Cardio-Respiratory Studies in Pre and Post Operative Funnel Chest (Pectus Excavatum)*

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Fourteen years ago an essentially standardized technique for the surgical reconstruction of the thoracic cage in Pectus Excavatum was described by one of us (A. L. B.)*. We have since followed the primary principles then outlined with minor changes and relative satisfaction. Until recently, many of the indications for operative interference as well as the possible benefits attained thereby have had to be judged empirically. That is, the effect, if any, of operation, was judged primarily by the physician's clinical acumen and the statement of the patient. Neither of these judgments can be statistically accurate. They are obviously subject to bias and misinterpretation. Two years ago we therefore began to study our patients from the cardio-respiratory standpoint both pre- and postoperatively. The tests employed have been mainly some of those suggested by Cournand2 which appeared applicable to our problem.

The material upon which this report is based consists of 44† personally observed instances of definite funnel chest most of whom were treated surgically. As was to be expected associated congenital anomalies, other than the thoraco-sternal depression, were noted in 14 (31.8 per cent). Twelve of our patients were infants.

Cardio-respiratory studies upon infants were impractical. The "complaints" for which we observed the infants were visible deformity, failure to gain weight, and frequent colds (Table I). Except for two instances of axis deviation in the electrocardiograph no positive findings were observed among those under two years of age. Clinically we have reached the conclusion that the simple operation is completely satisfactory if performed before the sternum becomes fixed in the retracted position, i.e., approximately at a biologic age of 18 to 24 months. Thereafter the adult major type operation must be employed. There is no way of knowing which cases observed in infancy will progress to fully developed

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*From the Thoracic Surgery Division, Mt. Zion Hospital, San Francisco. Presented at the Sixteenth Annual Meeting, American College of Chest Physicians, San Francisco, California, June 24, 1950.
†Eleven cases observed in the Department of Thoracic Surgery at the University of California Hospital are included in this group.
pectus excavatum with its accompanying cardio-respiratory dis-
abilities in later life. Therefore, simple operative interference is 
strongly advised whenever the deep rhythmic inspiratory retraction 
of the distal portion of the sternum and lower anterior thoracic 
cage persists beyond the 18th month of life.\textsuperscript{3}

We consider the deformity of the thoracic cage observed in 
funnel chest to result from a neuromuscular imbalance whereby 
the antero-posterior fibers of the diaphragm are overstimulated. 
Thereby, the chest, and in particular the lower segments of the 
sternum are retracted on inspiration. The manubrium, xiphoid 
and contiguous cartilages and ribs become fixed in a retracted 
position when the phenomenon persists beyond early infancy. 
In addition, there is an accompanying general decrease in the 
anterior-posterior diameter of the chest. The heart may remain 
in its normal mediastinal position or may fortuitously be shifted 
well into either the right or, as is more frequently the case, into 
the left hemithorax. Once the pattern of pectus excavatum has 
become fixed an individually abnormal cardio-respiratory problem 
should and clinically does result. The extent of the adverse path-
ologic effect of this unusual physiologic state depends upon the 
concerted action of the following individually variable factors:

1) Position assumed by the heart.
2) Total decrease in the antero-posterior diameter of the chest.
3) Degree and shape of depression of sternal segments.
4) Age.

\begin{center}
\textbf{TABLE I}
\end{center}

\begin{center}
\textbf{"SYMPTOMS IN INFANCY (UP TO 24 MONTHS) — 12 CASES"}
\end{center}

\begin{center}
\begin{tabular}{|l|c|c|}
\hline
No. & Cases & Per cent \\
\hline
Deformity & 12 & 100 \\
Frequent Respiratory Infections & 9 & 75 \\
Failure to Gain Weight & 7 & 59 \\
\hline
\end{tabular}
\end{center}

"Complaints" for which infants were referred to thoracic Surgeon.

