

## Complications and Pain in Obstructive Sleep Apnoea – Comparing Single and Multilevel Surgery

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### Abstract

**Introduction:** This study aimed to investigate differences in the complication rate and postoperative pain score between single and multilevel surgery performed on patients with obstructive sleep apnoea. **Materials and Methods:** A retrospective analysis was performed on patients with obstructive sleep apnoea who underwent surgery in a tertiary referral centre over 3 years. Patients who underwent single-level nasal, palatal or tongue surgery were compared with patients who underwent concurrent multilevel surgery of 2 or 3 levels. Complications and the postoperative Visual Analogue Scale pain score were recorded and the outcomes between single and multilevel groups were compared. **Results:** The overall complication rate for patients was 12.6%, 6.7% if only patients requiring intervention were considered. The adjusted odds ratio (OR) for complication rate for patients undergoing multilevel surgery and single-level surgery was 2.76. It was not statistically significant ( $P = 0.053$ ) after adjusting for confounders. There was more pain in patients who underwent multilevel surgery than in the single-level surgery group. **Conclusion:** Concurrent multilevel surgery is a feasible option in patients with multilevel obstruction, especially if they are undergoing palate and tongue surgery, nose and palate surgery or nose and tongue surgery. There may be more complications, though it is not statistically significant. Further studies are required to investigate the differences between single-level nasal surgery and 3-level multilevel surgery. More patients undergoing multilevel surgery than single-level surgery experienced pain. Multilevel surgery patients should have their analgesia reviewed regularly and titrated accordingly.

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**Key words:** Bleeding, Infection, Nose, Palate, Sleep surgery, Snoring, Tongue

### Introduction

Obstructive sleep apnoea (OSA) is a chronic medical problem with potentially serious consequences—increased cardiovascular risk, hypertension and sudden death.<sup>1,2</sup> Lifestyle modification and continuous positive airway pressure (CPAP) are the mainstay of treatment. Many OSA patients have CPAP compliance issues and often undergo surgery as a salvage procedure. As most OSA patients have multilevel obstruction, multilevel surgery (MLS) gives improved outcomes.<sup>3</sup> MLS can be staged to address the obstruction one level at a time, or performed concurrently,

where many levels of obstruction are addressed in the same operative setting. The advantages of concurrent MLS are: 1) single anaesthesia, 2) decreased total length of hospital stay, 3) decreased time away from work, 4) lower cost and 5) shorter postoperative recovery time.<sup>4</sup> However, there is concern that patients will experience increased pain and postoperative complications.<sup>5</sup>

The available literature comparing single-level surgery (SLS) and MLS is difficult to interpret. Firstly, surgical techniques such as lateral pharyngoplasty, transoral robotic tongue base reduction (TORS) and genial tubercle

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advancement (GTA) are often excluded. Secondly, inclusion criteria are different. Some groups only include OSA patients while others have both OSA and non-OSA patients.<sup>4,5</sup> Thirdly, the outcome measures are different. Some studies analysed patients based on the total number of procedures, instead of the number of levels of intervention. There is also limited data comparing postoperative pain in SLS and MLS patients. A literature search using the keywords 'OSA' and 'pain' did not yield any results. We are of the opinion that complications should be analysed according to levels as patients are treated based on their levels of obstruction. Therefore, the objective of this retrospective study is to investigate the differences in postoperative complications and Visual Analogue Scale (VAS) pain score between SLS and MLS performed on patients with OSA.

## Materials and Methods

### *Study Design*

We performed a retrospective review of all patients who underwent elective sleep surgery from January 2011 to December 2013 in an academic tertiary referral centre—the largest hospital in the country with 1597 beds and an annual average of 80,859 surgical operations. Only patients diagnosed with OSA were included and all had either declined or failed CPAP use. Diagnosis of OSA was made following a level 1 in-laboratory attended polysomnogram performed according to the American Association of Sleep Medicine guidelines for overnight polysomnogram. The criteria for apnoea and hypopnoea were defined according to the American Academy of Sleep Medicine guidelines and scoring manual.<sup>6</sup> The following information was collected from the cohort: age, gender, type of anaesthesia, race, body mass index, systolic and diastolic blood pressure, smoking history, alcohol consumption, lowest level of saturation during sleep study, apnoea-hypopnoea index, the immediate postoperative VAS pain score, surgical procedure/s performed, and complications occurring within the first 30 days of surgery. The review of medical records was approved by the Institutional Review Board.

