SOME DEFORMITIES OF THE CHEST IN CHILDHOOD AND ADOLESCENCE.

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SOME DEFORMITIES OF THE CHEST IN CHILDHOOD AND ADOLESCENCE.

In is the purpose of this Thesis to discuss some deformities of the chest found in childhood and adolescence, to classify them, trace their causes, and suggest preventive treatment.

Anatomy of Child's Chest.

(a) In Infancy.

The new born infant's thorax is cylindrical in shape, with the antero-posterior diameter approximately equal to the transverse diameter. Its circumference is less than that of the head. Its structure consists of a bony cartilaginous framework of the thoracic vertebral column, ribs, costal cartilages, and sternum, with the soft parts covering these. This framework lacks solidity due to the as yet imperfect ossification of the bony constituents; the sternum consists of cartilage with bony centres in it, and is especially flexible and pliant. The vertebral column, also, owing to imperfect ossification,and weakness of its supporting ligamentous and muscular elements, is freely movable. The ribs are flatter, less hooped, and placed more horizontally than in the adult, i.e.

the angle they make with the transverse vertebral process behind is less than in the adult, and the angle with the sternum is great. This causes the subcostal angle to be wide, but this is partly due to the comparatively great size of the abdominal viscera pressing out the lower ribs, and causing the diaphragm to occupy a high position. The thoracic spine has not the characteristic posterior concavity of the adult, because the infant does not assume the erect posture. In consequence of the absence of the adult vertebral curves, the upper border of the sternum is placed high, at the level of the disc between the first and second dorsal vertebrae (Symington).

(b) <u>After Infancy</u>.

As the infant begins to use its arms, the muscles which move them develop, causing the chest to grow more from side to side than antero-posteriorly, so that by the third year the antero-posterior diameter is less than the transverse, and the section of the chest has ceased to be circular, now becoming more elliptical in shape. Moreover, when the child assumes the erect posture, the posterior thoracic concavity of the spine begins to appear, thus causing a further diminution in the antero-posterior diameter. As the child grows, and the arms are used

as prehensile organs, thus developing the shoulder girdle and chest, the chest gradually becomes more like the adult type, the changes being more marked at puberty. The bony framework of the thorax is not completely ossified till the 25th year. The weak points in the child's chest are naturally at the junction of the ribs and their costal cartilages, and at its widest part, corresponding to the attachment of the diaphragm to the lower six ribs - along a line running from the xiphoid cartilage laterally on each side, slightly downwards to the axilla, below which line the abdominal viscera give support; further, there is an area in the infra-mammary region on either side, unsupported by muscles; it has, as its centre, the fifth space in the nipple line, being an interval between the insertions of the pectoralis, the serratus magnus, and the rectus abdominis muscles (vide, diagram addenda).

Physiology of Respiration in Childhood.

As in the adult, the act of respiration consists of two opposite or complementary movements - inspiration and expiration.

I. Inspiration. Its movement (the elevation and forward movement of the sternum, and the elevation and eversion of the ribs) produces enlargement

of the thoracic cavity antero-posteriorly and transversely. Its vertical diameter is increased by the descent of the diaphragm. This general enlargement causes a potential vacuum within, so that the air rushes in through the respiratory tract, and some blood from the circulation outside the thorax.

The muscles of ordinary inspiration are:-

Diaphragm
External Intercostals
Intra-chondral part of Internal Intercostals.
Levatores Costarum.
Serrati Postici Superiores.
Scaleni.

In children the action of the diaphragm is all important as the other muscles are not well developed till after puberty (Keating).

The diaphragm is a membranous and muscular structure of a dome like shape, the convexity upwards, situated between the thorax and abdomen. It has a central tendon to which lateral muscular planes are attached. They receive muscular slips from:-

1. The posterior surface of the xiphoid cartilage.
2. The deep surfaces of the lower six costal cartilages and ribs.
3. The lumbar vertebrae.

Action of the diaphragm. Its action is two fold (Cunningham, Anatomy, Page 397):-

1. Centrifugal, pulling on the ribs, elevating and slightly everting them.

2. Centripetal, drawing downwards the central tendon.

When it contracts, it does so from a fixed point, the attachment of the middle leaf of its central trefoil tendon to the pericardium above. Its lateral muscular fibres contract, shorten, wherefor the muscular planes become flattened and descend, pressing down the abdominal viscera which cause the abdominal wall to protrude. The diaphragm, also, acting from its central tendon must tend to pull the ribs and xiphoid cartilage from which it receives its muscular attachments inwards and downwards. This actually does occur in a living animal, from which the liver has been removed; (Landois and Stirling, Physiology, Page 200). But the abdominal viscera being forced down are also forced outwards and prevent the indrawing of the ribs; along the line just above the support of these viscera, the indrawing tendency is still present, but in normal conditions is counteracted by the elevating action of the intercostal muscles.

II. Expiration. This is ordinarily due to the elastic recoil of the lungs after the inspiratory muscles have ceased to act, to the weight of the chest wall, and the elevation of the diaphragm.

Tranquil Respiration.

In an infant, whose muscular system about the chest is poorly developed, tranquil respiration is carried on mostly by the action of the diaphragm. Apparently there is no separate type for each sex. Most authorities agree that this diaphragmatic breathing is continued up to, at least, the third year. Thereafter, in boys, the muscles attached to the lower seven ribs help the diaphragm. Correlated with this excessive activity of the diaphragm is the horizontal position of the ribs, which, on this account, when raised, do not increase the capacity of the chest so much as when they are placed more obliquely, e.g. in the adult.

Difficult Respiration.

Inspiration.

In difficult respiration other muscles than the ones mentioned in ordinary respiration are brought into play. Generally, those muscles which have an attachment to the sternum or ribs, may assist inspiration by raising the sternum or ribs.

These muscles are as follows:-

Sterno-Mastoid. The head is fixed by the posterior cervical muscles, and the sterno-mastoid muscles acting together from their fixed mastoid attachment, pull the sternum upwards and slightly

forwards at its upper end.

Pectoralis major and minor, serratus magnus, and latissimus dorsi. These muscles, normally acting from their thoracic attachments as fixed points, may act in the opposite direction, if the shoulder girdle is fixed. The shoulder girdle is fixed by the action of the trapezius, rhomboid, and levator anguli scapulae muscles, or the muscles of the arm and forearm.

Pectoralis Major. Acting from its attachment to the humerus, the shoulder girdle being fixed, its lower fibres will pull the lower part of the sternum, and probably the fourth, fifth and sixth costal cartilages forwards and upwards.

Pectoralis Minor. Acting from its attachment to the coracoid process of the fixed scapula, will pull the third, fourth and fifth ribs just external to the costo-chondral line, upwards and outwards.

Serratus Magnus. Acting from its attachment to the vertebral border of the fixed scapula, will tend to raise the lower of the upper eight ribs, outside the line of the attachment of the pectoralis minor.

Latiosimus dorsi. Acting from the humerus will tend to raise the lower four ribs. This action is only very slight.

Expiration.

In difficult respiration all the muscles which can depress the ribs, sternum, or force up the diaphragm, may be used.

I. The ribs are depressed by
- Rectus abdominis
- Triangularis sterni
- Quadratus lumborum
- Serratus posticus inferior.

II. The abdominal contents are compressed and forced against diaphragm by
- Obliquus externus
- Obliquus internus
- Transversus abdominis
- Rectus abdominis
- Levator Ani

Preliminary Considerations.

Under normal conditions the bony cartilaginous skeleton of the thorax maintains the chest in a definite normal shape.

The forces acting on the chest wall are:-

1. Externally. (a) Atmospheric pressure acting equally on all parts.

   (b) Muscular pull, those parts which are covered by muscles, being more protected than those not covered.

2. Internally. (a) Atmospheric pressure acts equally on every part of the inner aspect of the thorax, but the amount is decreased by the amount lost in overcoming pulmonary elasticity.

(b) Some parts of the thoracic wall are supported by solid viscera, notably the abdominal viscera - liver and spleen. The collapsible lung is not solid, although the collapsed lung may be so regarded.

Differences of Tensile Strength.

The ribs are flexible and elastic; deficient oxygenation of the blood will tend to delay the deposition of lime salts, and thus make the ribs more flexible and elastic than normal. The costal cartilages and the sternum are much more elastic and pliant than the ribs, and are therefore more easily constrained and bent by force applied to them. Under normal conditions the ribs, cartilages, and sternum maintain a certain definite shape. If, however, the forces acting on them are changed, or others are added, then to accommodate themselves to the new conditions, they change their shape, and if the altered conditions are not removed, the new shape will remain until the forces return to normal. Further, the forces ordinarily concerned with the formation of the definite shape of the chest act upon plastic parts, and even although their action return to the normal, the fixity or solidity of grown parts may prevent any restitutio ad integrum. These deductions are in accordance with Wolff's law.

The upper part of the chest can be expanded and kept expanded much more powerfully than the lower part can be. Hence when the diaphragm descends and the thorax, for any reason, cannot hold out against the vacuum, which would otherwise be this created, the lower part of the chest is the first to yield to atmospheric pressure upon it from without (Gee. Auscultation and Percussion, Page 14).

The shafts of the upper ribs are more acutely curved than those of the middle and lower ribs, in which the curves open out more. Consequently the upper ribs are, owing to their more acute curvature, more able to withstand external force.

Deformities of the Chest.

Perfect symmetry of the chest is not found in the child any more than in the adult; generally there is some slight disparity, most frequently the right side being larger in circumference.

Congenital Deformities.

Congenital cleft of the sternum, deficiency of ribs or cartilages, are of more anatomical than medical interest.

Funnel Shaped Chest. "Trichterbrust" (German).

Description. It is characterised by a depression in the anterior thoracic wall, and is a rare

deformity. The depression is more or less cup shaped, and situated at the lower end of the sternum. It may extend as high as the level of the third rib. Sometimes there is a corresponding compensatory kyphosis in the lower thoracic region.

The result of the deformity is a decrease in the antero-posterior diameter in that region. At the same time, it mechanically causes displacement of the thoracic viscera, causing the heart more especially to occupy a more vertical position.

Etiology. Opinion is divided as to the causation of it. It is generally conceded that, if not actually congenital in origin, it certainly is caused in early life. Those who believe it to be congenital in origin have suggested various causes, such as, intra uterine traumatism, excessive pressure of the foetal chin on the sternum. Ebbstein's theory is the most plausible. He suggests that there is a congenital arrest of growth of the sternum, causing a restriction in the vertical development of the thorax, and the ribs continuing to elongate, an incurving of their sternal extremities results. Associated with this deformity in some of the cases reported, other stigmata of degeneration were present, which lends support to the latter theory.

