and the base of the uvula are not visible

Grade 4: only the hard palate is visible

‡ Muller rp (retropalatal)

§ Muller rl (retrolingual)

Polysonnographic control revealed, overall, a good result with a reduction in mean RDI from 44.5 to 24.2 (45% reduction); nonetheless, only 6 cases (40%) could be considered surgically successful; 4 patients (26.6%) showed improvement whereas in the remaining 5 (33.4%), there was no significant variation in the RDI. A success rate of 40% was, therefore, obtained. No statistically significant differences were observed with the t test ( $p>0.5$ ) between responders and non-responders, as far as concerns morphometric and polysonnographic parameters. Of the 12 patients, 3 reported reappearance of snoring 1 year after treatment.

## Discussion

Ventilatory treatment via the nose, at a positive continuous pressure (n-Cpap), is still the therapy of choice in patients presenting moderate to severe OSA with a tendency to diffuse collapse of the oro-hypopharyngeal segment<sup>21</sup>. Compliance to this technique is, however, somewhat limited with 20% of patients refusing this form of treatment from the onset, whilst those who accept to undergo this type of treatment (i.e., 54-85%) do not use it properly<sup>22,23</sup>. It is thus necessary to offer the patient an alternative surgical procedure to control episodes of apnoea during sleep which would be acceptable, not only in terms of invasiveness but also risk of complications. Choice of surgical protocol is not an easy task, bearing in mind the numerous variables influencing the possibility of pharyngeal collapse during sleep. Indeed, it should not be forgotten that the evaluations that we carry out "photograph" the upper airways whilst the patient is awake, whilst during sleep, the relationship of the various structures (tongue, soft palate, pharyngeal walls) may change, thus, in turn, resulting in a change in the obstructive pattern. Uvulopalatopharyngoplasty alone, described by Fujita in 1981<sup>20</sup>, has been shown to be effective to correct snoring but the success rate as far as concerns OSA varies considerably. Sher et al.<sup>24</sup>, in a meta-analysis, observed a 40% success rate in non-selected patients; in patients with isolated retro-palatal obstruction, the success rate reaches >50%, whilst in those presenting also significant retro-lingual obstruction the success rate may show a significant fall.

On account of the poor success rate of UPPP, due, in most cases, to collapse of the retro-lingual segment, attempts were made to develop surgical techniques which would prove efficacious also at this level. Riley et al.<sup>17</sup> described a 2-stage surgical procedure: in phase I, UPPP was carried out associated with genioglossus advancement and hyoid suspension; with

this procedure, they reported a success rate varying between 60% and 80%<sup>25</sup>. In phase II, consisting in maxillo-mandible advancement, the surgical approach is much more aggressive with a success rate of around 95%<sup>24-27</sup>. Phase I with the Stanford protocol thus leads to very good results in the management of OSA, albeit other centres<sup>26</sup> have reported far less satisfactory results.

In 1997, De Rowe et al.<sup>15</sup> introduced a new mini-invasive technique, which was both easily and rapidly carried out in the treatment of the hypopharyngeal collapse with the suspension of the tongue base to the mandible. Few data are available in the literature regarding use of this technique. In the original study of De Rowe et al.<sup>15</sup>, on 16 patients submitted exclusively to tongue suspension, a considerable improvement was achieved in the quality of sleep, with a significant reduction in the grade of snoring and a reduction in RDI of 51.4%; 8 patients (50%) obtained a post-operative RDI <20. In 2001, Woodson et al.<sup>28</sup>, in a series of 39 patients with isolated retro-lingual collapse treated with the tongue suspension procedure alone, reported good subjective results at 1-2 months after surgery. Complications related to surgery were observed in 18% (sialoadenitis, phlegmon and haematoma of the oral cavity floor).

In the present study, the role of tongue suspension performed in association with UPPP has been evaluated in a series of patients presenting retro-palatal and retro-lingual obstruction; as in all studies concerning surgery at various levels also in the present case, it is not easy to evaluate the results related to the single surgical procedure. Terris and Kunda<sup>29</sup> had also previously carried out a similar study in a group of 12 patients, reporting a decrease from 32.2 to 14.4 in RDI (51.7% reduction) and a success rate of 67%. Miller et al.<sup>30</sup> in a study on 15 patients reported a reduction of 46% in RDI (pre-operative RDI=38.7, post-operative RDI=21) with a success rate of 20%. Also in this case, the incidence of complications was particularly high (26%). In the present study, the success rate was 40% (6/15 patients) with a mean reduction in RDI of 45% (range 44.4-24.26). No statistically significant difference was observed, in morphometric and polysonnographic parameters, between responders and non-responders. No important complications related to surgery were observed: the most significant untoward effects were, first of all, pain, then "pharyngeal discomfort" due to UPPP; in none of the cases was it necessary to remove the suture. One year after surgery, positive subjective results have dropped from 80% to 65% on account of recurrence of snoring, probably due to the fact that the effectiveness of the suture used to stabilise the tongue is reduced over time.



## Conclusions

Results of the surgical technique in the stabilisation of the tongue by means of Kit Repose in association with UPPP, in the present series, are rather poor also bearing in mind that these were selected patients with a not particularly severe retro-lingual obstruction. Even if the technique is mini-invasive as well as rapidly carried out and not hampered by important complications, the results are not unlike those obtained with UPPP + tonsillectomy alone and, moreover, are inferior with respect to those reported with genioglossus advancement in association with hyoid suspension<sup>31</sup>. Furthermore, the high cost of the Kit should not be overlooked, as well as the poor stability, over time, of the suspension effect exerted by the suture, due to the traumatic effects on the tongue muscles.

These data, as well as, indeed, those available in the literature would appear to suggest that the role of lin-

gual suspension in the overall panorama of surgical management of OSA is somewhat limited. This technique may be employed to improve retro-lingual obstruction in cases in which RDI is not increased (RDI <30) and in those patients in whom genioglossus advancement is not feasible. The latter technique, associated with hyoid suspension, is the technique of choice for hypopharyngeal stabilisation particularly in non obese patients, with <40 RDI and negligible skeletal disorders of the face<sup>32</sup>. In patients with severe OSA, the surgical solution of the retrolingual obstruction is feasible either with maxillomandibular advancement or with resection of the tongue base; these are definitely effective surgical procedures, even if extremely invasive and hampered by significant post-operative morbidity<sup>33</sup>. Finally, as far as concerns mini-invasive techniques, promising results would appear to be forthcoming with the use of radiofrequency, in reducing the volume of the base of the tongue<sup>29</sup>.

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