

Suspension Laryngoscopy Experiences in a Tertiary Airway Service: a Prospective Study of 150 Procedures

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Abstract

Abstract Objectives: In most cases, suspension laryngoscopy (SL) is efficient, bloodless and with minimal post-procedure discomfort. We aimed to identify predictive patient factors for acceptable surgical views at SL as well as quantify our tertiary airway unit's complication rates. **Design:** Prospective cohort study of 150 consecutive microlaryngoscopy procedures involving SL over an 8-month period between November 2019 and July 2020. Patients were assessed pre-operatively for pre-existing oral, temporomandibular, dental, pharyngeal or laryngeal pathology, interincisor distance and qualitative gross limitations to neck extension and forward head posture. Intraoperatively, the laryngoscopic view was graded by anesthetic and surgical teams, and complications were recorded on patient interview in recovery. **Setting:** Tertiary adult airway service for predominantly benign pathology. **Results:** Adequate surgical views were obtained in 149/150 procedures. BMI and limitations to chin and neck movement had mild positive correlations with more difficult views in their own rights, but did not correlate with a statistically significant increase in complications. There was a negative correlation between age and interincisor gap ($p=0.014$), and wider mouth opening correlated with a lower incidence of sore throat ($p=0.023$). Macroglossia showed a statistically significant positive correlation with tongue symptoms ($p=1.611 \times 10^{-8}$). **Conclusion:** In the context of an experienced airway unit with a high caseload of predominantly benign pathology, SL is very effective and safe with low associated morbidity and no mortality. Patient-reported neck and chin movement were found to correlate well with the surgical view obtained. The most common complication of SL is temporary sore throat and there remain recognized risks of temporary tongue and dental symptoms.

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Results: Adequate surgical views were obtained in 149/150 procedures. BMI and limitations to chin and neck movement had mild positive correlations with more difficult views in their own rights, but did not correlate with a statistically significant increase in complications. There was a negative correlation between age and interincisor gap ($p=0.014$), and wider mouth opening correlated with a lower incidence of sore

throat ($p=0.023$). Macroglossia showed a statistically significant positive correlation with tongue symptoms ($p=1.611 \times 10^{-8}$).

Conclusion: In the context of an experienced airway unit with a high caseload of predominantly benign pathology, SL is very effective and safe with low associated morbidity and no mortality. Patient-reported neck and chin movement were found to correlate well with the surgical view obtained. The most common complication of SL is temporary sore throat and there remain recognized risks of temporary tongue and dental symptoms.

Keywords : Suspension laryngoscopy; direct laryngoscopy; surgical complications; laryngeal exposure

Key Points

1. With a careful and standardized multidisciplinary approach, suspension laryngoscopy for benign pathology is usually efficient and bloodless with minimal post-procedure discomfort.
2. In 150 consecutive suspension laryngoscopy procedures undertaken by our specialist airway service, we were able to obtain a view adequate for successful surgery in all but one case, and saw no major or permanent complications.
3. The most common complication was temporary sore throat (66%), which significantly negatively correlated with interincisor gap.
4. Temporary alteration of tongue sensation (6.7%), mucosal abrasions (2.7%), and exacerbation of pre-existing dental/temporomandibular joint pain (1.3%) were also seen at rates favourable in comparison to the global literature.
5. Our centre advocates the exclusive use of the Dedo-Pilling® laryngoscope in most cases, apart from in isolated supraglottic pathology where the Lindholm laryngoscope may be of additional value.

Introduction

Suspension laryngoscopy (SL) is a staple procedure in otolaryngology which facilitates bimanual laryngeal instrumentation under direct vision, thus permitting microlaryngeal surgery using a wide variety of surgical techniques including cold steel excision, laser and radiofrequency ablation. With a careful and standardized approach, SL is usually efficient and bloodless with minimal post-procedure discomfort following reversal of general anesthesia (1). As with every procedure, there are recognized complications, the rates of which vary widely in the global literature. A distinction can be made between minor or temporary complications, which are generally localized to the oropharynx (such as pain, mucosal abrasions or bruising, dental pain or temporary tongue symptoms), and much rarer serious or permanent complications (such as airway swelling, major cardiovascular instability, dental loss or permanent tongue symptoms).