Jenner (Quain's Dictionary of Medicine, Page 313)

states that this deformity is never congenital, but results from an impediment to the free passage of air, to the pulmonary tissue, of a congenital origin, e.g. atelectasis, and commences to form immediately after birth.

Musser (Physical Diagnosis, Pages 468, 988) states that it is a more advanced deformity of chicken breast, due to chronic mouth breathing, but he further states that it is often congenital, and often seen in several members of a family.

Osler (Practice of Medicine, Page 449) believes that in some instances it is the result of obstructed breathing, in connection with adenoid vegetations, and mentions two cases in children in which the condition was in process of formation. This latter theory is favoured by the fact that adenoids are often present at birth, and have been observed as early as the tenth month.
(Clifford Allbutt - System of Medicine, Page 715).

Bilateral Symmetrical Deformities.

1. Relative Diminution in size of chest in all diameters.

Description. The chest is relatively small in all diameters; the ribs are placed obliquely, making acute angles with the costal cartilages, thus making the subcostal angle more acute than normal;

the intercostal spaces are generally decreased, but above may be increased in front. The shoulders droop and come forwards, tilting the lower angles of the scapulae backwards, thus causing prominence of their vertebral borders. This latter is partly due to muscular weakness especially of the serratus magnus muscles, which allow the vertebral borders to leave the thoracic wall, and also to the fact that the scapulae are not sufficiently supported by the narrow thorax, the shoulders falling forwards and downwards, owing to the weight of the arms.

Etiology. According to Jenner, there is one cause only, and that "small lungs", which are congenital, and due to original conformation. He further states that the lungs in relation to the length of the ribs are disproportionately small, and, as a necessary consequence, the relatively too long ribs are arranged more obliquely, and the diaphragm is pushed upwards into the thorax, by the pressure of the abdominal organs. (Jenner, Quain's Dictionary of Medicine, Vol.I., page 310). The causation of this type of chest may be argued in various ways. It may be assumed that the infant is born with small lungs, just as it may be, for example, with small kidneys. The foetal lungs contain no air; when the first breath is taken, the chest expands, and

the pressure of the inspired air has to overcome the adhesions obtaining between the walls of the alveoli in contact with each other; it takes some time for the lungs to pass into the fully distended condition, and this is apparently brought about by the thorax growing more rapidly, and so becoming relatively more capacious than the lungs. (Foster, Physiology, Book II., Page 537).

The small lung condition may be due to an excess of fibrous tissue in the lungs, causing a lack of elasticity, and thus creating an abnormal resistance to the full expansion of the lungs. Again, this would lead to a diminished oxygen absorption area, resulting in deficient oxygenation of the blood, with consequent malnutrition of the tissues, including the bony and muscular systems. The bones, in such a case, would not develop properly, and the muscles would act feebly, so that, it is not difficult to imagine, that the thorax would be small, when, added to abnormally resistant lungs, there are deficient growth of the bony and cartilaginous walls, and feeble muscles.

Again, it may be assumed that the infant exhibits congenital arrest of the growth of the bony cartilaginous wall of the thorax. Now, as physiologists state that the full expansion of the lungs is due to the more rapid growth of that wall, an

arrest in its development, would prevent the lungs from fully expanding, and here again deficient oxidation would result, with consequent malnutrition, preventing still further the growth of the wall in a normal direction.

2. General Enlargement of Chest.

Description. In this type the thorax is in a state of distension beyond what could be produced by the deepest inspiration in health. It is, in other words, in a more or less permanent inspiratory condition. The chest is barrel shaped; the antero-posterior diameter is increased and may be even greater than the lateral; it is arched before and behind; the sternal arching from above downwards is due to the fact that its upper end is fixed more than the lower end; the ribs are placed horizontally, the intercostal spaces are wide, and the subcostal angle is obtuse; the ribs, also, are more curved, and the angle of Lordovic is frequently well marked.

Etiology and Mechanism. Increase in volume of the lungs is the only accompanying condition, as is found in hypertrophic or large lunged emphysema. In childhood the occupation factor in the causation of hypertrophic emphysema may be excluded. The condition of the lung is due to persistently high

intra-alveolar tension acting on a congenitally weak lung tissue, and Osler (Practice of Medicine, Page 634) has been impressed by the frequency of its origin in childhood, and states that it may result from recurring asthmatic attacks due to adenoid vegetations. Cohnheim thinks that the congenital pulmonary weakness is probably due to a defect in the development of the elastic tissue fibres.

Recurring attacks of bronchitis, whooping cough, asthma, are the most common precursors of this disease, and it is most likely that the prolonged attacks of coughing in the two former are more specially causative factors.

Two theories are proposed as to the causation of the deformity of the chest.

I. In the first theory there is supposed to be a gradual enlargement of the thorax, causing the lungs to increase in volume to fill up the space. In consequence of great respiratory difficulty in the afore-mentioned diseases, with obstructed and forced inspirations repeatedly kept up, the great extraordinary muscles being called into play, these muscles lead gradually to over distension of the general thoracic cavity, causing the lungs to increase in volume to fill up the space.

II. The second theory is more plausible; the permanent increase of volume of the lungs, which is

the result of overdistension of the lungs with loss of elasticity first occurs. Expiration which normally results from the elastic recoil of the lungs does not occur properly; consequently, with incessant repetition of forced inspirations, and imperfect expirations, the chest wall yields to the heightened intra-thoracic pressure, and assumes the position of permanent inspiration.

3. Decrease in antero-posterior diameter of Chest.

Type - "Flat Chest".

Description. The chest is flattened from before backwards; the ribs are placed obliquely, and lose their normal curve; the costal cartilages become straightened; the subcostal angle is very acute; the antero-posterior diameter is diminished, and the transverse is increased.

Etiology and Mechanism. This type is allied to the first mentioned type "general diminution in all diameters". It is a natural deformity, the tendency to which is born with the individual and inseparable from him (Gee, Auscultation and Percussion, Page 13). The same theories as to the causation of the deformity hold good, as in the first type mentioned. The lungs of a flat chest are especially liable to the invasion of the tubercle bacillus.

4. Increase in Antero-posterior diameter of Chest.

(a) Rachitic Chest.

Description. There is an increase in the antero-posterior diameter; there is a series of nodes on each side of the chest in front, being the result of the excessive proliferation of cartilage at the junction of rib and costal cartilage; this series runs from above downwards and slightly outwards; outside this node line may be found a vertical groove; the sternum and costal cartilages are prominent and project forwards; frequently there is a depression which runs transversely from the lower end of the sternum across the chest on each side to the axilla, about the line of attachment of the diaphragm; there may be kyphosis in the lower dorsal region of the spine.

Mechanism. Rickets is a disease affecting the growth and nutrition of the growing organism. Growth is compounded of absorption and accretion of bone, and it appears that in rickets the osteoclasts work well, whilst the osteoblasts squander their energy. The bones, remaining largely cartilaginous and soft, yield readily under traction and pressure. The muscles are wasted and infeebled, the ligaments relaxed, and the mucous membranes are abnormally susceptible to catarrh.

The rachitic nodes of the ribs are due to the excessive proliferation of cartilage at the costo-chondral junction. With soft yielding ribs deformities are liable to occur, and at the places where the ribs are weakest, or least supported by solid viscera. These weak points are at the costo-chondral junctions where the excessive cartilaginous proliferation is going on, and along that transverse line, corresponding to the arch of the diaphragm, just above the upper limit of the abdominal viscera - liver and spleen - the solidity of which will give support to the ribs in front of them. In addition, there must be some alteration in the forces normally acting on the chest wall, to allow deformity to occur. This may be put down as a decreased intra-thoracic pressure allowing the external atmospheric pressure to force in the ribs at the weakest points. In severe cases of rickets, the diminished intra-thoracic pressure necessarily ~~necessarily~~ normally present during inspiration is sufficient to allow the external atmospheric pressure to force in the ribs along the lines of least resistance - the vertical line at the costo-chondral junctions, and transverse-ly, the line of attachment of the diaphragm. The transverse depression is further helped by the inspiratory contraction of the diaphragm. Again,

it may be argued that the muscular enfeeblement will cause the intercostal muscles to be inefficient in raising the ribs so that inspiration will not properly expand the lungs, and this would cause diminished intra-thoracic pressure in inspiration, which would create still greater inequality between the internal and external pressure.

Further there may be other conditions which cause decrease of intra-thoracic pressure during inspiration. These may be:-

I. Naso-pharyngeal Obstruction. In numerous cases of rickets naso-pharyngeal obstruction is present in the form of adenoid growths or enlarged tonsils. J. J. Clarke (Reports of Society for Study of Diseases of Children, 1904/05, Page 16), was impressed by the large number of rachitic children with adenoid growths, as found in post-mortem examinations. He explained this frequency by describing the adenoid growths as a part of a general hyperplasia of lymphoid tissue found in rickets.

II. Catarrhal Affections of the Respiratory Tract. It has been stated that catarrhal affections are especially liable to occur in rickets. The obstruction to the free inspiration of air in catarrhal affections of the respiratory tract can be explained by the diminished lumen of the respiratory

tract due to the inflammatory secretions poured out and to hyperplasia of the mucosa.

(b) Pigeon Chest.

Description. In this type there is also an increase in the antero-posterior diameter; the sternum, especially at the lower end, projects forwards markedly; the costal cartilages assume a more antero-posterior position, the true ribs becoming straightened in front of their angles; a horizontal section of the chest approaches a triangular form, the apex being in front at the sternum, and the base angles at the rib angles behind; associated with the deformity a transverse depression running outwards and slightly downwards on both sides, from the level of the xiphoid cartilage, is frequently found; sometimes the projection forwards is confined to the lower costal cartilages and the sternum lies in a depression between the two chondral projections.

Etiology. The cause of the deformity is a long existing or frequently recurring impediment to the free inspiration of air, while the ribs are yielding (Gee, Auscultation and Percussion, Page 16). Common affections which produce this impediment are:- catarrhal affections of the respiratory tract, such

as bronchitis and whooping cough, diphtheria, naso-pharyngeal obstruction, which is found in chronic enlargement of the tonsils,and adenoids. Rachitic subjects are very liable to this deformity.

Mechanism. When there is an obstruction to the free inspiration of air into the lungs, it follows there is diminished intra-thoracic pressure during inspiration. The upper part of the chest can be expanded and kept expanded much more powerfully than the lower part can be; hence when the diaphragm descends and the thorax, for any reason, cannot hold out against the vacuum which would otherwise be thus created, the lower part of the chest is the first to yield to the atmospheric pressure upon it from without: this comparatively feeble expansion of the lower thorax becomes manifest, when, during inspiration, an insufficient supply of air enters the lungs in consequence of obstruction in the respiratory passages; what air can enter goes to the part of the chest most powerfully kept expanded, so that the feeble lower thorax gets little or none, and succumbs to external pressure (Gee, Auscultation and Percussion, Page 14). Further the upper ribs are more curved than the middle and lower ones, and are therefore more able to withstand external pressure. The lower ribs are kept expanded

during inspiration by the action of the diaphragm on the abdominal viscera. In each infra-mammary region, there is an area, unsupported by muscles; it has, as its centre, the fifth space in the nipple line, being an interval between the insertions of the pectorales, serratus magnus, and the rectus abdominis muscles. Again external force applied to a rib will tend to produce deformity in that part in front of its angle, because of its smaller curvature anterior to the angle.

