

EVENTRATION OF THE DIAPHRAGM

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Eventration of the diaphragm was formerly considered very rare. The condition does not occur as often as hernia of the diaphragm, but thoracic departments come across several cases yearly.

Until 1954 more than 300 cases had been published, but only a few operated on (Laxdal, McDougall, and Mellin, 1954). In the Southampton and Portsmouth mass radiography study only 32 cases of eventration were found during five years of examinations comprising 412,000 persons (Chin and Lynn, 1956). Statistics are also available from the mass radiography units of the county of Vejle, Denmark (Slottved, 1958). In 1950-1 and in 1953 a total of 107,778 persons was examined after a general invitation to the population of the county, and 38 cases were found, i.e., the frequency was four times as great as in the above-mentioned study from England. In 1950 the population of the county of Vejle was 201,041.

The first case of eventration was described by Petit, published in 1774 in a posthumous edition of his work. Korns (1921) and later on Reed and Borden (1935) collected all cases and critically reviewed the literature until 1921 and 1935 respectively. Only two cases have so far been published in Denmark (Ottosen, 1924; Andersen, 1954).

DEFINITION

Eventration of the diaphragm is generally regarded as a condition in which the left or the right leaf of the diaphragm has ascended abnormally high into the chest. In rare cases both leaves are elevated. The elevated leaf may appear almost normal or show degeneration of varying degree; it may even be a thin, translucent membrane without muscular fibres. The eventration may be total or partial, the partial eventration often being difficult to distinguish from a hernia. As a point of difference between defects and hernias of the diaphragm, Töndury (1937) required that a layer of muscular tissue be present or a

layer representing one, so that even the thinnest leaf had to consist of three layers. (In most of the cases published microscopic study of sections has been lacking.) The size of the elevated area does not seem to be used as a criterion of the condition. Authors of articles about hernias of the diaphragm usually include eventration as a special group (Halonen, Peräsalo, and Viikari, 1952; Meyer, 1950; Rinsma, 1956).

Even in the extensive cases the visible degeneration is often limited to the central part of the diaphragm and the narrow peripheral portion looks normal; in several cases the response to stimulation of the phrenic nerve was normal. Many authors maintain that elevation of the diaphragm resulting from a paralysis of the phrenic nerve should never be called "true" eventration, which they consider to be of congenital origin only (for example, Reich, 1926; Chin and Lynn, 1956). If so, the above-mentioned frequency of the condition has to be reduced considerably. We, as most other authors, use the term "eventration" whatever the origin of the condition.

In the majority of cases the eventration is found on the left side, as are hernias of the diaphragm. Reed and Borden (1935) stated that in 165 cases of the 183 cases collected from the literature eventration appeared on the left side. Nylander and Elfving (1951) are of the opinion that cases of total eventration appear mainly on the left side and partial ones mainly on the right. The latter are placed by the same authors in three groups according to their site and partly according to their presumed origin. Ordinarily the condition is said to be more common in men than in women, but the ratio stated by the various authors is very inconstant. Reed and Borden found the ratio to be 4:3. The difference may be fictitious and may be explained by the usually heavier work of men, which may cause the symptoms to appear to such an extent that examination and treatment are wanted more often than in women.

AETIOLOGY

Eventration may be congenital or acquired, although there has formerly been much discussion about the existence of the acquired form. Gruber (1953) maintains that the acquired forms are the most frequent. Some of the numerous hypotheses of the origin of the condition are given below.

The congenital form is possibly due to disturbance of the complicated development of the diaphragm from damaged or missing genes (Halonen and others, 1952; Gruber, 1914; Rinsma, 1956; Meyer, 1950). Several cases have been reported in which eventration was associated with other abnormalities such as hare lip, cleft palate, hypospadias, aplasia of the lung, hypoplasia of the aorta, transposition of the abdominal contents, etc. The condition has been seen in the foetus. Among others, Mertins (1952) reported inherited anomalies of the diaphragm, including eventration.

