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Intercostal Lung Hernias Presenting After Minimally Invasive Cardiac Surgery

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This study was carried out at the Cardio VID Clinic, Medellín, Colombia.

ABSTRACT

Introduction: With the introduction of minimally invasive cardiac surgery, more commonly cases of lung herniation are starting to appear. Acquired lung hernias are classified as postoperative, traumatic, pathologic, and spontaneous. Up to 83% of lung hernias are intercostal. Herein, we describe patients presenting with intercostal lung hernias following minimally invasive cardiac surgery at a single center in Medellín, Colombia.

Methods: We conducted a retrospective search of all patients presenting with intercostal lung hernias secondary to minimally invasive cardiac surgery at our clinic in Medellín since the beginning of our program, from 2010 to 2022. Mini-sternotomies were excluded from our study. We reviewed the incision type and other possible factors leading to intercostal lung hernia development. We also describe the approach taken for these patients.

Results: From 2010 up until 2022, 803 adult patients underwent minimally invasive cardiac surgeries through a mini-thoracotomy. At the time of data retrieval, nine patients presented with intercostal lung hernias at the previous incision site. Five hernias (55%) were from right 2nd intercostal parasternal mini-thoracotomies for aortic valve surgeries. Four hernias (45%) were from right 4th intercostal lateral mini-thoracotomies for mitral valve surgeries. Our preferred repair technique is a video-assisted thoracoscopic mesh approach.

Conclusion: Minimally invasive cardiac surgical approaches are becoming more routine. Proper wound closure is critical in preventing lung hernias. Additionally, timely diagnosis and opportune hernia surgery using video-assisted thoracoscopic mesh repair can prevent further complications.

Keywords: Hernia. Thoracotomy. Sternotomy. Mitral Valve. Video-Assisted Thoracic Surgery. Surgical Mesh. Cardiac Surgical Procedures. Lung.

Abbreviations, Acronyms & Symbols	
AHT	= Arterial hypertension
ASD	= Atrial septal defect
AVR	= Aortic valve replacements
IC	= Intercostal
MICS	= Minimally invasive cardiac surgery
MIDCAB	= Minimally invasive direct coronary artery bypass
MVR	= Mitral valve repair or replacement
VATS	= Video-assisted thoracoscopic surgery

INTRODUCTION

In 1499, Roland was the first to describe lung herniation[1]. Morel-Lavalee further classified lung hernias according to their anatomical locations and whether they are acquired or congenital[1]. Acquired lung hernias are again classified as postoperative, traumatic, pathologic, and spontaneous[1]. Up to 83% of lung hernias are intercostal (IC)[1]. With the introduction of minimally invasive cardiac surgery (MICS), more and more cases of lung herniation are starting to appear[1,2]. Although the majority are right-sided hernias because of the right-sided approach to mitral valve repairs and aortic valve replacements (AVR), left-sided lung hernias may also appear secondary to minimally invasive direct coronary artery bypass (MIDCAB)[2,3]. Since the introduction of MICS in Colombia in 2010, our clinic in Medellín has been the epicenter for MICS in the country and the only Colombian center with over 300 MICS cases[4,5]. During this time, a total of 803 adult patients underwent MICS through mini-thoracotomies. Of these, seven were left mini-thoracotomies for MIDCABs. At the time of data collection (12 years of MICS), nine patients developed IC lung hernias secondary to MICS; an incidence of 0.01%. To date, no lung hernias secondary to robotic cardiac surgeries have been reported in Colombia (one

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center in Bogota performs robotic cardiac surgery)[6]. Of the nine patients who developed lung hernias, eight were taken to surgical correction while one asymptomatic patient is in routine follow-up.

METHODS

We conducted a retrospective search of all patients presenting with IC lung hernias secondary to MICS at our clinic in Medellín, Colombia, since the beginning of our program, from 2010 to 2022. Mini-sternotomies were excluded from our study. We reviewed MICS incision type and other possible factors leading to IC lung hernia development. We also describe the approach taken for these patients. Ethics board approval was obtained and patient consent was given.

