Transpalatal Advancement Pharyngoplasty for Obstructive Sleep Apnea Syndrome

Results and Analysis of Failures

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Objective: To assess the polysomnographic outcomes of patients with obstructive sleep apnea undergoing transpalatal advancement pharyngoplasty for retropalatal collapse and to compare responders with nonresponders to surgery.

Design: Retrospective medical record review.

Setting: Tertiary referral teaching hospital and private practice.

Patients: Sixty patients undergoing transpalatal advancement pharyngoplasty alone at a single sitting with preoperative and postoperative sleep studies were reviewed.

Intervention: Transpalatal advancement pharyngoplasty.

Main Outcome Measures: Preoperative and postoperative polysomnographic data were analyzed and comparisons were assessed between responders and nonresponders.

Results: Following surgery, the mean (SD) respiratory disturbance index (RDI) decreased from 37.2 (20.4) to 15.4 (12.3), with an overall change of 21.8 (21.8) (95% confidence interval [CI], 16.2-27.4). Similarly, the mean (SD) arterial oxygen saturation nadir after transpalatal advancement pharyngoplasty surgery improved from 83.9% (5.4%) to 87.4% (4.3%), with an overall change of 3.5% (5.9%) (95% CI, 2.0%-5.0%). Between the traditional Gothic arch incision (n=31) and the propeller incision (n=29) an observed 31% (95% CI, 7%-51%) difference in success rate in favor of the latter was noted.

Conclusions: Transpalatal advancement pharyngoplasty appears to be an effective and safe treatment option in selected patients. No preoperative variable was associated with surgical success in this study. The association of the propeller incision and surgical success requires further analysis.


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ONTINUOUS POSITIVE AIR

way pressure (CPAP) venti-

lation has been the treat-

ment of choice for obstruc-

tive sleep apnea syn-

drome (OSAS) since its introduction by Sullivan et al in 1981. Although it is a safe and effective therapy, it has several draw-

backs including discomfort or skin irri-

tation from the mask, dry or stuffy nose, and eye irritation. Such complications result in compliance rates of between 50% and 70%, even in patients with successful ame-

lioration of OSAS symptoms by using CPAP ventilation. Patients with OSAS who cannot tolerate or refuse CPAP therapy may be considered for surgical treatment.

Surgery for OSAS has evolved greatly in the years since uvulopalatopharyngoplasty (UP3) was first described by Fujita et al. The current surgical approach to OSAS is based on the understanding that the oropharynx is the dominant area of ob-

struction, which may be broadly subdi-

vided into retropalatal, retrolingual, and lateral pharyngeal wall collapse. Transpalatal advancement pharyngoplasty (TPA) is a surgical procedure aimed at addressing obstruction at the retropalatal level. It has been shown to result in a larger postoperative retropalatal cross-

sectional area and a greater reduction in respiratory disturbance index (RDI) than UP3 alone. However, to our knowl-

edge, no study to date has reported the re-

sults of a large cohort of patients exclu-

sively undergoing TPA without additional multilevel procedures.

The aim of the present study was to re-

view the polysomnographic outcomes of pa-

tients with OSAS who had undergone TPA surgery and to compare the preoperative and perioperative features of responders and nonresponders to treatment.
METHODS

PATIENTS

Patients referred to the study institutions for assessment were only offered surgery if they had (1) sleep study–documented OSAS; (2) had a full-overnight sleep evaluation by a physician; (3) had refused to undergo or could not tolerate CPAP therapy; and (4) had a body mass index (BMI) lower than 40 (calculated as weight in kilograms divided by height in meters squared). Initial surgical assessment included inter alia, history of oropharyngeal surgery, full physical examination of the upper aerodigestive tract including flexible endoscopic examination (including Muller maneuver), measurement of BMI, and sleep nasendoscopy. All patients with putative retropalatal obstruction and fulfilling the aforementioned criteria were offered TPA surgery. Those patients with additional potential retrolingual obstruction were offered multi-level surgery, generally staged to address the retrolingual obstruction following TPA and follow-up sleep study. Occasionally, and usually at patient request, multi-level single-sitting surgery may be performed. The staged procedure is now our standard approach to multilevel disease.