When there is an obstruction to the free inspiration of air, forced inspiration becomes necessary, calling into play the muscles of extra-ordinary inspiration, namely, the sterno-mastoid, pectorales, serratus magnus, and latissimus dorsi muscles, acting in an opposite direction to their normal one. They cause over expansion of the upper part of the thorax chiefly. In particular, the sterno-mastoids pull the sternum upwards and slightly forwards at its upper end at the same time fixing the upper end, which is owing to its junction with clavicles and first ribs normally more fixed than the lower end. The pectoralis major on each side by contraction of its lower fibres, acting from its fixed humeral attachment, pulls the lower end of the sternum and the fourth, fifth and sixth costal cartilages forwards

and upwards. During obstructed inspiration the intra thoracic pressure is diminished, and this has been shown to be most marked in the lower thoracic area, just above the dome of the diaphragm. Moreover, with the forward protrusion of the sternum especially at its lower end, some alteration in the shape of the ribs is demanded. The result of the altered conditions is that, at the level of the lower end of the sternum external atmospheric pressure forces the ribs to become more straight in front of their angles, so that with the forward protrusion of the sternum, the costal cartilages assume a more antero-posterior position. To recapitulate, the lower end of the sternum is pulled forwards by the pectoralis major muscles, and at the same time atmospheric pressure straightens the corresponding ribs in front of their angles, and still further forces the sternum to protrude.

(c) Kyphosis (Dorsal).

Cause. 1. Angular curvature

2. "Round Shoulders".

1. Angular curvature.

Description. In the upper and mid-dorsal regions spinal caries giving rise to angular curvature, leads to a deformity of the chest of the

pigeon shape. There is flattening from before backwards of the upper part of the chest in front, whilst the sternum sinks downwards and becomes prominent; the chest is compressed from side to side, and there is an increase in the antero-posterior diameter of the chest.

Mechanism. Tubercular osteitis of the vertebral bodies leads to destruction and absorption of the bones affected, so that they collapse under the pressure of the superincumbent weight. This results in the adjacent vertebral bodies falling together. In the thoracic region the normal backward curve of the spine, and the leverage exerted by the weight of the head and arms, when the vertebral bodies collapse, cause a more or less posterior angular curvature to occur. The vertebral bodies above the angular prominence have a marked forward inclination. This forces the sternum downwards and forwards at its more free lower end, so that it tends to become prominent there. The posterior excursion of the vertebrae tends to drag the attached ribs, into a more straight position, that is, to obliterate the curve of the shaft. Above, the ribs are more curved, the resist this tendency, but, below, the shafts are not so curved, and will yield more easily to the dragging force. When the shafts become

straighter, the sternum is pushed forward by the corresponding straightened ribs, and this is more marked at its lower end. Owing to the falling together of the vertebrae the ribs become crowded together, the intercostal spaces, in some cases, being almost obliterated.

2. "Round Shoulders".

This is produced by a posterior curvature of the spine with the convexity backwards, chiefly in the upper dorsal region. This backward convexity tends to cause increase in the antero-posterior diameter of the chest. It may accompany a "flat chest".

Etiology. Conditions which give rise to relaxation or weakness of the ligamentous and muscular systems predispose to this deformity. Improper or insufficient food, whereby the tissues are not properly nourished; defective hygienic surroundings, resulting in deficient oxidation of the blood; diseases which cause deficient oxidation of the blood, such as catarrhal affections of the respiratory tract, cardiac disease, and enlarged tonsils and adenoids, will lead to insufficient nourishment of the tissues, and thereby cause muscular and ligamentous weakness.

Mechanism. In the erect posture, the weight of the head, and of the thoracic and abdominal organs,

is tending to draw the spine forwards, but normally this is resisted successfully by the action of the posterior muscles of the trunk. When, muscular and ligamentous weakness is present, the tendency to the posterior curvature formation is increased, and if the predisposing causes are not removed the deformity becomes more or less permanent.

Asymmetrical Deformities.

1. Unilateral.

(a) Enlargement.

(b) Diminution.

(a) Enlargement. This is usually more prominent at the base, and may be of a temporary or permanent nature. The affected side is more rounded, the ribs are elevated, the costal angle is more obtuse, and the interspaces may bulge compared with the opposite side; the scapula on the affected side may be displaced outwards - its distance from the spine being greater than the corresponding distance on the opposite side.

Cause. Enlargement of one side indicates enlargement of its contents. This may be produced by:-

1. Unilateral Compensatory emphysema.
2. Presence of abnormal contents in the pleural sac.

3. Scoliosis.

1. Unilateral compensatory emphysema.

When one lung does not expand fully in inspiration, the air vesicles of the other lung become overdistended, the lung increasing greatly in size, in fact, becoming emphysematous. Conditions which permanently prevent unilateral inspiratory expansion are chronic interstitial pneumonia, chronic pleurisy with adhesions, and the collapse and retraction following on a long standing empyema which has been operated on late; theoretically it may occur in a case of complete occlusion of a main bronchus, leading to collapse of the lung on that side.

Mechanism. The mechanism is the same as described under "Bilateral Symmetrical deformities - general enlargement". The rounded shape of the affected side being due to the ribs becoming more curved, changes which are explained by the fact that of all figures possessing a periphery of fixed and certain length the circular is that which includes the greater area (Gee, Auscultation and Percussion, Page 21).

2. Presence of Abnormal Contents in the Pleural Sac.

The most frequent abnormal contents in the pleural sac in children are inflammatory effusions -

serous and purulent. When unilateral, pleural effusion may cause enlargement of the side affected, and when the effusion is great, and this is often purulent, the unilateral enlargement may be well marked.

Mechanism. Pleural effusion, as it accumulates gradually compresses the lung, and prevents it from expanding on inspiration; at the same time it exerts a pressure on the thoracic wall, and when the muscles of the intercostal spaces are feeble, as they are in debilitated children, ~~and~~ these spaces bulge; again, after inspiration, the elastic recoil of the lung, which should follow, being diminished or absent, in fact, replaced by the pressure of the effusion, expiration is deficient, and the ribs on that side tend to assume the inspiratory position. This unilateral bulging is, of course, of a temporary nature, lasting until the effusion is removed, by absorption, aspiration, or operation in the case of empyema.

3. A third cause of unilateral enlargement is that found in scoliosis. In this condition one side of the chest may be enlarged and the other diminished.

Definition. Scoliosis is an habitual or fixed deformity in which the spine is deviated in whole

or part to one or other side of the median line (Whitman, Orthopaedic Surgery, Page 149). Marked lateral curvature is necessarily combined with rotation of the vertebral bodies, and it is this rotation which largely determines the associated deformities of the thorax.

Causation of Scoliosis. There are many varieties of predisposing causes, which may be grouped as follows:-

Deformity due to

1. Occupation
2. Congenital Causes.
3. Rickets
4. Disease of the Nervous System affecting the Muscular System
5. Static or Compensatory Changes
6. Intra Thoracic Disease
7. or associated with Nasal and Post Nasal Obstruction.

General Predisposing Causes. These must also be considered, and are such conditions as, anaemia, fatigue, and relative inanition whether respiratory or alimentary, whereby muscular and ligamentous weakness are induced. When these conditions - one or more - are present, and some event occurs to disturb the normal forces acting on the spinal column,

as for example, a faulty attitude, lateral flexion of the spine follows. The muscles of the weaker side yield, and the spine bends with a convexity on that side. This lateral flexion is only possible within small limits, and rotation must occur in larger movements. The weight of the head, shoulders, and upper extremities if the cause persists, will tend to increase the deformity. The normal contour of the spine is the result of static conditions, and a change from this normal relation of one part necessitates a corresponding change elsewhere. This is necessary to restore the balance of the body, so that if there is a primary lateral curvature, for example, to the left in the lumbar region, there is a corresponding curvature to the right in the region above. Sometimes the whole spine is involved in one curve - total scoliosis; there may be more than two curves, but usually there are two curves, one primary, the other compensatory. The condition may be associated with either an exaggeration or a decrease in the normal antero-posterior contour of the spine.

With reference to the predisposing causes enumerated, they will now be discussed in detail:-

1. Occupation. In children this implies school. The children, who adopt postures other than the

erect or symmetrical are those who -

(a) are growing very rapidly, and whose ligaments and muscles have not developed proportionately with the weight and length of the skeleton. This rapid growth implies plasticity of bones and ligaments.

(b) are suffering from relative inanition - alimentary or respiratory - the former being due to deficient or improper food, and the latter to unhygienic surroundings or to naso-pharyngeal obstruction.

In such children muscular fatigue is easily induced, and a faulty posture is adopted habitually. As has been stated this may lead to lateral deviation and rotation of the spine and in this type, the primary curvature is generally to the left in the lumbar region, with a compensatory curve to the right in the dorsal region.

2. Congenital. Several cases have been reported and in some of them the deformity was extreme (Whitman, Orthopaedic Surgery, Page 167).

3. Rickets. The general predisposition to deformity in this disease has been discussed in a previous section. The rachitic kyphosis has been described, and lateral curvature may be associated with this condition or exist primarily. The deformity may be induced in the child by the mode of carrying the child on the flexed forearm of the

mother. The forearm is frequently placed at an angle with the arm, and the child rests on an inclined plane. The primary curve is generally to the left in the dorsi-lumbar region, and this may be explained by the more frequent use of the left forearm for carrying purposes.

In children, who have begun to walk, the tilting of the pelvis due to, for example, unilateral knock knee, may induce lateral curvature.

4. Disease of the Nervous System. After infantile paralysis (anterior polio-myelitis), lateral curvature may be induced. The extreme cases of deformity are caused by unilateral paralysis of the muscles of the trunk, whereby the expansion of the thorax on that side is deficient, and the other side takes on increased development producing a curve with the convexity to the sound side; a similar condition results after the loss of an arm by amputation. Further the disease may induce the deformity by inequality of a lower extremity due to retardation of growth, or by loss of function of an upper extremity, or by general weakness.

5. Static or Compensatory. If there is a shortening of a lower limb, the pelvis is tilted to that side, and a lumbar curve with the convexity

to that side occurs, and a subsequent dorsal curve to the opposite side is added to maintain the general axis of the body.