Injury to the phrenic nerve during delivery is mentioned among the causes of the acquired forms of eventration. Bingham (1954) reported two cases in newborn infants who had been delivered as breech presentations. Both infants were operated on. In one of them, 6 weeks old at the time of operation, the diaphragm looked normal, but microscopy showed the muscle fibres to be degenerate. They were swollen and hyalinized and had lost their pattern of striations. Five months after operation the affected leaf of the diaphragm still showed paradoxical movements on screening, but seven months after operation, though still slightly elevated, it was moving synchronously, a sign of restitution of the phrenic nerve. According to Bingham it is possible that in certain cases an incomplete recovery of the phrenic nerve or the diaphragm is all that can be expected. This may explain the fact that the thin central part of the elevation, often seen in cases of eventration in later life, does not contract, while the peripheral part contracts normally on stimulation of the phrenic nerve. (The same appearance and reaction of the diaphragm are identical to the condition, which is called by some authors the "true" eventration of congenital origin.) Tyson and Bowman (1933) and Greenebaum and Harper (1946) have described diaphragmatic paralysis of infants diagnosed within a few days after delivery in whom the diaphragm recovered its function later on. Cavrot and Richard (1956) write that diaphragmatic paralysis in the newborn is seen unexpectedly often as a result of rough obstetrical

handling. In 75% it is combined with some paralysis of the brachial plexus; and it is generally overlooked. They consider eventration another condition, and that it is of congenital origin. Kwerch (1949) has reported a case of eventration in an infant who died at 3 months of age from volvulus of the stomach. At necropsy the left phrenic nerves looked normal, but microscopy showed segmental medullary atrophy and increase of the endoneurium.

Among others, Felix (1953) stated that eventration rarely arose from cutting the phrenic nerve, as in cases of phrenic exaeresis. This does not seem to be in conformity with the general experience and may be explained by the accessory phrenic nerve having been left uncut. An accessory nerve is considered to be present in 75% of persons, whereas formerly it was considered to be present in 30% only (Kelley, 1950).

Morrison (1923) in one case found the phrenic nerve to be involved in a mass of fibrous tissue, in another the phrenic nerve was invaded by a tumour.

According to Jansen (1931) and Strauss (1933), the phrenic nerve is the only motor nerve of the diaphragm, but there is some cross-innervation. The branches from the intercostal nerves are said to be purely sensory. The tone of the diaphragm is maintained by the sympathetic nervous system (Moran Campbell, 1958).

Reed and Borden (1935) stated that eventration of the diaphragm had been seen in connexion with measles, typhoid, diphtheria, rheumatic fever, pulmonary tuberculosis, spondylitis, pneumonia, fracture or luxation of the spinal column, alcoholic neuritis, mediastinitis, Huntington's chorea, subphrenic abscess, and pericarditis. Caughey and Gray (1954) have published three cases of elevation of the diaphragm among 25 cases of dystrophia myotonica. Pasteur (1890) reported cases during an epidemic of diphtheria. Freedman (1950) has published cases associated with pneumonia and Abeles and Leiner (1944) with poliomyelitis.

During the epidemic of poliomyelitis in Copenhagen in 1952, 1,235 patients who had paralytic, and 1,006 patients who had non-paralytic, poliomyelitis were admitted to one hospital alone in five months. In 333 cases the lesion threatened life on account of insufficient respiration of varying degree; 39 of the patients developed right-sided, 20 left-sided, and 72 bilateral paralysis of the diaphragm (Lassen, 1956). Fifty-two surviving adults have been

submitted to follow-up examinations, and seven cases of permanent eventration were found, four right-sided, two left-sided, and one bilateral (Sötrup, 1958).

Inflammatory conditions in the abdomen may also produce eventration (Harley, 1949), presumably because the terminal branches of the phrenic nerve fan out on the lower side of the diaphragm.

In some cases trauma has been mentioned as the cause of eventration, almost exclusively of the left leaf; but most investigators do not accept trauma as a cause. Wood and Wood (1931) have reported a temporary high elevation of the left leaf of the diaphragm after injury to the chest wall. They considered the effect to be reflex.