RESULTS

Since the start of our MICS program in 2010 up until 2022, 803 adult patients underwent MICS through a mini-thoracotomy. Of these, seven had left mini-thoracotomies for a MIDCAB approach (Table 1). MICS surgeries included mitral valve repair or replacement (MVR), AVR, and atrial septal defect closures. At the time of data retrieval, nine patients presented with IC lung hernias at the previous incision site. Five patients (55%) were female, and four patients (45%) were male. Five hernias (55%) were from right 2nd IC parasternal mini-thoracotomies for AVRs. Four hernias (45%) were from right 4th IC lateral mini-thoracotomies for MVRs. Two hernias (one AVR) and (one MVR) developed following postoperative reintervention through the same MICS incision to control bleeding (Table 1). Average time from the first MICS surgery to lung hernia development was 1.5 months, while average time from hernia diagnosis to hernia correction was four months. One exception was a patient who had her hernia corrected three years after diagnosis. Patients present initially with IC pain with a bulging mass in the hernia site and intermittent dyspnea. Chest computed tomography scans reveal the herniated lung and pleural space (Figure 1A-B). The surgical approach used for lung hernia repair in these patients involves hernia reduction, hernia sac resection, adhesion lysis, decortication depending on intraoperative findings, and mesh repair through a video-assisted thoracoscopic (VATS) technique (Figure 1C-F). We use a polypropylene mesh and polydioxanone sutures for rib approximation and closure of the augmented IC space. Six patients had a VATS approach without using a Finochietto rib spreader. One patient required both rib spreading and VATS, while another patient had a direct open thoracic wall reconstruction without VATS nor rib spreading.

DISCUSSION

Up until 2002, only three cases of lung hernias following MICS were reported[7]. Although the exact incidence of lung hernias is unknown, some centers are beginning to report cases following MICS and soon incidence reports will start to surface. Table 2 outlines recent reports of IC lung hernias following MICS. Although the exact cause of lung hernia development is not known, improper chest wall closure and severe coughing seem to be important contributing factors. In 2020, Cetinkaya et al. reported 20 cases of lung hernias at a German center from a subset of 1,381 patients indicating an incidence of 0.01% during seven years[8]. This

Table 1. Characteristics of patients with lung hernias following MICS in Medellín, Colombia.

Patient no.	Sex	Age (years)	Primary surgery	Time of hernia	Same incision re-intervention	Hernia characteristics	Comorbidities	Surgery technique
1	Female	51	AVR	3 years	None	2nd IC, right parasternal	Takayasu arteritis, AHT	VATS, mesh repair
2	Male	65	AVR	2 months	Postoperative bleeding	2nd IC, right parasternal	AHT, epilepsy	VATS, mesh repair
3	Male	77	MVR	1 month	None	4th IC, right lateral	Abdominal aortic aneurysm, peripheral arterial disease	VATS, mesh repair
4	Female	63	AVR	2 months	None	2nd IC, right parasternal	AHT, obesity, prediabetes, hiatal hernia, fatty liver	VATS, mesh repair
5	Female	53	Mitral annuloplasty	1 month	None	4th IC, right lateral, periareolar	AHT, obesity, hypothyroidism	VATS, mesh repair
6	Female	32	MVR	1 month	Postoperative bleeding	4th IC, right lateral	Hydrocephaly (pediatric)	Open mesh repair
7	Male	71	MVR + maze + tricuspid valve repair	1 month	None	4th IC, right lateral	AHT, dyslipidemia, atrial fibrillation	VATS, mesh repair
8	Male	70	AVR	1 month	None	2nd IC, right para-sternal	AHT, dyslipidemia	VATS, mesh repair

AHT=arterial hypertension; AVR=aortic valve replacement; IC=intercostal; MICS=minimally invasive cardiac surgery; MVR=mitral valve repair or replacement; VATS=video-assisted thoracoscopic surgery