### *Surgical Procedure*

The level of obstruction was determined after in-office oral and nasoendoscopic examination. Following this, counselling was performed and the type of surgery and levels of surgical intervention decided upon. The surgical procedures were classified into nasal, palatal, and tongue base levels. Nasal surgeries included inferior turbinoplasty, septoplasty, adenoidectomy, radiofrequency of inferior turbinates, and functional endoscopic sinus surgery. Palatal reconstructive surgeries included uvulopalatal flap, lateral pharyngoplasty, tonsillectomy, and radiofrequency of soft palate. Tongue-base surgeries included TORS, GTA, radiofrequency of tongue-base, midline glossectomy, and hyoid suspension.

After surgery, all patients who underwent general anaesthesia were admitted to the surgical intensive care unit or high-dependency care unit for overnight observation before being transferred to the general ward on postoperative day 1 or 2. Patients with surgical procedures performed under local anaesthesia were discharged on the same day. All patients who underwent TORS, GTA, and palatal reconstructive surgery received intravenous antibiotics, intravenous dexamethasone sodium phosphate, intravenous omeprazole, analgesia, and lozenges. All patients who underwent nasal surgery received oral antibiotics, nasal douche, and analgesia. All admitted patients were discharged when their airway was adequate and they were able to achieve oral feeding. They were taught to recognise complications and advised to return to the hospital if these complications occurred. Patients returned for consultation within 2 weeks of discharge.

### *Classification and Grouping*

The patients were divided into SLS and MLS groups (Fig. 1). The SLS group was subdivided into patients who only had nasal surgery (Group N), palatal surgery (Group P), or tongue surgery (Group T). The MLS group was subdivided into patients with 2- or 3-level surgery. MLS patients who underwent 2-level surgery were further classified into nasal and palatal surgery (Group NP), nasal and tongue surgery (Group NT), or palatal and tongue surgery (Group PT). Patients in 3-level surgery had nasal, palatal and tongue surgery (Group NPT). Patients who underwent multiple surgeries at the same level (for example bilateral inferior turbinoplasty, septoplasty and adenoidectomy) belonged to the same SLS subgroup.

The complication rate and VAS pain score were compared between SLS and MLS groups, with the SLS patients as controls.

Further subgroup analysis was also performed. Patients who underwent single-level nasal surgery (Group N) were in the control group and were compared with patients who underwent nasal and palatal surgery (Group NP) or nasal and tongue surgery (Group NT). Group N patients were also compared with those who underwent nasal, palatal and tongue surgery (Group NPT). Group NPT patients were then compared with Group NP or Group NT patients.

None of the patients who underwent palatal surgery alone (Group P) had complications. Hence, we could not compare SLS and MLS using Group P patients as controls. However, patients who underwent nasal and palatal surgery (Group NP) or palatal and tongue surgery (Group PT) were compared with those who underwent nasal, palatal and tongue surgery (Group NPT).

Similarly, patients who underwent single-level tongue surgery (Group T) were controls and were compared with

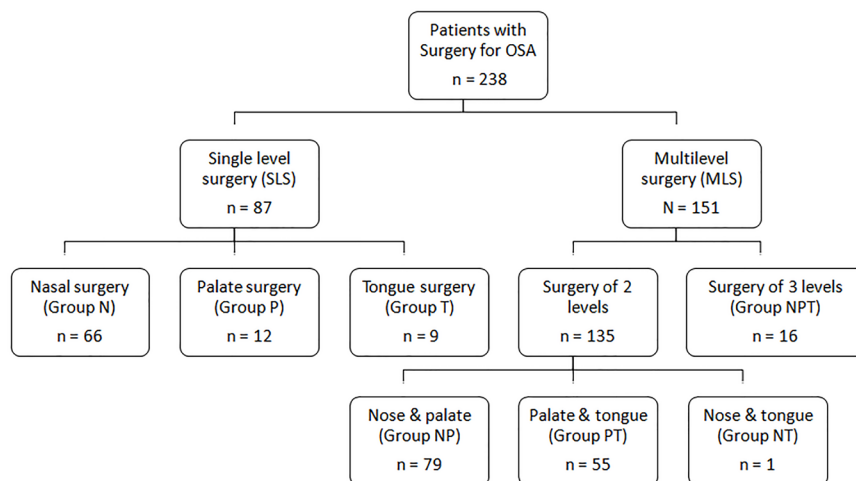


Fig. 1. Classification and distribution of patients who underwent surgery for OSA. n: patient number.

patients who had nasal and tongue surgery (Group NT) or palatal and tongue surgery (Group PT). Group T patients were also compared with patients who underwent nasal, palatal and tongue surgery (Group NPT). Group NPT patients were then compared with Group NT or Group PT patients.

