Safe vascular and bronchial division techniques for VATS uniportal lung resections

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Abstract: VATS anatomic lung resections are becoming the standard of care for lung cancer with a long record of safety, feasibility, oncological adequacy. Following the multi-port VATS, uniportal VATS resections are becoming popular. However, uniportal VATS approach has unique challenges concerning vascular anatomy, angle of traction, stapler insertion and safe division of vessels and bronchi. In this article we are presenting a systematic description of technique for safe vascular and bronchial division for VATS uniportal anatomic resections. All operations were performed through a 3–5 cm utility incision at 5th intercostal space, using thoracoscopic and open surgical tools and endoscopic harmonic scalpel. After preparation of a vessel for division, a vascular tape was placed around the vessel and appropriate retraction for safe stapler orientation and passage was provided through intrathoracic manipulation of the vascular tape using a systemic approach. Bronchus was divided with the principle of cartilage to membranous approximation. Safe vascular and bronchial division are the most critical points for VATS lobectomy/segmentectomy operations. Uniportal VATS approach imposes additional geometric challenges for stapler orientation and placement due to further restriction of access, equipment crowding and hilar anatomy. Our technique provides practical solutions for uniportal lung resection.

Keywords: VATS; lung resections; uniportal approach; vascular; bronchial division

Received: 21 August 2016; Accepted: 17 November 2016; Published: 10 February 2017.

doi: 10.21037/vats.2016.12.04

View this article at: http://dx.doi.org/10.21037/vats.2016.12.04

Introduction

VATS anatomic resections for early stage non small cell lung cancers are becoming the standard of care with a record of at least equivalent safety, feasibility, oncological quality compared with open technique (1). Following the minimally invasive trend, uniportal VATS resections have been described in large case series (2) and results have been comparable to multi-portal VATS. Safe vascular division techniques using endoscopic roticulating staplers in triportal VATS have been described in detail (3), but uniportal VATS approach has unique challenges concerning a limited incision, vascular anatomy, angle of traction, stapler insertion and safe division. In this article, we are presenting a systemic description of technique for safe vascular and bronchial division for VATS uniportal anatomic resections.

All patients included in the article gave written consent for the use of anonymised medical data for scientific studies and also informed consent about the procedure per institutional protocol.

Surgical technique

Forty six consecutive uniportal anatomic lung resections [left upper (n=6) and lower lobectomy (n=11), left upper trisegmentectomy (n=4), left pneumonectomy (n=1), right upper (n=11), middle (n=2) and lower (n=10) lobectomy] were performed by a single surgeon (HFB) since April 2014 using the described technique in Marmara University Hospital, Istanbul/Turkey. All patients underwent standard of care preoperative workup and clinical staging. After confirmation of single lung ventilation patients were placed

in classic lateral decubitus position with an axillary roll in place. A 5-cm incision was performed between anterior and posterior axillary line at the 5th intercostal space (ICS). Ten or 5-mm 30 degree scopes, surgical instruments and endoscopic harmonic scalpel were used. After preparation of a vessel for division, a vascular tape was placed around the vessel and appropriate retraction was performed through manipulation of the vascular tape with a long curved clamp inside the thoracic cavity. This maneuver allowed easy and safe passage of the stapler behind the vessel. Retraction and manipulations for various vascular and bronchial structures are listed in *Table 1*. *Figure 1* shows appropriate utility port placement (A), outside view and angulation of stapler, thoracoscope and lung retractor during division of pulmonary vein (B) and also various intrathoracic manipulations of structures prepared for division.