Constipation, gas, and obesity have been considered able to produce an eventration. It seems more likely that these conditions may turn silent cases into symptom-giving ones by pushing the lax diaphragm higher into the chest, and in the case of obesity by exposing the heart and lungs to increased work.

SYMPTOMS

In their review of 183 cases from the literature Reed and Borden stated that nearly all cases of eventration were connected with symptoms that might be respiratory, dyspeptic, or circulatory; whereas several later authors were of the opinion that few of the cases gave symptoms, Laxdal and others (1954) estimated that about 50% of the cases were silent.

In the order of frequency the symptoms are dyspeptic, respiratory, and cardiac. The dyspeptic symptoms are pain in the abdomen, nausea, vomiting, belching, etc., and are due to the displacement of the abdominal contents. The "cascade" type of bilocular stomach often met with has rotated and been pushed upwards with the greater curvature lying adjacent to the lower surface of the elevated leaf of the diaphragm (Fig. 3), thus giving the appearance of an inverted fish hook (Rosenfeld, 1944). In some cases the inversion of the stomach may cause a twisted bend of the oesophagus at the cardia or of the pyloric part leading to dilatation of the oesophagus or retention in the stomach respectively.

The respiratory symptoms of dyspnoea, pain in the chest, cough, and cyanosis are due to the reduced lung space and the not infrequently associated atelectasis due to compression of the basal part of the lung. In the newborn with paralysis of the diaphragm without elevation

the main symptoms may be attacks of cyanosis or polypnoea (Cavrot and Richard, 1956).

The cardiac symptoms of palpitations, tachycardia, and extrasystole are probably caused by the displacement of the mediastinum or the mediastinal flutter often seen. Reed and Borden mention that the symptom of pain in the chest, often associated with pain down the left side of the arm, may lead one to suspect angina involving the coronary arteries, but no such condition was reported in any of the necropsy observations in the literature. One of our patients who had the symptoms mentioned died from a coronary occlusion.

DIAGNOSIS

The diagnosis is almost invariably made by radiographs. In the distinct cases they show an unbroken, curved line representing the elevated diaphragm (Fig. 1). On the lateral film the difference of level between the normal and the elevated leaf may be still more pronounced than it appears from the frontal film, because the top of the curve of a normal leaf lies more anteriorly than that of an elevated leaf, so that the real reduction of the lung space is bigger than a frontal film suggests (Fig. 2). A gastric bubble of air is often seen below the diaphragm, and lateral to that a colonic bubble. Radiographs of the chest should be supplied with films of the stomach, both in the erect position and in the position of Trendelenburg, and sometimes with films of the colon. The degree of dislocation of the stomach is thus revealed, and the procedure may help in diagnosing the condition if the radiographs of the thorax are dense. Fluoroscopic examination of the chest to observe the movements of the diaphragm and the mediastinum may be of value, especially when one is to estimate if an operation will better the condition in elderly persons with suspected stiffness of the tissues. In our opinion screening may often yield better information than do lung function tests. On the affected side the movements of the diaphragm may be normal, diminished, absent, or paradoxical. Sniffing during a fluoroscopy may reveal paradoxical movements of a diaphragm which seems to have synchronous, diminished movements or to be immobile. There may be a displacement of the mediastinum to the opposite side, rotation of the heart, and mediastinal flutter.

In the newborn the elevation is as a rule high. When only a temporary paralysis is present, the position of the diaphragm is often normal, but it moves paradoxically so that the diagnosis is apparent on screening.

