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Marlex Mesh Support for the Correction of Severe Pectus Excavatum

—Abstract—

Pectus excavatum is a congenital anomaly of the anterior chest wall with a sharp concave curvature of the body of the sternum, from above downward and from side to side, especially just before the junction of the glandioloxiphoid. There are two major operative procedures -Ravitch[1] or Wada operation[2]- for the correction of pectus excavatum. We used the modified Ravitch operation which consists of mobilization of the sternum, transverse osteotomy, and parasternal resection of the costal cartilages followed by placement of Marlex mesh using methyl methacrylate behind the sternum and suturing the edge of the Marlex mesh to the peripheral stump of the resected ribs. This was performed in a patient with severe pectus excavatum with good results at the Department of Thoracic and Cardiovascular Surgery Yonsei University College of Medicine in Seoul, Korea on January 12, 1989.

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Introduction

It is generally agreed that if the deformity is severe enough, it should be surgically corrected. Since Ludwig Meyer[3] performed his first operation for pectus excavatum in 1911, Various operative methods have been used widely to improve and stabilize the position of the sternum. All of these techniques can be roughly divided into the following groups:1) Operations that do not use special support or fixation[4,5,6], 2)Methods in which external support is applied[7,8,9,10] and, 3) procedures using internal support[11,12,13,14]. The operative procedures using internal support were performed. We experienced a patient with severe pectus excavatum and used Marlex mesh with methyl methacrylate as internal support with good results at the Department of Thoracic and Cardiovascular Surgery, Yonsei University College of Medicine in Seoul, Korea on January 12, 1989.

Case Report

The patient was a 15 year old male who had severe pectus excavatum which was aggravated progressively after birth. He had experienced dyspnea on exertion and intermittent resting dyspnea. He was transferred to this hospital for the repair of pectus excavatum. Physical examination showed very severe depression of the sternum (Fig. 1). The volume of the depressed space was 125 cc of water. The breath sound was clear, and there was no murmur at the apex. He had scoliosis and lordosis(Fig. 2,3), his body weight was 30 kg and his height was 147cm. An EKG revealed right axis deviation and incomplete RBBB. A preperative pulmonary function test revealed moderate pul-

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Fig. 1,2. Pre-operative chest P-A and left lateral view of chest shows severe scoliosis and depressed sternum

monary insufficiency of the obstructive type. The FVC was 1.82L(64% of predicted value). FEV1/FVC was 74% and MVV was 46cc(52% of predicted value).

The repair of pectus excavatum with Marlex mesh was performed under general endotracheal anesthesia at our clinic. The operative field was prepared and the bilateral submammary incision was made through subcutaneous tissues to the sternum. The pectoralis major muscles were split in the direction of their fibers to expose each cartilage to be resected. This was an adequate exposure of the depressed portion of the depressed portion of the sternum and adjacent deformed costal cartilages from the second costal cartilage to the eighth costal cartilage in both sides. The freeing of the undersurface of the sternum from its ligamentous and facial attachments to the mediastinum and diaphragm was performed. Resection of the involved costal cartilages, including the division of the attachments of the rectus muscles to the costal margins, and a transverse osteotomy on the sternum were performed. All costal cartilages including intercostal muscles were excised lateral to both internal mammary vessels from the second costal cartilage to the eighth costal cartilages, resulting in an opening to both pleural cavities.

The Marlex mesh was designed according to the size of the defect. The Methyl methacrylate was pasted on the surface of one sheet of the Marlex mesh, which was marked out for appropriate shape and size so as to overlap the defect, and another layer of Marlex mesh was applied. The

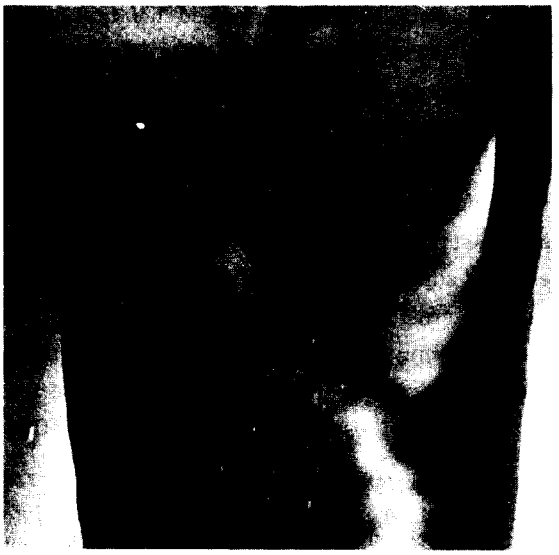

Fig. 3. Pre-operative photo of the patient shows severe depressed sternum

Marlex mesh was placed beneath the sternum and was anchored to the surrounding costal cartilages and intercostal muscles with heavy nonabsorbable suture materials after all bleeders were controlled with electrocoagulation or sutures ligation(Fig. 4).