There were no instances of intraoperative vascular or bronchial injury or reoperation due to bleeding. In a left pneumonectomy case, a second port was opened at the 8th ICS posterior axillary line to achieve a short pneumonectomy stump. Lobectomy and pneumonectomy specimens were slid through the utility incision after being placed in a appropriately cut sterile serum bag. We did not encounter the need to enlarge the incision for the specimen

Table 1 Techniques for manipulation and placement of the dividing instruments and retraction of the lung and loop

Structure	Preferred instrument and length for division	Angle of the stapler (degree)	Grasping site for the lung	Retraction of the lung	Retraction of the loop	Stapler location at the incision
Arteries						
Right main PA	Stapler 30–45 mm	45–60	Anterior segment of RUL	Anterior and lateral	Anterior towards IMA	Apex
Left main PA	Stapler 30–45 mm	0–30	Apical and anterior segment of LUL	Lateral and inferior	Superoanterior towards manubrium	Bottom
Anteroapical segment PA of RUL	Stapler 30–35 mm	0–30	Apical and anterior segment of RUL	Lateral	Superoanterior towards manubrium	Bottom
Posterior ascending PA of RUL	Stapler/clip/ energy device	0–30	Posterior segment of RUL	Lateral and slightly Superior	Inferior	Bottom
RML PA	Stapler 30–35 mm	0–30	Medial segment of RML	Slightly anteroinferior	Posterosuperior	Bottom
RLL PA including branches	Stapler 30–35 mm	0–45	None*	None*	Lateral chest wall and slightly superior	Bottom
LUL anteroapical segment PAs	Stapler 30–35 mm	0–30	Apical and anterior segment of LUL	Lateral and slightly inferior	Superoanterior towards manubrium	Bottom
Lingular artery of LUL	Stapler 30–35 mm	0–45	None	None	Lateral chest wall	Bottom
Other segmental arteries of LUL	Stapler/clip/ energy device	0–45	Anterior segment**	Anterior and slightly inferior	Lateral chest wall	Bottom
LLL PA including branches	Stapler 30–35 mm	0–45	None*	None*	Lateral chest wall and slightly superior	Bottom
Veins						
Right superior PV	Stapler 30–35 mm	45–60	Anterior segment of RUL	Anterior and lateral	Anterior towards IMA	Apex
Right inferior PV	Stapler 30–35 mm	30–45	Posterolateral basilar segment of RLL	Superior and lateral	Inferior towards diaphragm	Bottom

Table 1 (*continued*)

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Structure	Preferred ınstrument and length for division	Angle of the stapler (degree)	Grasping site for the lung	Retraction of the lung	Retraction of the loop	Stapler location at the ıncision
Left superior PV	Stapler, 30–35 mm	45–60	Anterior segment of LUL	Anterior and lateral	Anterior towards IMA	Apex
Left ınferior PV	Stapler 30–35 mm	30–45	Posterolateral basilar segment of LLL	Superior and lateral	Inferior towards diaphragm	Bottom
Superior segment vein of both sides	Stapler/clip/ energy device	30–45	Superior and posterior segment	Lateral	None	Bottom
Right middle lobe vein	Stapler/clip/ energy device	30–45	Lateral segment	Superior	Inferoanterior	Bottom
Left upper lobe trisegment vein	Stapler 30–35 mm	45–60	Anterior segment of LUL	Anterior and lateral	Anterior towards IMA	Apex
Lingular vein	Stapler/clip/ energy device	30–45	Medial segment of lingular	Superoposterior	Inferoanterior	Bottom
Bronchi						
Right main bronchus	Stapler 30–45 mm	45–60	Posterior segment of upper lobe	Anterosuperior	None	Apex
Left main bronchus***	Stapler 30–45 mm	45–60	Posteroanterior segment of upper lobe	Anterosuperior	None	Apex
RUL	Stapler 30–45 mm	45–60	Posterior segment of upper lobe	Lateral and slightly anterior	None	Apex
RML	Stapler 30–35 mm	0–30	Medial segment or RML	Anteroinferior	None	Bottom
RLL	Stapler 30–45 mm	30–45	Posterolateral segment of LL	Anterior and lateral	None	Bottom
LUL	Stapler 30–45 mm	30–45	Anterior segment of UL	Anterosuperior	None	Bottom
LLL	Stapler 30–45 mm	30–45	Posterolateral segment of LL	Anterior and lateral	None	Bottom
Trisegment bronchus	Stapler 30–45 mm	45–60	Anterior segment of UL	Lateral and slightly anterior	None	Apex
Lingular bronchus	Stapler 30–35 mm	0–30	Medial segment of lingular	Lateral and slightly superior	None	Bottom
Basilar segment bronchi both sides	Stapler 30–45 mm	30–45	Posterolateral Segment of LL	Anterior and lateral	None	Bottom
Superior segment bronchi both sides	Stapler 30–35 mm	0–30	Superior segment	Lateral and slightly Superior	None	Bottom
Anterior segment bronchus	Stapler 30–45 mm	45–60	Apical segment of UL	Lateral and slightly superior	None	Apex

