Elective pectus bar removal following Nuss procedure for pectus excavatum: a single-institution experience

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Abstract

Objective: Very few data are available on complications following elective bar removal after the Nuss procedure for pectus excavatum. The objective of this study was to investigate the data from 343 consecutive patients.

Methods: From 2003 to 2009, 343 patients (85% males) had their pectus bar removed. Nine patients were excluded because of bar removal within the first year after implantation. Data were recorded from hospital records regarding: operation time, formation of callus around the bar, unilateral or bilateral incision, complications, postoperative hospital stay and if a senior resident or an intern performed the operation.

Results: The median age at the time of bar removal was 19.1 years. The median time for removal after insertion of the bar was 1139 days (range 641—2575 days). The median operation time was 34 min (range 5—183 min). The operation time depended on the formation of callus around the bar (p < 0.0001), numbers of bars to be removed (p < 0.0002), the need for bilateral incision (p < 0.0001) and the charge of the surgeon performing the operation (p < 0.0008). Eight patients (2.4%) had complications after the surgery. Five patients had pneumothorax, of which three were treated with chest tubes, and two controlled with chest X-ray. Three patients had hemothorax. Two were treated with a chest tube and the third required open surgery. Most of the patients were discharged on the day of surgery (94%) or the day after surgery (4%). Only six (2%) required more than a single day of hospitalization.

Conclusions: Bar removal following the Nuss procedure is a quick and safe operation with very few complications. Occurrence of complications is not dependent on the experience of the surgeon.

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Keywords: Pectus bar; Removal; Pectus excavatum; Minimal invasive surgery

1. Introduction

The Nuss procedure has been widely accepted and used for correction of pectus excavatum for several years, and many articles have been published on the technique used for implanting the pectus bar [1—6]. Most commonly, the bar is removed 2—3 years later. Data on removing the bar are few, and only a small number of centers have published data on what technique they use and what complications they have experienced [7—9].

Different customized techniques have been described involving either turning the patient during the operation, using two operating tables or specially designed and customized instruments [7,9]. In our institution, we use a simple method, which does not involve any moving of the patient or special instruments.

The aim of this study was to report our experience in removing the pectus bar in a simple manner and with very few complications.

2. Materials and methods

From 2003 to 2009, 343 patients had one or two pectus bars removed at Aarhus University Hospital, Skejby. Nine patients were excluded due to removal of the bar prematurely, within the first year after implantation. Two patients had infection around the bar, and did not wish further treatment for the excavatum. One patient had a fistula between the bar and the skin and six had the bar removed prematurely because of pain. A total of 334 were included in this study. Hospital records were retrieved and information regarding operating time, callus formation around the bar, uni- or bilateral incision, complications, duration of hospital stay and experience of the surgeon registered.

All data were entered into a Microsoft Excel® Database. Statistical analysis was performed using STATA 11 (StataCorp LP, College Station, TX, USA). Data were analyzed by two-sided t-tests. Values of p < 0.05 were considered statistically significant.

2.1. Surgical technique

All patients underwent operation under general anesthesia in a supine position with both arms abducted and placed ...
on the operating table toward the side in which the stabilizer was. Our surgical technique has previously been described [5,6]. As a standard procedure, we normally place one stabilizer and the incision was performed in that side. All bars and stabilizers were placed subcutaneously. The end of the bar and the stabilizer were located and dissected free using diathermy. Once freed, the stabilizer was either removed from the bar or removed together with the bar itself (Fig. 1). A hook was placed in the eyelet at the end of the bar, which was pulled downward to make sure that the opposite end of the bar followed the shape of the chest wall (Fig. 2). In case of callus formation around the bar, a hammer and chisel were used to remove the osteogenic tissue to free the end of the bar and stabilizer. If the bar was still fixed, a new incision was performed on the opposite side of the patient, and this end of the bar was dissected free as well. If the bar was extremely bent, a bending tool was used to straighten the bar somewhat in the end before removing it, but it was not used as a routine.

3. Results

The median age of the patients was 19.1 years and the median time from implantation to removal was approximately 3 years (1139 days, range 641–2575 days). Eight patients had their bar removed between 1 and 2 years after implantation. The majority (85%) were males. The median length of the bar was 11 in.

The overall median operation time was 34 min (range 5–183 min). As seen in Table 1, the operation times varied according to formation of callus, number of bars to be removed, bilateral incisions and the surgeon’s experience. There were 21 different surgeons performing the operations (five senior residents and 16 interns). No assistant was required for the operations.

Eight patients (2.4%) experienced complications after the procedure. In five cases, the patients had a pneumothorax. Of those, four were suspected during surgery and one was discovered afterward because of respiratory symptoms. Two of the patients had a chest X-ray the following day, revealing recovery of the pneumothorax and were discharged without further control, and three patients were treated with a chest tube for 1 day. The three remaining patients had a hemothorax. Two of them were treated with a chest tube for 2 and 5 days, respectively. One patient required open surgery because of bleeding from an intercostal artery.