#### Complication Rate and Pain Score

Complications were tracked using emergency department visit records, hospital admission records and operative procedure records. Complications were defined as events needing additional medical attention within the first 30 days of surgery. These included nasal packing, cautery in the outpatient setting, hospitalisation, need for return to the operating theatre, and emergency department visits. Early complications were those that occurred in the first 24 hours after surgery and late complications were those that occurred after 24 hours. Patients who had either early or late complications, regardless of the number, were recorded to have an event in the analysis. Complications were also classified into minor and major complications. Minor complications were defined as those without haemodynamic compromise, such as cases managed with digital pressure, electrocautery in the clinic, and examination under anaesthesia with haemostasis. Major complications were defined as those with haemodynamic instability, bleeding requiring transfusion, unplanned reintubations, or mortality. Postoperative VAS pain scores were obtained immediately after surgery when the patient first reached the ward.

#### Statistical Analysis

Continuous variables were summarised as means  $\pm$  standard deviation and analysed using the simple t-test. Categorical variables were summarised as counts (percentages) and analysed using chi-squared test or the

Fisher's Exact test as appropriate. Univariable analysis was performed for all variables. Variables with  $P < 0.20$  or deemed to be clinically relevant were inserted into multivariable logistic regression model. The adjusted odds ratios (OR), 95% confidence intervals and  $P$  values comparing complication rate and pain score between SLS and MLS were presented.

The pain scores were grouped into binary outcomes: no pain (score = 0), and pain (score = 1).

$P$  values  $< 0.05$  were considered statistically significant. Statistical analysis was performed using SAS 9.3 (SAS Institute, Cary, NC, USA).

#### Results

There were 238 OSA patients who had undergone a total of 426 procedures; 194 were men and 44 were women. Patient demographics and severity of OSA were similar between the SLS and MLS groups (Table 1). There was a difference between the number of single-level and multilevel palatal surgery patients. There was also a difference between the number of single-level and multilevel tongue surgery patients ( $P < 0.05$ ), which suggests more patients underwent multilevel tongue or palatal surgery than single-level tongue or palatal surgery. Mean hospital stay was  $3.4 \pm 0.9$  days. Eighty-seven patients underwent SLS and 151 underwent MLS, of which 135 had surgery of 2 levels and 16 had surgery of 3 levels (Fig. 1). All patients were seen at least once in the first 30 days following surgery and 86.6% were seen twice.

After adjusting for apnoea-hypopnoea index, age, gender, blood pressure, lowest oxygen saturation level, smoking and alcohol consumption, there was an almost statistically significant difference in complication rate between the SLS and MLS groups (adjusted OR = 2.76,  $P$  value = 0.053).

Table 1. Patient Demographics

|                        | Overall (n = 238)  | Single-level Surgery (n = 87) | Multilevel Surgery (n = 151) | P Value* |
|------------------------|--------------------|-------------------------------|------------------------------|----------|
| Age, year              | 44.1 (11.4)        | 45.1 (10.8)                   | 43.6 (11.8)                  | 0.315    |
| BMI, kg/m <sup>2</sup> | 28.7 (5.2)         | 28.8 (5.7)                    | 28.6 (4.9)                   | 0.823    |
| SBP, mmHg              | 130.3 (13.8)       | 129.7 (13.0)                  | 130.6 (14.3)                 | 0.661    |
| DBP, mmHg              | 79.2 (10.1)        | 79.4 (10.3)                   | 79.2 (10.1)                  | 0.860    |
| Gender, male           | 194 (81.5)         | 71 (81.6)                     | 123 (81.5)                   | 0.977    |
| Race                   |                    |                               |                              |          |
| Chinese                | 183 (76.9)         | 68 (78.2)                     | 115 (76.2)                   | 0.980    |
| Malay                  | 27 (11.3)          | 10 (11.5)                     | 17 (11.3)                    |          |
| Indian                 | 22 (9.2)           | 7 (8.1)                       | 15 (9.9)                     |          |
| Others                 | 6 (2.5)            | 2 (2.3)                       | 4 (2.7)                      |          |
| Smoking                | 53 (22.4)          | 17 (19.5)                     | 36 (24.0)                    | 0.427    |
| Alcohol consumption    | 28 (11.9)          | 9 (10.5)                      | 19 (12.7)                    | 0.615    |
| AHI                    | 28.7 (14.4 – 59.0) | 30.0 (13.2 – 59.3)            | 27.1 (14.8 – 59.0)           | 1.000    |
| LSAT                   | 79.0 (70.0 – 86.0) | 79.0 (69.0 – 84.0)            | 79.5 (71.0 – 86.0)           | 0.412    |
| Surgery site           |                    |                               |                              |          |
| Nose                   | 162 (68.1)         | 66 (75.9)                     | 96 (63.6)                    | 0.050    |
| Tongue                 | 81 (34.0)          | 9 (10.3)                      | 72 (47.7)                    | < 0.001  |
| Palate                 | 162 (68.1)         | 12 (12.8)                     | 150 (99.3)                   | < 0.001  |
| Pain reported          | 125 (53.0)         | 36 (41.9)                     | 89 (59.3)                    | 0.010    |
| Complications, n = 31  |                    |                               |                              |          |
| Early                  | 3 (1.3)            | 1 (1.1)                       | 2 (1.3)                      | 0.488    |
| Late                   | 28 (11.8)          | 5 (5.7)                       | 23 (15.2)                    |          |
| Minor                  | 30 (12.6)          | 6 (6.9)                       | 24 (15.9)                    | 1.000    |
| Major                  | 1 (0.4)            | 0 (0.0)                       | 1 (0.7)                      |          |