PA, pulmonary artery; RUL, right upper lobe; IMA, internal mammary artery; LUL, left upper lobe; RML, right middle lobe; RLL, right lower lobe; LLL, left lower lobe; PV, pulmonary vein; LL, lower lobe; UL, upper lobe. *, When lung is adequately deflated the fissure is flat and there is usually no need for retraction of the lung during division of interlobar arteries; **, this retraction is used if you are dividing those vessels via anterior approach. If the vessels are divided through the fissure it would require an anterior and apical retraction; ***, left main bronchus is deeply located, thus an open surgery bronchial stapler from the uniportal incision or a second port at the 8th intercostal space is recommended to obtain a good main bronchial margin.

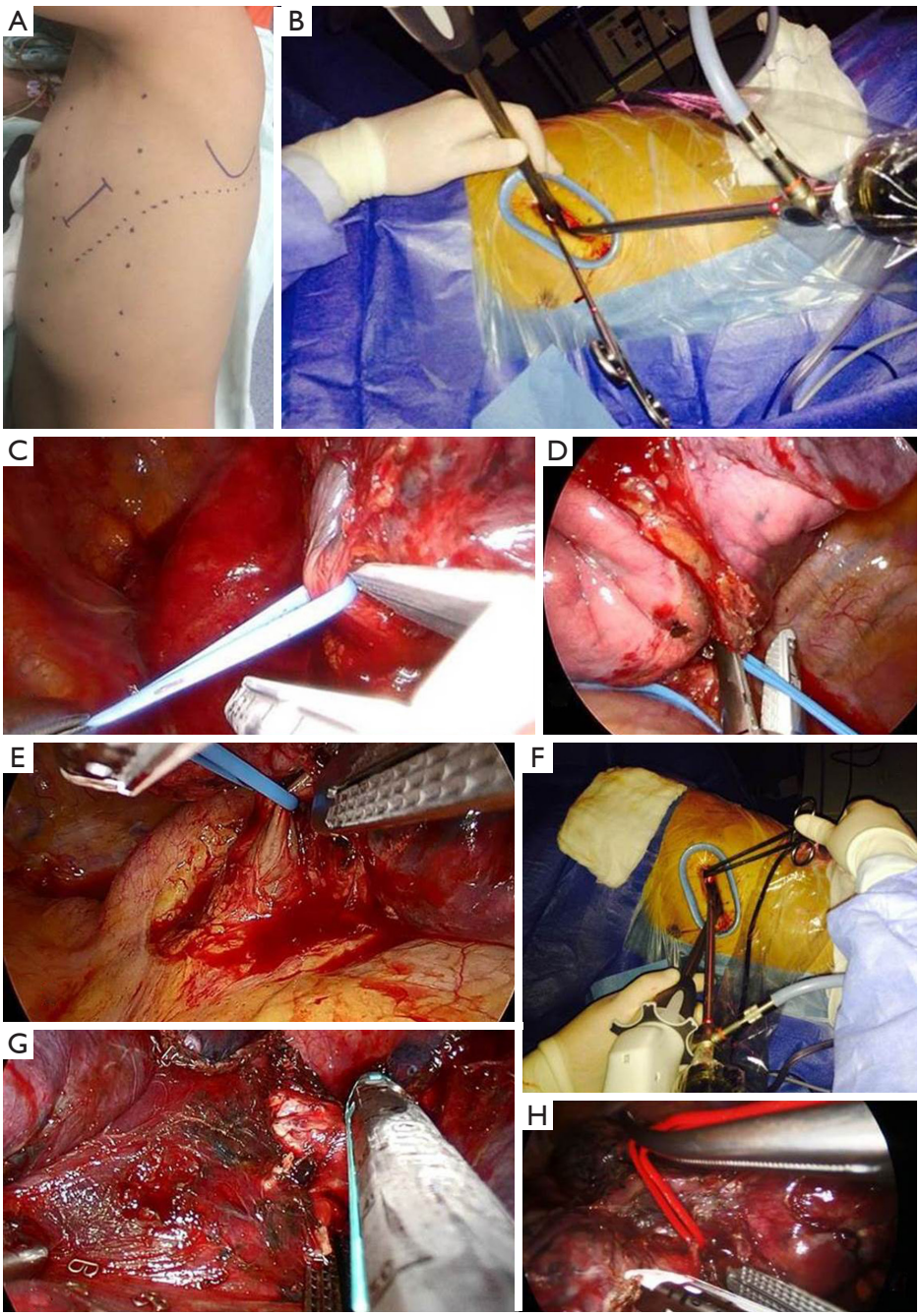

Figure 1 Appropriate utility port placement. (A) Typical incision for left sided uniportal lung resections. 3-5 cm incision between anterior and posterior axillary line 5th intercostal space; (B) position of instruments during division of upper lobe pulmonary vein. The stapler is fully angled and inserted from the top of the incision. Camera is in the middle of the incision. Lung retraction can be achieved from the bottom or top of the incision depending on the size of the instrument. If a 5 mm instrument is used it can be placed to the top; (C) the vessel loop is retracted anteriorly towards internal mammary artery and stapler leg is easily slided behind the vein. The stapler leg does not insert any pressure on the vessel wall; (D) division of the inferior pulmonary vein with the same maneuver. Vessel loop is pulled towards the diaphragm; (E) approach to apical and anterior segment arteries of the left upper lobe. The vessel loop is pulled superoanteriorly; (F) external view of the position of clamp that retracts the vessel loop, camera and stapler are shown; (G) division of the left upper lobe bronchus through the fissure. This maneuver allows correct approximation of membranous and cartilaginous parts; (H) approach to right middle lobe artery with the same maneuver.

but the ones with bigger (3–5 cm) tumors were considerably more difficult to pull out.

Discussion

