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.


**Continuous Positive Airway Pressure (CPAP) Ventilation** has been the treatment of choice for obstructive sleep apnea syndrome (OSAS) since its introduction by Sullivan et al in 1981. Although it is a safe and effective therapy, it has several drawbacks including discomfort or skin irritation 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 amelioration 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 obstruction, which may be broadly subdivided 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 knowledge, no study to date has reported the results of a large cohort of patients exclusively undergoing TPA without additional multilevel procedures.

The aim of the present study was to review the polysomnographic outcomes of patients with OSAS who had undergone TPA surgery and to compare the preoperative and perioperative features of responders and nonresponders to treatment.
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 Müller 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 multilevel surgery, generally staged to address the retrolingual obstruction following TPA and follow-up sleep study. Occasionally, and usually at patient request, multilevel 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 Malampati 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. A total of 93 patients who underwent TPA surgery from February 2002 to October 2006 were identified. All patients had 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. Multilevel disease was not approached as a single-stage procedure.

SURGERY

In all cases, surgery was performed with general anesthesia requiring orotracheal intubation. Transpalatal advancement pharyngoplasty was always undertaken as an adjunctive procedure to UP3, with or without tonsillectomy, depending on whether the tonsils had been previously removed. To this end, TPA in our practice always includes UP3 (primary or revision) with tonsillectomy if not previously performed. Patients with no history of oropharyngeal surgery had tonsillectomy and UP3 performed initially. The same highly conservative UP3 technique was used by both surgeons, using a lateral incision from the root of the uvula to the junction of the palatoglossus muscle and the soft palate rim by monopolar needlepoint electrocautery. The superior portion of palatopharyngeus muscle is incised and separated from the soft palate. The palatopharyngeus is then advanced anterolaterally to the apex of the superior palatoglossus, thus giving the soft palate a squared-off geometry. The uvula is then trimmed, thereby completing the UP3. Patients who had previously undergone UP3 had this revised to achieve a similar anatomy to the result of the previously described procedure. Transpalatal advancement pharyngoplasty was performed in the same fashion as described by Woodson.10 Since July 2005, we have used a modified trifurcated incision, termed the propeller incision.12

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 χ2 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 waived 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, 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 \( \text{SaO}_2 \) 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) \( \text{SaO}_2 \) nadir after TPA surgery improved from 83.9% (5.4%) to 87.4% (4.3%), with an overall change of 3.5% (5.9%) (95% CI, 16.2 to 27.4). A small, nonsignificant reduction in mean (SD) 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 (\( \chi^2 \) 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]).

### 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; \( \text{SaO}_2 \), 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 Mean (SD)</th>
<th>After Mean (SD)</th>
<th>( P ) Value</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>( \text{SaO}_2 ) 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; \( \text{SaO}_2 \), arterial oxygen saturation.

### 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.

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

mixed results. No current criterion standard tech-

ey, sleep nasendoscopy, and the Müller maneuver with cal success in more than 60% of patients. These data are of obstruction are secondary to the palatal obstruction. be the dominant level of obstruction or that other levels who respond favorably to TPA surgery, the palate may identified but that in those patients with multilevel collapse in all patients and informed them preoperatively that this is imperative regardless of symptomatic outcome to con-

While the majority of patients experienced a reduc-
tion in RDI, this may not have been of sufficient magni-
tude to improve disease stratification or be considered a surgical success. Ideally, identification of these nonre-
sponders to treatment prior to embarking on surgery would spare potential nonresponders the morbidity of an ineffective procedure and improve surgical results over-

neither disease severity nor obesity was associated with the outcome of surgery. In the present study, ne-

erative possible explanations for this. It may be that the pro-
peller incision offers a true advantage over the Gothic arch incision in terms of the geometry of the incision and post-
operative 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 pro-
peller 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 alter-

Alternatively, a larger cohort may reveal that there is indeed a significant association between multilevel disease and surgical failure. Regardless of the explanation, in those patients with putative multilevel collapse, TPA may be sufficient surgical treatment. It is our current prac-
tice not to perform single-sitting multilevel surgery, favoring a staged approach with TPA as the initial pro-
dure followed by interval sleep study prior to embarking on further surgery.

The results of surgery, in terms of postoperative RDI and overall surgical success, were statistically signifi-
cantly better in those patients undergoing TPA via the propeller incision approach. The propeller incision was introduced to reduce postoperative oronasal fistula, a tran-
sient 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 pro-
peller incision offers a true advantage over the Gothic arch incision in terms of the geometry of the incision and post-
operative 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 pro-
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from the present study, cited resolution of symptoms and snoring as the reason for refusal. More recently and po-
tentially coinciding with the introduction of the propel-
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sient 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 prop-
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peller 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 alter-

While in the present cohort, a trend toward an association between multilevel collapse identified preoperatively and an unsuccessful outcome was noted, it failed to reach statistical significance. This lack of an association in the present study may be related to inaccurate preoperative evaluations of the levels of ob-

exclusively from patients undergoing TPA without con-
comitant multilevel surgical procedures, thus eliminat-
ing a notable potential confounder. When patients were used as their own historical control, TPA was associated with a statistically significant reduction in RDI and in-
crease in SaO2 nadir, with a clinically significant surgi-
cal 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 polysomnographic outcomes of TPA surgery.

unidentified presence of multilevel disease or tech-
tical failure at the palate itself. The expectation in per-
foming TPA surgery is to minimize failure at the level of the palate. Hence, the logical conclusion would be that failures in TPA surgery are more likely due to the presence of multilevel disease. Unfortunately, the accurate identification of multilevel disease preoperatively has proven to be difficult. A wide variety of diagnostic tech-

The results of surgery, in terms of postoperative RDI and overall surgical success, were statistically signifi-
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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.

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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>.051a</td>
</tr>
<tr>
<td>Previous UP3, No. (%)</td>
<td>3 (10)</td>
<td>3 (14)</td>
<td>.67b</td>
</tr>
<tr>
<td>Tonsillectomy, No. (%)</td>
<td>7 (23)</td>
<td>3 (14)</td>
<td>.72b</td>
</tr>
</tbody>
</table>

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

a Mann-Whitney test.  
b 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 studies 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 in 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 leveled at research regarding UP3 for OSAS by Schechtman et al 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 management has failed and who are willing to undergo surgery 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.

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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 interpretation of data: Shine. Drafting of the manuscript: Shine. Critical revision of the manuscript for important intellectual content: Shine and Lewis. Statistical analysis: Shine. Obtained funding: Lewis. Administrative, technical, and material support: Shine and Lewis. Study supervision: Lewis.

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REFERENCES