claimed to have been derived from suprarenal in this type of case.⁵ It is here, I think, where adrenalin in frequently repeated doses might be of value. Certain forms of mental disease, mostly of the maniacal type, have been found to be associated with an abnormally low blood pressure, and in some cases that have been reported by W. R. Dawson, Easterbrook, and others, in which suprarenal extract was tried, distinct improvement has taken place coincident with a rise in the blood pressure. W. R. Dawson also observed in some of his cases that the effect on the blood pressure is of the nature of a levelling up of the evening pressure to that of the morning, as in Cases I, II, and III above mentioned.⁶ All of the cases to which I administered suprarenal preparations were suffering from some form of mental disease. Case I was of a subacute maniacal type characterized by much noisy excitement and extreme variations in the emotional state. During the period when her blood pressure was raised she was certainly less excitable and more stable in every way. In Case II, which was of a more chronic type, the rise in blood pressure was accompanied by a decided attack of depression; this, however, may have been due to the *malaise* and gastric disturbance caused by the drug, for it disappeared with it. The remaining cases were quite uninfluenced mentally.

Among conditions not directly connected with the vascular system in which suprarenal preparations have been recommended is epilepsy, but some consider it distinctly harmful.⁷ In Case III of those mentioned, that of an epileptic imbecile, the fits increased in frequency and severity during the administration of the drug, culminating in status five days after its withdrawal; it is, of course, impossible to say what influence the suprarenal exerted in this case.

The results obtained in the treatment of Addison's disease are naturally of most interest. Although many cases have been reported in which recovery and improvement has followed on suprarenal treatment, the results, on the whole, have not been anything like so satisfactory as those obtained in the treatment of myxoedema by thyroid extract. It must, however, be remembered that in many cases the treatment is not commenced until so late in the disease that it is almost hopeless to expect any benefit; this was so in the only case I have had the opportunity of so treating, a case in which *post mortem* the medulla of both suprarenals was found entirely replaced by dense fibrous tissue.

Before concluding, I would refer to one other condition, namely, Graves's disease, in which the internal administration of suprarenal extract has been recommended, and at least one case has been reported in which recovery has followed. This is a disease in which some benefit might be expected from this drug, for the most prominent feature present is a general want of tone of the circulatory system, a relaxation of the arteries, rapidity of the pulse and a tendency to cardiac dilatation, all conditions which suprarenal tends to correct and in which digitalis has been found of value. A somewhat interesting relationship exists between a constant condition found *post mortem* in Graves's disease and in animals in which experimental extirpation of the suprarenal capsules has been performed, namely, hypertrophy of the thymus.⁸ The exact significance of this is unknown, but the thymus is considered by some authorities to provide an internal secretion which is antagonistic in action to that of the suprarenal bodies; Schäfer and Oliver, however, doubt this, having been unable to obtain any definite results from experiments with thymus extract that would point to this body having any specific function. Whether this relation between the suprarenals and thymus can be regarded as a basis for treatment, or not, I think it worth while to give suprarenal preparations an extended trial in exophthalmic goitre.

In this paper I have not touched on the local applications of suprarenal preparations, so much has appeared of late in the various medical papers on the subject and it suffices to say that in ophthalmic, nasal, and obstetric work, they form a useful addition to our means for the control of hæmorrhage and of other conditions dependent on vascular turgescence.

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THE FUNCTIONS OF THE EPIGLOTTIS.

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SOME ten years ago Professor Kanthack said, "The exact function of the epiglottis is not even yet fully understood," and these words might be repeated with probably equal truth to-day. The uncertain nature of our knowledge of the subject is well shown by the diverse opinions expressed in the leading textbooks of physiology. Roughly speaking, these opinions may be divided into two classes, of which the first support the old theory that the main function of the epiglottis is to close down upon the glottis during deglutition, and so prevent food, etc., from entering the larynx; the other class deny this, but do not give any explanation of the movements of the epiglottis, or assign any function to it.

The old theory of the epiglottis acting as a lid to the glottis is well described by Sir Michael Foster in his *Textbook of Physiology*.¹ When speaking of the second stage of deglutition, after explaining the movements of the soft palate and its dependents, he says:

The epiglottis is depressed over the larynx, the cushion at the base of the epiglottis, covering the rima glottidis..... Thus, both the entrance into the posterior nares and that into the larynx being closed, the impulse given to the bolus by the tongue can have no other effect than to propel it beneath the sloping soft palate over the incline formed by the root of the tongue and the epiglottis.

The idea is, apparently, that the epiglottis closes down tightly on the glottis, so that the anterior surface looks more or less upwards and backwards; the posterior part of the tongue is at the same time elevated, and thus the surface, ordinarily almost in contact with the anterior surface of the epiglottis, comes to form a continuous sloping plane with it, which descends from the dorsum of the tongue to the oesophagus.

Against this theory, various points have been urged by many authors, amongst which we may notice the following:

1. The muscles attached to the epiglottis, consisting of a few fibres of the aryteno-epiglottideus and part of the thyro-arytenoideus externus, are very weak, and do not seem capable of bending the cartilage transversely, as it would be necessary for them to do in order to depress it over the larynx. Their function seems to be to draw back the two lateral margins of the epiglottis, and to make the ary-epiglottidean folds tense.