Safe vascular division is the most critical point for VATS lobectomy/segmentectomy operations. Uniportal VATS approach imposes additional geometric challenges for stapler orientation and placement due to further restriction of access, equipment crowding and hilar anatomy. For classical VATS catastrophic intraoperative complications are reported at 1% (4). For uniportal operations the surgeon should be able to fit the operation according to the specific anatomy, as the uniport restricts otherwise appropriate classical actions.

Safe division during uniportal VATS resection depends on a few principles. There should be minimal instrument crowding and instruments should not apply pressure on each other. Such problems transfer the pressure and tension to anatomic structures and also cause pain through impingement of the intercostal nerve. Moreover, since most of the vascular preparation and exposure is done from the anterior side with the lung retracted posteriorly, traction of the vessel for division should be roughly opposite to the lung retraction to avoid harming of the posterior structures. This can not be achieved with a vascular tape manipulated outside the thorax, which causes an upwards retraction and an unfavorable angle for easy passage of a stapler. Classical bronchial closure technique involves meticulous alignment of membranous side to cartilaginous part (5) and also requires precise manipulation in minimally invasive setting (*Table 1*).

The described technique transfer the tension to a wider area on the vessel tape and prevents traction by the legs of the stapler. The tension is also distributed to lung surface with correct grasping and retraction of the lung. It enables us to safely pass the stapler even in instances of inability to gain vascular and bronchial length due to larger and more central tumors.

In conclusion, uniportal resections opens a new era when surgeons have to think of the geometry and tension distribution on the anatomic structures more than ever before. The technique described in this article follows these principles and is safe and effective.

doi: 10.21037/vats.2016.12.04
Cite this article as: Bilgi Z, Batirel HF. Safe vascular and bronchial division techniques for VATS uniportal lung resections. Video-assist Thorac Surg 2017;2:4.

Acknowledgements

None.

Footnote

Conflicts of Interest: Hasan Batirel, MD, PhD serves as a consultant for Johnson and Johnson and Marmara University Faculty of Medicine Department of Thoracic Surgery has an educational agreement with Johnson and Johnson.

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