Multiple preoperative scoring systems have been proposed to predict the acceptability of the view obtained at SL (2-7); however it is our view that these often involve measuring excessive numbers of additional variables outside of our routine clinical care, increasing time burdens on staff without demonstrable gains in management-changing data. We aimed to elucidate SL complication rates from our tertiary airway population with comparison to the global literature, in order to:

- identify easy-to-measure factors which might predict acceptable anesthetic and surgical views at SL;
- establish baselines against which to introduce measures to decrease complications;
- identify potential at-risk subgroups who could benefit from additional pre-operative planning to avoid injury; and
- increase the robustness of our consenting process.

Methods

Ethical considerations

This project received Institutional Board Approval as a Quality Audit (ID: ENT_025) from Imperial Healthcare NHS Trust in accordance with Good Clinical Practice guidelines. The STROBE reporting guidelines for cohort studies were followed.

Study Design

We performed a prospective observational study, amongst a cohort of 150 consecutive SL procedures for suspected benign laryngeal pathology, in our tertiary adult airway service. We recorded the grade of surgical view obtainable by SL according to our current practice (Figure 1), as well as the minor and major complication incidences, over an 8-month period between November 2019 and July 2020.

Inclusion and Exclusion Criteria

All patients undergoing SL to enable their surgical procedure were recruited unless they were unable to self-report complications (i.e. patients who remained intubated post-procedure or with persistently reduced conscious levels). Patients provided additional verbal consent to be included in the study at the time of written documentation of procedural consent.

Data Collection

Age, gender at birth, height, weight, dentition, gross macroglossia and Mallampati score were pre-operatively recorded. On the day of surgery, patients were assessed by both surgical and anesthetic teams for the presence of pre-existing oral, temporomandibular, dental, pharyngeal or laryngeal pathology. The maximum inter-incisor gap achievable by the conscious patient was also quantitatively measured, as well as any gross limitations to comfortable neck extension and forward head posture - reasons for limitations included high muscle mass/body mass index (BMI) or cervical spine immobilization (Figure 2).

Intraoperatively, laryngoscopic view was independently graded with reference to the Modified Cormack-Lehane System (MCLS, Table 1) by both anesthetist and surgeon using their usual laryngoscopes. The duration of time spent in suspension and the occurrence of major adverse events were also recorded (e.g. major cardiovascular instability, deep prolonged desaturations or airway fires). As far as practicable, surgical assessment of view was blinded with respect to preoperative measurements and anesthetic view.

Post-operatively, patients were specifically asked about symptoms relating to SL complications by a surgical team member. Any patient-reported symptoms were monitored by telephone follow-up on the first postoperative day and subsequently monthly until resolution.

Statistical Analysis

Interpretation of data was performed using Prism 8 software (Graphpad, CA, USA). Parametric or non-parametric tests were used as appropriate following normality testing. Patient factors were assessed for correlation with grade of view and complications using Spearman's correlation of multivariables.

Missing data relating to preoperatively determined patient factors was retrospectively addressed using the Hospital electronic documentation system where possible. Patients who were not questioned about their symptoms in recovery (usually due to exceptionally efficient delivery back to the postoperative ward for same day discharge) were telephoned on the first postoperative day and asked about their symptoms retrospectively – although this potentially introduced recall bias of symptoms, this resulting in no patients being lost to follow-up.

Results

Patient Demographics

150 consecutive microlaryngoscopy procedures (141 adult patients) involving SL were prospectively recorded. Patient characteristics are shown in Table 2. Pathologies were generally benign although 2 patients with endoscopically-managed slow-growing airway tumors were also included. No patients reported pre-existing dental or tongue symptoms at the preoperative stage. The median procedure time was 16 minutes (range 2-61min).