A prospectively maintained database of all patients undergoing surgery by either of 2 surgeons for OSAS at Royal Perth Hospital, Perth, Australia (N.P.S. and R.H.L.), and a private practice setting (R.H.L.) from February 2002 (when the TPA was first performed by the senior author [R.H.L.]) to October 2006 was reviewed.

All patients had sleep-study documented OSAS. Only patients undergoing TPA were considered for this study. Inclusion criteria were that patients (1) had sleep study–documented OSAS results available for review; (2) had undergone TPA alone at a single operative sitting; and (3) had postoperative (TPA) sleep study results available for review. Exclusion criteria were that patients (1) had undergone multilevel surgery at the same sitting as TPA; (2) had no follow-up sleep study results available for analysis; (3) had no postoperative sleep study results available for review; and (4) had no operative notes confirming single-level TPA surgery.

Variables recorded preoperatively in patient medical records included patient demographic data, history of previous oropharyngeal surgery, smoking history, and BMI. A variety of techniques were used to assess the level(s) of obstruction including anatomical configuration, modified Malampatti score, and sleep nasendoscopy, and although the findings from these investigations did not always concur with each other, the surgeons’ opinion at the time whether multilevel disease was present was recorded. Body mass index was also recorded postoperatively, and sleep nasendoscopy. All patients had sleep-study documented OSAS. Only patients undergoing TPA were considered for this study. Inclusion criteria were that patients (1) had sleep study–documented OSAS results available for review; (2) had undergone TPA alone at a single operative sitting; and (3) had postoperative (TPA) sleep study results available for review. Exclusion criteria were that patients (1) had undergone multilevel surgery at the same sitting as TPA; (2) had no follow-up sleep study results available for analysis; (3) had no postoperative sleep study results available for review; and (4) had no operative notes confirming single-level TPA surgery.

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POLYSOMNOGRAPHY

All patients had undergone full-overnight polysomnography preoperatively and between 3 and 6 months postoperatively, which was performed and interpreted by a respiratory physician with a special interest in sleep medicine. Surgical success was defined as a postoperative RDI of lower than 20 and a reduction of 50% or higher from the preoperative RDI. Improvement was defined as a positive change in disease severity stratification. Based on the RDI, OSAS severity was stratified as follows: mild, 5 to less than 15; moderate, 15 to less than 30; and severe, 30 or higher. Cure was defined as a postoperative RDI of 5 or less. Nonresponders to treatment were defined as those patients not achieving surgical success.

STATISTICAL ANALYSIS

Statistical analysis was undertaken using SPSS version 14.0 (SPSS Inc, Chicago, Illinois). A paired t test was used to compare preoperative and postoperative polysomnographic results and BMI data. Categorical variables were analyzed using chi-square and Fisher exact tests. Continuous variables were compared using the Mann-Whitney test. P < .05 was considered statistically significant. When appropriate, 95% confidence intervals (CIs) were calculated. Institutional ethics committee approval for this study was waivered by the ethics committee chairman.

RESULTS

A total of 93 patients who underwent TPA surgery from February 2002 to October 2006 were identified. All patients had full-overnight sleep study–documented OSAS and had either refused or could not tolerate CPAP therapy. Of these 93 patients, 33 were excluded. Reasons for exclusion were multilevel surgery at same sitting (n = 10) and no postoperative polysomnographic results (n = 23). Of the 23 patients without postoperative polysomnographic results, 9 had recent surgery and were awaiting a follow-up sleep study. 7 patients refused follow-up sleep study because of symptom improvement, and 7 did not have documented reasons for not undergoing the study. A total of 60 patients (n = 51 [R.H.L.] and n = 9 [N.P.S.]) were eligible for inclusion in the present study.

There were 55 men and 5 women. Mean age, preoperatively and between 3 and 6 months postoperatively, which was performed and interpreted by a respiratory physician with a special interest in sleep medicine. Surgical success was defined as a postoperative RDI of lower than 20 and a reduction of 50% or higher from the preoperative RDI. Improvement was defined as a positive change in disease severity stratification. Based on the RDI, OSAS severity was stratified as follows: mild, 5 to less than 15; moderate, 15 to less than 30; and severe, 30 or higher. Cure was defined as a postoperative RDI of 5 or less. Nonresponders to treatment were defined as those patients not achieving surgical success.