\begin{center}
\textbf{TABLE II}
\end{center}

\begin{center}
\textbf{POSITIVE ASSUMED BY HEART}
\end{center}

\begin{center}
\begin{tabular}{|l|c|c|}
\hline
No. & Cases & Per cent \\
\hline
Right Hemi-thorax & 3 & 7 \\
Beneath Sternum & 17 & 38 \\
Left Hemi-thorax & 24 & 55 \\
\hline
\end{tabular}
\end{center}
Although segments of cartilage and rib are removed, elevation of the anterior ends of the ribs increases the antero-posterior diameter of the chest. Thereby, in spite of a decreased perimeter the capacity of the thoracic cage is actually increased.
**Position Assumed by the Heart:**

The heart may assume any position in the thoracic cage but is most frequently observed in the left hemithorax (Table II). Obviously displacement of the heart from its normal position may well be accompanied by more or less rotation and this is confirmed by the frequent presence of right axis deviation on the electrocardiograph. In one instance the heart was so displaced that the apex was under the right clavicle. One might assume that patients in whom the heart is fixed under the sternum would present predominately cardiac symptoms. Actually this is the case once such symptoms are noted. Cardiac symptoms did exist in a majority of the adults regardless of the position of the heart. But displacement of the heart laterally decreases the likelihood of severe adverse alteration of cardiac function.

**Total Decrease in the Antero-Posterior Diameter of the Chest:**

Shortening of the diaphragm in its antero-posterior diameter decreases not only the capacity of the thoracic cage but also greatly impedes or completely obliterates the normal elevation of the ribs on inspiration. Thereby one of the three components of the act of respiration is more or less lost to the patient. He is then unable to efficiently clear the tracheobronchial tree of retained secretions. Hence the greatly increased susceptibility to respiratory infections. Seventy-five per cent (9 cases), of the infants and an identical percentage of the adult series (24 cases), exhibited this symptom. Furthermore, frequency of respiratory infections is usually the first symptom complained of and is the one most often satisfactorily influenced by operative interference. Granted that removal of rib and cartilage segments decreases the perimeter of the thoracic cage, concomitant elevation of the anterior rib ends widens the thorax in its antero-posterior diameter. This, plus elevation of the sternum and lengthening of antero-posterior diameter of the diaphragm results in a positive increase in the capacity of the thorax (Diagram 1). Not infrequently there is marked asymmetry of the two sides of the thorax, one side being relatively well developed and the other depressed. The asymmetry is accompanied by a tilt of the manubrium. Operative repair of the deformity does not give a completely symmetrical result (Diagram 2). The asymmetrical status is probably dependent upon one, rather than both, phrenic nerves being overstimulated.

It is appropriate to state here that we believe “pigeon breast” to be due to comparable neuromuscular abnormality in which the lateral fibers of the diaphragm are overstimulated, thereby, causing a contraction of the thorax in its transverse diameter.
Degree and Shape of Depression of Sternal Segments:

The depression of the sternum commonly starts at the junction of the gladiolus and the manubrium and continues to its greatest depth at a constant slope to the xyphoid. We have observed the separation between the anterior bodies of the vertebrae and the xyphoid to be as little as 2 cm. Occasionally a deep spoon shaped depression of manubrium is seen (Figure 1). As was to be expected, the most severe respiratory and particularly cardiac symptoms were noted in those adults whose heart was fixed near the midline and severely impinged upon by a marked depression of the sternum.

Age:

Our patients varied from nine months to 40 years of age. Each decade presented approximately the same number. The majority of all groups exhibited respiratory symptoms of one kind or another. In this series psychological problems related to the funnel chest deformity became manifest particularly in the second decade of life and were apparent as an associated major complaint occasionally thereafter. Similarly "cardiac" symptoms usually appeared towards the end of the second decade and became more frequent

FIGURE 1a
Made from x-ray films showing spoon shaped depression impinging directly upon the heart (1a). Tomogram after operative repair showing relief of impingement and absence of angulation of sternal segments. No post operative fixation of any kind was employed in this instance to maintain the correction (1b).
and pronounced as the patient's age increased. Cardiac disease, other than that which could be solely attributed to the thoracic cage deformity, was frequently observed. Suffice it to say that respiratory symptoms and psychological complaints are usually benefited by operative interference. The same can not be said for "cardiac" symptoms. By the time such symptoms become apparent to the patient the underlying adverse pathology appears to be so well established that it probably is irreversible. Most of the patients are benefited by operation, but this benefit appears to be mainly due to the improvement in the associated respiratory symptoms. Perhaps the advance of the cardiac status is retarded. Further observation is needed to definitely establish this impression.

