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ON

TUMOURS OF THE CEREBRUM.

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BY

H. S. SOUTTAR, C.B.E., M.Ch., F.R.C.S.,
SURGEON (WITH CARE OF OUT-PATIENTS), LONDON HOSPITAL.

THE SYMPTOMS OF TUMOURS OF THE CEREBRUM.

THE symptoms of cerebral tumours are so varied in form and so complex in origin that it is difficult to present a view of them which can be compressed into a short space of time. Their effect upon function is as subtle as is the function of the structure in which they grow, but our knowledge of cerebral structure has now advanced so far that we can at least lay down certain principles which may guide us in detecting the existence of an intracranial tumour, and in forming some idea as to its situation, and which may sometimes enable us to define its position with extreme accuracy.

General Symptoms.

From time immemorial it has been customary to describe three phenomena—headache, vomiting, and optic neuritis—as the classical symptoms of cerebral tumour. Undoubtedly these phenomena will appear in the great majority of cases if we wait long enough, but they are no more the primary symptoms of cerebral tumour than is acute intestinal obstruction the primary symptom of carcinoma of the colon. They are the symptoms of increased intracranial pressure due, not to the size of the tumour itself, but to a very definite series of events of which the tumour is the cause. The key to these events is to be found in the circulation of the cerebro-spinal fluid.

We now have convincing experimental evidence that the cerebro-spinal fluid is secreted by the choroid plexuses into the ventricular system of the brain. Most of it is produced in the lateral ventricles, from which it pours through the third ventricle, through the narrow aqueduct of Sylvius into the fourth ventricle, and out by the foramina of Luschka and Magendie into the subarachnoid space. It is absorbed into the venous sinuses, apparently by way of the Pacchionian bodies. Anything which obstructs this flow gives rise at once to an internal hydrocephalus and to a high degree of intracranial tension. I have recently had a case under my charge which illustrates this. A woman of 20 was referred to me by Dr. Riddoch with all the evidences of an internal hydrocephalus of long standing but becoming acute. Bilateral decompression failed to give relief, and she died. On examination we found a gross internal hydrocephalus due to the obstruction of the aqueduct by a minute nodule growing downwards from the posterior commissure and blocking its entrance. In dogs a millet seed experimentally placed in the same situation produces on identical effect.

Now any cerebral tumour if left to itself may ultimately produce the same result. If it lies below the tentorium it may produce it at a very early stage by distortion of the pons and mid-brain or by simple pressure. This rise of general intracranial pressure has a curious effect. It drives the cerebellum down into the foramen magnum and down the spinal canal, where it may reach even the third cervical lamina. A "cerebellar cone" is thus formed, beneath which the medulla is compressed as by a wedge, the cardiac and respiratory centres are seriously embarrassed, and the obstruction to the outflow of the cerebro-spinal fluid is further increased. But a tumour lying above the tentorium may in time produce an identical result, though only when it has grown to a very large size. By its gradual encroachment upon the intracranial space it may slowly force the cerebellum down into the spinal canal, and by obstructing the outlets for the cerebro-spinal fluid it may induce a secondary hydrocephalus. If it has developed in a frontal lobe or in some other region of comparative silence, it is quite possible that the first

striking symptoms may be those of secondary hydrocephalus, arising in this way, and the diagnosis of a subtentorial tumour may then be almost irresistible.

The classical symptoms of cerebral tumour are, therefore, those of the late stage, really indicating cerebral obstruction, and it ought to be our aim to diagnose and treat the case before they arise. As this is, however, not always possible it will be well to consider their special characters. The headache is persistent, but with periods of increased severity. It is often worse on waking in the morning, and it is always increased by anything which increases the intracranial pressure, such as exertion or excitement. Vomiting may also take place on rising in the morning, and it has the peculiar character of occurring as a sudden violent act, without cause or warning, which has earned for it the title of "projectile." The fundi may show severe swelling of the discs before the patient is conscious of any visual defect, though a careful examination will usually show some narrowing of the fields for colour or for small white objects. Transient attacks of blindness may occur, but persistent deterioration of vision suggests the onset of atrophy, when complete recovery is impossible.

Among other general symptoms are a certain loss of initiative, mental lassitude and drowsiness, attacks of giddiness, slowing of the pulse, and possibly generalized epileptiform convulsions. A transient diplopia, occurring as it may at a very early stage, should be regarded as a symptom of the very first importance. These are all symptoms of high intracranial tension, and as such they may appear apart from cerebral tumours in such conditions as renal disease, severe anaemia, or lead poisoning. The latter are, however, readily excluded.