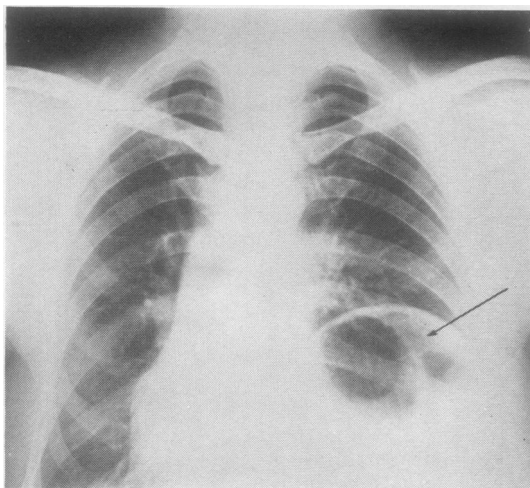


FIG. 1.—A radiograph showing a pronounced left-sided eventration of the diaphragm. The picture demonstrates the unbroken, curved line of the diaphragm. Below the left diaphragm the air bubbles in the stomach and in the colon can be seen. The arrow points to the triangle, the sides of which are formed by these three structures. When present the triangle is pathognomonic of an eventration. Unfortunately in most cases the condition cannot be so readily recognized.

The diagnosis is more difficult to make when a basal atelectasis of the lung is present. It is not always possible to determine whether the atelectasis is produced by compression of an elevated diaphragm or by some other condition (for instance, tumour or pneumonia). Negative findings by bronchoscopy, bronchography, and examination of the sputum do not exclude other diseases, apart from the fact that, if present, an eventration may be secondary to these diseases.

The diagnosis may also be difficult to make in the case of partial eventration especially on the right side, because the elevated dome is often filled by protrusion of the liver simulating a tumour. In these instances the condition is as a rule first discovered at operation.

Of the diseases from which partial eventration must be differentiated hernia of the diaphragm is by far the most frequent. From the literature it appears that in most cases of partial eventration operation has been carried out on the diagnosis of hernia of the diaphragm. The curved line of a dome seen on a film of the thorax may be the wall of the stomach. It may even reach such a size that it is mistaken for a total eventration. A radiograph of the stomach after ingestion of a barium meal may reveal a lace groove of the stomach corresponding to the defect in the diaphragm, which itself is often difficult to recognize on account of density of the film.

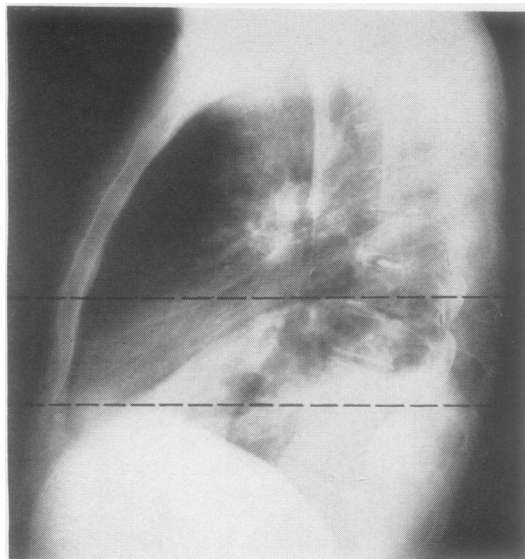


FIG. 2.—On the lateral radiograph the difference of level between the normal and the elevated leaf may be more pronounced than in the postero-anterior film, as the top of the curve of a normal leaf lies anterior to that of an elevated leaf.

Pneumoperitoneum may give valuable information when there are no adhesions in the abdominal cavity. Formerly many authors warned against this procedure, considering it risky. Among others, Nylander and Elfving (1951) and Evans and Simpson (1950) have successfully used the method in differentiating between partial eventration and hernia.

Of conditions other than hernia that are to be differentiated from eventration, most authors mention cysts and tumours of the diaphragm. These conditions are rare. From 1868 until 1950 only 35 cases of primary "tumours" of the diaphragm, including cysts, have been described (Samson and Childress, 1950). Pleurisy with fluid, neoplasm, atelectasis, cyst of the lung, cyst of the liver, and cyst of the pericardium are also mentioned.

MATERIAL

From 1953 until 1958, 17 cases of eventration have been admitted to our thoracic departments and one case to Dronning Louises Børnehospital, but operated on by our staff. The diagnoses under which the patients were admitted were as follows:

Hernia of the diaphragm	5
Suspected tumour of the lung	3
Dermoid cyst of the lung	1
Tumour or cyst of the lung	1
Eventration of the diaphragm	8

The patients were aged as follows:

Below 1 year of age	..	..	..	..	2 cases
From 10 to 20 years of age	..	..	..	..	1 ..
.. 20 .. 30	..	..	..	..	1 ..
.. 30 .. 40	..	..	..	..	0 ..
.. 40 .. 50	..	..	..	..	6 ..
.. 50 .. 60	..	..	..	..	4 ..
.. 60 .. 70	..	..	..	..	4 ..