Grade of View

The Dedo-Pilling® laryngoscope was used exclusively in 90.7% procedures. The median anesthetic view was grade 2a (IQR 1-2b), whilst median surgical view was grade 1 (IQR 1-2, $p < 0.0001$). There was no significant correlation between the seniority of surgeon and the view eventually obtained, although this may have been confounded by more senior surgeons needing to take over in difficult cases. BMI and patient-demonstrated limitations to chin and neck movement were all significantly positively correlated with each other, and each also had mild significantly positive correlations with higher grade (i.e. more difficult) views (Figure 2). Neck extension was also negatively correlated with interincisor gap ($r = -0.268$, $p = 0.001$).

Complication Rates

There were no episodes of major cardiorespiratory instability related to SL itself, although one patient suffered a short but major drop in oxygen saturations in response to the apneic period during subglottic balloon dilatation. 4 further patients required temporary intraoperative intubation to allow positive pressure ventilation and recruitment maneuvers as SJV alone was insufficient to maintain oxygen saturations; all patients were successfully extubated post-procedure. No other major complications were encountered over this data collection period.

The rates of minor complications associated with SL are shown in Table 3. The most common complication was that of a temporary sore throat without significant dysphagia (66%), which universally resolved by the third postoperative day. On multivariate analysis, the incidence of sore throat was negatively correlated with interincisor gap ($r = -0.186$, $p = 0.023$) – although interincisor gap was also negatively correlated with age ($r = -0.2$, $p = 0.014$), no significant direct correlation was found between age and sore throat. Tongue symptoms occurred in 10 cases (6.7%), all of which were mild and temporary sensory disturbances. These positively correlated with macroglossia on multivariate analysis ($r = 0.452$, $p = 1.611 \times 10^{-8}$). No incidences of tongue weakness occurred in our cohort. Oropharyngeal trauma occurred in 4 patients (2.7%) – these were mild in all cases. Dental and temporomandibular joint pain were reported in a further 2 cases, both of which were exacerbations of pre-existing symptoms on further questioning. There were no incidences of dental loosening or injury. Despite correlations with poor grades of view, the chosen markers for unfavorable patient body habitus did not significantly correlate with increases in complications. No other statistically significant correlations between patient or procedural factors and complications were identified.

Discussion

Over an 8-month period of 150 airway procedures, we were able to obtain views by SL adequate for the procedure (grade S1-3) in all but one case (in which failure had been predicted preoperatively and planned flexible bronchoscopy back-up was successful) (8). This high success rate, together with our low complication rates, compares well with series from other centers specializing in laryngeal surgeries (Table 4), and is likely multifactorial in nature. We are the UK referral service for tertiary airway surgery - as such we have a high turnover of cases, including many patients undergoing regular repeated procedures under our care (albeit fewer in this time period due to COVID-19), and we have an experienced surgical, anesthetic and nursing team who regularly work together (1). Other factors which we feel contribute to this high success rate include correct patient positioning (no shoulder roll and head forward position), routine use of supraglottic jet ventilation, infrequent endotracheal intubation and our predilection for the Dedo-Pilling laryngoscope (although it must be stated that use of the Lindholm laryngoscope was not correlated with increased complications) (Figure 1).