6. Intra Thoracic Disease. The most frequent causative factor is empyema after ~~latter~~ operation, especially when of long duration before operation. The sequence of events is that the lung is compressed by the fluid, and becomes more or less collapsed, and later its function is further diminished by the adhesions set up binding it down. If the pressure of the fluid is continued for long, the lung fails to expand when the fluid is removed by operation. The ribs become flattened by the external atmospheric pressure forcing them in on account of the diminished intra thoracic pressure in inspiration consequent upon non expansion of the lung, and also by the cicatricial contraction of pleural adhesions. The function of the unaffected lung is increased, but the functionless lung by non expansion leads to muscular disuse and atrophy on its side, so that, as in the paralytic cases, the spine bends laterally with the convexity towards the active side.

Chronic pleurisy with adhesions, by preventing full expansion of the affected side, and chronic interstitial pneumonia also lead to unilateral retraction, and lateral curvature.

7. Associated with nasal and post-nasal obstruction. Tubby (Deformities, Page 155) states that there is a close connection between scoliosis and the above conditions. He states that if a series of cases of adenoids be watched, these facts may be observed. During infancy and early childhood the subject of nasal obstruction shows deformity of the chest alone; in other subjects, and especially between the ages of six and ten years, kyphosis makes its appearance. Later from ten to sixteen years of age, scoliosis supervenes on kyphosis, the abnormal shape of the chest still being apparent. We have, therefore, this order of events:- adenoids, contracted chest, kyphosis, scoliosis. He proves the connection by the result of treatment, and states that the deformities are cured by the removal of the obstruction in the nasal and post nasal spaces. Feeble nutrition and general want of muscular development, owing to the insufficient entrance of air into the thorax, serve to explain the incidence of kyphosis and scoliosis, the onset of the latter being coincident with the period of rapid growth.

Deformity of the Thorax. This is marked in advanced scoliosis. The ordinary antero-posterior diameter is increased or decreased according to an increase or decrease in the normal antero-posterior

contour of the spine. On the convex side, the capacity is markedly decreased, ~~and~~ the tip of the sternum is deflected, and the sternum is rotated and looks to the side of the convexity. On the convex side the antero-posterior and transverse diameters are diminished, and on the concave side the diameters are increased; a horizontal section shows it to be elliptical in shape, the longest axis being from the most prominent part of the ribs behind to the opposite nipple in front, instead of between the mid-axillary lines. The rotation of the bodies of the vertebrae is the chief cause of the deformity, and the sternum is to be considered as more or less of a fixed point. At the apex of the convexity of the curve the ribs are drawn sharply backwards with the transverse processes to which they are attached; their angles project by the side of and beyond the spinous processes, and the lateral roundness of the chest is lost; on the opposite side, owing to the unfolding of the ribs at their angles, the back of the thorax is broadened and flattened. On the convex side, the ribs are raised and their inclination increased, whereas, on the concave side the ribs are often huddled together, the intercostal spaces narrowed, and their inclination lessened.

Unilateral Deformities.

(b) Diminution. This may be caused by:-

1. Collapse of a lung due to complete occlusion of a main bronchus; the lung fails to expand in inspiration, therefore there is increased negative pressure in inspiration between the lung and the inner thoracic wall, so that the external atmospheric pressure causes the ribs to be forced in to overcome this decreased pressure. This cause is an extremely rare one.

2. Shrinking of a lung due to chronic interstitial pneumonia, the same mechanism being at work.

3. Pleural adhesions, which prevent the free expansion of the lung in inspiration, so that if the adhesions are extensive considerable flattening of the chest wall may result, on account of the increased difference between external and internal thoracic pressure during inspiration. Moreover these adhesions by contraction will tend to draw the ribs in.

4. The unilateral diminution found in scoliosis and empyema after operation, which have been described.

Local Changes.

(a) Bulging.

1. When the base of one lung is collapsed, the upper part will

become emphysematous, and this will be most marked at the apex, because the lung is least supported there, and fulness above the clavicle will result.

2. Cardiac disease. In young children, whose ribs are plastic and whose muscles are feeble, local bulging of the precordium may be present, as a result of pericardial effusion, or of dilatation and especially of hypertrophy of the heart, due to chronic endocarditis. In the former case the bulging is temporary in character, and in the latter permanent. The bulging occurs between the third and seventh cartilages on the left side, and extends from the left nipple line to the sternum, or even to the right nipple line.

3. Pleural effusion. When this is of a circumscribed character a localised bulging may occur.

(b) Shrinking.

1. Phthisis. In this disease retraction at the apex is common. Three processes may be at work:-

(a) Occlusion of bronchioles by tubercles, and by inflammatory products, causing collapse of the alveoli.

(b) Overgrowth of the connective tissue that attends the more chronic forms.

(c) Localised pleurisy, which by causing adhesions will restrict expansion or cause compression of the lung.

These three conditions will lead to a diminished amount of inspired air, and thus cause increased difference between the external and internal atmospheric pressure.

2. Empyema after late operation, and old standing pleurisy with adhesions, may lead to local shrinking just as they may lead to unilateral shrinking.

Prophylaxis and Preventive Treatment.

Under prophylaxis the prevention of the diseases and conditions which are likely to give rise to deformities of the chest, is to be considered; and under preventive treatment the careful treatment of these diseases and conditions when present, so as to avoid if possible, the occurrence of deformities.

Naso-pharyngeal Obstruction.

This has been shown to be a frequent cause of deformities of the thorax. A child preserves its habit of nasal respiration for long after the obstruction has reduced the air entry beneath its needs, and mouth breathing, only commences after many of the structural deformities have become initiated, although mouth breathing itself, tends to cessation of the deformity producing stresses, in as much as it allows free air entry.

It is true, further, that adenoid growths and enlarged tonsils tend to atrophy at puberty or shortly afterwards, but permanent deformities of the chest may be established years before that physiological atrophy occurs.

Operative treatment for the removal of naso-pharyngeal obstruction - adenoids and enlarged tonsils - is advisable whenever definite symptoms

referable to the obstruction are present, and the younger the child the greater the reason for removing the growths without delay.

Following upon the removal of the naso-pharyngeal obstruction, attempts must be made to get the lungs fully expanded, and this can be done by systematic exercises, which cause the air to be drawn freely and forcibly in and out through the naso-pharynx.

Catarrhal Affections of the Respiratory Tract.

These must be prevented by suitable measures, bearing in mind the frequency of these affections in infancy and childhood.

Ewart (Clifford Allbutt System of Medicine, Vol.V., p.47), emphasizes the importance of prophylaxis in early bronchial delicacy. He sums up the prophylactic plan in one word - "hardening"; its essentials lie in the management of respiration and atmosphere, of temperature, of clothing, and of the skin. Attention should be directed towards training the child to live and sleep in a pure and fresh atmosphere, avoiding sudden changes of temperature, and overclothing the child, whilst promoting a vigorous habit of the skin, by the daily cold sponge and other measures.

That whooping cough is a preventable disease is not fully realised by the lay mind, and isolation of a case of whooping cough should always be insisted on to prevent its spread.

Measles, with its accompanying catarrh, calls for careful treatment to prevent the spread of the catarrh ending in severe bronchitis or broncho-pneumonia. Moreover, the possibility of the coryza becoming chronic, and causing irritation of the lymphoid tissues of the naso-pharynx, resulting in adenoids or enlarged tonsils, must not be forgotten, and watchfulness during the acute stages and convalescence of the disease is required.

When catarrhal affections of the respiratory tract are present, careful treatment during their course is to be carried out, in order to shorten the duration of the disease, and thus tend to prevent deformities which may be in process of formation, from becoming permanent.

Rickets.

The avoidance of conditions likely to lead to the disease should be enforced, and when the disease is present the proper treatment of it will lessen the tendency to deformity.

Rickets being essentially a diet disease, its prevention will largely depend on the choice of a

proper food for the infant. The health of the mother during pregnancy should be a matter of consideration, and conditions likely to lead to debility in her are to be avoided. The mother should, if possible, suckle the infant, but prolonged suckling and a too rapid change from suckling to a carbohydrate diet, must be discountenanced. If the mother is unable to suckle the infant, artificial feeding, cow's milk, diluted according to the age of the child, should constitute the principal food. If curds appear in the stools, the child is taking too much milk, or in too concentrated a form.

Other preventive measures are abundance of fresh air and sunlight in the dwelling rooms, and so far as is prudent to insist on the child being taken out daily in the fresh air and sunlight, and further the daily cold sponge.

When the disease is present the diet must be corrected, and deformities prevented by keeping the infant as much as possible quiet on its back. Fresh air, sunlight, massage, daily cold sponging are important, and prevention of respiratory complications by seeing that the body heat is maintained by suitable clothing and by avoiding sudden changes of temperature.

Acute Lobar Pneumonia.

The frequency of accompanying pleurisy in this disease which may lead to sero-fibrinous or purulent effusion should be borne in mind. If the fever persists the possibility of this complication must be remembered, and the diagnosis aided if necessary by the use of the exploring needle. A sero-fibrinous effusion should be aspirated, and a purulent opened and drained, in order that the pressure of the fluid on the lung may be relieved, and thus allow the lung to expand freely.

Pleurisy with Effusion.

In children physical signs are deceptive, and the early use of the exploring needle is advised in a doubtful case to settle the diagnosis. If the effusion is serous, it should be aspirated if after a fortnight medical means have failed to produce any absorption. Moreover, if the effusion is large enough to fill the pleural cavity, aspiration should be resorted to. The fact that numerous cases of empyema show marked unilateral retraction after operation, suggests that the operation is frequently delayed too long.

Spinal Caries.

Early diagnosis is called for, and if the condi-

tion is suspected the child should be kept at rest in bed in the recumbent posture to prevent deformity occurring.

Scoliosis.

Prevention must involve the avoidance of all the predisposing or exciting causes of weakness as well as deformity.

The routine examination of the naked bodies of children might often discover commencing deformities or tendency to them when the incipient deformity might be checked. Improper attitude and postures must be corrected, special attention being directed to the seats and desks of school children.

REFERENCES, etc.

References have been mentioned, when quoted, as far as possible. In the addenda there are crytometric tracings reduced from the original by one fourth by the aid of a "Pantograph". The cases reported have been In or Out-patients at the Royal Infirmary, Preston. The photographs have been taken for me by Mr James Busby, of Preston.

REPORT OF CASES.