Three of the patients were women and 15 were men. Fourteen cases were left-sided (12 total and two partial) and four right-sided (two total and two partial). Eight of the patients had respiratory complaints alone, seven had both respiratory and dyspeptic symptoms, while three had no symptoms. In 10 pain in the chest or epigastrium was present and in six cases palpitations (one of these patients had coronary attacks and died three years later from a coronary occlusion). The two children, aged 9 and 11 months, were admitted to hospital on account of repeated attacks of pneumonia.

Twelve of the 18 patients were operated on. Of the rest of the patients three refused operation, and in three operation was considered too risky on account of severe, chronic thoracic disease. There were no serious complications in these operations. Follow-up examinations have shown nine of the patients to be without symptoms, two were much improved, and in one the respiratory complaints were unchanged, as expected, because the lung function tests showed a fibrosis, but the patient was relieved of dyspeptic symptoms, which had been serious. The stomach was displaced (Fig. 3) and he could take only fluid meals.

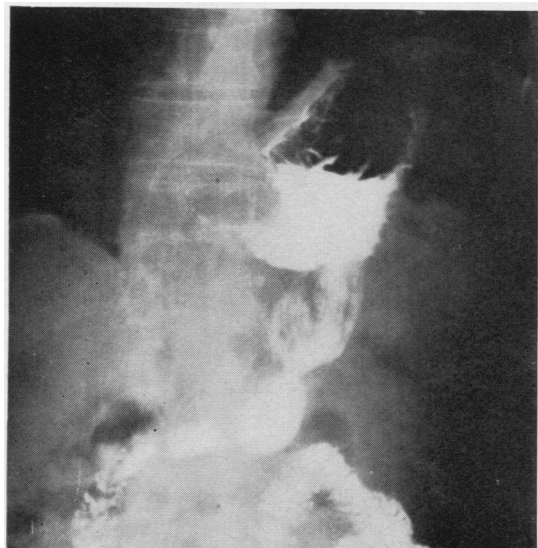


FIG. 3.—A postero-anterior radiograph showing a stomach of the cascade type having inverted up under the elevated left leaf of the diaphragm. The stomach has rotated so that it is seen from the edge.

In four of the cases the diaphragm has again ascended notably, though it does not reach the pre-operative level. As might be expected it has taken place when a paralysis of the phrenic nerve was present. Nevertheless two of the patients are stated to be free of symptoms, the third one felt much improved but was not quite satisfied. The fourth patient was the one whose dyspeptic symptoms had disappeared. In spite of the diaphragm having again risen to half the pre-operative level, the stomach has retained its normal position achieved by operation. His appetite improved so that he gained too much weight, which was not favourable for the preservation of the low level of the diaphragm. Two of the other patients had abundant gaseous collections in the bowel.

In five of the cases radiographs taken earlier have been traced and these showed that a silent eventration had been present from three to 12 years before admission to hospital. In three of the cases symptoms arose which led to the admission. In one of these we presume that a sudden big increase of weight had been the releasing factor of the patient's symptoms. In the fourth case, which was still silent, the patient was operated on with a diagnosis of a dermoid cyst. In the fifth the patient was admitted to hospital on account of an advancing elevation of the left leaf. He has had no symptoms for at least 10 years and is still symptom-free, although the elevation is high and the mediastinum is displaced (Fig. 1). This patient is aged 41 years. He does not want an operation.

In one of our cases it is of genetic interest that a series of radiographs taken in the course of a few weeks in connexion with pneumonia show a gradual development from a normal level to a pronounced elevation of the left leaf of the diaphragm, and the condition has become permanent. There was no atelectasis of the lung. In the literature I have found radiographs of cases of temporary elevation of the diaphragm associated with pneumonia (Freedman, 1950), but to the best of my belief there were no radiographs like the above-mentioned series, which proves as closely as attainable that a permanent eventration may be caused by pneumonia.