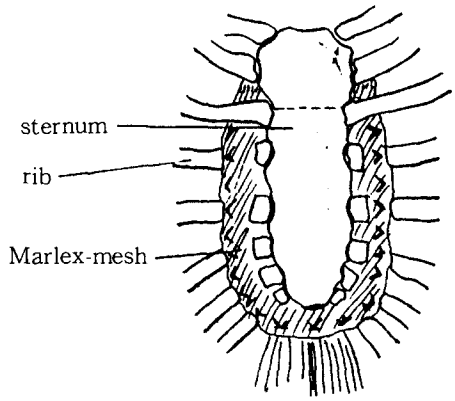

Fig. 4. Operative situs following transverse osteotomy, resection of the cartilage, and Marlex mesh support of the depressed sternum

The sternum was elevated in the overcorrected position with Marlex mesh. Closed drainage tubes were placed in both pleural cavities for evacuation of bilateral pneumothorax and drainage of the accumulated blood around the main wound(Fig. 5). Subcutaneous tissues and skin were approximated in the usual manner after control of all bleeders. The patient was required to have assisted ventilatory support for 8 days after operation because he could not have good inspiratory force during the weaning state due to the possible instability of the chest wall and chest pain. The postoperative course was uneventful and the patient was discharged with good results after extubation(Fig. 6,7). He has had a Milk-Walk brace for the correction of scoliosis and lordosis from the Orthopedic Department for 6 months up to now.

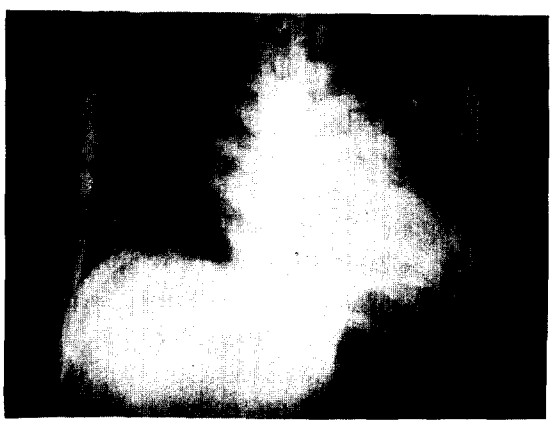

Fig. 5. Immediate post-operative chest P-A shows two drainage tubes placed in both pleural cavities

Fig. 6. Post-operative left lateral view of the chest shows elevated sternum with Marlex mesh

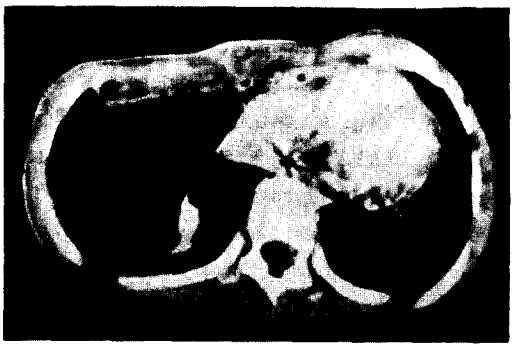

Fig. 7. Post operative chest C-T scan shows the dense Marlex mesh on anterior chest wall

Discussion

Pectus excavatum-funnel chest or trichterbrust-presents as a depression of the sternum and the lower costal cartilages and it involves the anterior portion of the ribs in most patients. The first and second ribs, corresponding costal cartilages and manubrium are usually normal. The lower costal cartilages grow too rapidly, the sternum is forced inward and a concave deformity ensues[15]. If uncorrected, the deformity usually worsens at adolescence. By following children over periods of several years, we have found that some sternal depressions become more pronounced, others remain static, while others may become even less apparent. Thus far we have been completely incapable of predicting the natural progression of any of these deformities. So, in patients over 3 years old, some forms of reconstruction with a strut of the anterior chest wall might be employed. And also, correction of a pectus excavatum may be carried out in teenagers and young adults with equally good results. There can be little question that reduction in the anterior-posterior diameter of the mediastinum, resulting from sternal depression, can cause distortion or rotation of the heart and great vessels. Cardiorespiratory problems are relatively unusual during childhood but progression of the deformity may result in later difficulty[16]. The prevention or correction of cardiorespiratory embarrassment is considered a prime indication for operative correction of a pectus excavatum[16,17]. A depression or deformity of the chest wall may be a source of considerable embarrassment, especially during adolescence and young adulthood. The other and equally valid indication for surgical correction is for cosmetic and psychologic reasons. Children under 3 years of age have also been more difficult to manage postoperatively than older children. The sternum is readily held in a slightly overcorrected position, a situation which gives a better cosmetic result on long-term follow-up, particularly in those children who are in a period of rapid growth. The first surgical treatments of pectus excavatum were reported by Meyer in 1911 and Sauerbruch[18] in 1920. Ochsner and DeBakey[9] summarized their early experience with surgical repair using various techniques in 1939. Ravitch[19] in 1949, reported a technique that included excision of all deformed costal cartilages with the perichondrium in 1949, division of the xiphoid from the sternum, division of the intercostal bundles from the sternum, and a transverse sternal osteotomy overcorrecting the sternum anteriorly with Kirschner wire fixation, which Ravithc labeled "hammock support" procedures in 1949. The technique of passing a homologous rib graft beneath the sternum and anchoring it to the appropriate costal cartilages was first advocated by Dailey in 1950. after autogenous tissues was recommended by Daniel[20] in 1958 and by Robiscek[21] in 1963, Marlex mesh by Hoffman[22] in 1966, Marlex mesh and Kirschner wire by Ravitch[23] in 1964, Teflon-felt by Ravitch[24] in 1976, and Marlex mesh with methyl methacrylate was used by Robicsek[25] in 1978. For the severe pectus excavatum or recurrent cases, the modified Ravitch operation with a sandwich of Marlex mesh and methyl methacrylate may be applied with good results. This technique has several advantages over other methods. No form of external traction device is necessary, obviating the need for cumbersome appliances on the chest wall. The strut gives stability to the sternum and anterior chest wall, preventing paradoxical motion in the postoperative period. In 1954 and 1956, the sternal turnover was proposed by the Judets[26] and Jung[27] in the French literature. Wada and colleagues[28] reported a large series from Japan that used this technique, which is essentially a free graft of the sternum, but it appears to be a radical approach and has been associated with major complications if infection