Postoperative X-ray was not used as a routine, and was only performed in case of complications.

The majority of patients (94%) were discharged on the same day of the surgery. In some cases, the surgery was performed late in the afternoon or the patients had a long travelling distance; hence, the patients were discharged the following day (4%). Most of the following-day discharges

<table>
<thead>
<tr>
<th>Numbers</th>
<th>Operation time</th>
<th>Difference in operating time p-value</th>
<th>95% confidence interval</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>No callus</td>
<td>197</td>
<td>25 min</td>
<td>&lt;0.00001</td>
<td>23–27</td>
</tr>
<tr>
<td>Callus</td>
<td>137</td>
<td>45 min</td>
<td></td>
<td>42–49</td>
</tr>
<tr>
<td>Unilateral incision</td>
<td>218</td>
<td>27 min</td>
<td>&lt;0.00001</td>
<td>25–29</td>
</tr>
<tr>
<td>Bilateral incision</td>
<td>116</td>
<td>47 min</td>
<td></td>
<td>43–50</td>
</tr>
<tr>
<td>Senior resident</td>
<td>201</td>
<td>30 min</td>
<td>0.0008</td>
<td>28–33</td>
</tr>
<tr>
<td>Intern</td>
<td>133</td>
<td>38 min</td>
<td></td>
<td>35–42</td>
</tr>
<tr>
<td>One bar</td>
<td>281</td>
<td>32 min</td>
<td>0.0002</td>
<td>29–34</td>
</tr>
<tr>
<td>Two bars</td>
<td>53</td>
<td>44 min</td>
<td></td>
<td>38–50</td>
</tr>
</tbody>
</table>
We believe that, even using this technique, there will not be minimizing bleeding complications using the plastic cover. Patient so far, and there is not sufficient data on the effect on modification has only been published with respect to one tube on the bar before removing it[11]. Testing this suggested adding a plastic cover, that is, a piece of a chest and was caused by the dentation of the bar. De Campos et al. very few patients. Straightened before pulling; but this was only necessary in the space allowed in a normal supine position of the patient, which, in our institution, is seen in less than 2% of cases [6].

Using the technique to stabilize the bar at both ends means that bilateral incisions are necessary. With our strategy, the bar is shaped as a part of a circle and, due to its shorter length, it is only placed on the anterior chest wall. This facilitates removing the bar, as a single incision in the side with the stabilizer is sufficient in most cases. A long pectus bar often requires either straightening the bar or rotation of the patient to avoid laceration of the lateral chest wall with the end of the bar when pulling it out. Rotation of the patient to 90° allows pulling in the correct direction, but this necessitates that the patient is turned under the operation, which is difficult to do in a sterile manner. St Peter et al. [7] described a method of placing the patient so that the pull can be made without turning. This involves a larger set-up and the use of two different operating tables.

The pull used for removing a short bar can be made within the space allowed in a normal supine position of the patient, who is placed near the edge of the operating table. If the ends of the bar are bent to a great extent, they have to be straightened before pulling; but this was only necessary in very few patients.

Laceration of an intercostal artery was seen in one case and was caused by the dentation of the bar. De Campos et al. suggested adding a plastic cover, that is, a piece of a chest tube on the bar before removing it [11]. Testing this modification has only been published with respect to one patient so far, and there is not sufficient data on the effect on minimizing bleeding complications using the plastic cover. We believe that, even using this technique, there will not be a perfect surface on the bar, and damage to an intercostal artery will still be a risk.

The operating times in this study show a correlation between the number of bars to be removed, need for bilateral incision, formation of callus around the bar and what charge the surgeon performing the operation had. Both callus formation and bilateral incision add approximately 20 min to the operating time; and this is probably because formation of callus is the most common reason for the need for bilateral incision. Interns performing the operation add 8 min to the operation time, but, even though this is statistically significant, we do not find it to be a clinically relevant difference.

By using a short pectus bar, we have found that the complication rate was very low during its removal. The operation was quick, easy to perform for all the involved surgeons no matter their surgical experience and could, for the most part, be done in an outpatient set-up.

4. Discussion

Since Nuss et al. [1], in 1998, introduced the minimally invasive technique for correcting pectus excavatum, the procedure has gained wide acceptance around the world. The technique was introduced in our institution in 2001, and we have corrected more than 700 patients. In our institution, we have, like other groups [4,9,11], modified the Nuss technique. Many authors suggest further fixation of the bar [4,10,11]. Instead, we routinely use a bar that is 5—8 cm shorter than originally described by Nuss et al. [1]. By using a shorter bar, the stabilizer can be placed very close to the turning point of the bar and thereby reduces bar displacement, which, in our institution, is seen in less than 2% of cases [6].

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