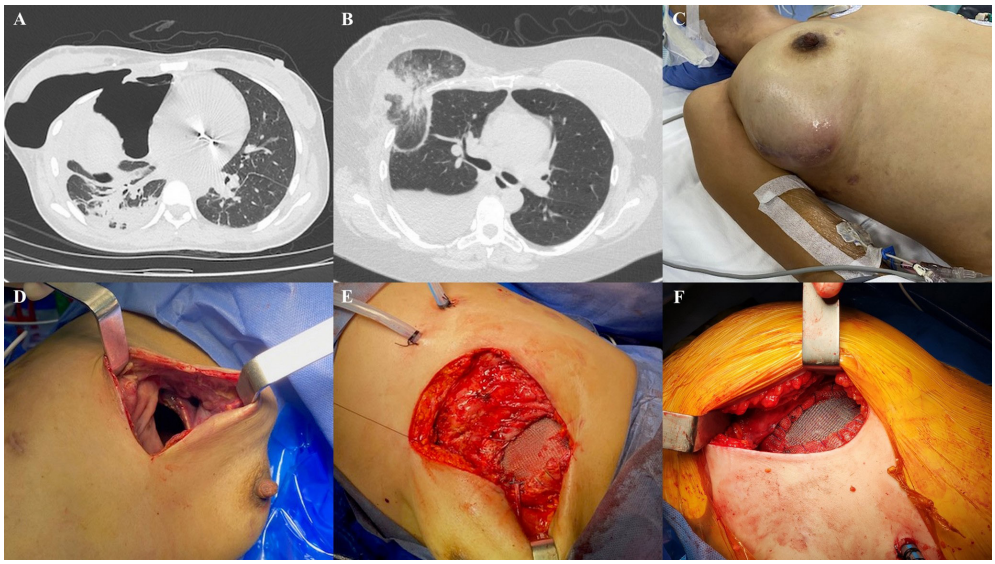

Fig. 1 - *A-B) Chest computed tomography showing a right-sided intercostal defect with a pneumothorax and protrusion of lung parenchyma into the herniated space. C) Preoperative image showing a bulging mass into the right chest of the patient. D) Right intercostal defect after lung reduction revealing wide intercostal space. E) Direct open mesh hernia repair. F) Post-video-assisted thoracoscopic mesh lung hernia repair.*

Table 2. Latest published cases of lung hernias following MICS.

Author	Year	Patient's sex	Patient's age (years)	Primary surgery	Time of hernia appearance	Hernia characteristic
Deeik	1998	Male	66	MIDCAB	1 month	4th IC, left
Gouda	2002	Male	36	MICS, mitral	6 weeks	Not stated
Athanassiadi	2007	Male (12)	Between 23-77	Not stated	Not stated	Right (8)
		Female (4)				Left (6)
						Bilateral (2)
Santini	2008	Female	59	MICS, mitral	7 months	4th IC, right
Wiedemann	2011	Not stated	50	ASD repair	Not stated	4th IC, right
Waymann	2011	Male	67	MIDCAB	1 year	3rd IC, left
Bhamidipati	2012	Male	60	Robotic mitral annuloplasty	1 year	3rd IC, right
		Male	48	Robotic mitral annuloplasty	1.5 years	4th IC, right
Cafarotti	2013	Not stated	Not stated	MICS, aortic valve	5 years	Not stated
Kumar	2013	Female	62	VATS, pulmonary vein ablation	6 weeks	7th IC, left
Chen	2014	Male	29	MICS, mitral	5 years	4th IC, right
Wilgus	2018	Male	52	Robotic mitral valve repair	4 months	4th IC, right
Meana	2018	Male	87	MICS, mitral repair	10 years	Not stated
Koichi	2019	Female	51	MICS, mitral annuloplasty	5 days	4th IC, right

ASD=atrial septal defect; IC=intercostal; MICS=minimally invasive cardiac surgery; MIDCAB=minimally invasive direct coronary artery bypass; VATS=video-assisted thoracoscopic surgery

number agrees with the incidence reported here by our center also at 0.01%. In 2009, Santini et al. described a VATS approach for lung hernia repair followed by Cafarotti in 2014[9,10]. At our clinic, VATS is the technique and approach of choice. Robot-assisted cardiac surgery is also subject to the development of IC lung hernias[1,11]. Although symptomatic lung hernias require surgical repair, in some cases manual repositioning may be an option[12]. In fact, smaller asymptomatic hernias may not require surgery, and these patients can be followed on an outpatient basis keeping in mind the risk of lung strangulation and/or symptom development. Because of the rare entity and low incidence of IC lung hernia development especially following MICS, true indications of surgery are still not standardized. As for large IC defects and symptomatic patients, surgery should be considered[13-15]. The best treatment approach remains hernia prevention, therefore, wound closure should be meticulous and carefully performed ensuring proper rib approximation.

CONCLUSION

Minimally invasive cardiac surgical approaches are becoming more routine. This progressive increase in smaller incisions also introduces newer challenges and possible complications which demand more from the surgeon. Proper wound closure is critical in preventing lung hernias. Additionally, timely diagnosis and opportune hernia surgery using VATS mesh repair can prevent further complications.