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There were 55 men and 5 women. Mean age, preoperative BMI, preoperative RDI, and preoperative SaO2 nadir are presented in Table 1. Patients tended to be overweight or borderline obese and had severe OSAS. The presence of important historical and examination findings was noted in the study cohort, of whom 52 had complete data pertaining to these variables (Table 2).
Postoperative polysomnographic parameters of RDI and SaO2 nadir, recorded at follow-up sleep study, were compared with the preoperative values for each patient acting as their own historical control. Following surgery, the mean (SD) RDI dropped from 37.2 (20.4) to 15.4 (12.3), with an overall change of 21.8 (21.8) (95% CI, 16.2 to 27.4). Similarly, the mean (SD) SaO2 nadir after TPA surgery improved from 83.9% (5.4%) to 87.4% (4.3%) (95% CI, −0.05 to 0.81) (Table 3). The overall postoperative BMI of 0.38 (1.66) was noted (95% CI, −0.05 to 0.81) (Table 3). The overall postoperative clinical outcomes were calculated based on the criteria detailed in the preceding section and presented in Table 4. Surgical success occurred in 38 of the 60 patients (63%) in the study cohort, with complete cure of OSAS in 21 patients (35%).

With surgical success as the outcome variable, a categorical analysis was undertaken with regard to preoperative demographic, historical, and clinical variables to identify any associations with outcome (Table 5 and Table 6). No preoperative variable was significantly associated with the outcome of surgery. Data pertaining to the level(s) of obstruction diagnosed preoperatively were available for 52 patients. In those patients undergoing surgery for putative isolated retropalatal disease (n = 33), 23 (70%) had a successful outcome, whereas only 8 of 19 patients (42%) with multilevel disease undergoing the first stage of possible multilevel surgery had a successful outcome, but this difference in success (28% [95% CI, 0% to 51%) failed to reach statistical significance (χ2 test, P = .051). Of the 2 different soft tissue approaches that were used in this study (the traditional Gothic arch incision [n = 31] and the propeller incision [n = 29]), use of the propeller incision was significantly associated with a successful outcome, which was observed in 23 of 29 patients (79%), while use of the Gothic incision resulted in success in only 15 of 31 patients (48%), an observed difference in success rates between incisions of 31% (95% CI, 7% to 51%). A comparison between patients undergoing these 2 different incisions failed to identify any significant differences in terms of the following variables (data given as mean [SD], propeller vs Gothic): age, 46.2 (10.2) years vs 48.6 (9.2) years; preoperative BMI, 29.1 (3.3) vs 29.8 (2.9); preoperative RDI, 35.3 (16.2) vs 38.9 (23.8); preoperative SaO2 nadir, 83.2% (5.5%) vs 84.5% (5.3%); or postoperative BMI, 28.9 (3.2) vs 29.2 (3.1).

Complications noted in the study cohort included 5 oronasal fistulae, all of which closed spontaneously. Of these fistulae, only 1 occurred in a patient who had undergone a propeller incision soft tissue approach. Two patients who underwent tonsillectomy as part of their procedure were readmitted to hospital at 5 and 8 days postoperatively with secondary tonsillar hemorrhages, one of which required operative intervention. Both of these patients subsequently made an uncomplicated recovery. One patient, a nonresponder to surgery, had his airway obstructed during recovery and required an emergency tracheostomy following a failed intubation attempt. The patient was subsequently decannulated without further complication.

**COMMENT**

Transpalatal advancement pharyngoplasty has been shown to increase retropalatal airway size and decrease retropalatal collapsibility compared with UP3 alone.13 To our knowledge, the present series is the largest to date in the literature regarding TPA and the only one to present data

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**Table 1. Preoperative Variables Measured in Overall Study Cohort**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD) (n=60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>47.47 (9.7)</td>
</tr>
<tr>
<td>Pre-BMI</td>
<td>29.45 (3.06)</td>
</tr>
<tr>
<td>Pre-RDI</td>
<td>37.0 (20.4)</td>
</tr>
<tr>
<td>Pre-SaO2</td>
<td>83.9 (5.4)</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); RDI, respiratory disturbance index; SaO2, arterial oxygen saturation.