No.	Name	Age	Sex	Deformity of Chest	Signs of rickets	Adenoids	Enlarged tonsils	Previous respiratory disease.	Previous health	Family history.	Remarks.
1	W.R.	21	M.	"Trichterbrust". Chest flattened antero-posteriorly: deep depression in lower sternal region - secondary kyphosis of corresponding dorsal vertebrae.	Yes	Yes	Yes	None	Always subject to sore throats: otherwise good.	A younger brother exhibits a similar chest deformity.	Mother states that she noticed the depression shortly after birth. Patient is of a dull, stupid nature; thin, attenuated, muscularly; subject of double inguinal hernia: genital organs small and undeveloped: is a weaver, but nothing in occupation to cause deformity. Height 5 ft.3 ins. weight 7 stone 10 lbs.
2	T.W.	3½	M.	"Funnel-shaped". Depression marked in lower sternal region extending up to 3rd rib level.	No	Yes		None	Has never walked.	Only child. nothing of importance	Child is an imbecile; the depression has been present since birth.
3	E.A.	5	M.	"Barrel-shaped". The sternum is arched forwards from above downwards: the supraclavicular spaces are filled out: shoulders round: the ribs are placed horizontally: subcostal angle is very wide.	No	Yes	Yes	Since he was 6 months old has had several attacks of bronchitis generally with laryngitis.	Pertussis when six months old, probably with broncho-pneumonia.	Tubercular on Mother's side. Two other children, subject to bronchitis and Broncho pneumonia	The patient was admitted to Infirmary with capillary bronchitis of a severe type. The causative factor of the emphysematous chest probably whooping cough, and recurring attacks of bronchitis.
4	W.C.	5	M.	"Barrel-shaped". This case in shape of chest much like the previous one.	No	Yes	Yes	Since 2 years old has had recurring attacks of bronchial asthma.	Measles when 2 years old. Never had whooping cough	Tubercular father died of phthisis: 4 other children subject to bronchitis	The patient admitted to Infirmary for operative treatment of cervical adenitis (tubercular). The emphysematous chest probably due to the recurring attacks of asthma, due to presence of adenoids.
5	A.C.	11	F.	"Barrel-shaped". The contour of the chest much similar to the two previous cases.	No	No	No	Has had recurring attacks of bronchitis since 7 years old when she had measles.	Pertussis when 5 years old.	Nothing of importance	The subject of chronic bronchitis; the child is a congenital syphilitic one, and was admitted to Infirmary with gummatous ulceration of the legs.
6	W.P.	13	M.	"Flat chest". Marked flattening from before backwards; ribs placed obliquely: small subcostal angle: costal cartilages straightened: "round shoulders": slight scoliosis to left in lower dorsal region.	No	Yes	Yes	Had broncho-pneumonia when 7 years old, after Measles	"Inflammation of Brain" when 5 years old. Measles when 7 years	Tendency to adenoids & enlarged tonsils. 2 brothers operated on for them No tubercular taint	Patient admitted to Infirmary for removal of adenoids and enlarged tonsils, and chorea, from which he was convalescent.

No.	Name	Age	Sex	Deformity of Chest	Signs of rickets	Adenoids	Enlarged tonsils	Previous respiratory disease.	Previous health.	Family history.	Remarks.
7	P.F.	12	M.	"Flat Chest". The chest is flattened in front, costal cartilages straightened, ribs placed obliquely, subcostal angle small. Scapular vertebral borders prominent. The shoulders are "round".	No	No	No	Negative	Has never been a strong boy. Measles when 3 years old. Good recovery.	Mother died of Phthisis	A thin, emaciated boy, admitted to Infirmary on account of acute osteomyelitis of right tibia.
8	C.F.	13	F.	"Flat Chest". The usual characteristics of the type present.	No	No	No	A severe attack of bronchopneumonia when 7 years old, after measles.	Never been robust.	Nothing of importance	A case of early Phthisis: signs of consolidation at left apex.
9	M.F.	12	F.	"Flat Chest". In addition to signs of flat chest, marked "Harrison's groove" present.	Yes	Yes	Yes	Negative	Nothing of note	Bad. Only child living out of 8 born all of whom died in infancy of "wasting"	Admitted to Infirmary with cervical adenitis right posterior triangle: old scars on left side of neck, which resulted from "abscesses" 3 years ago.
10	A.W.	11	M.	"Flat Chest". The chest is flat and the sternum slightly depressed: below level of costal cartilages especially at its lower end.	No	No	Yes	Negative	Good	Good.	Admitted for haemorrhoids: before operation had an attack of follicular tonsillitis: the retraction of the lower end of the sternum probably due to naso-pharyngeal obstruction.
11	J.D.	6	F.	"Flat chest". Chest flat; slight retraction lower end of sternum.	No	Yes	No	Bronchopneumonia after Measles when 3 years old.	Never been well since she had measles.	Good.	Admitted to Infirmary with signs of tubercular peritonitis: consolidation at left apex of lung: leucorrhoea.
12	W.M.	2	M.	"Rachitic". Rosary marked: lateral vertical groove: transverse lateral groove: marked inspiratory retraction along last named line.	Well marked	Yes	No	Bronchitis when 6 months old: always had a cough since.	Healthy till 6 months old. Brought up on Cow's milk.	Only child parents both under 20 years of age.	Admitted for phimosis, with double inguinal hernia; signs of bronchitis in chest: deficient oxidation signs well marked: child's fingers clubbed: cold livid extremities.
13	W.W.	2	M.	"Rachitic". Rosary marked: lateral, vertical and transverse grooves: well marked: chest narrow in front.	Well marked	No	No	Bronchitis 3 months ago.	Has been "ailing" since 11 months old: Brought up on Nestle's milk.	2 other children healthy	Admitted on account of bronchitis, and peevishness probably due to "irritation" from phimosis.

No.	Name	Age	Sex	Deformity of Chest	Signs of rickets	Adenoids	Enlarged tonsils	Previous respiratory disease.	Previous health.	Family history.	Remarks.
14	G.G.	17/12	M.	"Rachitic". Narrow front: rosary: lateral transverse groove.	Well marked	Yes	No	Negative	Never been well since 5 months old.	Only child.	Admitted with infective diarrhoea, due to improper feeding: double inguinal hernia: phimosis: acute bronchitis: Brought up on cow's milk.
15	A.R.	4	M.	"Rachitis". Narrow front: marked forward projection of sternum and costal cartilages: xiphoid projects backwards making angle with lower end of sternum: rosary: lateral vertical and transverse grooves.	Well marked	Yes	No	Has had cough since he had measles 11 months previously.	Pertussis when 2½ years old	Tubercular (father) 3 children died in infancy from broncho-pneumonia.	Admitted with signs of general tuberculosis: broncho-pneumonia both lungs throughout: otitis media double: dactylitis tubercular right foot and left index finger: developed squint, and died 3 days after admission after repeated convulsions. Brought up on cow's milk.
16	M.L.	17/12	F.	"Rachitic". Narrow front: rosary: lacteral transverse groove: marked inspiratory retraction along that line.	Well marked	Yes	No	Bronchitis when 6 months old.	Pertussis when 1 week old, which lasted 3 months. Never been well since.	Mother has Phthisis. 2 other children healthy.	Admitted with furunculosis: taenia solium: phlectenular conjunctivitis: after she was discharged, developed tubercular meningitis. Breast fed till 6 months old: thereafter cow's milk, and patent food.
17	M.S.	19/12	F.	"Rachitic". Signs as in previous case.	Well marked	No	No	Negative	Subject to diarrhoea.	Nothing of note	Admitted on account of diarrhoea, and prolapse of rectum: filthy home: child allowed to eat whatever the family is eating: brought up on cow's milk.
18	C.N.	4	M.	"Rachitic". narrow front: marked projection of sternum at lower end: marked transverse lateral groove: rosary.	Well marked	Yes	Yes	Negative	Good.	Nothing of note	Admitted for radical cure right inguinal hernia, and removal of enlarged tonsils and adenoids: brought up on cow's milk since 2 months old.
19	T.F.	3	F.	"Rachitic". rosary: lateral groove transverse: narrow front.	Well marked	Yes	No	Broncho-pneumonia 11 months ago.	Never been strong since birth: subject to diarrhoea.	Nothing of note	Admitted for rectification of double genu valgum: child brought up on patent food.
20	S.L.	5	M.	"Rachitic". narrow front: well marked lateral, vertical and transverse grooves: rosary.	Yes	Yes	Yes	No history available.			Born in workhouse: boarded out: brought up on patent food. Admitted with capillary bronchitis.

No.	Name	Age	Sex	Deformity of Chest	Signs of rickets	Adenoids	Enlarged tonsils	Previous respiratory disease.	Previous health.	Family history.	Remarks.
21	J.M.	14	M.	"Pigeon". Projection forwards of lower end of sternum with costal cartilages: marked inframammary flattening: retraction of xiphoid cartilage.	No	No	Yes	Since infancy numerous attacks of bronchitis: when 2 had pneumonia and again when 5 years old.	Pertussis when 5 years old	Tubercular taint on father's side	Right morbus coxae: repeated attacks of bronchitis, and the presence of naso-pharyngeal obstruction the cause of the pigeon chest.
22	F.J.	12	F.	"Pigeon". Projection forwards of lower end of sternum with costal cartilages. Inframammary flattening.	Slight	Yes	Yes	Negative	Always deaf	Good.	Admitted on account of deafness, and snoring at night: tonsils and adenoids removed. Causation of deformity of chest, naso-pharyngeal obstruction.
23	J.W.B.	10	M.	"Pigeon". Projection of costal cartilages at lower end of sternum: sternum lies depressed between the projections: Harrison's groove marked: marked retraction of xiphoid cartilage.	No	Yes	Yes	Negative	When 3 months old had "consumption of bowels". Not well till 3 years old. No pertussis Morbilli when 5 years old: ill a week.	6 Children born. 2 died in infancy of "wasting" Uncle died of Phthisis.	Admitted with cervical adenitis tubercular, and signs of tubercular peritonitis: marked adenoid facies.
24	M.P.	13	F.	"Pigeon". Signs as in previous case.	No	Yes	Yes	Negative	Pertussis when 3 years old. Measles 5 years old. Subject to "sore throats" and "colds in head."	10 Born. 4 died in infancy with "Inflammation of the lungs".	Admitted for appendicectomy: marked adenoid facies.
25	E.D.	14	F.	"Pigeon". Signs as in previous 2 cases.	No	Yes	Yes	Negative	Had otitis media after scarlet fever when 9 years old. Always deaf since.	Good. Another child has enlarged tonsils.	Admitted for removal of tonsils and adenoids.
26	S.O.	6	M.	"Pigeon". Projection of lower end of sternum with costal cartilages: marked Harrison's groove.	No	Yes	Yes	Recurring attacks of bronchitis every winter	Has not had Pertussis.	Good.	Admitted for removal of tonsils and adenoids, and for circumcision.