Regional Symptoms.

It is, however, to the local effects produced by a cerebral tumour that we must direct our attention if we are to diagnose its presence at an early stage and if we are to discover its precise situation. These local effects are not usually the results of destruction of brain tissue, for this only occurs in metastatic carcinoma and sarcoma; nor are they the direct result of pressure upon the nerve cells. They are the result of the interference with the circulation in that particular region of the brain which the growth of the tumour produces, and as such they may appear in two contrasting forms. At first a moderate degree of pressure interferes only with the veins and congestion of the region results, and, as has long been recognized, congestion reveals itself as irritation of which it is the pathological basis. Later a higher degree of pressure will interfere with the arteries, and the resulting anaemia finds its clinical expression in paralysis. As the effect gradually spreads we are likely to have a zone of congestion surrounding a centre of anaemia, and a clinical picture of an advancing irritation leaving paralysis in its wake. Moreover, round any tumour an acute oedema may suddenly arise, with a wide extension of its regional effects and a dangerous increase in the general intracranial pressure.

THE MOTOR AREA.

The most important part of the cerebral cortex from the surgical standpoint is that which lies immediately in front of the fissure of Rolando—the precentral or ascending frontal convolution. This great fissure, placed almost at the middle of the lateral surface of the hemisphere, might well be described as the watershed of the brain. Behind it the cortex is receptive, in front executive. Behind it lie the post-central convolution for the reception of cutaneous and body sensations, the occipital lobe for the reception of vision, the temporal lobe where sound enters, and the parietal lobe where all these sensations are analysed and gathered together into concrete impressions. In front of the fissure of Rolando lie the precentral convolution, where resides the whole final motor control, the post-frontal area, where memories of combined movements and skilled acts are stored, and the frontal lobe itself, where conduct and initiative reside and which appears to hold the key of all our powers of executive action.

The function of the precentral area appears to be to hold the muscles in just such a state of tone that they may be ready for instant action, and so to transmit demands for

such action that the muscles will respond in a co-ordinate manner. It contains a series of centres which essentially represent simple co-ordinate movements, such as flexion and extension, and these centres are arranged according to a definite plan. At the extreme upper end come the centres for the leg, those for the toes and ankle being actually on the mesial aspect of the hemisphere. The knee and hip are followed by the trunk, and below this come the shoulder, elbow, wrist, fingers, and thumb, in this order. The eyelids, mouth, tongue, and larynx follow; whilst, just in front of the hand area is a special centre devoted to the conjugate movements of eyes and head in rotating to the opposite side. It is usual to describe the fissure as having two genua separating the arm area from the leg area above and the face area below, but a more accurate statement would be that the precentral convolution presents three backward expansions, formed by the development of centres controlling the leg, arm, and face.

The first effect of a tumour pressing upon this region is the production of irritation of those centres around which it produces the most congestion. Periodically this irritation may give rise to a discharge of nervous energy, starting at these centres and spreading to the surrounding cortex. Such a discharge is the basis of an attack of Jacksonian epilepsy, of which it is characteristic that it always starts in the same locality and spreads to other parts of the body in a definite order corresponding precisely to the cortical plan. The fits may be preceded by twitching or tingling in this locality, and they commence with a stage of tonic spasm succeeded by a series of clonic jerks as the cortex becomes exhausted. This exhaustion is further shown in the fact that after a fit there is always very definite weakness in the limb or part of the body in which it started.

As an example of the mode of spread we may cite a case where the fits always started with twitching of the left thumb. After a few moments the tonic stage came on, a tonic spasm spreading successively to the fingers, wrist, and arm, and simultaneously to the left side of the face and tongue, whilst at the same time the head and eyes were forcibly turned to the left. Only occasionally did the fits spread to the leg, and they then became general with loss of consciousness.

If, however, a tumour lies deeply beneath the cortex it may produce a paralysis without any of the signs of irritation. Such a paralysis is essentially a paralysis of movement and not of muscles, and it gives rise to postures of a definite type. Thus the arm will tend to take up a position of adduction, with flexed elbow, pronated forearm, and flexed wrist and fingers. The leg, in striking contrast, tends to be strongly extended at the hip, knee, and ankle, with adduction at the hip. In most cases the deep reflexes will be exaggerated and there will be an increase of tone in the muscles which may amount to rigidity.