**Cardio-Respiratory Studies:**

Over two years ago we began to subject all patients with funnel chest to cardio-respiratory tests. This was originally undertaken to make available a definite basis for determining what benefit, if any, might be expected from operative interference. We knew that good structural results and an improved psychological status usually ensued. We wished further to know what physiological changes were brought about. Tests were made as outlined in the accompanying "Chest Work-Up Sheet." It soon became apparent that, for our purpose at least, many of these tests were of no particular value.

**TABLE III**

**PRESENTING COMPLAINT OF INFANT CASES (0-24 mos.)**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age</th>
<th>Complaint</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.P.</td>
<td>M</td>
<td>9 mos.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>R.M.</td>
<td>M</td>
<td>14 mos.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>J.F.</td>
<td>M</td>
<td>15 mos.</td>
<td>Respiratory and failure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>to gain weight</td>
</tr>
<tr>
<td>H.J.</td>
<td>M</td>
<td>16 mos.</td>
<td>Deformity</td>
</tr>
<tr>
<td>M.O'B.</td>
<td>F</td>
<td>18 mos.</td>
<td>Failure to gain weight</td>
</tr>
<tr>
<td>P.R.</td>
<td>M</td>
<td>18 mos.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>R.R.</td>
<td>M</td>
<td>19 mos.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>R.G.</td>
<td>M</td>
<td>21 mos.</td>
<td>Deformity</td>
</tr>
<tr>
<td>G.S.</td>
<td>F</td>
<td>21 mos.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>J.C.</td>
<td>M</td>
<td>21 mos.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>A.R.</td>
<td>M</td>
<td>23 mos.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>J.T.</td>
<td>M</td>
<td>23 mos.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>Patient</td>
<td>Sex</td>
<td>Age</td>
<td>Complaint</td>
</tr>
<tr>
<td>---------</td>
<td>-----</td>
<td>--------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>W.M.</td>
<td>M</td>
<td>2½ yrs.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>S.S.</td>
<td>M</td>
<td>3 yrs.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>R.V.</td>
<td>M</td>
<td>5 yrs.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>V.L.</td>
<td>F</td>
<td>5 yrs.</td>
<td>Psychological</td>
</tr>
<tr>
<td>F.H.</td>
<td>M</td>
<td>5 yrs.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>E.J.</td>
<td>M</td>
<td>7 yrs.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>O.R.</td>
<td>F</td>
<td>7 yrs.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>J.J.</td>
<td>M</td>
<td>7 yrs.</td>
<td>Failure to gain weight</td>
</tr>
<tr>
<td>M.M.</td>
<td>M</td>
<td>9 yrs.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>J.O'R.</td>
<td>M</td>
<td>10 yrs.</td>
<td>Cardiac</td>
</tr>
<tr>
<td>J.W.</td>
<td>M</td>
<td>11 yrs.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>D.R.</td>
<td>M</td>
<td>13 yrs.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>M.S.</td>
<td>F</td>
<td>15 yrs.</td>
<td>Respiratory and psychological</td>
</tr>
<tr>
<td>H.H.</td>
<td>M</td>
<td>16 yrs.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>L.F.</td>
<td>F</td>
<td>17 yrs.</td>
<td>Respiratory and psychological</td>
</tr>
<tr>
<td>T.J.</td>
<td>F</td>
<td>17 yrs.</td>
<td>Respiratory and psychological</td>
</tr>
<tr>
<td>M.DM.</td>
<td>F</td>
<td>18 yrs.</td>
<td>Respiratory and psychological</td>
</tr>
<tr>
<td>W.W.</td>
<td>M</td>
<td>18 yrs.</td>
<td>Other congenital defects</td>
</tr>
<tr>
<td>R.C.</td>
<td>M</td>
<td>19 yrs.</td>
<td>Respiratory and psychological</td>
</tr>
<tr>
<td>D.D.</td>
<td>M</td>
<td>20 yrs.</td>
<td>Psychological</td>
</tr>
<tr>
<td>H.G.</td>
<td>M</td>
<td>22 yrs.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>W.M.</td>
<td>M</td>
<td>22 yrs.</td>
<td>Cardiac</td>
</tr>
<tr>
<td>M.H.</td>
<td>F</td>
<td>24 yrs.</td>
<td>Cardiac (congenital) and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Respiratory</td>
</tr>
<tr>
<td>J.M.</td>
<td>M</td>
<td>24 yrs.</td>
<td>Respiratory and cardiac</td>
</tr>
<tr>
<td>M.M.</td>
<td>F</td>
<td>25 yrs.</td>
<td>Respiratory and cardiac</td>
</tr>
<tr>
<td>G.C.</td>
<td>F</td>
<td>28 yrs.</td>
<td>Cardiac and psychological</td>
</tr>
<tr>
<td>H.C.</td>
<td>F</td>
<td>32 yrs.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>L.H.</td>
<td>F</td>
<td>32 yrs.</td>
<td>Respiratory and psychological</td>
</tr>
<tr>
<td>L.J.</td>
<td>F</td>
<td>34 yrs.</td>
<td>Respiratory</td>
</tr>
<tr>
<td>H.M.</td>
<td>M</td>
<td>35 yrs.</td>
<td>Cardiac cripple and respiratory</td>
</tr>
<tr>
<td>H.A.</td>
<td>F</td>
<td>36 yrs.</td>
<td>Respiratory, cardiac and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>psychological</td>
</tr>
<tr>
<td>G.W.</td>
<td>F</td>
<td>40 yrs.</td>
<td>Cardiac and respiratory</td>
</tr>
</tbody>
</table>
THORACIC SURGERY CLINIC — CHEST WORK-UP