In another patient the diaphragm was temporarily elevated in association with pneumonia. Eight months later the elevation was lower but still present. The next radiograph taken three years later revealed that the diaphragm had regained its normal position. In the reports of Freedman (1950) there has been a

latent period up to five weeks after the onset of pneumonia before an elevation developed. The temporary elevations lasted from a few weeks to several months.

Three other of our patients had suffered from pneumonia once or several times on the same side as that on which a permanent eventration was later found. We were not able to determine whether the pneumonia was primary or secondary to the eventration.

Three of the patients had had severe diphtheria in childhood. In two tracheotomy was performed. No information as to paralysis was available. It has not been possible in these cases to prove a connexion between the diphtheria and the eventration found several years later.

In one of our patients the course of symptoms, examinations, and operations indicated that eventration might have been due to syphilis. The patient had temporary paretic symptoms of the limbs and speech 13 years earlier. His chest had been controlled regularly by screening for 10 years, and the latest screening six months before admission to our hospital showed a normal position of the diaphragm. Examinations revealed no active syphilis. The Wassermann reaction was of grade 2 and the Kahn of grade 2. There was no reaction of the spinal fluid. As his former paretic symptoms had disappeared after specific treatment, the eventration was suspected to be of syphilitic origin. It was determined to observe the patient for three months and to give penicillin in the meantime. On the patient's second admission to hospital the elevation of the diaphragm was only a little lower, but he felt better. On screening, the formerly immobile left leaf was now moving synchronously with the right leaf, although the movements were diminished. The pulmonary function tests showed a slight improvement. Three months earlier electro-stimulation of the phrenic nerve in the neck and directly on the chest at the level of the diaphragm did not give any contraction of the left leaf, whereas an electro-stimulation of the right leaf gave a normal contraction. At operation stimulation of the nerve showed a clear but sluggish contraction of the diaphragm and stimulation to the diaphragm itself showed a fast and vigorous contraction. Electro-stimulation was not applied immediately before operation, as the patient considered it unpleasant. The basal atelectasis had remained unchanged, and, though pre-operatively the most likely diagnosis was eventration with atelectasis of the lung from compression, an operation was preferred to exclude a tumour as the origin of the atelectasis. We feel that the evidence is in favour

of considering this a case of eventration of syphilitic origin. The phrenic nerve may have been interrupted at the site where the nerve crosses the arch of the aorta, caused by syphilitic inflammation of that vessel. The apparent temporary character may be due to the intensive treatment with penicillin.

Of further interest in the same case is the history of a severe injury to the left chest wall 10 years earlier, confining the patient to bed for a couple of weeks. Had there been no screening shortly after the incident and once yearly during the next 10 years, the trauma might erroneously have been considered the cause of the eventration.

PULMONARY FUNCTION TESTS

Ordinary spirometry and bronchosprometry have not been important. When the results of the tests were abnormal, the respiratory symptoms of the patient were so pronounced that they alone demanded an operation. On the other hand, when the function tests showed the presence of pathological changes in the lung such as fibrosis, we could not improve the condition of the patient if his complaints were respiratory alone. In one case the pulmonary function tests, indicating fibrosis, and the respiratory complaints were unchanged after the operation, and for some time the subjective symptoms were worse. However, the patient was operated upon mainly on account of the dyspepsia that resulted from the displacement of the stomach. He was relieved of dyspeptic symptoms.

It may be difficult to tell if changes found by the pulmonary function tests in connexion with an eventration are such that the condition cannot be improved by operation, among other things because the functions of the heart and the lung are so intimately connected. Thus in cases of doubt we operate if symptoms are pronounced.