AHI: Apnoea-hypopnoea index; BMI: Body mass index; DBP: Diastolic blood pressure; LSAT: Lowest oxygen saturation during polysomnogram; SBP: Systolic blood pressure; SD: Standard deviation

\*Compares single and multilevel surgery, and was calculated by simple t-test for continuous variable or chi-squared test/Fisher's Exact test for categorical variables. A value of  $P < 0.05$  was considered statistically significant.

Continuous variables (age, BMI, SBP and DBP) were presented as mean standard deviation (SD) and apnoea-hypopnoea index (AHI) and lowest oxygen saturation during polysomnogram (LSAT) were presented in median (interquartile range).

Categorical variables (gender, race, smoking, alcohol consumption, surgical site, pain and complications) were presented in counts (percentages).

The SLS and MLS groups were further analysed in their nasal, palatal and tongue subgroups (Table 2). After adjusting for the same confounders, there was no statistical difference in complication rate between Group N (SLS) and Groups NP or NT (2-level MLS) and between Group NPT (3-level MLS) and Groups NP or NT (2-level MLS). There was an almost statistically significant difference between Group N (SLS) and Group NPT (3-level MLS, adjusted OR 4.51,  $P = 0.059$ ).

There was no statistical difference in complication rate between Group NPT (3-level MLS) and Groups NP or PT (2-level MLS, adjusted OR 2.05,  $P = 0.275$ ). We could not compare Group P (SLS) with NP, PT or NPT as there was no complication in Group P.

There was no statistical difference in complication rate between Group T (SLS) and Groups NT or PT (2-level MLS), between Group T (SLS) and Group NPT (3-level MLS), and between Group NPT (3-level MLS) and Groups NT or PT (2-level MLS).

There was more postoperative pain in the MLS group than the SLS group; 41.9% of SLS patients had pain while 59.3% of MLS patients had pain (adjusted OR 2.09,  $P = 0.008$ ) (Tables 1 and 3).

Thirty of the 238 patients (12.6%) had complications, of which 1 patient had early and late complications (counted as 2 complications). Six underwent SLS, 20 underwent MLS of 2 levels and 4 underwent MLS of 3 levels. The subgroup complication rate was 7.6% for Group N, 0% for

Table 2. Association between Postoperative Complication and Surgery on Patients with Obstructive Sleep Apnoea

|                                     | Adjusted Odds Ratio | 95% Confidence Interval | P Value |
|-------------------------------------|---------------------|-------------------------|---------|
| Multilevel vs single-level, n = 204 | 2.76                | 0.99 – 7.73             | 0.053   |
| Multilevel vs SLS nose, n = 137     | 2.35                | 0.70 – 7.86             | 0.166   |
| Multilevel vs SLS tongue, n = 71    | 1.19                | 0.12 – 12.33            | 0.882   |
| Nose, n = 137                       |                     |                         |         |
| NP or NT vs N                       | 1.89                | 0.53 – 6.77             | 0.329   |
| NPT vs N                            | 4.51                | 0.94 – 21.54            | 0.059   |
| NPT vs NP or NT                     | 2.39                | 0.58 – 9.76             | 0.226   |
| Palate, n = 127                     |                     |                         |         |
| NPT vs NP or PT                     | 2.05                | 0.57 – 7.43             | 0.275   |
| Tongue, n = 71                      |                     |                         |         |
| NT or PT vs T                       | 0.96                | 0.09 – 10.49            | 0.972   |
| NPT vs T                            | 1.98                | 0.16 – 25.04            | 0.596   |
| NPT vs NT or PT                     | 2.07                | 0.46 – 9.36             | 0.345   |

