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Case Report

Anesthesia Management of a Child with Severe Pectus Excavatum Complicated with Heart Compression Displacement

Jiaqi Yang, Xuejie Li*

Department of Anesthesiology, West China Hospital, Sichuan University and The Research Units of West China (2018RU012), Chinese Academy of Medical Sciences, Chengdu, China

Abstract

We report the anesthesia management of a severe pectus excavatum with cardiac compression displacement under thoracoscopic correction with general anesthesia. Preoperative chest computed tomography showed that the lower end of the sternum was significantly depressed, and the distance between the depressed sternum and the spine was less than 2cm. The heart was obviously compressed and shifted to the left thoracic cavity. During the intraoperative reversal of the orthopedic plate, the blood flow velocity of the tricuspid valve increased to 87.9cm/s and showed a single peak. The transesophageal echocardiography indicated mild tricuspid valve regurgitant flow, and the blood pressure dropped rapidly. After the surgeon was informed of the situation, the orthopedic plate was quickly turned to the convex side up, and the locally depressed anterior chest wall was lifted up. Satisfactory correction of chest wall malformations.

Keywords

Pectus Excavatum, General Anesthesia, Transesophageal Echocardiography, Paravertebral Nerve Block

1. Introduction

Pectus excavatum (PE) is a congenital malformation of the chest wall in which the sternum, costal cartilage and some of the ribs are concave and funnel-shaped towards the spine [1]. It accounts for 90% of congenital chest wall malformations, and 1 case in every 400 to 1000 newborns is infundibular chest, with a male to female ratio of 3 to 5:1. Generally, the depression is deepest at the junction between the sternal body and xiphoid process, and there is often a family tendency or congenital heart disease [2, 3]. Some people think that this deformity is due to the rib growth is not coordinated, the lower part is faster than the upper part, and the sternum is compressed backward; It is also believed to be caused by the anterior attachment of the diaphragm fibers to the lower end of the sternal body and the xiphoid process, which pulls the sternum and xiphoid process backward for a short time in the central tendon of the diaphragm [4]. The symptoms of infundibular chest compression in infancy are usually not noticed. Children are often thin, inactive, prone to respiratory infections, activity is limited. Forced expiratory volume and maximum volume of air decreased significantly. Fluster, shortness of breath and difficulty breathing during activity. In addition to thoracic deformity, there are often special body

*Corresponding author: lizuima@hotmail.com (Xuejie Li)

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types such as mild hunchback and abdominal bulge [5].

Surgical guidelines include two or more of the following criteria: Heller index (maximum internal transverse diameter of the deepest sternal depression/distance from the posterior sternum to the anterior thoracic vertebra) > 3.25; Pulmonary function suggests restrictive or obstructive airway disease; Ecg or echocardiography found incomplete right bundle branch block; Mitral valve prolapse and other abnormalities; The degree of deformity progresses and the symptoms get progressively worse; PE makes children or parents depressed, have a strong desire to correct [6, 7]. The difficulty of anesthesia management lies in the damage of large blood vessels and acute circulatory failure caused by compression of the heart.

2. Case Presentation

The child was a 5-year-old boy with a height of 115cm and a weight of 17.5Kg. He was admitted to the hospital due to "chest malformation for 5 years". After the birth of the child, his parents found that the patient's anterior chest wall was depressed, and there was no obvious chest wall pain at ordinary times. After admission for physical examination, the anterior lower chest was significantly depressed (Figure 1). Preoperative chest computed tomography showed that the lower end of the sternum was significantly depressed, and the distance between the depressed sternum and the spine was less than 2cm, and the heart was obviously compressed and shifted to the left thoracic cavity (Figure 2). Preoperative color Doppler echocardiography showed that the heart was shifted to the left under pressure, but the blood flow was not affected. The operation requires a subcutaneous tunnel from the left and right anterior axillary line to the lateral chest wall to the costal space. Although the operation is performed under thoracoscopic vision, due to the small size of the child and the limited operating space, there are risks of large blood vessel injury and cardiac compression. After routine anesthesia, the patient was implanted with a No. 5 enhanced tracheal tube for double lung ventilation, and invasive arterial blood pressure and central venous access were established. After positioning, the child transesophageal echocardiography (TEE) probe was placed to check the tricuspid valve blood flow velocity of 66.7cm/s across the valve (Figure 3). During the process of reversing the orthopedic plate, the blood flow velocity of the tricuspid valve increased to 87.9cm/s and showed a single peak (Figure 4). Transesophageal echocardiography indicated mild triple inversion (Figure 5), and the blood pressure dropped rapidly. After the surgeon was informed of the situation, the orthopedic plate was quickly turned to the convex side up and the locally depressed anterior chest wall was lifted up, and the blood pressure of the child gradually increased and the blood flow velocity of the tricuspid valve returned to the pre-operation. There was no obvious triple inversion, and the chest wall deformity was corrected satisfactorily. After careful hemostasis, lung drums and exhaust gas, the chest was closed layer by layer. After surgery, bilateral paravertebral nerve block was performed under the guidance of ultrasound to manage postoperative pain, and the tracheal tube was successfully removed and returned to the ward safely. The VAS score was 1 on the first day after surgery.

