View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Elsevier - Publisher Connector

J Ped Surg Case Reports 9 (2016) 40–42

Contents lists available at ScienceDirect

Journal of Pediatric Surgery CASE REPORTS

journal homepage: www.jpscasereports.com

Minimally invasive repair of pectus excavatum in a 17-year-old boy with a history of congenital diaphragmatic hernia and lack of pericardium

Stefan M. van der Heide, Simone T. Timman*

Department of Cardiothoracic Surgery, Radboud University Medical Center, Postbus 9101, 6500 HB Nijmegen, The Netherlands

ARTICLE INFO

Article history:
Received 13 March 2016
Received in revised form
10 April 2016
Accepted 13 April 2016

Key words:
Pectus excavatum
MIRPE
Minimally invasive repair
Nuss procedure
Pericardium
Diaphragmatic hernia

ABSTRACT

We reported a 17-year-old boy with very deep asymmetric pectus excavatum and with a history of congenital diaphragmatic hernia repair and hypoplastic left lung. We performed a minimally invasive repair of pectus excavatum as described by Nuss et al., in 1998. We performed a left-sided thoracoscopy, instead of the right-sided according our normal routine, to provide a safe route. We created a substernal tunnel to have a clear definition of the deviant anatomy after congenital diaphragmatic hernia repair. However, we noticed an absence of the pericardium, which, by itself, can increase the risk of cardiac injury in both bar insertion and removal. Instead of the usual right-sided thoracoscopy, we recommend providing a safe view by left-sided thoracoscopy in comparable cases (e.g. congenital diaphragmatic hernia, other cardiac or vascular malformations) to reduce the risk of rupture or perforation of cardiac structures.

© 2016 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Pectus excavatum (PE) or 'funnel chest' is by far the most common congenital thoracic wall deformity which affects 1/400 children and is predominantly found in male patients [1,2]. PE can be treated either by the 'modified Ravitch procedure,' an open surgical procedure with resection of the deformed costal cartilage and sternal osteotomy, or by 'minimally invasive repair of pectus excavatum' (MIRPE) also, called the 'Nuss-procedure,' by placing a retrosternal bar to uplift the sternum. The first insertion of a retrosternal stainless steel bar was published in 1975 by Skobos et al. This steel bar was added to the conventional open procedure to prevent relapse of the sternum [3]. In 1998, Nuss et al., published their first results of correcting PE by placing a retrosternal stainless steel bar without performing costal cartilage resection or sternal osteotomy as an answer to the labor-intensive conventional Ravitch procedure [4]. MIRPE has excellent cosmetic results and a low complication rate [5–7]. Only a few major complications, such as cardiac perforation, hemothorax, pulmonary vessel arrosion, are reported in literature [8–12]. To minimize the risk of mediastinal or cardiac injury, most of the surgeons perform MIRPE thorascoscopy-guided [13]. There have been two reports of minimally invasive repair for pectus excavatum done in a patient with a history of congenital diaphragmatic hernia in literature in the past [14]. We report our altered technique for MIRPE in a 17-year-old boy with a very deep pectus excavatum and a history of congenital diaphragmatic hernia repair, hypoplastic left lung by left-sided thoracoscopy instead of the more commonly used right-sided thoracoscopy.

1. Case report

A 17-year-old boy with a history of congenital diaphragmatic hernia and hypoplastic left lung visited our clinic three years ago. The patient underwent diaphragmatic hernia repair one-week post partum. In the following years, the patient developed a pectus excavatum with asymmetric anterior wall in disadvantage of the left thoracic wall and a scoliosis. The patient had no physical complaints. A cardiac magnetic resonance imaging (CMR) was performed and showed a very deep asymmetric pectus with a Haller index (HI) of 16 and a mispositioned heart in the left thorax (Fig. 1).

The minimal distance between sternum and the spinal cord was less than 1 inch. Compression of the right atrium and ventricle and elongation of the great vessels was described. However, no evidence for flow obstruction, malfunction of the valves was witnessed. The left and right ventricle function seemed to be normal.

* Corresponding author. Tel.: +31 24 14744; fax: +31 24 3635118.
E-mail address: simone.timman@radboudumc.nl (S.T. Timman).