N: Single-level nasal surgery, NP: Nasal and palatal surgery, NT: Nasal and tongue surgery, NPT: Nasal, palatal and tongue surgery, PT: Palatal and tongue surgery, SLS: Single-level surgery; T: Single-level tongue surgery

\*Adjusted for apnoea-hypopnoea index, age, gender, systolic blood pressure, lowest oxygen saturation during polysomnogram, smoking, drinking. None of them were statistically significant in the multivariable models.

Table 3. Association between Pain and Surgery on Patients with Obstructive Sleep Apnoea (n = 234)

|                                     | Adjusted Odds Ratio | 95% Confidence Interval | P Value |
|-------------------------------------|---------------------|-------------------------|---------|
| Multilevel vs. single-level surgery | 2.09                | 1.21 – 3.62             | 0.008   |
| Gender (female vs male)             | 0.54                | 0.27 – 1.07             | 0.079   |
| Smoking (yes vs no)                 | 0.62                | 0.32 – 1.19             | 0.149   |
| Drinking (yes vs no)                | 1.20                | 0.52 – 2.74             | 0.668   |

Group P, 11.1% for Group T, 13.9% for Group NP, 0% for Group NT, 18.2% for Group PT and 25% for Group NPT.

There were 3 early and 28 late complications. Thirty complications were minor and 1 was major. The main complication was bleeding (27 cases, 87.1%). The other 4 complications consisted of 2 infections, 1 flap dehiscence and 1 case of dehydration due to poor oral intake. Fifteen complications resolved following conservative management. Six required intervention in the ward or clinic. Of the 10 who returned to the operating theatre, there were 6 post-tonsillectomy bleeds, 1 post-turbino-plasty bleed, 1 post-TORS bleed, 1 postmidline glossectomy bleed and 1 post-GTA infection. The major complication occurred in a patient who resumed smoking immediately after TORS SLS. He had intermittent bleeding from the tongue base. Examination under anaesthesia and haemostasis was uneventful. However, while changing the orotracheal tube to a nasotracheal tube intraoperatively, he experienced transient desaturation, therefore needing intubation and observation

in the intensive care unit for presumed aspiration. He was extubated successfully the next day and discharged well with no permanent sequelae. There was no airway complication nor mortality.

## Discussion

The overall complication rate is 12.6%, which is within the range quoted by other studies (7.1 to 14.6%).<sup>3,7,8</sup> If only patients requiring intervention were considered, the complication rate would be 6.7%. Patients undergoing MLS may have a higher possibility of developing complications compared to patients undergoing SLS (adjusted OR 2.76), but this is not of statistical significance. More patients undergoing MLS had pain compared to patients undergoing SLS.

### Complication Rate

There are 2 main reasons for a relatively high complication rate; firstly, complications occurring up to the first 30 postoperative days were included. In contrast, other studies had shorter follow-up periods. Secondly, our inclusion criteria encompassed a wide range of minor complaints, such as epistaxis which resolved with digital pressure.

### Multilevel versus Single-level Surgery – Complication Rates

The literature comparing complication rates in SLS and MLS is diverse, with different patient selection criteria, different definitions of single and multi-level surgery and only specific types of surgery were analysed. There were contradicting results. Kezirian et al<sup>9</sup> found concurrent uvulopalatopharyngoplasty (UPPP) and nasal surgery to be safe, while simultaneous UPPP and non-nasal upper airway

procedures were significantly associated with higher risk of serious complications. A review of 347 OSA patients showed higher complications with multiple nasal procedures (septoplasty and inferior turbinate reduction) and concurrent UPPP.<sup>10</sup> In 91 OSA patients who underwent nasal and palatal surgery in a synchronous or staged fashion, there were 3 complications in the synchronous surgery group and 1 complication in the staged surgery group. The authors concluded the complication rate was comparable in both groups and synchronous surgery was safe, but no statistical analysis was performed.<sup>11</sup>

The aim of our study was to include a wide repertoire of surgical procedures, including a significant number of TORS and GTA patients and a study of our surgical practice for OSA. This is because there has been an increasing number of such surgeries being performed in recent years and comparative information on complication rates should be obtained. After adjusting for confounders, our data shows that the difference in complication rate between SLS and MLS is near statistical significance ( $P=0.053$ ). Upon further analysis of the data in subgroups, the difference between Group N and Group NPT was close to statistical significance as well ( $P=0.059$ ). Surgery involving the other levels of obstruction (palate and tongue), as well as comparing NT and NP with NPT had similar complication rates.