A tumour pressing on this region may present other features of great interest. Thus, if it is at the upper end of the motor area it may so compress the opposite hemisphere as to produce a paralysis of both legs. If it is low down on the left side it may involve the area of Broca which lies just in front of the foot of the precentral convolution, and the patient may suffer from motor aphasia and lose the power of speech. Again, if it involves the face area, only the lower portion of the opposite side of the face will be paralysed, since the muscles of the forehead and eyelids, usually working together, are activated by impulses from both sides of the brain. An even more remarkable phenomenon is that in a cortical paralysis of the face, though voluntary movement is impossible, emotional movements, controlled by the thalamus, are not

affected, and one may see a patient unable to move his face at will doing so in a perfectly normal manner in laughing at his own efforts. The importance of these phenomena in diagnosing between a lesion of the brain and of the facial nerve is obvious.

Behind the fissure of Rolando lies the post-central convolution, where are grouped centres for sensory reception roughly corresponding in arrangement with the motor centres we have just described. Injury to this area may produce in the corresponding region of the body a loss of postural sense, of localization, of touch, or of the perception of the degrees of heat and cold, and it is of diagnostic import that this loss is irregular in distribution and in the extent to which each element of sensation is affected. Irritation produces a sensation of tingling in the corresponding area, and as these sensory centres are in such close proximity to the motor centres, it follows that a tumour is likely to involve both and that tingling in a limb may be the definite precursor of a Jacksonian convulsion. The following case illustrates certain of these points:

A woman, aged 47, was referred to me by Dr. Riddoch with the history that for four years she had been liable to attacks of cramp in the left leg, occurring as a rule once a month. In an attack twitching behind the left knee was followed by slow forcible flexion at that joint and by plantar flexion of the ankle and toes. This was followed by a dozen violent twitches in the leg, lasting, perhaps, two minutes. The attacks were very painful and were followed by numbness, starting in the left knee, spreading up the leg, and sometimes involving the whole of the left half of the body. The numbness persisted for about an hour.

She was a healthy-looking woman with slight weakness of all movements in the left lower limb, increase of the deep reflexes, and an up-going toe.

The upper part of the right motor cortex was exposed and a large rounded tumour was seen springing from the upper part of the dura in this region. The tumour was enucleated and removed with as much of the dura at its base as possible.

FIG. 1.—Localization in the motor area.

I have said that the centres in the precentral area represent simple movements and that their action is the production of that muscular co-ordination which these movements require. In front of this area is another, the intermediate precentral area, where these simple movements are compounded into the complex actions required in the execution of skilled acts. Here resides the memory of those subconscious actions, which by long practice we have learnt to accomplish with unconscious skill. These are most highly developed on the left side, and here at its lowest point lies Broca's area, where are stored the movement memories required for speech, whilst a little higher are those required for writing. The pressure of a tumour on the left hemisphere may destroy both of these and the patient will be unable to speak or write, although he may be perfectly aware of the words he wishes to use, and may even be able to find them in a dictionary. But apart from injury to the special centres a tumour on either side may induce a subjective feeling of clumsiness, and a mechanic, for example, may find it impossible to carry out manipulations which for years he has executed with ease, although there may be no objective weakness in the arm at all.

Still further forwards we reach the frontal lobe itself, where apparently reside the centres for that more complex combination of actions which we call conduct. A tumour in this region may show its first signs in some alteration in the effect of environment upon action, often in a childish exuberance or an undue sense of well-being and of personal aggrandisement, such as is commonly seen in general paralysis of the insane from atrophy of the cortex in this region. More rarely the result may be fits of unreasoning passion, or an invincible and unreasoning depression. A fine tremor in the ipsilateral hand and a loss of

the superficial reflexes on the opposite side of the body may occur as early localizing signs. Certain of these points are brought out very clearly in the history of a case recently under my charge.

