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Mechanical occlusion of the inferior vena cava: An early complication after repair of pectus excavatum using the Nuss procedure

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Abstract The Nuss procedure is the most widely used surgical procedure to correct pectus excavatum. Although it is a minimally invasive approach, a number of major early complications, such as heart perforation, have been reported. We describe a 15-year-old boy in whom acute occlusion of the inferior vena cava developed after a Nuss repair. The diagnosis was confirmed by emergency postoperative CT examination, and treatment consisted of immediate removal of the Nuss bar.

Pectus excavatum is a common chest wall deformity, occurring in at least 1 per 1000 live births [1]. In addition to the obvious cosmetic consequences, it may also result in adverse cardiopulmonary complications [2]. The Nuss procedure is a surgical repair technique for pectus excavatum that was introduced into clinical practice in 1998 [3]. This minimally invasive surgery consists in the placement under the sternum of a steel bar bent into the desired chest shape, by video-assisted thoracoscopic surgery. The bar is removed after 2 years, or 3 years in older patients. This approach has shown excellent functional and cosmetic results [4] and has been performed on an increasing number of patients. Perioperative mechanical complications are rare and the most serious among them are penetrating thoracic lesions [5].

1. Case report

A 15-year-old boy with severe symmetric pectus excavatum underwent a Nuss procedure. The Haller index

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[6] measured on the preoperative non-enhanced CT was 4.7. The surgery was performed according to the modifications proposed by Nuss [3] under videothoracoscopic guidance. Before the preformed Nuss bar was guided into the retrosternal area, the tunneling instrument used caused a mild perforation of the right lung. No breach of the pericardium was noted. Cardiopulmonary collapse occurred during the reduction of the pectus deformity, which was attributed to a tension pneumothorax. The patient's condition improved within a few minutes after an intravenous fluid bolus and placement of bilateral chest tubes. The final bar position was satisfactory, and the patient was rapidly extubated.

Two hours after surgery, in the recovery room, the patient once again became hemodynamically unstable. A left femoral venous catheter was inserted without difficulty, and prompt crystalloid infusion was administered. An echocardiogram was performed, which showed no pericardial effusion and satisfactory cardiac function. The patient had abdominal pain and distension. Despite massive infusion, the patient became hypotensive. His hemodynamic status worsened, and he was reintubated 3 h after extubation. An intravenous contrast-enhanced CT study was performed in emergency (Fig. 1). The Nuss bar was located where expected, and no pneumothorax was observed. The pectus excavatum was repaired. In the abdomen, venous congestion of the liver and kidneys was detected, as well as mild ascites and a dilated inferior vena cava.

We hypothesized that the inferior vena cava was completely obstructed, and this was confirmed by Doppler ultrasound (Fig. 2). We then hypothesized that the displacement and distortion of the inferior vena cava into the diaphragmatic area were due to the Nuss bar, which caused pericardial traction. Therefore, the bar was rapidly removed. During the procedure, immediately after the bar was removed, the patient went into cardiac arrest. Cardiopulmonary resuscitation was performed with chest compressions for 15 s, and resulted in prompt restoration of sinus rhythm and stable hemodynamic status. Perioperative Doppler ultrasound confirmed that the caval obstruction had disappeared.

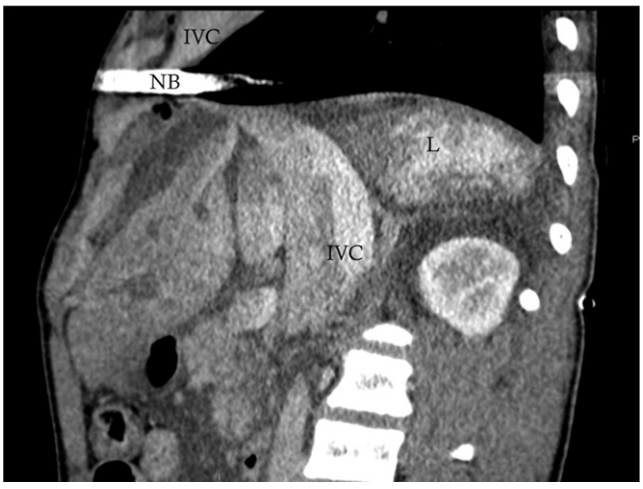

Fig. 1 Immediate postoperative contrast-enhanced CT. Double-oblique sagittal multiplanar reconstruction showing the distortion effect of the inferior vena cava (IVC) centered on Nuss bar artifacts (NB). Venous congestion of the liver (L) can be observed.