Many other documented ‘laryngoscores’, whilst useful in research contexts, are limited in their potential for widespread clinical adoption by the need for multiple time-costly measurements of specific head and neck movements (2-7). We suggest, given that we found patient-demonstrated gross limitations to neck or chin movement to correlate with the surgical view, that the absence of problems with patients preoperatively demonstrating the appropriate surgical position (i.e. a forward head posture with or without neck extension) is generally sufficiently predictive of procedural success without the need to measure (3, 4, 7). A ‘Mini-Laryngoscore’ predicting glottic exposure was recently proposed by Incandela *et al* based solely on thyromental distance, interincisor gap and upper jaw dentition (3). However, interincisor distance and upper

jaw dentition did not correlate significantly with our grade of view in this series. The anesthetic literature generally holds that BMI alone is not usually a strong independent predictor of difficult intubation unless extremely high (9) - although BMI and neck and head movement limitations were all significantly correlated with higher grade view in our series, intercorrelation of these variables could represent a confounding effect (10).

Comparing anesthetic and surgical views can provide useful management-changing information in the pre- to intra-procedure transition, such as predicting the likelihood of requiring a senior surgeon to perform the procedure, or to guide appropriate ventilatory choices. We therefore adapted the widely-used MCLS anesthetic grading system for our purposes to make the surgical score more relevant. The anesthetic goal at laryngoscopy is somewhat different as the goal is topicalization rather than to try and achieve the best view possible for intubation; in cases where intubation is considered as first-line, a video laryngoscope would usually be employed as a first choice in these patients. The use of the straight-bladed Dedo, in contrast to the curved anesthetic Mackintosh blade, may further explain the improved view of the surgical team. If faced with a potentially difficult airway, the anesthesia regimen would usually include higher doses of induction agents and muscle relaxant to improve the view for the first attempt.

In this data collection period, we had no incidences of major complications such as severe cardiovascular instability, esophageal perforation or permanent tongue sequelae, incurring only mild temporary complications (Table 3). Reassuringly, most large reported series also report an absence of severe complications (1, 8, 11-19) and the literature on these subjects is limited to isolated case reports (20). The main complication experienced by our patients, in line with other studies (18), was that of temporary sore throat (66% of patients). It can be difficult to unpick complications associated with SL itself versus the procedures that it enables (for example, ablative surgery is likely to cause throat pain in its own right irrespective of SL). Our results showed those patients with wider mouth opening had a significantly lower correlation with sore throat, although age, which also positively correlated with an increased interincisor gap, did not have a significant association with sore throat. This leads us to suggest that interincisor gap may be a useful independent clinical indicator for sore throat, although it must be acknowledged that the Spearman coefficient indicates a very modest effect only (21).

In this time period, 6.7% of patients experienced tongue symptoms, all of which were followed up and seen to resolve by the end of the second postoperative week. This is a relatively low incidence compared to other reported series (8, 12, 13, 15, 17, 19, 22, 23). There was no significant correlation between tongue symptoms and SL duration, however as might be expected, there was a moderate significant positive correlation with macroglossia ($r=0.452$, $p=1.611 \times 10^{-8}$). Anecdotally, one patient reported that ‘they always get tongue numbness, and it always resolves’. Given this patient was young with a low BMI, no gross limitations to movement, an average interincisor gap and no macroglossia, this leads us to hypothesize that some patients may be more at risk of developing lingual nerve compression, perhaps due to internal jaw anatomy as others have suggested (24). As with most other reported studies, we saw non-significant associations with gender, although others have suggested a female preponderance (11, 19). Detailed further studies to investigate this could form the basis for future cohort research. In this data collection period, we had no serious dental complications, although there were two cases of temporary exacerbation of existing dental/temporomandibular joint pain. Our team are extremely careful not to lever the laryngoscope on the teeth, but additional care is taken in patients who self-report painful teeth, given this is a potential sign of underlying instability requiring additional vigilance and care (12).

