Use of a subxiphoid incision for pectus bar placement in the repair of pectus excavatum

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Abstract

**Background:** Since the first description of the Nuss repair for pectus excavatum, many technical variations have been described. Over the past 10 years, we have used a subxiphoid incision to allow finger guidance to protect the mediastinum which obviates the need for thoracoscopy.

**Methods:** A retrospective review was conducted on all our patients who have undergone pectus excavatum repair from December 1999 to March 2009. Demographic, treatment, and outcome variables were recorded. All operations were performed with 2 lateral incisions, one subxiphoid incision, and 2 stabilizers.

**Results:** During this timeframe, 307 patients underwent pectus bar placement. Mean age was 14.0 ± 3.3 years, and 78% were male. Mean operating time was 50.0 ± 15.9 minutes, length of hospitalization was 4.1 ± 1.1 days, and time to bar removal was 33.0 ± 7.3 months. There were no intraoperative events. Postoperative complications included a bar infection in 13 patients (4.2%), stabilizer displacement/discomfort requiring removal in 5 patients (1.6%), and bar rotation in 4 patients (1.3%). Rotation required operative correction in 3 cases and early removal in the other owing to a cracked sternum. No reoperations have been done for recurrence.

**Conclusions:** The subxiphoid guided technique is a simple, safe, and reproducible method for the minimally invasive repair of pectus excavatum that obviates the need for thoracoscopy.

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Since the first description of the pectus bar repair of pectus excavatum by Nuss et al, many technical variations have been described [1]. The application of thoracoscopy has been widely used in an attempt to prevent cardiac injury as the bar passes through the mediastinum. In order to assure safe passage of the bar, we have used a simple technique that employs a subxiphoid incision through which the surgeon’s finger is used to guide the bar under sternum. This technique obviates the need for thoracoscopy. In this series, we report our results with this modification.

1. Methods

After institutional review board approval (IRB# 08 07-113X), a retrospective review was conducted on all patients who underwent pectus excavatum repair from December, 1999, to March, 2009. Demographic, treatment and outcome variables were recorded. Data are expressed as mean ± SD.
1.1. Operation

In addition to the 2 axillary incisions, a small subxiphoid incision is made that allows the surgeon to pass his/her finger under the lower sternum and bluntly dissect the retrosternal space. The xiphoid can be removed or elevated to allow access to the substernal plane as is done in preparation for a sternotomy. In the correct tissue plane directly beneath the sternum, this dissection is very easy and can be carried as cephalad as necessary. In addition, the surgeon’s finger is used to create a large pocket that pushes the pericardium away from the chest wall on the left and the pleura away from the chest wall bilaterally. Regarding the axillary incisions, the subcutaneous plane of dissection is carried anterior to the thoracic cage until the appropriate interspace is reached. The surgeon then passes the bar passer from each axillary incision through the appropriate interspace next to the sternum onto his/her finger that is positioned in the retrosternal space to guide the passer out via the subxiphoid incision. Two strips of umbilical tape are introduced through the slit in the bar passer and pulled back out through each lateral incision with the passer. Using the umbilical tape as a guide, the pectus bar is pulled through the anterior mediastinum from one axillary incision to the other, again using the surgeon’s finger in the retrosternal space to protect the heart. The bar is secured on each lateral chest wall with 2 stabilizers that are sewn in with #5 Tev-dek sutures. The bars are left in place for 2 to 3 years.

2. Results

During the study timeframe, 307 patients underwent this operation, 7 of which were for recurrence after the traditional open repair. The mean age was 14.0 ± 3.3 years, and 78% were male. The mean operating time was 50.0 ± 15.9 minutes. Mean length of hospitalization was 4.1 ± 1.1 days, and the mean time to bar removal was 33.0 ± 7.3 months. Sixteen patients needed 2 bars for a deep defect. There were no significant intraoperative complications. Postoperative complications included the development of a bar infection in 13 patients (4.2%), stabilizer displacement/discomfort requiring removal in 5 patients (1.6%), and bar rotation in 4 patients (1.3%). Rotation of the bar required operative repair in 3 of these 4 patients and early removal in the other one because of a cracked sternum. There have been no patients requiring reoperation for recurrence. A pneumothorax was detected on the postoperative chest radiograph in 64.2% of the patients. However, only 2 patients (0.6%) needed a chest tube for a symptomatic and/or expanding pneumothorax.

3. Discussion

Pectus excavatum is the end product of dysmorphic costal cartilages which push the sternum posteriorly and flare the ribs laterally. Ravitch popularized the initial operation for this condition that involved complete excision of the offending cartilages [2-4]. The Ravitch technique became the standard approach for pectus excavatum repair for the next 4 decades during which the observation was made that extensive resection, particularly in very young patients, could result in subsequent asphyxiating chondrodystrophy (iatrogenic Jeune’s syndrome) [5,6]. The early results of patients undergoing the Nuss procedure appeared in 1998 [1,7].