The patient was a man, aged 53, whose wife told us that for some months he had been peculiar and a little irresponsible. Ten weeks before I saw him he had spoken of some clumsiness in the right arm, and he appeared to have difficulty in finding the right words for expression. When he wanted a fork he asked for a biscuit, and he seemed more amused than worried at his mistakes. These symptoms became more marked, when suddenly, after about a month, he lost all power of speech, his right arm became rigid, and his face was drawn to the right. He recovered, but a second attack occurred a few days before I saw him. He was then desperately ill, unable to speak at all or to move his tongue. His right arm was held absolutely rigid, the shoulder adducted, the elbow flexed to a right angle, the forearm pronated. The right side of the face was paralysed, but he could move both legs freely. A diagnosis was made of a deep gliomatous cyst in the lower part of the left frontal lobe. The diagnosis was exactly verified at operation, when 40 c.cm. of fluid was withdrawn from the cyst.

The early history suggested a tumour of a frontal lobe, the attacks placed it on the left side, the rigidity without convulsions suggested that it lay deeply, the involvement of the speech and arm areas, and not that of the leg, placed it low down, and, finally, the sudden onset of acute symptoms, and still more the recovery from one attack, rendered a cystic glioma the most likely diagnosis. It is of interest that two days after decompression and aspiration he talked with freedom and had full control of his right arm.

This case illustrates a point of great moment in the diagnosis of cerebral tumours—the importance of the evolution of the case. It is only by a close study of the gradual development of symptoms, rather than by an elaborate investigation at any one time, that we can hope to arrive at an exact diagnosis. The gradual advance of the tumour may be accompanied by the development of a train of symptoms, sometimes quite transient, which may establish the diagnosis beyond all doubt, though at any one time the symptom complex may be very difficult to unravel. In no case is this more true than in those tumours which, perhaps starting in the more silent regions of the brain, come into contact with the motor paths.

THE VISUAL TRACTS.

The tumours of which I have so far spoken have as their chief characteristic some interference with motion. Another group, not perhaps so common but even more fascinating as problems for diagnosis, interferes with vision. Visual impressions starting in the retina pass through the whole length of the brain to the occipital lobe behind. The fibres of the optic nerves decussate in the optic chiasma in such a way that the visual impressions from the visual fields on each side of a median plane are transmitted entirely to the opposite side. Through the optic tracts impulses from the contralateral fields are carried back to the external geniculate body and the pulvinar of the thalamus. From the former run tracts connecting it with the mid-brain and with the centres which control the movements of the eyes. From the latter spread out the optic radiations, looping round the descending horn of the lateral ventricle to reach their destination in the cortex of the occipital lobe. It is to this final portion of the optic path that I would for a moment direct your attention.

The optic radiations are so arranged that the upper fibres receive impulses from the upper portions of the retinae, the lower from the lower. This order they maintain right up to the point when they terminate in the cortex above and below the calcarine fissure on the mesial aspect of the occipital lobe. In relation to tumours of the occipital lobe itself this distinction is not of importance, for as a rule the whole visual area is involved, with result-

ing disturbances of vision in the contralateral visual field. These disturbances may be of two kinds—irritative or paralytic. The former are more likely to be produced by cortical tumours, and appear as flashes of light, often coloured and suggesting fireworks. Probably the fortification lines of migraine are due to vascular disturbance in this region. Deep tumours, on the other hand, produce a gradual contraction of the visual field on the opposite side, best shown by testing with small objects, white or coloured. The superficial tumours again tend to spread forwards over the cortex and to involve the lower sensorimotor areas, producing numbness in the opposite face or hand. The deep tumours tend to involve the posterior part of the internal capsule, producing sensory changes in the opposite half of the body and paresis in the opposite leg.

But to the optic radiations themselves we owe a syndrome as beautiful as any in cerebral pathology, and in the hands of Cushing they have supplied the key to what was one of the most obscure regions of the brain. These radiations as they leave the optic thalamus wind forwards, outwards, and finally backwards round the descending horn of the lateral ventricle, occupying as they do so the posterior part of the temporal lobe. Their arrangement in upper and lower groups connected with the upper and lower portions of the retinae has already been noted. A tumour, then, in the

lower part of the right temporal lobe will involve those fibres which carry impulses from the opposite upper visual field, and the left upper quadrant will be blind, and we have the condition known as a left upper quadrantic homonymous hemianopia. The discovery of these quadrantic hemianopias has revolutionized localization in the temporal lobes.

It is typical of quadrantic hemianopias that the visual defect is incomplete, and it is owing to this fact that they have so long escaped attention. They can only be discovered by the most accurate and painstaking perimetry, and only at an early stage of the develop-

ment of the tumour. A rough perimetry will miss them entirely, and in a late stage they will be merged in a complete hemianopia, but if found they are almost conclusive evidence of a tumour in the temporal lobe.