Reassuringly, there was no significant correlation between any investigated complication rate and more difficult views or longer procedural duration, both of which would imply greater cumulative oropharyngeal tissue compression (11, 25). However, other series report associations of longer procedural duration with increased complications (8, 17, 19). Our airway unit treats predominantly benign pathologies and is separate from the Head & Neck unit which manages malignant cases. Our cases therefore tend to have shorter procedural times, and the absence of adjuvant radiotherapy renders our patients’ oropharyngeal tissues less stiff, and dentition more stable, than that seen by the Head & Neck team. This makes comparison with other

reported series difficult (1, 8, 12, 15) as most report a mix of benign and malignant cases and have much longer average procedural durations. Our findings of common and uncommon procedural complications therefore pertain specifically to benign laryngology and are not generalizable to mixed or Head & Neck patient populations. In addition, rarer risks (i.e., those with a <0.7% incidence) may not have occurred in our sample size of 150 cases and the consent process should still contain mention of more serious or long-lasting risks reported in the literature, such as tongue weakness.

The major limitation of our work is that this is an unblinded snapshot study, albeit one representative of our practice. Anesthesia regimes also varied throughout the study by anesthetic consultant, and the administered muscle relaxant dose was often incomplete on the electronic documentation system - this factor was therefore subsequently excluded from multivariate analysis. The relationships between relaxant dosage and timing between administration and visualization, and between relaxant type or dose and complication rates, are also important avenues for further study.

Conclusion

In the context of an experienced airway unit with high caseloads of predominantly benign pathology, SL with the Dedo-Pilling laryngoscope is effective and safe with low associated morbidity and no mortality. Patient-demonstrated neck and chin movement correlate well with the grade of surgical view obtained. The most common complications of SL are temporary sore throat, occurring in 66% of patients, and temporary tongue and dental discomfort.

Funding

None declared.

Conflicts of Interest

None declared

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Tables

Table 1: The widely used Modified Cormack-Lehane anaesthetic grading system for ease of laryngoscopic view was adapted for the surgical team. Anaesthetic teams carried out assessments using curved Mackintosh blades, whereas surgeons used the Dedo laryngoscope and therefore the situation of not being able to pass past the supraglottic structures including epiglottis was less relevant to include as a surgical grading point.

Grade of view (Anaesthetic)	Description	Grade of view (Surgical)
A1	Full view of cords including anterior commissure	S1
A2 a	Partial view of cords, full view of anterior commissure	S2
b	Partial view of posterior glottis/arytenoids	S3
A3	Only epiglottis visible	-
A4	No view	S4

Table 2: Demographic characteristics of adult patients undergoing benign airway procedures (n=141).

	Average	Range		No	Yes
Age (median)	48 yrs	18-86 yrs	Limitation to neck extension	127 (90%)	14 (10%)
Gender at birth	87F : 55M	87F : 55M	Limitation to chin forward	132 (94%)	9 (6%)
BMI (median)	27.6	17.4-59.2	Pre-existing loose teeth/caps/crowns	137 (97%)	4 (3%)
Interincisor gap (mean)	4.5 cm	2.8-6.9 cm	Macroglossia	138 (98%)	3 (2%)

Table 3: Incidences of minor complications in patients undergoing SL by our team over the data collection period.

Complication	Number (%)	Notes
Sore throat	99 (66%)	Maximum duration 3 days, all were discharged as planned
Tongue symptoms	10 (6.7%)	
Numbness/ paraesthesia	7 (4.7%)	All resolved by end of second postoperative week. One mild
Pain	3 (2%)	Mild in all cases with resolution by third postoperative week
Dysgeusia (metallic/bitter)	0	
Weakness	0	
Oral abrasion/bruise/haematoma	4 (2.7%)	Resolution in all cases by end of second postoperative week
Tongue	0	
Gum	0	
Lip	2 (1.3%)	1 crack in dry lip, 1 haematoma from LMA insertion
Palate	0	
Pharynx	2 (1.3%)	1 abrasion, 1 haematoma from LMA insertion
Dental problems	2 (1.3%)	
Dental pain	1 (0.7%)	Multiple loose tender teeth preoperatively
Loose/chipped tooth - own	0	

Complication	Number (%)	Notes
Loose/chipped tooth - cap/crown/implant	0	
TMJ pain	1 (0.7%)	Pre-existing TMJ pain - exacerbated by procedure, settled