2213-5766/© 2016 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
http://dx.doi.org/10.1016/j.epsc.2016.04.012

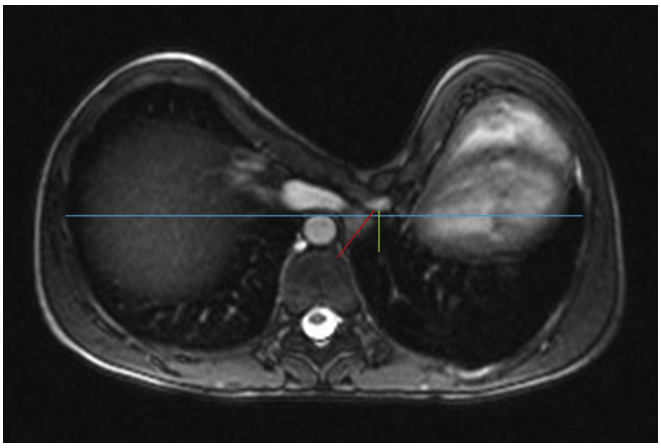

Fig. 1. CMR shows a very deep asymmetric PE and a mispositioned heart in the left thorax. Red line: minimal distance between spine and sternum <1 inch. Haller index: 16.

2. Bar insertion technique

We performed a minimally invasive repair of pectus excavatum, video-assisting thoracoscopic surgery (VATS) guided and monitored by electrocardiography (ECG). We implanted a 12-inch bar. Due to the abnormal anatomy, the thoracoscope (30°) was first inserted into the left thorax to avoid cardiac, vascular or pulmonary injury. The trocar was placed in the fourth intercostal space in the anterior axillary line. In our opinion is left-sided introduction of the first trocar safe. Firstly, the fourth intercostal space in the anterior axillary line is above the heart. Secondly, after carefully opening of the pleural space the lung will collapse and the heart will shift backwards to the posterior thoracic wall. Unexpectedly, we noticed the absence of the pericardium during inspection of the left thorax (Fig. 2).

Furthermore, we safely introduce to pectus introducer in the left thoracic space. A left-to-right substernal tunnel was created away from the heart instead of toward the heart. Due to the extreme deep pectus we were unable to bring the pectus introducer to the right-sided extra-thoracic tunnel. Therefore, we created a small extra right-sided incision and used a steel wire to lift the pectus introducer to advance it through the thoracic cavity. The use of substeral lifting was unattractive due to his former CDH repair which crosses the linea alba. Bar insertion went without further complications. There were no events during follow-up. Fig. 3 shows pre- and post-operative results.

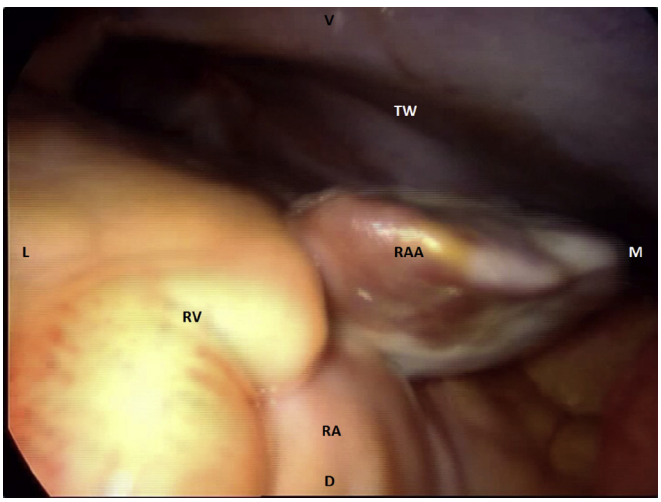

Fig. 2. Thoracoscopic left-sided view shows cardiac structures in absence of pericardium. Anatomic position: L = lateral, M = medial, V = ventral, D = dorsal, structures, RV = right ventricle, RA = right atrium, RAA = right atrial auricle/appendage, TW = thoracic wall.

3. Bar removal technique

Three years later the bar was removed during an elective procedure. We expected a higher risk of cardiac adhesions to the thoracic wall or to the Nuss bar because of the lack of its natural cardiac sheet (i.e. pericardium). Consequently, we had VATS standby in case any arrhythmias were shown on ECG which may occur during bar manipulation due to cardiac adhesions. The bar removal went without complications. After surgery, the patient fully recovered and was discharged the same day.