3. Discussion

PE is a type of disease in which the sternum and its adjacent costal cartilage are deformed and grow into the spine and press backward on the chest cavity. The standard treatment for PE is the thoracoscopic assisted Nuss procedure developed by Nuss and his team, in which a plate is implanted under the depressed sternum and fixed to the lateral chest wall [8]. Nuss surgery is a minimally invasive treatment of PE without incision or excision of costal cartilage. It has the advantages of less trauma, less intraoperative blood loss, obvious postoperative effect and quick recovery, and has gradually become the gold standard of PE treatment [9, 10]. Haller index, also known as CT index, is used to evaluate the severity of PE by using chest CT to calculate the ratio of the thoracic transverse diameter of the lowest depression and the distance from the lowest depression to the leading edge of the thoracic vertebra. According to the size of the ratio, it is divided into: mild: <3.2; Moderate: 3.2 ~ 3.5; Severity: 3.5 ~ 6; Extreme severity: >6.0. At the same time, chest CT can clearly show the degree of compression of lung tissue and the displacement of heart. Therefore, Haller index is the most widely used PE evaluation index in clinical practice [11, 12]. Severe PE can lead to compression and displacement of the heart, which increases the difficulty of intraoperative anesthesia management [13]. Surgical complications mainly include heart injury, large blood vessel injury, lung injury, liver injury and gastrointestinal injury. Heart injury is the most serious complication of Nuss operation. Although only a few cases have been reported in the world, this complication may be underestimated clinically to some extent, and it is extremely dangerous to the life of patients once it occurs [14, 15]. Hemodynamic monitoring should be strengthened in the case of intraoperative displacement of the heart under pressure and with limited operating space, because the operation may cause compression or damage to the mediastinal vessels and the heart [16].

4. Conclusion

Patients with severe PE complicated with heart compression displacement have high risk of perioperative anesthesia, which should be prevented and treated by effective monitoring means. In this case, through real-time invasive arterial blood pressure and esophageal ultrasound monitoring, we quickly detected the hemodynamics about to deteriorate and guided surgical treatment in time to avoid the occurrence of malignant events. After the operation, the lung was fully ex-

panded and exhaust gas was discharged. Meanwhile, bilateral paravertebral nerve block under the guidance of ultrasound was performed to improve postoperative analgesia. It provides a strong foundation for the rapid recovery of patients.

Figure 1. *Marked depression in the anterior lower chest.*

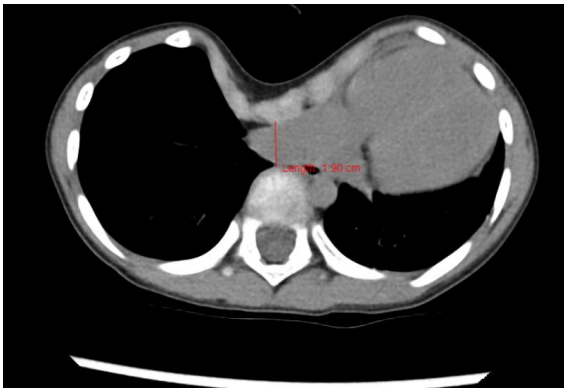

Figure 2. *Preoperative chest CT showed significant depression at the lower end of the sternum. The minimum distance between the depressed sternum and the spine was less than 2cm, and the heart was obviously compressed and shifted to the left thoracic cavity.*