Patient Date

Provisional Diagnosis

I. VENTILATORY FUNCTION:

1. Vital Capacity

<table>
<thead>
<tr>
<th></th>
<th>Basal</th>
<th>Exercise</th>
<th>After Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>1' 2' 3' 4' 5'</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4</td>
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<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Max. Breathing Cap. (1/min.)
3. Ventilation (1/min.)
4. Breathing Reserve (1/min.)

   BR
5. Ratio: MBC x 100 (in %)

II. RESPIRATORY FUNCTION:

1. Oxygen Intake,
   (a) in cc./lit. vent.
   (b) in cc./sq.m.B.S.A.

2. Arterial O₂ Saturation,
   (a) O₂ content (Vol.%)
   (b) O₂ capacity (Vol.%) Hgb: gm.
   (c) O₂ saturation (%)

III. CARDIO-PULMONARY FUNCTION:

1. Exam. of heart

   E.C.G.

2. BP
3. Venous Pressure

4. Circ. Time (Decholin arm to tongue) appearance

   Disappearance

5. Response to rapid IV infusion of 1500 cc. of NSS in 30 min.

   Vital Cap. before
   Vital Cap. after

   Per Cent Reduction

IV. CONCLUSIONS:
Figure 2: Graphic representation of principle complaints by decades. It is clear that respiratory factors predominate at all ages. Psychological problems are prominent from the second decade onward. "Cardiac" symptoms appear late. — Figure 3: Comparative and Post Operative Maximum Breathing Capacity.
Specifically we might summarize our experience with each examination as follows:

**Vital Capacity:** Normal or above unless complicated by other pathology.

**Maximum Breathing Capacity:** Of value in all cases.

**Ventilation:** No particular deviation from normal.

**Breathing Reserve:** This will be reduced at the same time maximum breathing capacity is reduced. Unnecessary additional test.

**Oxygen Intake:** No remarkable deviation from normal.

**Examination of Heart:** No specific findings except in presence of independent heart disease. Usually less is evinced than is evidenced by x-ray and electro-cardiograph studies.