4. Discussion

There is minimal experience of MIRPE in patients with CDH. Theoretically, these patients have an increased risk of major complications during bar placement such as cardiac or pulmonary rupture or perforation due to formed adhesions in the thoracic cavity after CHD repair in childhood. Moreover, extremely severe pectus excavatum, such as in our case, seems to have a higher risk on major complications such as perforation of cardiovascular structures [10,15,16]. Kabbaj et al., recommend a sub- and retro-xiphoid approach to guide implant insertion or a classic sterno-chondroplasty procedure instead of thoracoscopic PE correction in this situation [17]. In addition, lack of pericardium layer to protect the heart and great vessels aggravates the risk of perforation during bar insertion as well as during bar removal [18]. The combination of CDH repair, severe PE and absence of pericardium makes this a high risk case for MIRPE. We advise providing a safe view by a left-sided thoracoscopy. The left-sided view will ensure a safer way to create a substernal tunnel and to insert the bar without damaging any cardiovascular structures. In addition, Metzelder et al., also describe a safe thoracoscopic adhesiolysis before bar placement by left-sided thoracoscopy [14]. Furthermore, a lack of pericardium was unexpected in our case. Apparently, it is a very rare anomaly with an incidence of less than 1/10.000 [19,20]. There are only a few cases of congenital absence of the pericardium associated with PE reported in the literature [21]. Its association with CDH remains unclear. CMR is considered the gold standard to detecting absence of pericardium [22]. Unfortunately, even after revision we could not recognize it on CMR in our case. For bar removal, lack of pericardium increases the risk of cardiovascular adhesions to the thorax wall or retrosternal bar. Therefore, we advise removing the bar guided by ECG or VATS. ECG, in this case, provides more information about arrhythmias during manipulation of the bar caused by adhesions between cardiac structures and the bar. Our ECG did not show any arrhythmias during careful manipulation. Therefore, new cardiac adhesions were unlikely, so we did not require use of VATS during removal. For bar removal, we intended to use VATS for an optimal view just as in the previous procedure (cause of absence of cardiac protection layer: pericardium). In conclusion, we provided a very safe and clear view for MIRPE by left-sided thoracoscopy in a case of severe PE, CHD repair. Furthermore, we did a successful ECG-guided bar removal, despite the lack of pericardium (i.e. with an increased risk of cardiovascular adhesions to the thorax wall or retrosternal bar). In order to reduce the risk of rupture or perforation of cardiac structures we recommend ECG and, if the ECG shows any arrhythmias during traction, left-sided VATS for a safer removal in case of any cardiac adhesions.

Fig. 3. Left image: pre-operative status. Note the scar after CDH repair. Right image: post-operative result after placement of a single bar.

References

[1] Fokin AA, Steuerwald NM, Ahrens WA, Allen KE. Anatomical, histologic, and genetic characteristics of congenital chest wall deformities. Semin Thorac Cardiovasc Surg 2009;21:44.

[2] Kelly RE, Lawson ML, Paidas CN, Hruban RH. Pectus excavatum in a 112-year autopsy series: anatomic findings and the effect on survival. J Pediatr Surg 2005 aug;40(8):1275–8.

[3] Sbokos CG, McMillian IK, Akins CW. Surgical correction of pectus excavatum using a retrosternal bar. Thorax 1975 Feb;3D(1):40–5.

[4] Nuss D, Kelly RE, Croitoru DP, Katz ME. A 10-year review of a minimally invasive technique for the correction of pectus excavatum. J Pediatr Surg 1998;33:545–52.

[5] Croitoru DP, Kelly Jr RE, Goretsky MJ, Lawson ML, Swoveland B, Nuss D. Experiecne and modification update for minimally invasive Nuss technique for pectus excavatum repair in 303 patients. J Pediatr Surg 2002 Mar;37(3):437–45.

[6] Nuss RE, Goretsky MJ, Obermeyer R, Kuhn MA, Redlinger R, Haney TS, et al. Twenty-one years of experience with minimally invasive repair of pectus excavatum by the Nuss procedure in 1215 patients. Ann Surg 2010 Dec;252(6):1072–81. http://dx.doi.org/10.1097/SLA.0b01e3181effdce.

[7] Pilegaard HK, Licht PB. Routine use of minimally invasive surgery for pectus excavatum in adults. Ann Thorac Surg 2008 Sep;86(3):952–6.