Interpreting the data in a straightforward manner is difficult because it is close to statistical significance. Concurrent MLS is mostly safe for OSA patients, especially if they are undergoing palate and tongue surgery, nose and palate surgery, or nose and tongue surgery. Concurrent surgery in this group of patients avoids higher complications while reaping the benefit of single anaesthesia, reduced hospitalisation, shorter postoperative recovery time, and decreased time away from work.<sup>4</sup>

While it seems advisable for a patient who requires 3-level surgery to undergo nasal surgery separately from palate and tongue surgery because NPT vs N is almost statistically significant, the converse is not true. A patient who is undergoing both palate and tongue surgery has the same complication rate as a patient undergoing 3-level surgery. In view of this, and that the overall complication rate is low with minor complications, it is still reasonable for a patient needing 3-level surgery to have concurrent surgery of all the levels in the same sitting after being adequately counselled on the risks and possible alternatives. Further study may be able to yield data to suggest whether there is a true statistical difference between these 2 groups.

#### *Multilevel versus Single-level Surgery—Postoperative Pain*

MLS results in a larger proportion of patients with postoperative pain than SLS. Logically, the presence of pain is higher in the group that had undergone more levels of

surgery as they had more operations and surgical wounds; our results confirm this. Importantly, the pain scores were obtained with analgesia on board. Therefore, we recommend regular review of VAS pain scores and analgesia in MLS patients. The managing team should consider starting postoperative MLS patients immediately on a cocktail of analgesics. Our current regime includes a combination of paracetamol and COX-2 inhibitor. Patients undergoing palatal and tongue-base surgeries are also given topical pain relief in the form of lozenges and sprays. If pain control is poor or if the patient is allergic to either medication, an opioid is sometimes prescribed, with particular attention paid to respiratory rate and oxygen saturation.

#### *Limitations and Areas of Improvement*

We acknowledge that this study has limitations. Firstly, the number of patients in the 3-level surgery group is relatively small compared with those in the 2-level and SLS groups. This retrospective study can be improved by increasing the period of study to recruit more patients in the SLS and 3-level surgery groups, thereby reducing the disparity in number of patients between the groups. A larger number of patients may be able to give more information on whether there is truly a difference in the complication rate between the single-level nasal surgery group and the 3-level surgery group. Alternatively, conducting a prospective study with the same objectives will enable the recruitment of an equal number of patients in each group.

Secondly, long-term complications were not captured in our study. A longer follow-up period, or a prospective study with longer follow-up will enable us to capture this data.

Thirdly, a wide variety of procedures were performed in our patients, ranging from minor procedures such as radiofrequency of the tongue-base to major procedures such as midline glossectomy and GTA. Our study analyses the levels of surgery but does not differentiate between minor or major surgeries. As major procedures tend to have higher complication rates than minor procedures, a matched study may help analyse surgery-specific outcomes between single and multilevel surgery groups.

In addition, in our study, we were unable to compare single-level palatal surgery with multilevel palatal surgery because none of the patients in the single-level palatal surgery group had complications. Increasing the cohort size has a higher likelihood of a single palatal surgery patient with a complication and will allow us to perform this comparison.

Lastly, none of the patients defaulted during the follow-up period. However, the complications detected were based on hospital records. Some patients with complications may not be captured if they presented to another clinic or hospital. To prevent this, we advised our patients—prior

to discharge—to return to our hospital if they experienced difficulties or complications. Another solution would be to have a follow-up teleconsult with each patient after 30 days to capture out-of-hospital treatments.

## Conclusion

Our study has shown single-level surgery and multilevel surgery to have similar complication rates, although single-level nasal surgery may have a lower complication rate than 3-level multilevel surgery. As the overall complication rate remains low, even for 3-level surgery, patients may still proceed with multilevel surgery following adequate counselling and informed consent. Patients can safely undergo concurrent multilevel surgery if they are undergoing palate and tongue surgery, nose and palate surgery, or nose and tongue surgery. There is more postoperative pain in the multilevel group of patients and they may require more analgesia titration than single-level surgery patients.

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