**Table 2. Historical and Examination Parameters Recorded in Study Cohort**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Patients, No. (%) (n=52)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smokers</td>
<td>7 (14)</td>
</tr>
<tr>
<td>Previous nasal surgery</td>
<td>14 (27)</td>
</tr>
<tr>
<td>Previous tonsillectomy</td>
<td>10 (19)</td>
</tr>
<tr>
<td>Previous UP3</td>
<td>6 (12)</td>
</tr>
<tr>
<td>Possible multilevel collapse</td>
<td>19 (37)</td>
</tr>
</tbody>
</table>

Abbreviation: UP3, uvulopalatopharyngoplasty.

**Table 3. Comparison of Preoperative and Postoperative Polysomnographic and BMI Data**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Before</th>
<th>After</th>
<th>P Valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDI, mean (SD)</td>
<td>37.2 (20.4)</td>
<td>15.4 (12.3)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SaO2 nadir, mean (SD), %</td>
<td>83.9 (5.4)</td>
<td>87.4 (4.3)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>BMI, mean (SD)</td>
<td>29.45 (3.06)</td>
<td>29.06 (3.16)</td>
<td>.09</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); RDI, respiratory disturbance index; SaO2, arterial oxygen saturation.

aPaired t test.

**Table 4. Clinical Outcomes Following TPA Surgery: Overall Cohort, Putative Single Level Retropalatal Disease, and Putative Multilevel Disease Patients**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Total Cohort (n=60)</th>
<th>Single Level Disease (n=41)</th>
<th>Multilevel Disease (n=19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Success</td>
<td>38 (63)</td>
<td>23 (70)</td>
<td>8 (42)</td>
</tr>
<tr>
<td>Improved</td>
<td>43 (72)</td>
<td>26 (79)</td>
<td>10 (53)</td>
</tr>
<tr>
<td>Cure</td>
<td>21 (35)</td>
<td>14 (42)</td>
<td>3 (16)</td>
</tr>
</tbody>
</table>

Abbreviation: TPA, transpalatal advancement pharyngoplasty.
exclusively from patients undergoing TPA without concomitant multilevel surgical procedures, thus eliminating a notable potential confounder. When patients were used as their own historical control, TPA was associated with a statistically significant reduction in RDI and increase in $\text{SaO}_2$ nadir, with a clinically significant surgical success in more than 60% of patients. These data are similar to those reported by Woodson and Toolhill and Woodson et al., the only other studies to our regarding TPA, transpalatal advancement pharyngoplasty.

The results of surgery, in terms of postoperative RDI and overall surgical success, were statistically significantly better in those patients undergoing TPA via the propeller incision approach. The propeller incision was introduced to reduce postoperative oronasal fistula, a transient yet bothersome postoperative complication of TPA surgery. Why this incision is associated with a better outcome in the study cohort is not clear. There are several possible explanations for this. It may be that the propeller incision offers a true advantage over the Gothic arch incision in terms of the geometry of the incision and postoperative scarring; however, it is the bony resection, which is the same regardless of the incision, that improves the retropalatal airway in TPA surgery. It may be that the propeller incision is merely a proxy measure for some other temporally related change in technique. Over the course of the study period, we may have adopted minor alterations in operative technique, resulting in the apparent improvement in the propeller incision cohort (after June 2005). Another possibility is that although the 2 groups of patients were similar in recorded preoperative variables, we have been selecting better patients by some unmeasured parameter(s), thus resulting in better overall outcomes. One further possibility is that an exclusion bias introduced by the study design resulted in the difference between the 2 incisions. Seven patients who refused follow-up sleep study, and hence were excluded from the present study, cited resolution of symptoms and snoring as the reason for refusal. More recently and potentially coinciding with the introduction of the propeller incision, we have insisted on follow-up sleep studies in all patients and informed them preoperatively that this is imperative regardless of symptomatic outcome to confirm disease status. Thus, it may be that more patients were excluded from the study with a successful outcome than those excluded with a poor outcome, thus skewing the results of the study.

