

Non-intubated vs. intubated video-assisted thoracoscopic bullectomy – a retrospective cohort study

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ABSTRACT

Introduction: Thoracic surgery procedures evolved enormously over time from open surgery to video assisted thoracoscopic surgery (VATS) and now non-intubated uniportal VATS. At our centre, the initial approach for bullectomy was by uniportal intubated VATS (iVATS) for most cases. Only in mid-2020, in the midst of COVID-19 pandemic, uniportal non-intubated VATS (NiVATS) took precedence. We compared the outcome of bullectomy via iVATS versus NiVATS for a period of 5 years.

Materials and Methods: We reviewed the medical records of all patients that underwent bullectomy from 1st June 2017 to 31st May 2022. Mann Whitney U-test was completed for all variables. Primary objective was to compare operating time (OT), global operating time (GOT), post-operative length of stay (LOS) and complication rate.

Results: A total of 90 bullectomies performed in which 36 were approached via iVATS and 54 NiVATS. It was found that the post-operative LOS, GOT, and OT were significantly shorter in the NiVATS as compared to iVATS. Complication rate between both groups showed no significant difference.

Conclusion: NiVATS bullectomy demonstrated a safe and reliable alternative surgical approach with superior surgical outcome than iVATS bullectomy.

KEYWORDS:

Thoracic surgery, bullectomy, NiVATS

INTRODUCTION

Traditionally thoracic cases are performed intubated with either double lumen or bronchial blocker to achieve single lung ventilation. The associated risk of intubation primarily led to transition to non-intubated approach.^{1,2} The likely reason of the slow transition to non-intubated is both the familiarity of surgeon with the cases and a supportive anaesthesia team. Challenges faced during the surgery led to many cases being performed with intubated general anaesthesia. With the advancement of good regional blockade and intravenous anaesthesia, non-intubated thoracic surgery has become feasible and is an option for most thoracic procedures in recent times.¹⁻⁵

There is no doubt that the COVID-19 pandemic brought many changes to the way institutionalised medicine has been practiced.⁶ For the most part of the pandemic, it resulted in a generalised cessation of elective non-emergent procedures across specialties worldwide, leading to a backlog of cases. Being an aerosol generating procedure (AGP), non-urgent thoracic surgery procedures were put on hold. The advantage of non-intubated video assisted thoracoscopic surgery (NiVATS) not requiring intubation and hence the reduction in augmentation of the airway reduced the AGP exposure risk of healthcare personnel, in specific our anaesthesia colleagues. This is especially during the extubation period when patients cough.⁷ Hence, selective thoracic surgery procedures were continued to be performed in our centre with the introduction of non-intubated technique. Bullectomy cases were regularly performed as we serve as the regional referral centre for thoracic cases.

This retrospective cohort study aimed to examine the differences in outcome for those who underwent uniportal intubated video assisted thoracoscopic surgery (iVATS) versus NiVATS bullectomy in the aspects of post-operative length of stay (LOS), global operating time (GOT), operating time (OT) and complication rate.

MATERIALS AND METHODS

We retrospectively reviewed the medical records of all patients that underwent iVATS and NiVATS bullectomy from 1st June 2017 to 31st May 2022 in the Thoracic Unit of Hospital Kuala Lumpur. All patients with spontaneous pneumothorax within the age group of 12-80 years and with pre-operative Contrast Enhanced Computed Tomography of Thorax showing evidence of bullae or bleb were included in the study. Exclusion criteria were if patients underwent more than one procedure in the same sitting or if other pathology were identified during the surgery. All patients were given regional anaesthetic block by anaesthetists prior to induction. The surgical procedures were explained in detail to the patient and a written consent obtained.

Demographic data and pertinent information were gathered from the medical records and analysed. The primary outcome of post-operative LOS in the hospital, OT, GOT and complications were analysed. Complications were

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Table I: Demographic summary of iVATS versus NiVATS bullectomy.