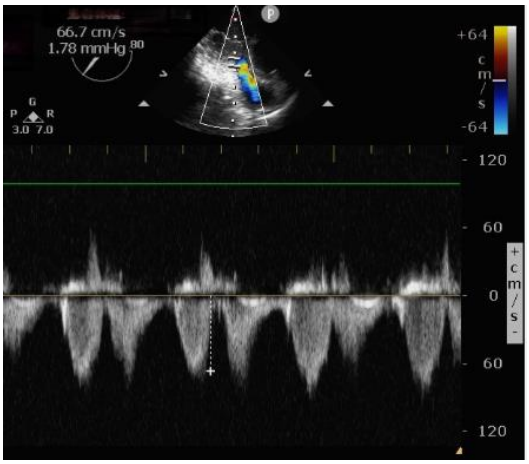

Figure 3. *Transesophageal echocardiography examination before operation showed a bimodal flow velocity of 66.7cm/s across the tricuspid valve.*

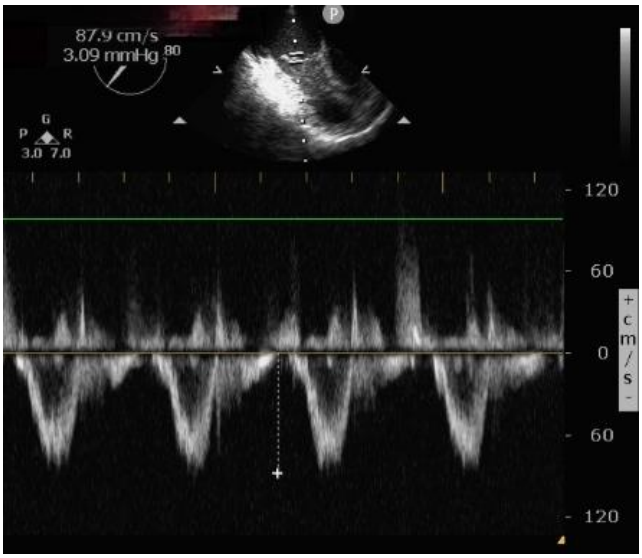

Figure 4. *In the process of reversing the orthopedic plate, the flow velocity of the tricuspid valve increased to 87.9cm/s and showed a unimodal peak.*

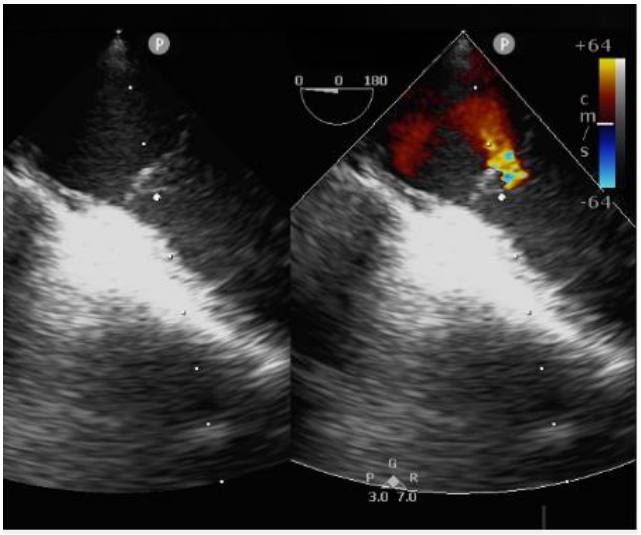

Figure 5. *Transesophageal echocardiography indicates mild tricuspid regurgitation during orthosis reversal.*

Abbreviations

PE	Pectus Excavatum
GA	General Anesthesia
TEE	Transesophageal Echocardiography
PNB	Paravertebral Nerve Block

Author Contributions

Jiaqi Yang: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Writing – original draft

Xuejie Li: Supervision, Writing – review & editing

Conflicts of Interest

All the authors do not have any possible conflicts of interest.

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