The fatal course in one of our cases seems to justify this opinion. The patient presented a highly elevated diaphragm with the most pronounced respiratory symptoms we have come across in this condition. He was 66 years old and overweight. Bronchosprometry showed an almost absent oxygen uptake in the affected lung and spirometry indicated emphysema of both lungs. The patient refused operation. Five months later he was admitted to another hospital because of respiratory complaints that had progressively increased during the foregoing 14 days. He now had to sit up in bed when sleeping. His visual power had simultaneously diminished

and the vessels of the eyes were found to be cyanotic. He died four days after admission to hospital with symptoms of anoxaemia and hypercapnoea. A radiograph showed displacement of the mediastinum causing some density of the unaffected lung. The electrocardiogram was normal.

Although there would be rigidity of the lung in such a case, screening showed a pronounced movement of the mediastinum to the unaffected side during inspiration, indicating a mobile mediastinum, so an operation would diminish the displacement of the mediastinum, and tightening of the affected leaf of the diaphragm at a lower level would give a better opportunity of increasing the respiration by "mediastinal ventilation."

Sarnoff, Gaensler, and Maloney (1950) and Sarnoff, Sarnoff, and Whittenberger (1951) have shown by electro-stimulation of one phrenic nerve in the neck of normal persons that it is possible to maintain ventilation of the contralateral side almost as great as the ventilation of the lung on the side stimulated. The contralateral respiration is carried out by "mediastinal ventilation."

In a work on analysis of lung function in some intrathoracic diseases, Svanberg (1956) stated the following about eventration of the diaphragm [*sic*]:

"A question is whether this condition indicates operation. As a rule these patients have only slight symptoms, and the average age in the present material was as high as 63 years. From a functional point of view it must be questioned whether such therapy is justified, since it is not certain that fixation of the diaphragm at a lower level, which decreases the possibility of the so-called mediastinal ventilation, will improve ventilation of the affected lung."

This statement is not in conformity with our experience. In three of our patients in whom the diaphragm had ascended notably after the operation, the lung function tests showed improvement. Bronchspirometry showed normal or almost normal oxygen uptake in the affected lung. Two were relieved of respiratory symptoms, and one was improved.

Although the symptoms are improved, they are not as good as may be suggested by oxygen uptake shown by bronchspirometry. The values are too high. The leaf of the diaphragm operated on is immobile or moves slightly paradoxically, and the mediastinum moves to the unaffected side during inspiration. The affected lung is thus better ventilated, but the unaffected lung is almost correspondingly less ventilated in operated persons.

It appears from the above that tightening of the diaphragm at a lower level does improve ventilation in the affected lung.

INDICATIONS FOR OPERATION

It is generally believed that an undiagnosed eventration has been the cause of death in some cases of dyspnoea, cyanosis, and dyspepsia in the newborn. In some the condition had been diagnosed, but until the end of the last decade surgeons dared not operate on these infants. Of 13 cases reported in the literature five of the patients died (Bingham, 1954). Bisgard (1947) performed the first operation on an infant. Later a number of infants were successfully operated on. Although some of the cases of eventration are due to a paralysis of the phrenic nerve during delivery and may be temporary only, it may nevertheless be necessary to operate. The condition may threaten life so that one dares not await a possible regression, as the patient may become beyond surgical care. The symptoms are in most cases severe, because the affected leaf of the diaphragm is high and the mediastinum is pushed towards the opposite side. On the other hand, if during fits of dyspnoea and cyanosis these infants respond to conservative treatment, such as oxygen and upright posture, and they can manage without permanent oxygen, it may be considered wise to postpone surgery for some months as advised by Laxdal and others (1954).

Newborn children with paralysis of the diaphragm and without elevation should be observed. When lying down they are placed on the affected side, which improves ventilation. Oxygen may be necessary.

Eventration rarely causes symptoms in persons between 1 and 40 years of age. Thereafter the number of cases increases. No statistics are available stating how many remain silent. Besides the height of the elevation this depends on whether the patient is doing heavy work (intra-abdominal pressure), and whether the affected leaf is being pressed further upwards by increased intra-abdominal pressure on account of obesity, constipation, or gaseous collections; and whether a displacement of the mediastinum is pronounced. Furthermore, the changes of the lung and heart with advancing years and the increasing stiffness of the thoracic cage play a role.

