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## **Emergency Ravitch procedure for inferior vena cava compression after surgical scoliosis correction**

Running Head: Exceptional emergency Ravitch surgery

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Keywords: Pectus excavatum; Inferior vena cave compression; Ravitch surgery

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## **Abstract**

Pectus excavatum is a common chest malformation, classically asymptomatic. Pectus excavatum surgery allows aesthetic correction. Funnel chest is a malformation frequently associated with thoracic scoliosis, especially in Marfan's syndrome. Scoliosis are treated with first-line non-surgical treatment. Second line treatment consists in scoliosis surgery.

In this case, we presented an exceptional emergency indication of funnel chest correction with Ravitch surgery for a 14 years old woman who was suffering from postoperative acute compression of the inferior vena cava due to a surgical scoliosis correction.

Pectus excavatum is a common chest malformation with 6.28 to 12 cases per 1000 people worldwide [1]. It is classically minimally symptomatic and can cause psychological and cosmetic problems. In rare cases, it can affect cardiac function [2].

Pectus excavatum surgery has evolved over time and several treatment options are now available. The main purpose of surgery is usually aesthetic correction.

Ravitch has described the first corrections of pectus excavatum by performing cartilage resection and stabilizing the sternum with or without internal fixation [3]. Nuss later described a minimally invasive approach without osteotomy or cartilage resection.

Other techniques as the one described by Chavoin, allow an aesthetic improvement without correction of the sternal malformation [4]. All these surgeries are ultimately adapted to the patient and the deformity.

Funnel chest is a malformation frequently associated with thoracic scoliosis and especially in Marfan's syndrome.

Scoliosis in children and adolescents is common, with a variety of etiologies and first-line non-surgical treatment such as bracing. Surgical intervention is only reserved in cases where conservative management has failed.

This case is an exceptional indication of Ravitch procedure to allow correction of compressive phenomenon related to a pectus excavatum after surgical intervention for scoliosis correction.

A 14-year-old girl was followed since 2014 in the paediatric orthopedic surgery department for a painful left lumbar spine idiopathic scoliosis associated with asymptomatic funnel chest.

Genetic research and general assessment for vascular abnormalities eliminated the diagnosis of Marfan's disease. Cheneau Toulouse Munster (CTM) brace was used with good compliance.

Despite this, there was a gradual progression of scoliosis with a Cobb angle from 39 ° at the first visit to 51 ° at 4 years of follow-up, with thoraco lumbar kyphosis. The patient weighted 39kg for 164 cm at the time of surgery (BMI=14.5). Posterior spinal instrumentation and fusion T3 to L3 allowed a

correction to 30° cobb angle and mostly the sagittal plane with restoration of physiological curves. No intraoperative complication was noted.

On the first day the patient had abdominal pain and anuria. An ultrasound scan revealed an abdominal and perirenal fluid collection suggestive of a bladder wound. A CT scan performed the same day showed a large perirenal, retroperitoneal and also intraperitoneal fluid collection and could not eliminate a posterior bladder wound.

A cystoscopy was performed. No anomaly of the urinary tract was found during these procedures.

An injected thoracic CT scan (FIGURE 1) found a bilateral pleural effusion of low volume associated with compression of the inferior vena cava between the lower plate of T8 and the upper plate of T10, and the distal portion of the sternum, without obvious thrombosis. An echocardiography confirmed the compression of the inferior vena cava.

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In total, this patient developed a postoperative acute compression of the inferior vena cava with ascitic oedematous decompensation with peritoneal and retroperitoneal fluid collection and acute renal failure.

A Ravitch intervention was performed urgently with resection of the costal cartilages in the sub-perichondral of the third to the sixth ribs and a partial resection of the seventh rib. A cuneiform osteotomy at the angle of Louis allowing the mobilization of the sternal piece and hemodynamic improvement (FIGURE 2). It was then set up a internal fixation using a femoral stainless steel plate.

The urine output improved perioperatively. Hemodynamics improved intra operatively when the sternum was pulled up. Her symptoms improved post operatively. Disappearance of fluid in her abdomen and lungs were noted. At 6 months post operatively, the patient was asymptomatic. The internal fixation was removed without complication (FIGURE 3).

**Comment**

This case is, to our knowledge, the second case of acute decompensation of a funnel chest by compression of the inferior vena cava in the immediate aftermath of scoliosis surgery. A similar case has been reported in a patient with Marfan's syndrome, in which a Nuss procedure was performed instead. In both cases, the pectus correction surgery allowed the disappearance of the venous compressive phenomena [5].

Pectus excavatum is an anatomical malformation of unknown aetiology but could possibly be secondary to an overgrowth of costal cartilage. This malformation is classically described as asymptomatic and its respiratory and cardiac consequences are controversial.

According to some authors, chest deformity could lead to a restrictive ventilatory disorder. Cardiac effects from this are also very much debated, although it could be an increase in right ventricular filling volume after corrective surgery [6].

Acute compression of the inferior vena cava is difficult to diagnose. Diagnosis is often delayed. It is responsible for various non-specific symptoms such as edema of the lower limbs, abdominal or lumbar pain or even caput medusae. The diagnosis requires imaging. The most common causes of this are thrombosis and extrinsic compression. Treatment is targeted to treating the underlying cause where possible.

Scoliosis in children and adolescents is a common pathology. Surgical treatment is proposed as an alternative to failure of non operative treatment. However, it is important to focus on taking into account all thoracic deformities during surgical management. Indeed, Tauchi described in 11 of 20 patients an increment of the Haller index postoperatively. All patients had funnel chest. None of them described cardiopulmonary dysfunction [7]. However, pectus surgery is a provider of spinal deformity and may worsen existing scoliosis [8].

In this case, the young patient had a scoliosis associated with funnel chest. The main complaint was back pain. There were no clinical signs of inferior vena cava compression preoperatively. These signs appeared quickly in postoperative period and probably resulted from an increased Haller index. The

Ravitch surgery was performed as a salvage procedure to allow the regression of clinical signs.

### *Conclusion*

In these complex situations, surgical management of anterior and posterior thoracic deformities should go through multidisciplinary team approach. Preoperative CT scan evaluation is important to implement a proper surgical plan. When an inferior vena cava compression is identified preoperatively, a stepped surgical approach should be planned in such situations starting by correcting the funnel chest and addressing the scoliosis in another step. This would prevent the undesirable consequences of inferior vena cava syndrome.

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### **Figure Legends**

Fig 1: Thoracic CT scan : extrinsic inferior vena cave compression.

Fig 2: Postoperative chest x-ray.

Fig 3: Chest x-ray 6 month later.