**Blood Pressure:** All within normal limits.

**Venous Pressure:** All within normal limits.

**Circulation Time:** All within normal limits.

Thus we are left with two tests of value, i.e., maximum breathing capacity and electrocardiograph.

Determination of the maximum breathing capacity in 11 cases preoperatively showed it to be diminished 50 per cent or more in nine instances. It was beneficially increased an average of 31 per cent by operative interference (Figure 4). In two instances where operation was delayed, repeated examinations showed a gradual decrease in the maximum breathing capacity.

Comparison of pre- and postoperative maximum breathing capacity determinations on persons with a fully developed pectus excavatum deformity were informative. They sometimes showed immediate postoperative improvement which was only partially maintained, tending to become somewhat reduced particularly after about three weeks although never to the preoperative level. These results prompted a change in the operative technique and the institution of a regime of breathing exercises and voice training early in the postoperative convalescent period.

Electrocardiographic tracings were often reported as abnormal but there appears to be no type pattern uniformly present or attributable to pectus excavatum. These were reviewed by Dr. A. Gropper, a cardiologist, at the Mt. Zion Hospital. He reported that of 16 cases studied preoperatively nine showed abnormal electrocardiograms, only three of which could not be attributed to other complicating factors. Moreover, comparative pre- and postoperative records in 11 patients showed postoperative changes in only three instances, either immediate or late, which might be considered as demonstrating improvement resulting from operation. These consisted in:

1) Improved A-V conduction.
2) More normal appearance of previously depressed S-T segment and inverted T waves.
3) P wave changes most likely due to rotation.

Lack of demonstrable improvement in the postoperative electrocardiographic tracings does not necessarily mean that benefit to the impaired cardiac status has not been attained.

Lester states he has seen no immediate postoperative change in the electrocardiogram. Dorner et al., report one instance in which the electrocardiogram taken the second postoperative day showed the right heart strain pattern had entirely disappeared and the P waves were normal.

Either a diminished maximum breathing capacity, an abnormal electrocardiogram, or both, may be obtained in a patient who is not yet aware of any cardio-respiratory symptoms.

It therefore appears reasonable to add both maximum breathing capacity determinations and electrocardiographic tracings to the preoperative study of a patient with funnel chest. Abnormal electrocardiographic tracings and lowered maximum breathing capacity determinations are additional indications for operative intervention. This is of particular value in those instances in which cardio-respiratory symptoms have not as yet become manifest. Repeated maximum breathing capacity determinations showing decreasing capacity would lend further weight to the advisability of recommending operation in the patient concerned.

We have considered and plan to do cardiac catheterization studies in selected cases. These should be of more than academic interest in establishing a better knowledge of the underlying disturbed physiology brought about by the pectus excavatum deformity. But it does not appear that they will usually be necessary to establish the advisability of operation in the majority of instances.

SUMMARY

1) Cardio-respiratory studies on infants are impractical.
2) Simple operative interference is advisable before the sternum becomes fixed in the retracted position, approximately at a biological age of 18 to 24 months. Such a procedure has thus far uniformly obviated the occurrence of adverse cardio-respiratory physiology in later years.
3) The extent of abnormal cardio-respiratory physiology in pectus excavatum is dependent upon four factors: (a) position assumed by the heart, (b) total decrease in the A.P. diameter of the chest, (c) degree and shape of depression of the sternal segments, and (d) age.
4) Respiratory symptoms predominate throughout all age groups.
Psychologic complaints are primarily noted in the second decade of life. Cardiac symptoms manifest themselves late in the course of the disease. They are apparently less influenced by surgery than either respiratory or psychologic deviations which are prone to be benefited by operation.

5) Determination of maximum breathing capacity is the best single test of the status of respiratory physiology in funnel chest. Decreased capacity may be noted before the patient himself is symptomatically affected. Repeated determinations may indicate progress of the disease preoperatively and comparative postoperative studies show what operation has accomplished.

6) Electrocardiographic studies are often reported abnormal but no findings peculiar to pectus excavatum are noted. In our series there were three instances entirely attributable to pectus excavatum in which improved postoperative tracings were obtained.