Table 4: Comparison of our complication rates in this series with relevant series in the global literature. Yr- year; No.- number; Avg-average; Lscope-laryngoscope; Sx- symptom; Anesth.-anesthetic; Comp.- complication; SL- suspension laryngoscopy; MLS- microlaryngoscopy; VC- vocal cord; min- minutes; d- day; w- week; m- month; POD – post-operative day; POW – post-operative week; f/u- follow-up; Max- maximum;

Author (First, Last), Yr	Study Type	No. patients/procedures	Avg age (yr, range)	Procedure type	Lscope	Avg procedure duration	Sore throat	Tongue Sx rate	Mucosal trauma rate	Dental Sx rate	Anaesth. Comp. Other	Resol	
Maughan Sandhu 2020	Department series Prospective	1150	48 (18-86)	All SL benign cases	Dedo-Pilling (+/- Lindholm)	16min (range 2-61min)	66%	6.7%	3%	1.3%		All b end sec- ond POW	
Okui, Watanabe 2019	Department record review Retrospective	550	43.9 (28-60)	All MLS benign cases	Nagashima or very small)	11min (+/- 14mins)	40%	22.8%	12%	4.9%	1 ana-phy-lactic shock to Suggama	1 VC oedema, 1 bleed-ing, 13.4% cough, 2% neck pain	All r most in 4 days 16.7% tong Sx took >PC to resol

Author (First, Last), Yr	Study Type	No. patients/procedures	Avg age (yr, range)	Procedure type	Scope	Avg procedure duration	Sore throat	Tongue Sx rate	Mucosal trauma rate	Dental Sx rate	Anaesth. Comp.	Other	Resou
Larner, Griffith 2019	Department series Retrospective	74/213	58.5 (24-89)	Benign & malignant SL cases	Ossoff-Pilling, Dedo-Pilling, Zeite-elf #4	Not reported (but 2/213 >30mins)	43%	1.2%	0.2%	0.5%		1 gum ulceration, 1 nasal tip laser burn	Not reported
Ozdamas, Celik 2019	Single surgeon series Prospective Blinded f/u	56/56	47.7 (19-84)	All benign & malignant SL cases	Kleinsass (small, medium or large)	26mins (range 20-45min)	Not reported	8.9%	-	-			3 Sx (2 mild numbness, ?what resolve in POW 2 ?what resolve in POW)

Author (First, Last), Yr	Study Type	No. patients/procedures	Avg age (yr, range)	Procedure type	Lscope	Avg procedure duration	Sore throat	Tongue Sx rate	Mucosal trauma rate	Dental Sx rate	Anaesth. Comp. Other	Resour
Feng, Song 2018	Experimental cohort Prospective Blinded	56/41	58 (19-83)	SL cases recruited in clinic, majority benign	Size 6 uni-versal modular glottiscope	34min (SD 7-18mins)	Not reported	53.5%	-	-		Not reported
Tessema Sesions 2016	Single surgeon series Retrospective	122/100	46 (14-83)	All SL therapeutic cases	Dedo-Pilling (+/- Lindholm)	43.6min. 19% (>60mins duration)	Not reported	18%	-	4.0%		14 resolved at POM 3 resolved at POM 1 residual dysg All tongue 'im-prov by end POM
Dos Anjos Corvo, Campos Duprat 2007	Department series Prospective	36/37	48 (18-80)	All SL benign or malignant suspicion cases	Holinger or Kleinsass	14 <30min, 16 30-60mins, 7 >60mins	Not reported	13.5%	130%	2.7%		

Author (First, Last), Yr	Study Type	No. pa- tients/ pro- ce- dures	Avg age (yr, range)	Procedure type	Lscope	Avg pro- ce- du- ra- tion	Sore throat	Tongue Sx rate	Mucosal trauma rate	Dental Sx rate	Anaesth. Comp.	Other	Res cour
Rosen, Buck- mire 2005	Department series Prospective	53/16	50	All SL be- nign cases	Size 4,5 or 6 uni- versal modu- lar glottiscope	52mins (range 5- 142mins)	Not reported	17.9%	-	12.5%		3 dry mouths	Avg POD long POD