But the temporal lobe yields another symptom as bizarre as any in cerebral symptomatology. When a tumour involves the uncus the patient is liable to peculiar attacks lasting for a few seconds and perhaps recurring many times in the day. In these he is overpowered by a dreamy sensation, the world seems remote, and voices sound far away. In this state he may have curious hallucinations of smell, taste, hearing, or vision. The first two are perhaps the most common, and though sometimes pleasant are usually so repulsive as to produce an expression of disgust on the face. Those of vision are very curious and form definite pictures, such as a row of black cats or a little figure, in contrast to the visual disturbances seen in tumours of the occipital lobe. These pictures are the same on every occasion, and they are always in the blind portion of the visual field. The combination of a quadrantic hemianopia with uncinate attacks thus forms a very complete and exact syndrome, distinguishing sharply when it occurs tumours of the temporal lobe.

THE POSSIBILITY OF SURGICAL RELIEF.

We see, then, that those tumours of the cerebrum which are accessible to surgery give rise in many instances to symptoms characteristic of their locality, though when the case is actually seen these are only too often masked by those of general intracranial pressure. It will be worth while to consider for a moment which of these tumours may be amenable to surgical treatment.

FIG. 2.—The course of the visual tracts.

The commonest tumour of the cerebrum is a glioma and its removal is impossible. The relief which may be obtained by decompression is, however, sometimes very considerable, and of this the following case furnishes an example.

A woman, aged 38, was sent to me with a history of severe frontal headaches extending over six years. A year before I saw her she suddenly fell down unconscious and had a series of violent convulsive attacks starting in the left arm. From this she recovered completely. It had for some time been noticed that she was somewhat unstable mentally, acting with excitable levity. She occasionally had a tremor in the right arm and leg, and vision was failing.

She was an excitable woman in abnormally high spirits. She had severe papilloedema, most marked on the right, but no changes in motion, sensation, or reflexes were discovered. A deep glioma of the right frontal region was diagnosed, and a large decompression in this region was performed, the brain being under very high pressure. She recovered completely, her headaches disappeared, and she regained her normal health and vision; even the fundi became normal. For eighteen months she remained in excellent health, though a left hemiparesis and an enormous hernia very gradually developed. She then quite rapidly became comatose and died.

Although a glioma cannot be removed it may degenerate in the centre and become cystic, and in such a case it is sometimes possible by aspiration of the cyst to give considerable relief to the patient. If the cyst is at all superficial and can be treated with formalin the relief may extend over a considerable period; in some of these cases the introduction of radium has given good results. In such cases a decompression not only relieves the pressure but enables the cyst to be aspirated with facility. The following is an example:

A man, aged 44, was referred to me by Dr. Riddoch with the story that six months previously he had had a sudden attack of giddiness, followed by pains in the back of the neck and difficulty in speaking, which lasted for a few minutes. Since then he had had a few similar attacks, and six weeks before I saw him, after one of these, the right arm began to shake and the right side of the face to twitch. When this had passed off the arm remained weak and the difficulty in speech persisted. He was an intelligent man with marked apraxia and aphasia. There was slight weakness of the right side of the face and tongue, and spastic paresis of the right arm and leg with increase in the deep reflexes. He rapidly became worse, complete right hemiplegia developed, he was unable to move his tongue, and had increasing difficulty in swallowing. He became very drowsy and the respirations stertorous. Left temporal decompression was performed and a large cyst discovered lying deeply in the left frontal lobe, from which 44 c.cm. of turbid fluid was withdrawn. He made a remarkable recovery. His speech commenced to return in four days and he regained full power in his limbs.

The only removable tumours which are at all common in the region of the cerebral hemispheres are the endo-theliomata. These arise from the inner surface of the dura, probably from the lacunae of the anterior longitudinal sinus. Sometimes they are firm, rounded, fibrous tumours, often, however, with central degeneration; sometimes they are soft and diffuent. They may have a pedicle or they may be sessile on the inner surface of the dura. The bone over them is very vascular, and they have a curious power of stimulating its growth, so that external bony tumours may appear on the skull. They may, indeed, invade the bone, with which they thus become indissolubly connected, but in no circumstances do they invade the brain; they press into its substance, and their removal may at first leave a large cavity, but in a few moments the brain returns to its normal position and the cavity is entirely obliterated.