Measure	Number of patients (%)		U	p value
	iVATS (n=36)	NiVATS (n=54)		
Gender				
Male	31 (84)	48 (89)	-	-
Female	5 (16)	6 (11)	-	-
Age (Median, year)	27.0	25.0	1148.5	0.146
Smoking/vaping	21(58)	29 (53)	927.0	0.667

Table II: Outcome summary of iVATS versus NiVATS bullectomy

Measure	Median		U	p value
	iVATS	NiVATS		
LOS (days)	4.5	3.0	660.0	0.008*
GOT (minutes)	149.0	90.0	256.5	< 0.001*
OT (minutes)	91.0	60.0	274.5	< 0.001*
Complications, N	3	2	1017.0	0.35
Chest drain >5 days	2	2		
Surgical site infection	1	0		

Note
 *Statistical significance p < .05
 N: Number of participants
 LOS (days): Post-operative length of stay
 GOT (minutes): Global operating time
 OT (minutes): Operating time

Table III: Non-intubated thoracic surgery (NITS) cases performed

Procedures	NiTS cases, n = 94 (%)
Bullectomy	54 (57)
Decortication	7 (7)
Lymph node biopsy	7 (7)
Endoscopic thoracic sympathectomy	7 (7)
Wedge resection	6 (6)
Lobectomy	3 (3)
Tracheal resection and reconstruction	3 (3)
Pleurodesis	3 (3)
Pleural	3 (3)
Mediastinal biopsy	1 (1)

Table IV: Summary of Bullectomy Studies Performed Comparing NiVATS versus iVATS

First author (year)	Type of study	Number of patients	Outcomes (p value)			
			LOS	GOT	Complications	Recurrence
Ahmed et al. (2022) ¹²	Retrospective	140	<0.0001*	<0.0001*	0.79	0.49
Noda et al. (2012) ¹³	Retrospective	16	0.7	0.006*	0.02*	-
Pompeo et al. (2017) ¹⁴	RCT	43	<0.0001*	<0.0001*	-	-
Irons et al. (2016) ¹⁵	Retrospective	62	<0.001*	<0.0001*	-	N = 0
Liu, J et al. (2014) ¹⁶	RCT	194	< 0.001*	-	0.004*	-
Palaniappa et al. (2022)	Retrospective	90	0.008*	<0.001*	0.35	N = 0

Note.
 *Statistical significance p < .05
 LOS (days): Post-operative length of stay
 GOT (minutes): Global operating time

documented and classified as per Clavein-Dindo classification.

NiVATS in our study is defined as cases that are performed with the patient having spontaneous breathing without muscle relaxant, under deep sedation via intravenous anaesthesia and without an endotracheal tube (ETT) across the glottis.⁸ iVATS is when a patient is on muscle relaxant and inhalational anaesthesia under mechanical ventilation with an ETT across the glottis.⁸

LOS was defined as the post-operative hospitalisation duration. OT was defined as the time taken for the surgical procedure (skin-to-skin) whereas GOT involved operating time and anaesthesia period from induction to the time patient reaches recovery bay post-operatively.⁹ All patients were followed up for a period of 1 year, after which they were discharged. Chest X-ray was performed during the first visit to the clinic at two weeks after discharge. No chest X-rays were performed in subsequent visits unless indicated. All data were statistically analysed via SPSS statistics v27. Mann Whitney U-test was performed for all variables.

RESULTS

Throughout the study duration, 90 patients underwent uniportal VATS bullectomy, out of which 36 cases via iVATS and 54 cases via NiVATS. Table I below summarises the demographic data.

All the outcome variables of the study violated the normality assumption test of Kolmogorov-Smirnov test and hence the Mann-Whitney U test was utilised. Demographically, age and incidence of smoking showed no statistical significance (Table I).

The test revealed that the post-operative LOS was significantly shorter in the NiVATS group as compared to the iVATS group ($p = 0.008$) with a small effect size. As for GOT and OT, it was found that patients in the NiVATS group had a significantly shorter time compared to the iVATS group with large effect size ($p < 0.001$) as shown in Table II below.

Out of the 90 cases, Five patients (5.56%) were found to have complications. Two patients (3.7%) in the NiVATS group had poor lung expansion post-operatively, requiring prolonged chest drain of more than 5 days. This was also seen in the iVATS group with an additional recorded case (8.3%) of surgical site infection. No statistical significance was seen comparing complications between patients in the NiVATS and iVATS group ($p = 0.35$). All the complications fall under the category of Clavein-Dindo Classification Grade II. There was no procedure related mortality.