No.	Name	Age	Sex	Deformity of Chest	Signs of rickets	Aden-oids	En-larged tonsils	Previous respiratory disease.	Previous health.	Family history.	Remarks.
27	H.O.	$1\frac{8}{12}$	M.	"Pigeon". Projection of costal cartilages at lower end of sternum: sternum depressed there.	No	Yes	Yes	Negative	Good	Good	Brother to previous case: admitted for circumcision: right inguinal hernia.
28	G.J.	$3\frac{1}{2}$	M.	"Pigeon". Signs as in previous case: marked Harrison's groove.	No	Yes	Yes	Negative	Always subject to "colds in head" since measles when 5 months old	Nothing of note except tendency to adenoids.	Admitted for removal of adenoids and tonsils.
29	M.J.	5	F.	"Pigeon". Signs as in previous case: marked retraction of xiphoid cartilage.	No	Yes	Yes	Negative	Frequent "sore throats"		Admitted for removal of tonsils and adenoids on account of persistent sore throats and deafness. Sister to previous case.
30	L.C.	12	F.	"Pigeon". Signs as in previous case: marked Harrison's groove.	No	Yes	Yes	Broncho-pneumonia after measles 3 years old.	Fair	Nothing of note	A thin, emaciated child, admitted for removal of large sebaceous cyst of neck.
31	H.L.	3	M.	"Pigeon". Marked projection of lower end of sternum: rosary, lateral, vertical and transverse grooves.	Yes	Yes	No	Frequent attacks of bronchitis	Been "ailing" since 10 months old.	2 Children died in infancy with pneumonia.	Admitted for rectification of double genu varum. Brought up on cow's milk and patent food.
32	E.F.	$\frac{10}{12}$	F.	"Pigeon". Marked infra-mammary flattening: lower end of sternum projects forwards: the process of formation well seen during inspiration.	No	No	No	Apparently had had severe cough since 5 months old, probably due to broncho pneumonia.		Mother died in work-house from rheumatic fever.	Admitted with broncho-pneumonia which was of an old standing character: cough very troublesome.
33	J.N.	$\frac{14}{12}$	M.	"Pigeon." The deformity is in formation: in inspiration there is marked retraction along the line of diaphragm attachment, with pushing forwards of the lower end of the sternum. Marked costo-chondral enlargement.	No	Yes	No	Had broncho-pneumonia 3 months ago, from which he is just convalescent	Healthy up to 3 months ago. Not had pertussis.	2 children healthy.	A terribly emaciated child with pressure sores: Signs of healing broncho-pneumonia on admission. Brought up on cow's milk.
34	N.S.	7	M.	"Pigeon". Projection of costal cartilages at level of lower end of sternum: sternum depressed between the projections: infra-mammary flattening.	Yes	Yes	Yes	Negative	Measles when 4: been subject to "colds in head" since.	Nothing of note	Admitted on account of deafness and persistent nasal discharge: adenoids and tonsils removed.

No.	Name	Age	Sex	Deformity of Chest	Signs of rickets	Adenoids	Enlarged tonsils	Previous respiratory disease.	Previous health.	Family history.	Remarks
35	A.M.	5	M.	"Pigeon". Projection of lower end of sternum, with infra-mammary flattening.	No	Yes	Yes	Negative	Pertussis 12 months ago. Measles when 2 years old: good recovery.	3 other children one of which suffers from deafness	Admitted for removal of tonsils and adenoids, on account of deafness and dulness.
36	E.S.	9	F.	"Pigeon". Projection of costal cartilages at level of lower end of sternum: sternum depressed there.	No	Yes	Yes	Bronchitis with measles when 5 years old.	Often has "sore throat" Not had Pertussis.	only child.	Admitted for removal of tonsils and adenoids.
37	E.B.	11	F.	"Pigeon". There is infra-mammary flattening which makes the lower end of sternum look prominent.	No	Yes	Yes	Negative	Pertussis when 7. Good recovery		Admitted for removal of tonsils and adenoids, on account of dulness, and frequent sore throats.
38	J.N.	4	F.	"Pigeon". Marked projection of lower end of sternum. Harrison's groove: rosary.	Yes	Yes	No	Bronchitis with pertussis when 2 years old, was ill for 6 months.	Had never been a strong child. Mother says the patient has had a cough since birth.	Parents very stupid and dirty.	Admitted for rectification of double genu valgum; the child was brought up on patent food, and was allowed to eat potatoes when 8 months old!
39	G.F.	11	M.	"Pigeon". projection of costal cartilages at level of lower end of sternum. marked Harrison's groove: sternum depressed retracted xiphoid.	No	Yes	Yes	Negative	Had chorea 12 months ago.	Large family. Drunken father	Admitted with chorea: marked adenoid facies.
40	H.T.	11	M.	"Pigeon". There is marked retraction and flattening in infra-mammary region: "shoulders round", upper parts of chest emphysematous.	No	No	No	Measles when 4 years old, since then he has always had a cough. At that time had pneumonia, was ill for 12 months	Has not had asthma, nor Pertussis	Good	A case of chronic bronchitis, the upper part of the chest is emphysematous, shoulders rounded and high, supra-clavicular spaces filled out. Physical signs are those of chronic bronchitis, with emphysematous changes. When an infant was suckled till 18 months old.
41	W.S.	12	M.	"Pigeon". The lower end of the sternum projects forwards. There is angular curvature 4th dorsal vertebra: the chest is flattened and sunken above in front. Marked transverse hollowing at level of xiphoid cartilage.	No	No	No	Negative	Nothing of note	Good	There is a right scoliosis extending from the 4th dorsal vertebra to the lumbar region with compensatory curves above and below. The case was operated on, on account of abscess formation (spinal caries).

No.	Name	Age	Sex	Deformity of Chest	Signs of rickets	Aden-oids	En-larged tonsils	Previous respiratory disease.	Previous health.	Family history.	Remarks.
42	T.S.	10	M.	"Pigeon". Angular deformity of spine at 5th dorsal vertebra: sternum projects markedly at its lower end: marked straightening of ribs in front of their angles: xiphoid cartilage is bent backwards at an angle with the sternum.	No	Yes	No	Pneumonia with pertussis when 4 years old.	The onset of the spinal caries dates from the attack of pertussis.	Tubercular on mother's side	A case of extreme deformity, admitted on account of fresh abscess formation. (spinal caries).
43	A.G.	11	F.	"Unilateral Enlargement". The left side of chest is fuller, intercostal spaces filled out, ribs more horizontally placed.	No	Yes	No	Bad broncho-pneumonia twice in infancy	Pertussis when 5, good recovery.	Tubercular a sister the subject of Phthisis.	Left Pleurisy with effusion: been ill 3 weeks on admission: physical signs: deficient movement: absolute dulness all left side back and front: absence of vocal fremitus and resonance: cardiac dulness extends 1½" ~~below costal~~ beyond right border of sternum margin: chest aspirated 2 pints clear fluid withdrawn. (liver dulness ½" below costal margin)
44	J.A.	2	M.	"Unilateral enlargement". Right side of chest looks fuller, intercostal spaces are filled out: ribs placed more horizontally and distance between vertebral border of scapula and spine greater than on left side.	No	Yes	Yes	Mother says he always has a cough which she thought was due to his throat.	Never been strong, never had pertussis or measles. Mother states that his nose is always running.	3 children, eldest has had broncho-pneumonia twice. Mother has suffered from bronchitis since 20 years old Aunt died of Phthisis.	Right empyema. 3 weeks previous to admission became feverish, & began to cough. On admission physical signs were - Increased vocal fremitus and resonance right base: dulness there, extending up to spine of scapula: breathing of a distant tubular character. Exploring needle discovered presence of pus: 8th rib resected. The case illustrates uncertainty of physical signs in children.
45	L.T.	12	F.	"Unilateral diminution": marked retraction left side of chest, most marked in front: there is scoliosis (right): general curve: right scapula higher than left, and its vertebral border prominent. Right side of chest appears abnormally full and round.	No	No	No	Negative	Usual children's complaints Apparently good recovery	Father died of Phthisis	6 Weeks previous to admission had shivering, pain left side, cough. On admission signs: diminished movement, absolute dulness, loss of vocal fremitus, " "distant" resonance, very ~~distinct~~ tubular breathing: (left side). with displacement of heart to right and evidences of pushing down of the liver: exploratory aspiration discovered pus: resection performed: large quantity of pus evacuated. The retraction resulted after operation.

No.	Name	Age	Sex	Deformity of Chest	Signs of rickets	Adenoids	Enlarged tonsils	Previous respiratory disease.	Previous health.	Family history.	Remarks
46	G.W.	13	F.	"Unilateral Diminution". Lateral curvature right in mid dorsal region, with opposite curve to left in lumbar region: the angles of right ribs project backwards prominently: right scapula raised & its vertebral border prominent: flattening and huddling together of left lower ribs behind; sternum rotated slightly and looks towards right: diminution right side of chest.	Well marked	No	Yes	Negative	Healthy till 9 months old when she had rickets. Measles 11 months old. Never had pertussis.	10 children born. Six died in infancy from "wasting". Mother has chronic bronchitis	Habitual posture scoliosis. Mother states that the girl has never been strong, and always is easily fatigued. She thinks she has always "walked on one side", but has been worse lately.
47	B.S.	13	F.	"Unilateral Diminution" Signs as in previous case only marked lordosis is present, diminution in right side of chest.	No	Yes	Yes	Had broncho-pneumonia when 5 years old.	Good.	14 in family, patient youngest. Nothing of note otherwise.	Has grown very rapidly within last 2 years, during which time mother states she has noticed that she has been in the habit of "standing with weight on left leg", and since she went to work, 6 months ago, as a weaver, has been much worse.
48	M.B.	14	F.	"Unilateral Diminution". There is marked diminution right side of chest. Some slight right dorsal scoliosis, with lumbar scoliosis to left. There is considerable kyphosis in the upper dorsal region.	No	Yes	Yes	Negative	Has suffered from frequent sore throats and deafness since 8 years old, when she had scarlatina.	Nothing of note	Admitted for removal of tonsils and adenoids; there is not much displacement of the spines of the vertebrae laterally, but rotation must be considerable. No intra-thoracic disease is present. The association of enlarged tonsils and adenoids with the scoliosis is probably intimate.
49	M.W.	19	F.	"Unilateral diminution". Right side of chest markedly smaller than left: marked right dorsal scoliosis, with compensatory curves above and below.	No	Yes	No	Negative	Good	15 children born. 11 living. good history.	When 7 years old child grew rapidly and mother noticed her right shoulder blade becoming prominent. When 11 left school, and was nurse-maid, carrying babies: the deformity became much worse, and now is extreme.