7) Determination of maximum breathing capacity and electrocardiographic tracings are valuable adjuncts in evaluating the status of an individual with pectus excavatum.

8) Cardiac catheterization studies are planned. They should give a better understanding of the disturbed physiology in pectus excavatum.

RESUMEN

1) Los estudios cardiorrespiratorios en los infantes son poco prácticos.

2) Antes de que el esternón se fije en la posición deprimida, o sea aproximadamente a la edad de 18 a 24 meses, es aconsejable la intervención quirúrgica sencilla. Este procedimiento ha evitado constantemente la aparición de trastornos fisiológicos cardiorrespiratorios en los años ulteriores.

3) La extensión de las alteraciones cardiorrespiratorias en el "pectus excavatum" depende de cuatro factores: (a) posición adoptada por el corazón, (b) total decrecimiento en el diámetro A.P. del tórax, (c) grado y forma de la depresión de los segmentos esternales, y (d) la edad.

4) Los síntomas respiratorios predominan a través de todas las edades. Las quejas de orden psicológico aparecen en la segunda década de la vida. Los síntomas cardíacos aparecen más tarde en la vida. Estos son aparentemente menos influenciados por la cirugía que los respiratorios y los psicológicos.

5) La determinación de la capacidad máxima respiratoria constituye el mejor procedimiento aislado para estimar el estado de la fisiología respiratoria en el pecho en embudo. Las pruebas reiteradas pueden indicar la marcha de la enfermedad antes de la opera-
ción y las postoperatorias demostrarán lo que la operación ha logrado.

6) Los estudios electrocardiográficos a menudo son referidos como anormales, pero no se han anotado hallazgos propios del "pectus excavatum." En nuestras series hubo tres casos enteramente atribuibles a pectus excavatum en los que los trazos postoperatorios mostraron mejoria.

7) La determinación de la capacidad máxima respiratoria y el electrocardiograma son adjuntos valiosos para valuar el estado de un individuo con pectus excavatum.

8) Se proyectan estudios del corazón por la cateterización. Ellos harán comprender mejor el trastorno que en pectus excavatum hay sobre la fisiología.

RESUME

1) Les études cardio-respiratoires sont impossibles chez les jeunes enfants.

2) Une opération consistant simplement à déplacer le sternum est possible avant que celui-ci ne soit fixé en position de rétraction, ce qui survient de 18 à 24 mois. Un tel procédé a, d'une façon générale, empêché dans la totalité des cas l'apparition de troubles cardio-respiratoires dans les âges plus avancés.

3) L'apparition de troubles cardio-respiratoires dans les cas de dépressions thoraciques dépend de quatre facteurs: (a) position prise par le coeur, (b) diminution totale du diamètre antéropostérieur du thorax, (c) importance et forme de la dépression sternale, (d) âge du malade.

4) Les symptômes respiratoires sont prédominants pour toutes les catégories d'âge. Les manifestations psychiques n'apparaissent que dans la seconde décennie de la vie. Les signes cardiaques se manifestent tardivement au cours de la maladie. Ils sont apparemment moins influencés par l'opération chirurgicale que les troubles respiratoires ou psychiques.

5) La détermination de la capacité respiratoire maximum est le meilleur test pour juger de l'état respiratoire dans les cas de dépressions thoraciques. Une diminution de la capacité peut être constatée avant que le patient ne ressent lui-même les symptômes. Des mesures répétées permettent de suivre les progrès de ces troubles, et de se rendre compte après l'opération des résultats que celle-ci a pu obtenir.

6) On a souvent rapporté les modifications électrocardiographiques, mais on n'a jamais signalé de constations particulières à cette affection. Dans nos séries, dans trois cas, les troubles étaient complètement attribuables à la dépression thoracique, et les tracés montrèrent des progrès après l'intervention.
7) La détermination de la capacité respiratoire maximum et les tracés électro-cardiographiques sont des auxiliaires utiles pour évaluer le bilan d'un individu atteint de dépression thoracique.


REFERENCES