DISCUSSION

Since the start of thoracic services in June 2017, thus far 1200 thoracic surgical procedures have been performed by a rather small unit (one thoracic consultant with two thoracic surgeons). Only in June 2020 did the concept of non-intubated thoracic surgery (NITS) take precedence and till date a total of 94 (8%) cases of various pathologies have been performed as shown in Table III below.

NiVATS bullectomy was the commonest NITS procedure performed (57%), hence it was chosen to be used as a comparison with iVATS bullectomy in this study. Criteria for NITS surgery are short procedure of <2 hours, simple surgery, Eastern Cooperative Oncology Group (ECOG) score of <1, American Society of Anesthesiologists (ASA) class one or two, with a good airway, a body mass index less than 30, and no significant cardiopulmonary issues.¹⁰ However with progress among surgeons and anaesthetist and as the learning curve improves; these criteria have expanded further to include more complex surgeries as the indication arises.

Our centre has been performing bullectomy surgery by uniportal iVATS from June 2017 to May 2020 and after which till to date, NiVATS technique is used. Savitsky et al. reported the incidence of spontaneous pneumothorax to be estimated at 17 to 24/100 000 in the male population and 1 to 6/100 000 in the female population.¹¹ This is in line with male preponderance in our case series. Both the groups comprise of smokers or vapers without significant difference, which could be the cause of the bullae or bleb formation. There were no comorbid to report in this young cohort with the median age between 25 to 27 years.

Focusing on literature search comparing bullectomies performed via NiVATS and iVATS, a few centres have embarked and published their findings. Summary of these studies are shown in Table IV below.

Based on Table IV, it is evident that NiVATS ensures a shorter LOS and reduced GOT. Recurrence and complications rates are similar. Noda et al. showed statistical in-significant result comparing the length of stay and this could be due to the small population size of that study. Our study showed significant results for all three primary outcomes of LOS, GOT and OT. Complications showed no significant difference ($p = 0.35$). This is in accordance to previous studies done.

The shorter LOS is highly attributable to the reduced anaesthesia effect post-surgery and faster recovery. All the patients received regional anaesthesia and this helps to control immediate post-operative pain as well.^{16,17} GOT and OT are lower in the NiVATS group in line with the papers published. Shorter GOT is due to the reduction of anaesthesia hours as patients are non-intubated and recovery is faster. OT on the other hand comprises only the time of procedure performed by a surgeon. The shorter time needed is likely due to the familiarity of surgeons rather than the type of anaesthesia. The steep learning curve of NiVATS requires one to adapt the skill and hence the initial cases performed may take a longer operating time.^{16 18} The process of transition from iVATS to NiVATS has to be in a stepwise manner. It is encouraged for thoracic surgeons to have performed at least 50 iVATS procedures including complex lobectomies and successful handling of intraoperative bleeding prior to embarking on NiVATS.¹⁸

It has to be highlighted that there was no conversion to intubated or open thoracotomy as far as NiVATS bullectomy is concerned and our pneumothorax recurrence rate at 1 year follow-up is zero as well. This is likely due to surgeon familiarity with bullectomy under iVATS hence the transition (NiVATS) outcome was excellent. Similarly, a meta-analysis by Tacconi et al. comprising of 1,441 participants showed a low conversion rate of 2.4%, majority being for adhesions (1.31%) followed by major bleeding (0.34%).¹⁹ This indicates NiVATS is a safe alternative option for bullectomy in a well selected population.

In handling complications intra-operatively, the surgical and anaesthetic team should be alert and prepared for an unfavourable situation that may need conversion to iVATS or even thoracotomy. Preparation of instruments for an open surgery as well as preparedness for lateral intubation by anaesthetist has to be ensured prior to start of the case. Limitations during NiVATS must be clear with low threshold for conversion to ensure patient safety.

In our study, the complications rate was found to be insignificant, however there are reported papers with a lower complication rate in NiVATS compared to iVATS (Table IV). The likelihood of our finding is due to small sample size in both arms and short follow-up duration.

CONCLUSION

Thoracic surgery has always been deemed as a surgery with high morbidity. NiVATS bullectomy in selected group of patients is a viable safe alternative with superior outcomes compared to iVATS. Keeping the benefits in mind, the managing teams, both surgeons and anaesthetists, must also be prepared to handle crisis situation intraoperatively. The long-term efficacy of non-intubated VATS remains to be investigated via a well-designed, large-scale, multi-centred RCT.

CONFLICT OF INTEREST

None

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