2. Persons in whom the epiglottis has been removed or has disappeared owing to destructive ulceration have little or no difficulty in swallowing solids, and only slight trouble with liquids, thus proving that the ingesta may be prevented from entering the larynx in the absence of the epiglottis.

3. The epiglottis is frequently irregular in shape and so folded upon itself that it could only with great difficulty be bent far backwards, and would then form a most inefficient lid to the larynx.

4. A case of corrosive acid poisoning has been described² in which the only part of the epiglottis found to be eroded was the "laryngeal surface of the petiolus," a position which should have been completely protected by a depressed epiglottis.

This theory was, however, universally accepted as the true account of the method by which the larynx was closed, until in 1892, Professor Anderson Stuart³ gave a much more satisfactory explanation. He maintained that the epiglottis did not fold down in a lid-like way, but that the occlusion of the lower air passages during deglutition depended entirely on the movement of the arytenoids, which were approximated and moved forwards, thus coming into contact with each other and with the base of the epiglottis. The closing of the laryngeal entrance was at the same time assisted by the upward and forward movement of the entire larynx.

This theory certainly fits in with many known facts of anatomy and physiology, the exact significance of which had been somewhat of a mystery before. The epiglottis not being depressed over the larynx, its occasional absence or irregu-

larity will not interfere with the act of deglutition. The erosion of its laryngeal surface in corrosive poisoning could be explained by the acid being carried forward upon the arytenoid cartilages. It appears to me, however, that Professor Anderson Stuart's theory is incomplete since it suggests no movements, active or passive, for the epiglottis, which undoubtedly does not remain stationary throughout the process of deglutition.

Professor Kanthack⁴ a year later vigorously attacked this theory, maintaining that in many of the animals which Professor Stuart had used, if allowed to swallow in a natural position, the epiglottis was depressed and acted as a laryngeal lid. He demonstrated that in many species the epiglottis was so long that its upper part lay posterior to the soft palate in the naso-pharynx, and that it was practically impossible for food to pass from the mouth to the oesophagus unless the cartilage was folded down. There is no doubt that the epiglottis in most of the mammals is proportionately a very much larger structure than in man. It should be remembered, however, that most animals in swallowing, assume a position in which the food, etc., has to be forced upwards along the oesophagus, and that the opening of the air passages lies immediately beneath that of the gullet; it is obvious, therefore, that a much stronger protection of the glottis is required than in the human being who swallows in the erect position with the larynx well protected by the overhanging base of the tongue. Indeed, the assumption of the erect position has caused so many modifications of the upper air passages that arguments derived from conditions obtaining in these parts in the animal world, however interesting, can have but slight weight when used to support theories of their functions in human species. In fact, the only satisfactory method of determining the exact movements of these parts in man seems to me to be that of actual observation by means of the laryngoscope, etc., coupled with a consideration of the anatomical structure of the parts and the modifications in function that result from disease.

The observation of the process of swallowing by means of the laryngoscope is difficult, as the tongue is forcibly thrust successively against the hard palate, soft palate, and posterior pharyngeal wall. The view is, therefore, interrupted first between the observer and the mirror, if held in the usual position (against the uvula near the posterior wall of the pharynx), and later below the mirror, as the tongue is drawn by the hyoglossi muscles tightly against the posterior wall of the pharynx (Fig. 1). It is possible, however, to get many tolerant people to swallow with the laryngoscope *in situ*, and some of them can go through what, apparently in the later movements, is a normal deglutition without the preliminary closure of the mouth, and with only a rapid lift of the dorsum of the tongue which does not necessarily dim the mirror surface. In these people, the entire movement, as far as the tongue, epiglottis, and arytenoid cartilages are concerned, may be observed, excepting during a very short interval of time immediately after the tongue and posterior pharyngeal wall come into contact. The various movements are as follows: As the tongue moves backwards towards the pharyngeal wall the arytenoid cartilages commence to slide inwards and forwards towards the cushion of the epiglottis, and at the same time the entire larynx is lifted upwards and somewhat forwards, thus opening the mouth of the oesophagus (Fig. 2). The epiglottis partakes of this upward lift of the larynx to some extent. It lies closely pressed against the posterior surface of the tongue, as this travels backwards, and with it cuts off the view of the forward movement of the arytenoid cartilages when about half of the distance to the cushion of the epiglottis has been travelled by them. It continues to occupy the same position, being pushed backwards by the tongue until when last seen it (the epiglottis) is lying between the posterior pharyngeal wall and the tongue in such a position that it is almost impossible for it to be drawn further down so as to cover the larynx (Fig. 3). Indeed, when it reaches this position the danger of the bolus entering the larynx has passed and it is already at the entrance of the oesophagus. During this backward movement of the epiglottis its lateral margins are drawn backwards and downwards by the aryteno-epiglottidean muscles, thus making the posterior surface of the cartilage more concave from side to side. The amount of this alteration in shape differs widely

in different persons; when the epiglottis is thin and supple the two lateral margins may be drawn backwards till they meet in the middle line, but as a rule the posterior concavity is only slightly increased. When the epiglottis first comes into view again as the constrictors relax it occupies the same position as when last seen, and returns to its normal position as the tongue comes forward.