Author (First, Last), Yr	Study Type	No. pa- tients/ pro- ce- dures	Avg age (yr, range)	Procedure type	Scope	Avg pro- ce- du- ra- tion	Sore throat	Tongue Sx rate	Mucosal trauma rate	Dental Sx rate	Anaesth. Comp.	Other	Res coun
Klussman Eckel 2002	Department series Prospective	339	59 (29- 86)	All planned SL be- nign & malig- nant cases, 82% intubated	Not specified	Not reported	Not reported	3.8%	105%	6.5%			Ling POV 60 (me- dian 4), h pogl sal POV 16 (me- dian 8)

Figure Legends

Figure 1: Summary of our current clinical practice for Suspension Laryngoscopy, including specific points of care from both anesthetic and surgical perspectives. Clinical photographs of our suspension laryngoscopy setup in the operating theatre. Of specific note is the placement of the patient’s neck on the break in the operating table (**A**), which allows for easy single-handed manipulation by the operating surgeon, and the use of the Dedo-Pilling laryngoscope (**B**).

Figure 2: Heatmap of Spearman correlation of multivariables. Those associations with p values <0.05 and with confidence intervals not including 1 are highlighted in yellow on the lower cross. Blank squares represent Spearman coefficients <0.001.

Supplementary Figure 1: Data collection form used by staff to record pre-, intra- and post-operative details.

Anesthesia:

- IV induction of anesthesia with muscle relaxant (Atracurium or Rocuronium as per anesthetist preference)
- Some degree of tachycardia and hypertension on SL setup almost universally seen on laryngeal instrumentation - usually self-limiting or managed with standard anesthetic techniques
- Anesthetic laryngoscopy for application of topical anesthesia to vocal cords (curved Mackintosh anesthetic laryngoscope)
- Temporary laryngeal mask airway (LMA) placed prior to surgical laryngoscope placement.
- High frequency automated supraglottic jet ventilation (Monsoon 3, Acuatronic, Switzerland or Twinstream, Carl Reiner, Austria) started as soon as an acceptable view of airway obtained

Patient positioning (A):

- Head ring
- No shoulder roll
- Neck lying over operating table articulation (allows for easy one-handed manipulation of table by operating surgeon to achieve 'sniffing the morning air' position)
- Gum guard to upper teeth (or wet swab to gums if edentulous)

LARYNGOSCOPY:

- **Dedo-Pilling® laryngoscope** (Pilling Weck Teleflex, NC, USA) is our instrument of choice – Lindholm laryngoscope (Karl Storz Endoscopy, Tuttlingen, Germany) can also be helpful for isolated supraglottic pathology
- Gentle advancement of lubricated laryngoscope under direct vision:
- **Care to lift base of tongue rather than levering on upper teeth**
- If view is suboptimal, stepwise application of maneuvers:
 - Surgeon serially raises patient's head with non-dominant hand under direct laryngoscopic vision
 - Assistant applies cricoid pressure (improves view in >90% cases)
 - If view is still suboptimal, start jet ventilation and wait for several minutes – view usually improves following displacement of tongue base tissue fluid
- On satisfactory placement, laryngoscope is held in place using Pilling laryngoscope holder, mounted on arm board above patient's chest (B).

Procedure:

- Aim to avoid intubation in majority of cases, to allow unobstructed views and instrument maneuverability in larynx whilst removing potentially flammable material from vicinity of laser delivery
- Mucosa, dentition and jaw carefully checked on final laryngoscope withdrawal
- LMA reinserted for ventilation until spontaneous breathing re-established and emergence from anesthesia occurs.