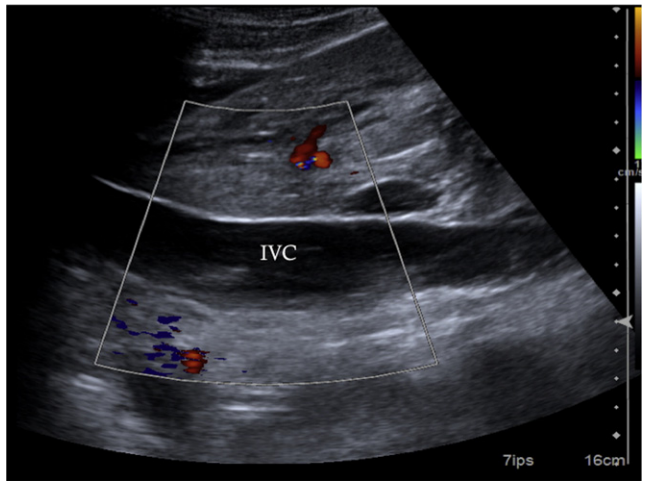

Fig. 2 Immediate postoperative abdominal Doppler ultrasound. Color Doppler ultrasound confirming the interruption of the blood flow in the enlarged inferior vena cava (IVC).

The patient was extubated 12 h after the procedure. Hemodynamics and creatinine levels rapidly improved, and the hepatic cytolysis decreased progressively over 10 days.

A control, intravenous contrast-enhanced CT of the abdomen was performed. It revealed thrombosis of the left external iliac vein, which was non-operatively managed. The patient was discharged after 2 weeks and is doing well, 3 months later.

2. Discussion

We report herein a rare but severe case of an early mechanical complication associated with the Nuss procedure. The complication consisted of an acute obstruction of the inferior vena cava due to pericardial traction caused by the placement of the Nuss bar. Removal of the bar immediately improved the hemodynamic condition.

Several modifications have been proposed for the Nuss procedure, but despite these modifications, many complications have been reported. Morbidity is mainly caused by bar displacement and pneumothorax [7]. Severe early complications include perioperative perforating lesions [5]. Thus, in the literature, eight cases of perioperative heart perforation have been reported [5-8], one of them resulting in death [9]. The most common early complications include pneumothorax, wound seroma, and bar displacement [10].

Perioperative mechanical compression of the inferior vena cava has been reported in the literature [11,12]. Emergency laparotomy and cavography were required for appropriate

diagnosis. A case of inferior vena cava compression during inspiration in an adult patient with pectus excavatum was detected by preoperative imaging [13].

In the present case, the complication was highly suspected based on CT findings and confirmed by ultrasonography. These imaging studies confirmed proper bar placement and showed severe kinking of the inferior vena cava above the diaphragm. Emergency removal of the bar was performed without laparotomy. Unfortunately, video-assisted thoracoscopic surgery was not performed to examine the distortion effect of the mechanical traction of the inferior vena cava.

No warning signs could be identified for this particular complication on preoperative CT. Particular caution should be taken when operating on severe cases of pectus excavatum. In case of cardiopulmonary collapse during bar placement, caval obstruction should be assessed by elective thoracoscopy. In case of refractory hypotension and abdominal distension, abdominal Doppler ultrasonography is recommended at the end of the procedure to examine the status of the inferior vena cava. We report an extremely rare but life-threatening complication associated with the Nuss procedure, i.e., a case of mechanical occlusion of the inferior vena cava. CT revealed obliteration due to mechanical traction and heart rotation. The complication was managed by emergency bar removal, which resulted in an immediate improvement in the hemodynamic status. To our knowledge, this is the second reported case of such a complication. Thus, surgeons should be aware of this potential problem, to avoid unnecessary laparotomy.

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