Fig. 1.—Parts at rest.

Throughout the entire movement, excepting for the incurving of its margins, the epiglottis plays a passive part, and all its movements depend on the pressure exerted on it by the tongue. These movements are aided by the increased pliancy of the cartilage, owing to the slackening of its attachments to the thyro-hyoid membrane, etc., by the raising of the thyroid cartilage.

In support of this view of the movements of the epiglottis I may quote the experiments of Majendie and Schiff⁵ who placed coloured fluids on the root of the tongue in dogs and found that on being swallowed they passed directly into the pharynx without coming into contact with and staining the upper surface of the epiglottis.

If these observations are correct and the epiglottis performs no important function during the deglutition, we must look in other directions for evidence of the advantage of its presence; for it is clear that an organ which is so persistent throughout the animal kingdom and is such a prominent object in every throat would not exist without some definite use. It does not appear at all probable that it is a vestige of some organ which has been useful in a more primitive stage of evolution, as in this case we should expect to find it frequently absent, or at least much more irregular in size and shape.

From its origin, embryologically, and its position it would be expected to form part of the protective machinery of the larynx. If, therefore, the adverse influences, which, deglutition excluded, may affect the larynx be considered, the particular form of protection afforded by the epiglottis will probably be discovered.

The larynx is a very important structure, both as the organ of phonation and as the entrance to the lower respiratory passages; and, in order that it may properly perform its functions, it is provided with a very sensitive mucous membrane, more sensitive, perhaps, than any other part of the

body excepting the conjunctiva. So sensitive are the walls of the larynx, that the least alteration in the character or amount

Fig. 2.—Commencement of second stage of deglutition.

Fig. 3.—Termination of second stage of deglutition.

of the fluid which covers them is sufficient to produce irritation, and the smallest drop of saliva or any other fluid entering the upper orifice of the larynx immediately sets up a prolonged and violent attack of coughing. Now, the amount of mucus, saliva, etc., constantly present at the lower end of the pharynx is very considerable. Here collect practically all the secretions from the upper portions of the alimentary and respiratory tracks; from the mouth comes saliva from the various salivary glands, and mucus formed by the buccal glands, and the secretions of the faucial and lingual tonsils. From the nose and naso-pharynx comes mucus secreted in the many large accessory sinuses and by the pharyngeal tonsil, and also secretions from points so far away as the mastoid cells and the lachrymal gland. All these secretions collect in the pharynx, those from the buccal cavity running over the dorsum and sides of the tongue, those from the naso-pharynx flowing almost entirely down the posterior surface of the soft palate, and dropping from its edge or from the uvula upon the base of the tongue. Were it not for the epiglottis there can be no doubt that a large quantity of this secretion would find its way by the natural force of gravity directly into the larynx. The epiglottis is placed as a natural shield to the glottis, receiving the mucus and other secretions upon its convex anterior and upper surface, and deflecting them laterally into the two sloping pyriform fossae, by which they pass easily and readily into the oesophagus. This seems to be the natural and most important function of the epiglottis. In persons who have no epiglottis this function is not performed, and we find that they are troubled with huskiness and frequent desire to clear the throat. They also experience some difficulty in swallowing fluids, due, I think, to a small amount of fluid not being thrown into the oesophagus by the elevation, etc., of the tongue, as is a bolus of solid food, but trickling over the back of the tongue on to the sensitive aryteno-epiglottidean folds.

Whether the epiglottis exercises any important function in phonation is a question which seems to require further investigation. Sir Felix Semon⁶ has stated that "it had been shown that 'timbre' depended on the position of the epiglottis, and that in the production of the more open tones the epiglottis is more upright." Of course the epiglottis in common with every other part of the upper respiratory passages must have some effect upon the tone and resonance of the voice. So far as my observations go, a man with a strong voice generally has a large, well-developed epiglottis, but one of the most irregular epiglottides that I have seen belonged to a man who had attained some repute as a tenor soloist.

The views expressed in this paper may be summarized as follows:

That the only function performed by the epiglottis during deglutition is to act as a slight lateral protection to the glottis. That the main function of the epiglottis is to prevent the secretions of the upper air passages, etc., from entering the larynx when in a state of rest. By its means these secretions are deflected into the pyriform fossae, and so find their way into the oesophagus. The influence of the epiglottis over phonation is at present undetermined and uncertain.

I am pleased to have this opportunity of acknowledging my indebtedness to Dr. Alex. Hodgkinson for much advice during the preparation of this paper.

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AN ANALYSIS OF HUMAN CHYLE.

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My best thanks are due to my colleague, Professor Barling, who very kindly drew my attention to a case of accidental wound of the thoracic duct near its entrance into the veins, which occurred in his private practice, and from which he allowed fluid to be collected for analysis.