[8] Moss RL, Albanese CT, Reynolds M. Major complications after minimally invasive repair of pectus excavatum: case reports. J Pediatr Surg 2001 Jan;36(1):155–8.

[9] Belcher E, Arora S, Samancilar O, Goldstraw P. Reducing cardiac injury during minimally invasive repair of pectus excavatum. Eur J Cardiothorac Surg 2008 May;33(5):931–3. http://dx.doi.org/10.1016/j.ejcts.2008.01.030. Epub 2008 Mar 4.

[10] Becmeur F, Ferreira CG, Haecker FM, Schneider A, Lacreuse I. Pectus excavatum repair according to Nuss: is it safe to place a retrosternal bar by a transpleural approach, under thoracoscopic vision? J Lapaoendosc Adv Surg Tech A 2011 Oct;21(8):757–61. http://dx.doi.org/10.1089/lap.2011.0035. Epub 2011 Sep 1.

[11] Kosumi T, Yonekura T, Owari M, Hirooka S. Late-onset hemothorax after the Nuss procedure for funnel chest. Pediatr Surg Int 2005 Dec;21(12):1015–7. Epub 2005 Oct 22.

[12] Leonhardt J, Kübler JF, Feiter J, Ure BM, Petersen C. Complications of the minimally invasive repair of pectus excavatum. J Pediatr Surg 2005 Nov;40(11):e7–9.

[13] Hebra A, Swoveland B, Egbert M, Tagge EP, Georgeson K, Othersen Jr HB, et al. Outcome analysis of minimally invasive repair of pectus excavatum: review of 251 cases. J Pediatr Surg 2000 Feb;35(2):252–7. discussion 257–8.

[14] Metzelder ML, Ure BM, Leonhardt J, Grigull L, Khelif K, Petersen C. Impact of concomitant thoracic interventions on feasibility of Nuss procedure. J Pediatr Surg 2007 Nov;42(11):1853–9.

[15] Bouchard S, Hong AR, Gilchrist BF, Kuenzler KA. Catastrophic cardiac injuries encountered during the minimally invasive repair of pectus excavatum. Semin Pediatr Surg 2009 May;18(2):66–72. http://dx.doi.org/10.1053/j.sempedsurg.2009.02.002.

[16] Ballouhey Q, Leobon B, Trinchero JF, Baunin C, Galinier P, Cales de Gauze J. Mechanical occlusion of the inferior vena cave: an early complication after repair of pectus excavatum using the Nuss procedure. J Pediatr Surg 2012 Dec;47(12):e1–3. http://dx.doi.org/10.1016/j.jpedsurg.2012.08.022.

[17] Kabbaj R, Burnier M, Kohler R, Loucheur N, Dubois R, Jouve JL. Minimally invasive repair of pectus excavatum using the Nuss technique in children and adolescents: indications, outcomes, and limitations. Orthop Traumatol Surg Res 2014 Oct;100(6):625–30. http://dx.doi.org/10.1016/j.otsr.2014.05.019. Epub 2014 Sep 8.

[18] Nagasao T, Takayama M, Miyamoto J, Ding W, Jiang H. Anatomical study of the thorax for the safe performance of the Nuss procedure for pectus excavatum. Thorac Cardiovasc Surg 2011 Feb;59(1):34–9. http://dx.doi.org/10.1055/s-0030-1249922. Epub 2011 Jan 7.

[19] Connolly HM, Click RL, Schattenberg TT, Seward JB, Tajik AJ. Congenital absence of the pericardium: echocardiography as a diagnostic tool. J Am Soc Echocardiogr 1995;8:87–92.

[20] Verloes A, Perrin L, Delbecque K, Gonzales M, Demarche M, Dekoster G. Congenital absence of the left pericardium and diaphragmatic defect in sibs. Eur J Med Genet 2010 May-jun;53(3):133–5.

[21] Nasser WK, Helmen C, Tavel ME, Feigenbaum H, Fisch C. Congenital absence of the left pericardium. Clinical, electrocardiographic, radiographic, hemodynamic, and angiographic findings in six cases. Circulation 1970 mar;41(3):469–78.

[22] Psychidis-Papakyritsis P, de Roos A, Kroft LJ. Functional MRI of congenital absence of the pericardium. AJR Am J Roentgenol 2007;189:W312–4. http://dx.doi.org/10.2214/AJR.05.1655.