No.	Name	Age	Sex	Deformity of Chest	Signs of rickets	Adenoids	Enlarged tonsils	Previous respiratory disease.	Previous health.	Family history.	Remarks
50	A.L.	8	F.	"Precordial Bulging". There is bulging in the precordium: the bulging extends from the 4th to the 7th ribs.	Yes	No	No	Negative	Rheumatic fever 3 years ago.	Mother died from rheumatic fever	"Mitral Regurgitation" with hypertrophy and dilatation of the left ventricle, apex beat diffuse, reaching 1" outside nipple line in 6th interspace: marked precordial pulsation, and epigastric pulsation. Loud blowing systolic murmur at apex, conducted into axilla, and round to the back. Liver much enlarged, reaches to level of umbilicus.

Addenda.

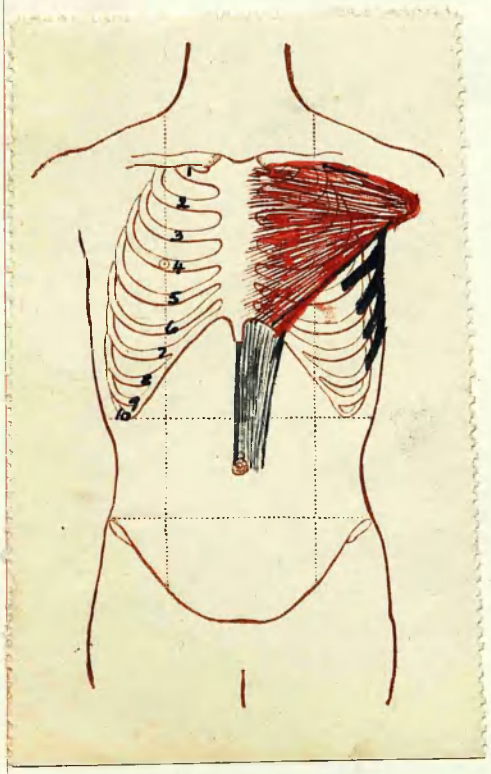
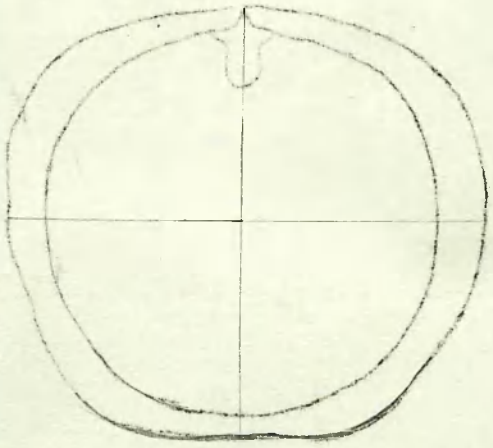


Diagram to illustrate the infra-mammary space unsupported by muscles.

Pectoralis major — red

Rectus Abdominis — fine blue shading.

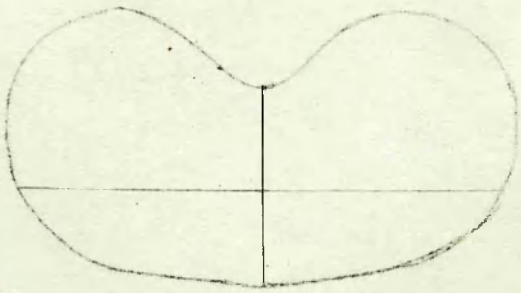
Serratus magnus — thick blue shading.



Transverse section of chest of an infant aged 9 months. (a circle drawn within the tracing for the sake of comparison.)

(Gee)

Case 1.



Transverse section at level of xiphoid cartilage.

antero-posterior diam: 4½"

transverse diam: 10½"

Case 2.

Transverse section at level of xiphoid cartilage.

antero-posterior diam: 4"

transverse diam: 8"

Case 3

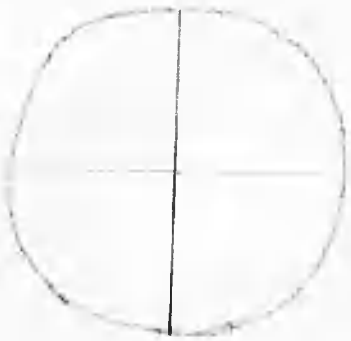
Transverse section at level of nipple line.

antero-posterior diam: 6½"

transverse diam: 7"

Circumference. 22"

Case 4



Transverse section at level of nipple line.

antero-posterior diam: 7¼"

transverse diam: 7¼"

Circumference 22½"

Case 5

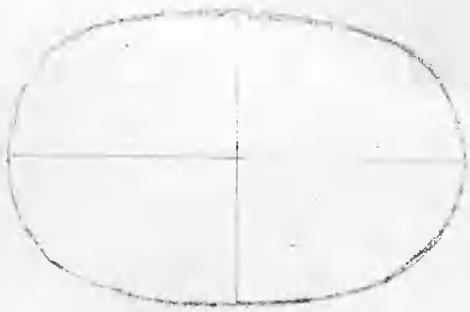
Transverse section at level of nipple line.

antero-posterior diam: 6½"

transverse diam: 7½"

Circumference. 24"

Case 6



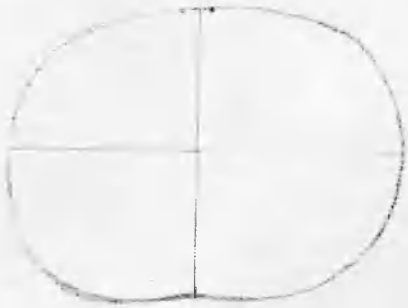
Transverse section at level of nipple line.

antero-posterior diam: 6"

transverse diam: 10"

Circumference. 24½"

Case 7



Transverse section of chest at level of nipple line.

antero-posterior diam: 6"

transverse diam: 9"

Circumference 24"

Case 8

Transverse section nipple level.

antero-posterior diam: 6"

transverse diam: 10"

Circumference. 26"

Case 9

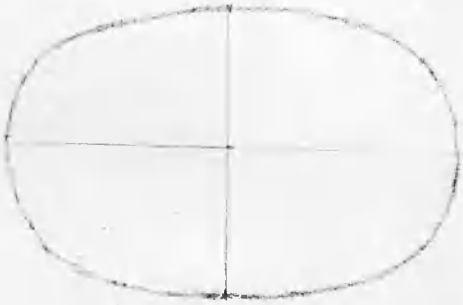
Transverse section nipple level.

antero-posterior diam: $6\frac{1}{4}$"

transverse diam: $9\frac{3}{4}$"

Circumference. $25\frac{1}{2}$"

Case 10



Transverse section at nipple level.

antero-posterior diam: $5\frac{3}{4}$"

transverse diam: $9\frac{1}{2}$"

Circumference. 26"

Case 11

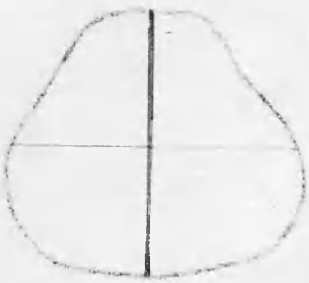
Transverse section nipple level.

antero-posterior diam: $4\frac{3}{4}$"

transverse diam: $8\frac{3}{4}$"

Circumference. 19"

Case 12



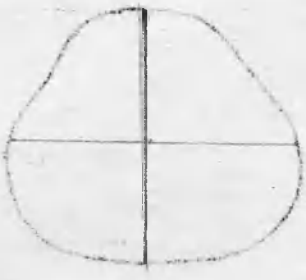
Transverse section nipple level

antero-posterior diam: 4"

transverse diam: 4"

Circumference. $17\frac{3}{4}$"

Case 13



Transverse section nipple level.

antero-posterior diam: 4"

transverse diam: $3\frac{7}{8}$"

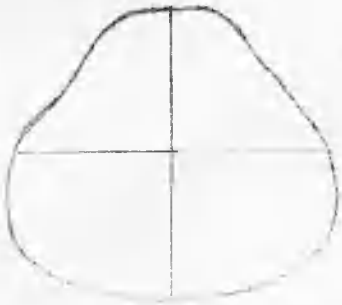
circumference. $17\frac{1}{2}$"

Transverse sections at nipple level.

Case 14

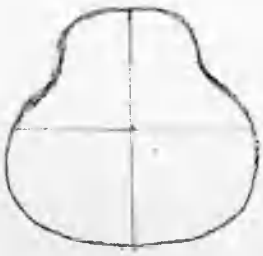
antero-posterior diam: 4 3/4"
transverse diam: 4 1/2"
circumference. 16"

Case 15



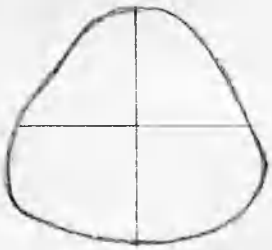
antero-posterior diam: 6"
transverse diam: 7 1/2"
circumference. 21"

Case 16



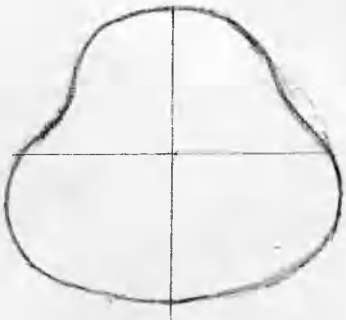
antero-posterior diam: 4 3/4"
transverse diam: 4 3/4"
circumference. 17 1/4"

Case 17



antero-posterior diam: 4 1/2"
transverse diam: 4 1/2"
circumference. 17"

Case 18

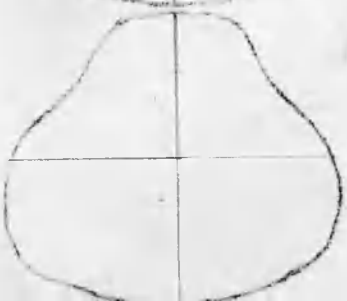


antero-posterior diam: 6 1/2"
transverse diam: 7"
circumference. 21 1/2"

Case 19

antero-posterior diam: 4 3/4"
transverse diam: 6 1/2"
circumference. 18"

Case 20



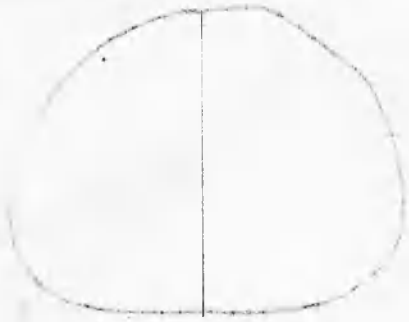
antero-posterior diam: 6 1/2"
transverse diam: 7 1/4"
circumference. 20 1/2"

Transverse sections at level of lower end of sternum.