In five of our cases a silent eventration had been diagnosed from three to 12 years before the patients were admitted to hospital. In three symptoms developed, whereas the fourth is still free of symptoms, although eventration is

pronounced (Fig. 1), but the elevation has been increasing during these 10 years, and symptoms will probably arise eventually. The patient is now 41 years of age. The course of these cases favours our opinion that it is advisable to operate even on silent cases if the elevation is fairly pronounced and especially when the mediastinum is distinctly displaced. It is difficult for patients to see the sense of an operation when they feel well; but the result will be better the younger the patient.

Patients with a less pronounced eventration ought to be checked up regularly, and, if the condition progresses, operation should be performed.

When the symptoms are pronounced the question is more simple. Several of our patients have been handicapped on account of dyspnoea. Some have even been unable to do their work and they have wanted an operation. When judging the indications for operation in elderly persons with presumed changes in the lung tissues, we find screening an important help.

It seems as if the dyspeptic symptoms make the patient more ready to accept operation than do the respiratory symptoms alone. The symptoms are mainly due to the stomach having rotated and ascended, so that the greater curvature lies adjacent to the under surface of the elevated diaphragm. The stomach is often lax and lengthened and may be folded so that food has difficulty in passing through it. The pain may disappear at once when the patient lies down on his left side, thus facilitating the onward flow. Sometimes the patient is not relieved of his pain until he has vomited. In the literature examples of a "false" stenosis of the cardiac end of the oesophagus have been seen, causing dilatation of the oesophagus, and also at the pylorus, causing retention in the stomach. By operation the abnormal site of the stomach is corrected, and the dyspeptic symptoms disappear.

When combined with a basal atelectasis of the lung the condition also requires operation, even if the symptoms are negligible. There is a risk of pneumonia and lung abscess in these cases, and a tumour cannot be excluded with certainty. The eventration may be secondary.

With the increasing frequency by which people in Denmark are submitted to routine x-ray mass examinations, it will be possible to find more people with a recently acquired elevation of the diaphragm. Three of our patients had an eventration acquired within one year of admission to hospital. Observation may ordinarily be advisable and when possible specific treatment

given. In consideration of the rapidly appearing atrophy from inactivity, it may be justifiable to keep the diaphragm active by electro-stimulation. A prolonged treatment may be suggested, lasting 10 minutes daily. The electrodes are placed on the back and the front of the thorax at the site of the diaphragm.

Apart from cases in newborn infants a fatal course associated with eventration of the diaphragm has been reported following rupture of the affected leaf during delivery (Blackford and Booth, 1932), during lifting of a heavy object (Hicks and Harding, 1944), and following volvulus of the stomach. The ligaments of the stomach were long, permitting it to turn round under the elevated diaphragm (Kwerch, 1949).

TREATMENT

There has been some discussion whether the abdominal, the thoraco-abdominal, or thoracic approach should be preferred (State, 1949; Butsch and Leahy, 1950). Surgeons preferring the abdominal approach maintain that it is easier to avoid catching abdominal structures when suturing the thin diaphragm. Most surgeons have chosen the thoracic approach, which offers the best facilities to reconstruct a normally situated diaphragm and which yields the best chance to inspect the thoracic structures.

We have used the technique which seems to be most common. After an oval, radial excision the diaphragm has been sutured in two or three layers by non-absorbable material. Some authors have used tantalum mesh or fascia lata grafts as reinforcement (Sanford, 1953; Monahan, 1951).

Post-operatively the patients must avoid heavy work, overweight, constipation, and gaseous collections in the bowel. The same instructions are given to patients who have not been operated on, who are also told to take small meals and to eat slowly.

SUMMARY

The main features of eventration of the diaphragm are reviewed, and the indications for operation practised at the University Hospital, Copenhagen, are mentioned.

The value of lung function tests is discussed.

The present material consists of 18 cases. Twelve were operated on. Three refused operation. In three others operation was considered too risky.

At the follow-up examination nine of the 12 patients operated upon were free of symptoms.

Two were much improved. In one of the patients the respiratory complaints were unchanged, but he was relieved of dyspeptic distress.

No serious complications arose post-operatively.

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