Theoretically these tumours should be completely removable and should never recur, but it is not always possible to obtain this result. In the soft type the tumour may break up so far that there can be no certainty of its complete removal, and in the sessile variety its connexions with the superior longitudinal sinus may be so complete that only a resection of the sinus, with the grave risks which that involves, could ensure total ablation. One case of the latter condition has already been mentioned, and of the former the following is an example:

In October, 1921, I operated upon a woman, aged 25, who for eighteen months had suffered from morning headaches of increasing severity, and latterly accompanied by vomiting. She had had attacks of tingling and numbness in the fingers of the left hand, spreading to the shoulders and to the left side of the tongue, and loss of sense of position in the fingers of the left hand.

The right Rolandic area was exposed by an osteoplastic flap, and a large, soft, purplish tumour was found arising from the inner surface of the dura over the middle of the right Rolandic area.

On opening the dura a mass of diffuent material about the size of a tennis ball oozed out, the cavity in the brain being almost instantly obliterated. The dura was removed as widely as was practicable and the osteoplastic flap was closed. She made an uninterrupted and complete recovery.

In April, 1924, after three and a half years of perfect health, she suddenly had a succession of violent fits, starting with tingling in the left fingers, but becoming general, and accompanied by loss of consciousness. The papilloedema, which had entirely disappeared, was found to have returned. Exploration showed masses of soft growth protruding through the old trephine holes in the bone, which was itself widely invaded by soft vascular growth. The bone was widely resected and the growth removed as completely as was possible, although it extended up to the middle line. She again recovered completely, and so far has remained in perfect health. It is possible that the use of x rays over the large opening left in the skull may enable us to prevent further recurrence.

It will thus be seen that although only in a very limited number of cases can we expect to effect a complete cure by surgical interference, there are many in which we can give considerable relief. The most important factors in success are early diagnosis and precise localization; both should be effected before general symptoms have developed and before an increased intracranial pressure has added to the difficulties and dangers of an operation. There is no field of surgery in which so much depends upon the close co-operation of the physician and the surgeon, upon the enterprise of the former and the restraint of the latter.

An Address

ON

MASSIVE PULMONARY COLLAPSE.*

BY

A. BERTRAM SOLTAU, C.M.G., C.B.E., M.D.,
M.R.C.P., F.R.C.S., K.H.P.,

PHYSICIAN, SOUTH DEVON AND EAST CORNWALL HOSPITAL, PLYMOUTH.

It might be supposed that the subject of pulmonary collapse is largely of academic interest, but the clinical manifestations are of great importance, both to the physician and to the surgeon, and a prompt recognition of the physical signs and the symptoms, and where possible their prevention or their rectification, is therefore of great value.

PHYSIOLOGICAL INTRODUCTION.

Before proceeding to discuss the causation of pulmonary collapse a brief recapitulation of the essential anatomical and physiological facts of respiration may be helpful. It is customary to regard the lung as a single organ, expanding as a whole, and to disregard a possible significance of its division into lobes. Keith¹ has, however, shown that the great fissure is of fundamental importance, in that it separates the lung into areas, the method of expansion of which is distinct, the upper lobe being expanded by the mechanism of the upper ribs, and the lower lobe by a compound mechanism formed by the diaphragm and lower ribs. Further, the extensibility of the lung is not uniform in degree, but varies with the three anatomical zones into which it is divided. These are (a) *the root*, practically non-extensible; (b) *the intermediate zone*, containing vascular and bronchial ramifications with some extensible tissue between; and (c) *the outer zone*, consisting entirely of expansile tissue. Expansion takes place by the moving apart of the rays of the inextensible structures, and the filling out of the intermediate and outer expansile areas, a mechanism which Keith has likened to the opening of a Japanese fan.

It is impossible here to enter into any detail of the muscular mechanism brought into play in respiration, and a somewhat dogmatic outline must suffice.

The upper part of the thoracic cavity is conical in shape, the lid being formed by the first ribs and the manubrium sterni. This lid is held immobile by the scaleni, and acts as the fixed point from which the upward movement of the ribs originates. In the main the expansion of the upper lobe is brought about by the lifting of the five upper ribs, with an increase in the antero-posterior thoracic diameter, owing to the axis of rotation of these ribs being set almost at right angles to a vertical section. Each successive rib

* Delivered before the Plymouth Medical Society.