

The Nuss procedure made safer: an effective and simple sternal elevation manoeuvre

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Abstract

The Nuss procedure requires the creation of a substernal tunnel for bar positioning. This is a manoeuvre that can be dangerous, and cardiac perforation has occurred in a few cases. Our purpose was to describe two technical modifications that enable the prevention of these fatal complications. A series of 25 patients with pectus excavatum were treated with a modification of the Nuss procedure that included the entrance in the left haemithorax first, and the use of the retractor to lift the sternum, with the consequent lowering displacement of the heart. These modified techniques have certain advantages: (i) the narrow anterior mediastinum between the sternum and the pericardial sac is expanded by pulling up the sternum; (ii) the thoroscopic visualization of the tip of the introducer during tunnel creation is improved; (iii) the rubbing of the introducer against the pericardium is minimized; (iv) the exit path of the introducer can be guided by the surgeon's finger and (v) haemostasis and integrity of the pericardial sac can be more easily confirmed. We observed that with these manoeuvres, the risk of pericardial sac and cardiac injury can be markedly reduced.

Keywords: Funnel chest • Heart injuries • Minimally invasive surgical procedures

INTRODUCTION

For years, open surgery techniques represented the 'golden standard' for patients with pectus excavatum (PE). This situation changed when a minimally invasive repair of PE (MIRPE) was introduced by Donald Nuss.

Although the technique is considered minimally invasive, the Nuss procedure requires the creation of a substernal tunnel for bar positioning. The advancement of the introducer between the sternum and the heart, the riskiest step of the procedure, is a manoeuvre that can be dangerous.

In a few patients, described in medical literature, cardiac perforation has occurred during MIRPE [1]. The purpose of this article is to describe two technical modifications that enable the prevention of these fatal complications.

MATERIALS AND METHODS

From September 2010 to December 2011, 25 patients with PE underwent MIRPE at São Paulo University. The procedure we employed is a modification of the Nuss technique already described [2]. To highlight the modifications that we propose, the main steps of the procedure are summarized.

The patients are intubated with single-lumen tracheal tubes. Ventilation with lower volumes or short periods of apnoea has avoided the necessity of double lumen intubation for single lung ventilation. The skin is marked at the point of deepest depression in the midline, and at the hinge point in each haemithorax.

An incision is made laterally to the hinge points in each haemithorax. A subcutaneous tunnel is created in the direction of the hinge points (Fig. 1).

At this stage, instead of entering the right haemithorax, we first enter the left haemithorax opening the intercostal muscle at the hinge point. This manoeuvre allows us to make a digital exploration and to position a Langenbech hand held retractor inside the thoracic cavity.

In the right haemithorax, the camera is introduced using a 5-mm blunt-tip trocar and another Langenbech retractor is positioned at the hinge point and both retractors are pulled upwards. This manoeuvre forces the sternum up and the heart sinks down because of its weight. This allows safe retrosternal instrumentation.

Having transversed the substernal space with the introducer, the left Langenbech retractor can be removed and the surgeon's finger, which can help to guide the introducer out of the thoracic cavity in a safe way, can be put in its place (Fig. 2).

The bar is positioned and one stabilizer is placed on each side, as close as possible to the hinge point, to avoid bar displacement.

RESULTS

With the employment of our modified techniques, we could observe that: (i) the narrow anterior mediastinum between the sternum and the pericardial sac is expanded by pulling up the sternum; (ii) the thoroscopic visualization of the tip of the

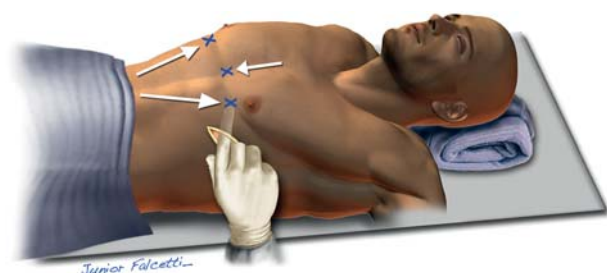


Figure 1: The arrows indicating the marks in the skin; the creation of the subcutaneous tunnel and the entrance in the left haemithorax first at the hinge point.

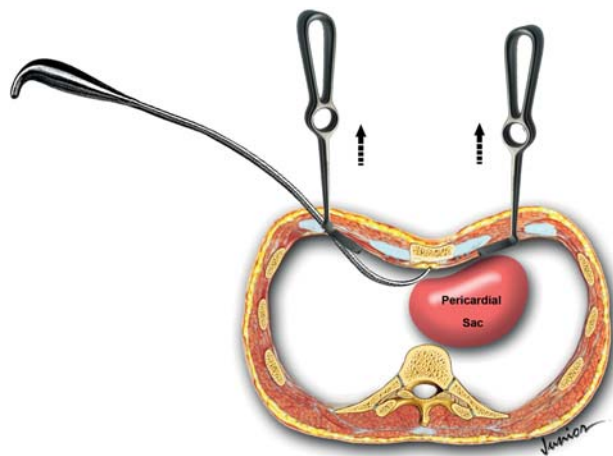


Figure 2: The Langenbeck retractor pulls the chest wall up while the heart is moved down by its weight creating more space between the sternum and the pericardial sac.

introducer during tunnel creation is improved; (iii) the rubbing of the introducer against the pericardium is minimized; (iv) the exit path of the introducer can be guided by the surgeon's finger and (v) haemostasis and integrity of the pericardial sac can be more easily confirmed. Our main result is that in this series of patients we did not experience any technical problems when creating the substernal tunnel.

DISCUSSION

Complications related to the Nuss procedure are not uncommon, and life-threatening ones have been reported. Thus far,

one case of aortic laceration and six cases of cardiac perforation have been reported [3].

Some authors recommend a modified bilateral thoracoscopic approach to make the mediastinal dissection safer [3].

The 'Vacuum Bell' system was utilized with this purpose too. A suction cup activated by a hand pump is used to create a vacuum in the anterior chest wall [4]. This device was used intraoperatively during the MIRPE procedure to enlarge the retrosternal space to ensure safer passage of the introducer.

Park *et al.* [5] recommended the use of wire stitches in the sternum (Crane technique), lifting the wire suture by an operating table-mounted retractor system, elevating the depressed sternum before insertion of the introducer to prevent internal organ injury.

The two modifications we proposed, the fruits of our interchange of experiences with Strasbourg University, the entrance in the left haemithorax first, and the use of the retractor to lift the sternum, with the consequent lowering displacement of the heart, are simple and effective in expanding the narrow space between the sternum and pericardium. We observed that with these manoeuvres, the risk of pericardial sac and cardiac injury could be markedly reduced.

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Conflict of interest: none declared.

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