This is a retrospective study and is subject to the limitations associated with such studies. The general-

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### Table 5. Comparison of Variables Between Responders and Nonresponders to TPA Surgery

<table>
<thead>
<tr>
<th>Variable</th>
<th>Responders (n=38)</th>
<th>Nonresponders (n=22)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>45.0 (8.9)</td>
<td>49.5 (10.9)</td>
<td>.28</td>
</tr>
<tr>
<td>Pre-RDI, median (range)</td>
<td>31.0 (15-108)</td>
<td>30.0 (16-66)</td>
<td>.98</td>
</tr>
<tr>
<td>Pre-BMI, mean (SD)</td>
<td>29.7 (3.1)</td>
<td>28.4 (3.5)</td>
<td>.21</td>
</tr>
<tr>
<td>Propeller incision, No. (%)</td>
<td>23 (61)</td>
<td>6 (27)</td>
<td>.01</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); RDI, respiratory disturbance index; TPA, transpalatal advancement pharyngoplasty.

*Comparison of preoperative variables between responders and nonresponders to TPA surgery.*

### Table 6. Association of Historical and Clinical Variables With Successful Outcome Following TPA

<table>
<thead>
<tr>
<th>Variable</th>
<th>Responders (n=31)</th>
<th>Nonresponders (n=21)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multilevel disease, No. (%)</td>
<td>8 (26)</td>
<td>11 (52)</td>
<td>.051&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Previous UP3, No. (%)</td>
<td>3 (10)</td>
<td>3 (14)</td>
<td>.67&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Tonsillectomy, No. (%)</td>
<td>7 (23)</td>
<td>3 (14)</td>
<td>.72&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Abbreviations: TPA, transpalatal advancement pharyngoplasty; UP3, uvulopalatopharyngoplasty.

*Comparison of preoperative variables between responders and nonresponders to TPA surgery.*

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<sup>a</sup>Mann-Whitney test.  
<sup>b</sup>Fisher exact test.
izability may be limited by the study design, and the
presented results may reflect outcomes in our practice.
However, it is our opinion that this is a relatively
straightforward procedure with a steep learning curve,
and there is no reason why similar results cannot be
achieved by others. As previously mentioned, selection
bias is inherent in any patient population undergoing
surgery for OSAS. Critics of sleep apnea surgery stud-
ies point out that reduction in disease severity may
merely reflect regression toward the mean rather than
treatment effects. While this phenomenon is well
recognized, it seems unlikely, although impossible to
disprove, that the improvements following surgery in
the present study were due to regression to the mean.
The best study method to control for this is a placebo-
controlled, blinded, randomized controlled trial. Such
studies are extremely difficult to undertake in surgery
general and for palatal surgery in patients with
OSAs, more than likely impossible. The reality is that
such studies may never be undertaken. The criticisms
levelled at research regarding UP3 for OSAS by Schech-
tman et al18 may in part be applied to the present
study in terms of short follow-up, the lack of patient-
based quality of life measures, and nonrandom loss to
follow-up, and these shortcomings should be addressed
ideally in a prospective fashion.

To our knowledge, this is the largest series reported
to date regarding the TPA procedure. It should be
considered in patients in whom conservative manage-
ment has failed and who are willing to undergo sur-
egery to improve the retropalatal airway. The propeller
incision is our soft tissue approach of choice because
it reduces postoperative oronasal fistula, but its effect
on surgical success, while apparently favorable,
remains undetermined.

Submitted for Publication: November 8, 2007; final re-
vision received June 3, 2008; accepted June 22, 2008.
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Author Contributions: Both authors had full access to
all the data in the study and take responsibility for the
integrity of the data and the accuracy of the data
analysis. Study concept and design: Shine and Lewis.
Acquisition of data: Shine and Lewis. Analysis and inter-
pretation of data: Shine. Drafting of the manuscript:
Shine. Critical revision of the manuscript for important
intellectual content: Shine and Lewis. Statistical analy-
sis: Shine. Obtained funding: Lewis. Administrative,
technical, and material support: Shine and Lewis. Study
supervision: Lewis.

Financial Disclosure: None reported.

Previous Presentation: This study was presented at
the Australian Society of Otolaryngology Head Neck
Surgery Annual Meeting; April 2, 2007; Adelaide, South
Australia, Australia.

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