This operation uses the pliability of the costal cartilages to correct the defect immediately with the cartilages remaining in place, thereby lessening the possibility of subsequent chondrodystrophy. However, passage of the bar under the sternum and across the mediastinum brought forth a new set of complications. Pleural violation resulting in an atmospheric pneumothorax is almost expected, but the potentially devastating complications occur from passing the bar behind the posteriorly displaced sternum through the mediastinum [8-14].

Technical modifications of the operation have been made in attempt to prevent these injuries. Routine use of left sided thoracoscopy has been used in an attempt to decrease mediastinal complications, including using an instrument to facilitate dissection from that side [15]. Others have advocated the use of right sided thoracoscopy under the impression that this allows the surgeon to perform the mediastinal dissection of the substernal tissue from the pericardial tissue with a superior view [16]. The use of bilateral thoracoscopy has also been reported in both children and adults to facilitate safe passage of the bar between the sternum and mediastinum [17,18]. Bilateral thoracoscopy has also been advocated to attempt placing the bar entirely extrapleural [19]. Although direct visualization of the mediastinum during bar passage is intuitively more safe and comforting, our concern is that the presence of an intrapleural telescope is not ideally suited to prevent an injury as the bar traverses behind a sternum that is wedged down into the mediastinum, although it would allow recognition of such an injury. Thoracoscopy can assure the surgeon that the initial course of the bar is in a satisfactory plane but does not assure safety as the bar passes across the mediastinum to the other chest cavity. Of the thorascopic options, bilateral thoracoscopy would certainly allow recognition of any injury, and would seem to decrease this risk the most. However, we are concerned that bilateral thoracoscopy does not allow prevention of an injury to the heart. Also, using a telescope in the chest cavity should not be considered insignificant as diaphragmatic and liver injuries have been reported [10]. One group has reported using an endoscopic saphenous vein harvesting device to create the substernal tunnel under thorascopic guidance without additional incisions or pleural insufflation [20]. This techniques still limits manual dissection and physical protection of the heart as the bar is passed.

While our technique offers assurance of cardiac protection and removes the extra incisions required for
thoracotomy, it replaces these lateral incisions with a more visible anterior incision. Although the incision is small, the location poses a possible cosmetic disadvantage to the lateral incisions with thoracotomy. An additional consideration with thoracotomy is the operative time. Before incision, the equipment occupies several minutes of preparation for the surgical team in the operating room and at the field. During the operation the placement of an intrapleural trochar, attainment of insufflation and orienting to an adequate view also requires some time, which is increased with bilateral deployment of thoracotomy. Our subxiphoid approach can usually be completed in less than five minutes with standard instrumentation.

The creation of the subxiphoid space pushes the pericardium and pleural away to attain a working space through which the bar can pass as opposed to the bar creating its own plane through a space that has not been created yet, albeit under visualization with a scope. We see this mechanical separation translate into improved outcomes created yet, albeit under visualization with a scope. We see this mechanical separation translate into improved outcomes in a few parameters. The reported incidence of interventions for postoperative pneumothorax ranges from a low of 0.9% to a high of 24% [16]. In our series, only 2 patients (0.6%) required a thoracostomy tube. Similarly, pericarditis has been reported to have an incidence of 0.4% to 1.5% of patients [8,9]. We have not seen a single case of pericardial irritation or injury in our 307 patients.

Every surgeon who uses the Nuss approach for pectus excavatum repair is concerned with a fatal cardiac injury. Although uncommon, these injuries are well documented both at the time of bar insertion as well as removal [21]. A finger between the pericardium and the bar passer gives us the assumption that such injuries are prevented, but we acknowledge that since these injuries are rare, we should not suspect that such an injury is made impossible. One small series of 15 patients has been previously reported that also advocates using a subxiphoid incision to decrease mediastinal injuries [22]. However, this series also used lateral muscle dissection, which is problematic as we have previously shown that placement below the muscular fascia causes ossification [23]. We would also emphasize that our technique is readily reproducible regardless of the patient’s anatomy and can be easily taught to trainees.

References


Discussion

Robert Kelly, MD (Norfolk, VA): My first question is that recognizing that you have been able to employ this successfully, one of the major emphases of your center has been on laparoscopic and minimally invasive surgery. So why so much effort to avoid thoracotomy when it adds very little to the operation? The second question stems from one of the major morbidity with the Nuss
operation which is bar rotation necessitating a reoperation, and at our center, we have been able to decrease that problem dramatically by using an EndoCatch needle to put heavy PDS sutures around the rib guided by a thoracoscope. This technique obviously makes that much more difficult at least.

Shawn St Peter, MD (response): Regarding thoracoscopy, the concern is that you can see but you can’t necessarily prevent, and that’s pretty well documented. We have used heavy sutures and two stabilizers. We have had four rotations, one of which I think is understandable because of the titanium bar, so it’s effectively 1%.