Case 21

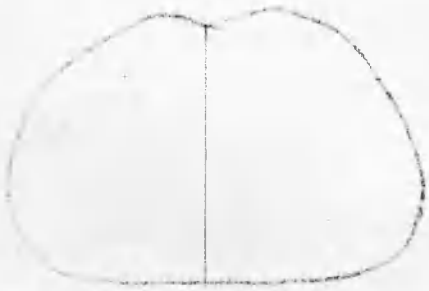
ant: post: diam: 6½"
transverse diam: 8¾"
Circumference. 26"

Case 22



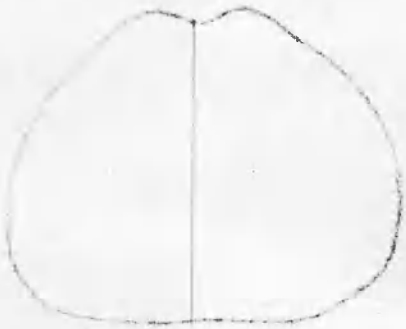
ant: post: diam: 6½"
transverse diam: 8¼"
circumference. 24"

Case 23



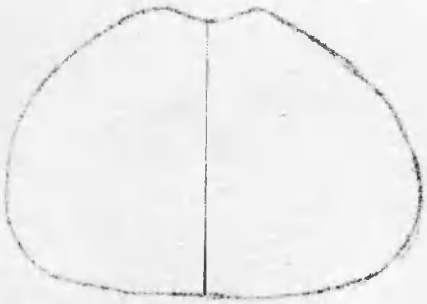
antero-post: diam: 6"
transverse diam: 8½"
circumference. 25"

Case 24



ant: post: diam: 6¾"
transverse diam: 8"
circumference 25"

Case 25



ant: post: diam: 6"
transverse diam: 9"
circumference. 25"

Case 26

ant: post: diam: 6"
transverse diam: 7¾"
circumference. 22"

Transverse sections at level of lower end of pleromus

Case 27

aut: post: diam: 4 3/4"
transverse diam: 6"
circumference. 17"

Case 28

antero-post: diam: 5"
transverse diam. 7"
circumference. 20"

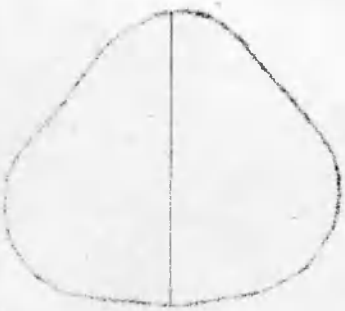
Case 29

antero-post: diam: 6"
transverse diam: 7 3/4"
circumference. 21"

Case 30

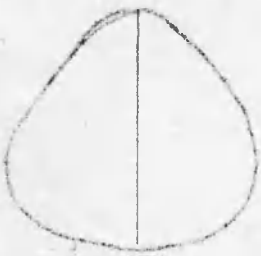
antero-post: diam: 5 1/2"
transverse diam: 7 1/2"
circumference. 22"

Case 31



aut: post: diam: 6"
transverse diam: 7"
circumference 21"

Case 32



antero-post: diam: 4 1/2"
transverse diam: 5 1/2
circumference. 17 1/2"

Case 33

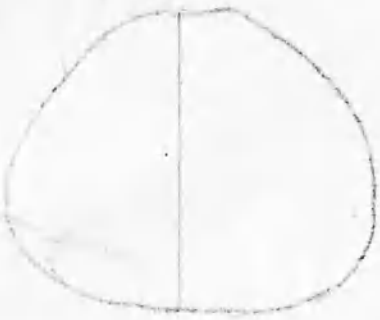
aut: post: diam: 4 1/2"
transverse diam: 5 3/4"
circumference. 18"

Transverse sections at level of lower end of sternum.

Case 34

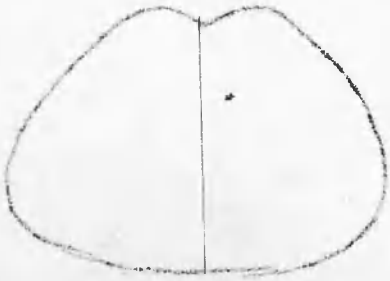
ant: post: diam: 6½"
transverse diam: 7¾
circumference. 22"

Case 35



ant: post: diam: 6"
transverse diam: 7¾"
circumference. 22"

Case 36

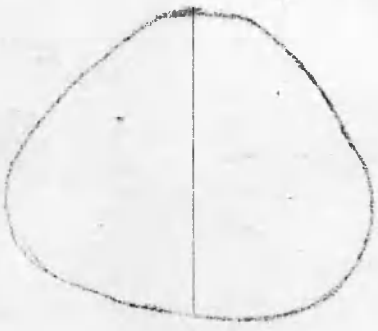


ant: post: diam: 5"
transverse diam: 7½"
circumference 22"

Case 37

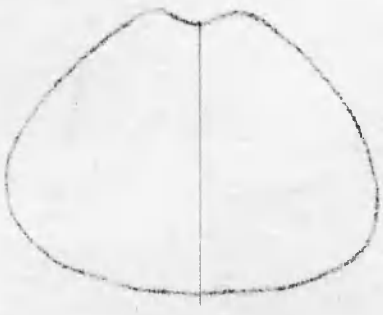
anter: post: diam: 6"
transverse diam: 8¼"
circumference. 24"

Case 38



anters-poster: diam: 6"
transverse diam: 7"
circumference. 20½"

Case 39



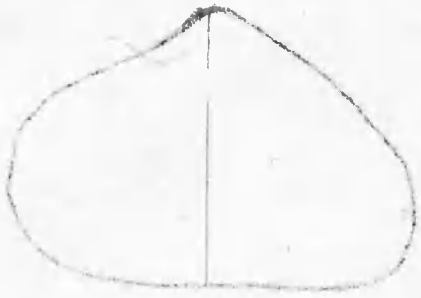
anters-poster: diam: 6½
transverse diam: 8"
circumference. 24½"

Case 40

Transverse section, level, lower end of sternum.

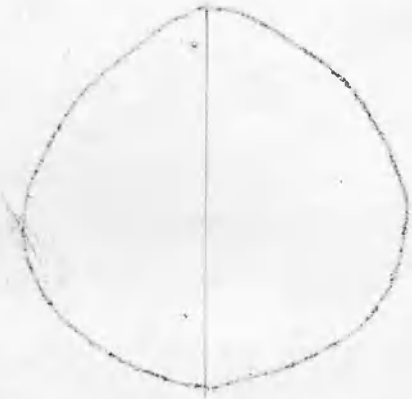
ant: post: diam:	6¼"
transverse diam:	9"
circumference	25½"

Case 41



ant: post: diam:	5¾"
transverse diam:	8"
circumference.	23"

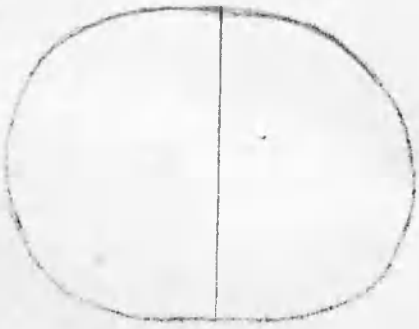
Case 42



transverse section, nipple line.

ant: post: diam:	8"
transverse diam:	9"
circumference	27"

Case 43



transverse section, lower end of sternum, level.

circumference.

right side	12"
left side	13"

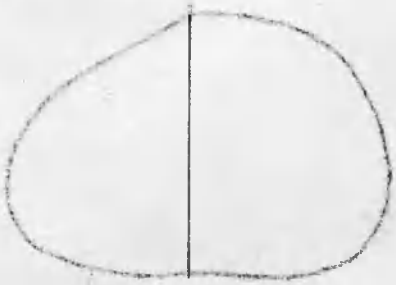
Case 44

transverse section, lower end of sternum level.

circumference.

right side	8¾"
left side.	8"

Case 45



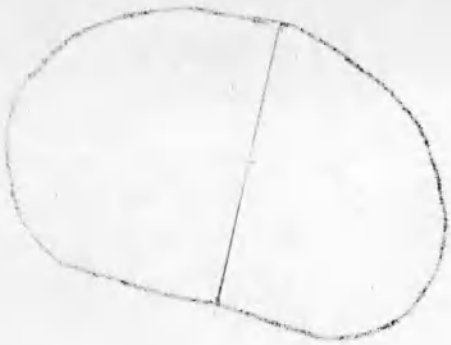
transverse section, level of nipple line.

circumference.

right side	11¾"
left side.	10¾"

Transverse sections at level of nipple line.

Case 46



circumference.

right side 12½"

left side. 14"

Case 47

circumference.

right side 11½"

left side. 13"

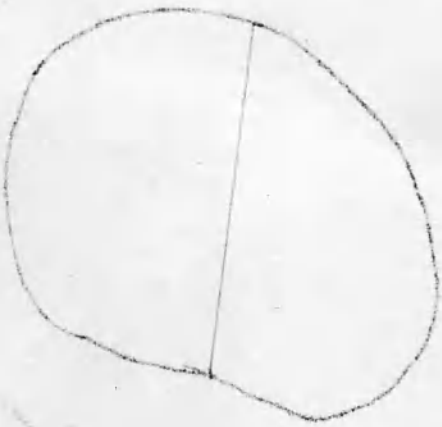
Case 48

circumference.

right side 11"

left side. 12½

Case 49

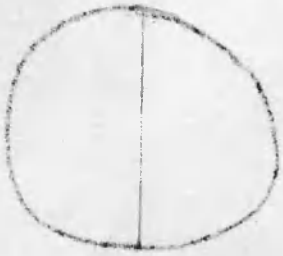


circumference.

right side 13½"

left side. 15"

Case 50



circumference.

right side 11"

left side. 11½

Case 2.

Funnel shaped chest.

Case 1.

Funnel shaped chest.

Case 7.

Flat Chest
" Round Shoulders "

Case 19.

Rachitic.

Case 13.

Rachitic.

Case 21.

Pigeon chest.
marked infra-mammary
flattening.

Case 23.

Tubercular cervical adenitis.

Adenoids.

Pigeon chest;
depressed lower end of sternum.

Case 33.

Pigeon chest in formation.
Marked Harrison's groove

Case 36.

Adenoids.

Pigeon chest.

Case 38.

Pigeon chest.
Rachitic.

Case 39.

Adenoids.
Pigeon chest.
depressed lower end of
sternum.

Case 41

Front view.

Pigeon chest.

marked Harrison's groove.

Case 41.

Back view.

Angular curvature

4th Dorsal vertebra.

Case 42

Front view.

Marked Pigeon chest.

Case 42.

Back view

Angular curvature

5th Dorsal vertebra.

Case 47.

Scoliosis to left, lower lumbar region; to right mid dorsal region.

Marked lordosis.

Case 43.

" Unilateral enlargement.

Left pleural effusion.

Flat chest

" Round shoulders"

Case 45.

Marked retraction left side of chest, after resection for long standing empyema.