occurs. All operations have been performed under general endotracheal anesthesia. We usually favor the bilateral submammary skin incision for several reasons. It yields a far better cosmetic results, especially in females, while affording excellent exposure of the lower sternum and adjacent costal cartilages. In addition, it gives easy access to the costal margins, which aften flare and need tailoring. This type of transverse skin incision does not overlie the osteotomy of the sternum, hence a direct bone marrow to skin communication is avoided. A slight upward convex transverse incision is made over the midsternum. The pectoralis muscles can be split in the direction of their fibers and thereupon retracted laterally. All involved cartilages are exposed. The depressed segments are resected, including the periosteum. A transverse cuneiform osteotomy of the sternum at the beginning of its abnormal downward curve is performed in a line that falls to an intercostal space rather than at a chondrosternal junction. The xiphoid process is detached from the sternum and is allowed to retract downward. The tip of the sternum is then lifted with a towel clip, and with blunt and sharp dissection, the sternum is freed of its mediastinal, pericardial, and intercostal attachments. The right pleural cavity is opened with incision of the right mediastinal pleura, entered deliberately and accumulated blood is drained through an intercostal water-seal catheter to assure undisturbed wound healing. To stabilize and maintain the sternum in its corrected position, a piece of Marlex mesh is cut to approximate size, placed over the defect under the sternum and sutured under slight tension to the distal ends of the divided costal cartilages with nonabsorbable heavy suture material(Fig. 4). Marlex mesh improves the cosmetic result and decreases the flail movement of the chest. a sandwich of Marlex mesh and methyl methacrylate is uned to reconstruct the sternum and to maintain the contour of the lateral chest wall. A 1 to 2cm cuff of Marlex mesh is left around the methyl methacrylate to secure the sandwich to the adjacent ribs. A myocutaneous flap without Marlex can be used for these flat surfaces, especially if the resected tissues are infected. We do not dissect the mediastinal tissues from the upper third of the posterior surface, but transect the chest wall lateral to the internal mammary vessels, leaving them on the posterior surface of the sternal plate to assure an adequate blood supply.

The principles of repair of pectus excavatum are : 1. adequate exposure of the depressed portion of the sternum and adjacent deformed costal cartilages 2. freeing of the undersurface of the sternum from its ligamentous and facial attach-ments to the mediastinum and diaphragm, 3. resection of the involved costal cartilages, including division of the attachments of the rectus muscles to the costal margins when deemed advisable and 4. soteotomy fo the sternum, which may be a transverse osteotomy depending upon the severity of the deformity and the ease of adequate mobilization of the sternum. The sternum is readily held in a slightly overcorrected position[25], a situation giving a better cosmetic result on long-term follow-up. Unilateral or bilateral pneumothorax during the repair of pectus excavatum might occur. If penetration into the pleural cavities is recognized at the time of operation, and intercostal catheter for water-seal drainage is inserted at the conclusion of the procedures. The major problem in the immediate postoperative period has been to keep a clear tracheobronchial tree during the first 48 hours after operation. Any significant degree of sternal depression, which has been present for a period of years, is accompanied by a weakness and shortening of the pectoral, trapezius and abdominal muscles, and to some degree, the other accessory muscles of respiration. Stretching and strengthening of these involved muscles, as well as postural training, play an important role in the achievement of successful cos-

metic results. The major disadvantage of the use of Marlex mesh is the possibility of infection, with persistent draining of the sinus postoperatively, and then the Marlex mesh would have to be removed and the sternal depression would again be present, but to a much lesser degree than preoperatively.

The evaluation of improvement is based on cosmetic appearance 6 months or more after operation. On this basis we have classified results as follow : 1. good, meaning no significant residual sternal depression. 2. fair, some residual depression but improvement over the preoperative status and 3. poor, showing no significant change over preoperative appearance.

Conclusion

Surgical correction of a pectus excavatum is feasible in teenagers and young adults as well as during childhood. In terms of sujective symptoms, this one patient had definite symptoms of exertional dyspnea and fatigability prior to operation. The patient is in a markedly improved state with respect to the symptoms and has felt good as a result of his cosmetic improvement and the patient exhibits good results.

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