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Authors' Roles & Responsibilities

EEV	Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; final approval of the version to be published
RAZ	Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; final approval of the version to be published
CAT	Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; final approval of the version to be published
CMM	Drafting the work or revising it critically for important intellectual content; final approval of the version to be published
UER	Drafting the work or revising it critically for important intellectual content; final approval of the version to be published
JCR	Drafting the work or revising it critically for important intellectual content; final approval of the version to be published
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OAM	Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved; final approval of the version to be published
LAG	Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved; final approval of the version to be published
DEL	Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved; final approval of the version to be published

REFERENCES

1. May-Lin W. Lung Herniation after Minimally Invasive Cardiac Surgery. Proc oUCLA Health. 2018;22:1-3.
2. Weymann A, Szabo G. Images in clinical medicine. Lung herniation after minimally invasive cardiothoracic surgery. N Engl J Med. 2011;365(9):e19. doi:10.1056/NEJMicm1013267.
3. Deeik RK, Memon MA, Sugimoto JT. Lung herniation secondary to minimally invasive direct coronary artery bypass grafting. Ann Thorac Surg. 1998;65(6):1772-4. doi:10.1016/s0003-4975(98)00242-2.
4. Vinck EE. Cardiac surgery in Colombia: history, advances, and current perceptions of training. J Thorac Cardiovasc Surg. 2020;159(6):2347-52. doi:10.1016/j.jtcvs.2019.09.079. Erratum in: J Thorac Cardiovasc Surg. 2020;160(5):1410. doi:10.1016/j.jtcvs.2020.09.001.
5. Vinck EE, Rendón JC, Andrade D, Escobar JJ, Núñez F, Sardari Nia P. Minimally invasive cardiac surgery in Colombia: evolution and the impact of international training. Innovations (Phila). 2021;16(4):305-9. doi:10.1177/15569845211030982.
6. Andrade D, Vinck EE, Parra JF, Balkhy HH, Núñez F. Robotic cardiac surgery in Colombia: overcoming the challenges of a middle-income setting. Braz J Cardiovasc Surg. 2020;35(6):990-3. doi:10.21470/1678-9741-2020-0064.
7. Gouda H, Multz AS, Khan A, Rossoff LJ, Green LM, Graver D. Lung hernia as a sequela to limited-access mitral valve surgery. Tex Heart Inst J. 2002;29(3):203-5.
8. Cetinkaya A, Zeriouh M, Liakopoulos OJ, Hein S, Siemons T, Bramlage P, et al. Pulmonary herniation after minimally invasive cardiac surgery: review and implications from a series of 20 cases. J Surg Case Rep. 2020;2020(11):rjaa415. doi:10.1093/jscr/rjaa415.
9. Santini M, Fiorello A, Vicidomini G, Busiello L. Pulmonary hernia secondary to limited access for mitral valve surgery and repaired by video thoracoscopic surgery. Interact Cardiovasc Thorac Surg. 2009;8(1):111-3. doi:10.1510/icvts.2008.190744.
10. Cafarotti S, Matarrelli E, Guerra A, Dutly AE. Large intercostal pulmonary hernia secondary to limited-access aortic valve surgery: video-assisted thoracoscopic technique repair. Lung. 2014;192(2):333-4. doi:10.1007/s00408-013-9538-5.
11. Bhamidipati CM, Iyalla KI, Seymour KA, Lutz CJ. Lung hernia following robotic-assisted mitral valve repair. J Card Surg. 2012;27(4):460-3. doi:10.1111/j.1540-8191.2012.01463.x.
12. Koichi Y, Ise H, Ohira S, Kobayashi D, Nakanishi S, Ishikawa N, et al. Manual repositioning of lung hernia after minimally invasive cardiac surgery. J Surg Case Rep. 2019;2019(3):rjz056. doi:10.1093/jscr/rjz056.
13. Wiedemann D, Kocher A. Lung herniation after minimally invasive atrial-septal-defect closure. Eur J Cardiothorac Surg. 2012;42(3):590. doi:10.1093/ejcts/ezs175.
14. Athanassiadi K, Bagaev E, Simon A, Haverich A. Lung herniation: a rare complication in minimally invasive cardiothoracic surgery. Eur J Cardiothorac Surg. 2008;33(5):774-6. doi:10.1016/j.ejcts.2008.01.027.
15. Kumar N, Pison L, Meir La M, Maessen J. Atraumatic lung hernia: a rare complication of minimally invasive surgical atrial fibrillation ablation. J Atr Fibrillation. 2013;6(4):1005. doi:10.4022/jafib.1005.