Funnel Chest (Pectus Excavatum) in Infancy and Adult Life

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The rhythmic inspiratory retraction of the distal portion of the sternum and lower thoracic cage, rather frequently noted in infancy, may disappear as the infant develops. Persistence of this physiologic phenomenon results in the permanent inward displacement and fixation of the inferior segments of the sternum and adjacent cartilages and ribs. This deformity is spoken of as funnel chest, trichterbrust or pectus excavatum.

In a previous communication1 one of the authors outlined simple corrective measures to be employed in infancy, and it was suggested that those measures “should at least prevent the full development of the deformity, thereby obviating the necessity of a major procedure later in life.” Fourteen years’ experience by the authors and the experience of other investigators4,6 have confirmed that hope. At the

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**SUMMARY**

Funnel chest, unless corrected, may lead to cardiorespiratory distress or psychic problems or both. Since operation to correct the deformity is relatively simple in infancy and much more extensive if done later, early surgical intervention is indicated. If the condition is not noted until the patient is beyond infancy, cardiorespiratory studies will aid in determining the advisability of operation.

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Figure 1.—View of the diaphragm from above, showing the direction of the muscle fibers. It is to be noted that the majority of the anteroposterior pull is directly beneath and adjacent to the sternum.
time of the communication mentioned, the author was concerned only with the correction of the visible deformity. Since then, however, it has been observed that persistence of the deformity may cause psychic injuries which are often of far greater gravity than the structural abnormality. Although the visible deformity, and to a great extent any attendant psychological problem, can be corrected by procedures after infancy, such measures seem never to fully repair the underlying injuries (cardiorespiratory). Since the operative procedure in infancy has thus far proved not only to be safe and simple but also to achieve the desired results, operation early in life seems advisable.

A common misconception is that rickets is an etiologic factor in funnel chest. Actually funnel chest has never been reported in an authenticated case of rickets. The authors believe pectus excavatum to result from a neuromuscular imbalance whereby the anteroposterior fibers of the diaphragm in particular are overstimulated (Figure 1). The entire process may perhaps be likened to pylorospasm of infancy. The distal end of the sternum is retracted, carrying along with it the contiguous cartilages and ribs. Finally the diaphragm becomes permanently shortened in its anteroposterior diameter, thereby retaining the sternum in a depressed state, and as growth progresses, the cartilages and ribs permanently conform to the retracted position of the sternum. The retraction of the anterior chest wall decreases the anteroposterior diameter of the chest, produces pressure upon or displacement of the heart, pressure upon the mediastinal vessels and structures, a decrease in the volume of the thoracic cage and an exaggerated dorsal curve with apparent abdominal protuberance. Funnel chest is commonly associated with congenital or hereditary defects. The cardiorespiratory manifestations are rarely if ever noted in infancy. When they do ensue, they tend to be more severe in those instances in which the heart is fixed beneath the sternal depression.

The indicated surgical procedure in infancy is now obvious—free the distal sternum from the pull of these overstimulated muscle fibers (Figures 2 and 3). The junction of the sternum and xiphoid is transected along with the substernal ligament. Then the sternal and immediately adjacent cartilaginous and rib attachments of the diaphragm are detached with the aid of a periosteal elevator. This permits the diaphragm to lengthen in its anteroposterior diameter and prevents the sternum from being pulled upon. The entire procedure is carried out through an incision of about 3 to 4 cm. and requires approximately ten minutes. To attain a satisfactory result this minimal operative interference must be boldly performed (Figures 4 and 5).

Operative interference in infancy is simple and obviates a major surgical procedure in later life. Experience has shown that the optimum time for the simple operation is when the patient is approximately 18 or 20 months of age. By then it is reasonably certain that the condition will persist, yet no fixation has taken place. In cases in which the simple operation was not done until after the end of the second year, results usually were unsatisfactory. The authors wish to stress, however, that their advocacy of early intervention is not primarily because of the greater magnitude of operation re-
Figure 4.—Upper: X-ray films of patient 20 months of age, showing heart in mid-position and retraction of sternum pressing directly thereon. Lower: Comparative x-ray films before and after operation, showing release of sternum.
quired later, but because of sequelae which often ensue and coexist with fully developed funnel chest. Although some persons who have the deformity may have no sequelae, the majority do have resulting infirmities which cripple them to a greater or lesser extent and seriously shorten life expectancy.

During the past two years the authors have made cardiopulmonary studies\(^2\) along the lines of those suggested by Cournand\(^3\) which bear this out. Of the adults with funnel chest who were studied, more than 70 per cent had abnormal electrocardiogram tracings (altered axis deviation, although usually present, was not included as an abnormality in arriving at that percentage figure).

The maximum breathing capacity (and this proved to be the simplest and most informative test of cardiopulmonary efficiency) averaged less than 50 per cent of normal in the series. Interest-

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Figure 5.—Patient (Figure 4) before and after operation.

Figure 6.—Photographs of patient, showing condition before operation, immediately after operation and 14 years later.
ingly, it was noted that in borderline cases—those in which there was fully developed deformity of the chest but no cardiorespiratory symptoms—there was sometimes a lowered maximum breathing capacity. Further, these same patients in a matter of six to twelve months became conscious of some respiratory embarrassment. Comparison of preoperative and postoperative maximum breathing capacity determinations gives a working index of the benefits of operative intervention in this regard. In the authors' series an average increase of about 35 per cent was observed.

The cardiorespiratory disease simulates and may finally become true cor pulmonale. The symptoms usually appear toward the end of the second decade or during the third decade of life. They are then of such nature as to be at least incompletely reversible.

In five instances in which psychic factors were the indication for correction of the deformity, operation satisfactorily solved the problems. Two of the patients, one male and one female, had delayed marriage because of embarrassment over the malformation. Another patient, a girl 15 years of age, was completely asocial and unhappy before the deformity was corrected. Two young men who felt unable to join their fellows in any kind of recreation in which the chest was bared were relieved of this embarrassment. Robb's reported similar experience, and Lester's reported psychic problems even in children four or five years of age. In no case observed by the authors has the operative scar been of psychic significance.

REFERENCES