ment, and the eyes should not be directly concerned with the gun, but with the object that is being fired at. You require both eyes fixed on the object, in order to judge of its distance, and that is an essential datum for forming a judgement as to the rate at which it is travelling past stationary objects, and the angle the eye has to travel through in following it. Now, if it be granted that the sportsman does not look exactly along the barrel of his gun with his master eye, there must be another requirement, and that is estimation of the angle of deviation of the gun from the line of vision, not of the master eye, but of the two eyes; and, as I explained just now, that is from a point halfway between the two eyes. There is usually a certain amount of lateral or horizontal deviation, because the head cannot be got sufficiently over so as to bring the vertical plane of the line of vision over the vertical plane of the gun. There will also be a certain amount of vertical deviation, and the head is accordingly inclined to the gun to reduce these angles of deviation to the smallest degree, for the smaller the angle of deviation the easier it is to estimate, and a certain amount of cast-off helps this. The same process is gone through with people who shoot rabbits from their hip. They do not try to force their master eye down in a line with the gun. They look at the rabbit with both eyes. They estimate the lateral, if any, and vertical deviation that is required; and this process of rabbit shooting from the hip is not different from shooting from the shoulder, though there is more difficulty in estimating the correct aim. In shooting, then, you require to have a gun well fitted that will always come up to the shoulder true. When you have a gun that will come up readily, and you have trained it to come up true with your mental line of vision, then all you have to do for the purpose of a good shot is to estimate the distance and secondarily the pace of the object and to make due allowance for them. Your gun should subconsciously feel the line of vision and swing slightly in front of the bird as you fire. If you begin to concern yourself greatly about the position of your gun, you begin to poke and miss by shooting behind; poking is produced by trying to make quite sure that your gun is aimed truly and then a brain impulse is sent down to the muscles of the forefinger to pull the trigger—in other words, trying to align with one eye along the barrel, and then when you think you are well on the mark sending a brain impulse down to the muscles of the forefinger to pull the trigger. Now, there is always a latent period before the muscles respond to the brain impulse, and during this latent period the bird or whatever it is at which you are shooting has moved on. I must, however, point out that there are some, and a few who are quite good shots, who do not shoot in the way I have described. They add another estimation to the process, namely, the point in front of a bird that they have to shoot at in order that when the latent period required for pulling the trigger combined with the flight of the bird is allowed for, the bird will arrive at that point at the same moment as the shot. They do not swing on to the bird but fire at a fixed spot in front of the bird. Though, as I have said, some few good shots adopt this method, they must rely upon a human factor that is notoriously variable, and that is the latent period, the latent period being, as I have said, the time the muscles take to act after the impulse has been given to pull the trigger. This latent period has been shown by physiologists to be delayed by alcohol, hastened by tea or coffee, again delayed by fatigue, and this mental process being entirely subconscious, the individual considered cannot allow for the variation. As regards rifle shooting, the matter is different; no immediate judgement is needed for distance, that is estimated beforehand, and allowance for movement is not required to any very great extent; nearly the whole question at the moment of pulling the trigger is one of keeping the aim true—a question of extremely minute detail. Aim like this of such extreme exactitude cannot be estimated by brain judgement or experience, it has to be made anew each time the rifle is aimed, and can only be secured with the exactitude that is required by direct alignment, which can only be done by the use of one eye.

I said at the beginning of the lecture that the eye very largely involved the sense of touch. This is so especially in the case of fencing, where touch is actually of more importance in establishing "eye" than the anatomical

eyes themselves. It is generally supposed by those who do not practise the sport that very acute sight is required. So little is this the case that it is by no means difficult to fence with the eyes bandaged, either of one or of both the combatants.

I have briefly skimmed over some of the points in which "eye" is involved in several sports. Of course, I have attempted no more than a sketch, but such as it is I hope you will accept it as a sporting attempt.

THE INFLUENCE OF DIET UPON THE FORMATION AND HEALING OF ACUTE ULCER OF THE STOMACH.*

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THE present research is one of a series which was initiated in order to inquire into the exact part played by the gastric juice in the production and healing of acute gastric ulcer. For many years the hypothesis has been prevalent that the gastric juice plays an important rôle in the pathology of gastric ulcer, mainly because ulcers having the characters of those found in the stomach are almost entirely limited to the parts of the alimentary canal which are directly exposed to the action of the gastric juice. Many experiments indirectly bearing upon this problem have been performed in order to substantiate this hypothesis, but, it must be confessed, without much success. I have no intention in this short communication of discussing the relative merits of these experiments, because I have already referred to most of them in various other papers, and because they have no particular bearing upon the subject of this discourse. In all my experiments acute gastric ulcers have been produced in animals by the injection of gastro-toxic serum, the preparation of which I was able to demonstrate some years ago.¹ By means of this method of producing gastric ulcer I have arrived at the following definite conclusions, which have been already published in various papers:

1. That acute ulcer fails to appear if the gastric juice be put out of action, although the animal may die from the effects of the poison.
2. That the ulceration produced in the presence of hyperacid gastric juice is much more extensive than that produced in a stomach secreting juice of the normal acidity.²
3. That the gastric juice is able to attack the gastric cells and produce an ulcer, although the cells are not actually killed by the poison. It is merely necessary to damage the cells to some extent.
4. That hydrochloric acid of the various strengths found in the condition of hyperacidity in the human subject is able to act as a poison for the gastric cells.
5. That acute gastric ulcer heals equally well, whether the gastric juice be increased or diminished in acidity to the extent usually found in man, provided that the stomach empties itself in the normal time.³
6. That acute ulcer is more easily produced in the digesting than in the resting stomach, and that in the former case it is much more extensive in character.
7. That undue retention of food in the stomach delays the healing of acute ulcer for at least twice the normal time, because the prolonged action of the gastric juice irritates the base of the ulcer, and may cause necrosis of the granulation tissue in the early stages, and excessive formation of fibrous tissue in the later stages. The growth of the new mucous membrane over the base of the ulcer is thus delayed, and there is produced more inflammatory thickening than usually occurs in the condition of normal healing.⁴

Since motor insufficiency of the stomach prolongs the period of healing of an ulcer, it follows that food which is retained for a considerable time in the stomach, and which excites a copious secretion of gastric juice, should be more

* A paper read before the Pathological Section of the Royal Society of Medicine.

unfavourable to the healing of ulcer than food which leaves the stomach rapidly and excites only a moderate flow of gastric juice.

This is a question of great importance to the clinician, as I think most physicians will agree that rectal feeding is inadvisable in any case in which it can be avoided, so that it is necessary to have the question definitely settled with regard to what diet is the most suitable for a case of gastric ulcer. In all the present experiments cats were used. The ulcer was in each case produced on the anterior wall of the stomach, midway between the cardiac and pyloric orifices, by the local injection of gastro-toxic serum, obtained by immunizing the goat with the gastric cells of the cat, as described in a former paper.⁵ The two diets chosen were meat and milk respectively.

After a meal of 100 to 120 grams of meat the cat's stomach is usually not empty till a period of about twelve hours has elapsed, whilst after a meal of 6 oz. of milk it is empty in three hours. The stomach of a 3,000 gram cat will hold, when fully distended, a little over half a pint, but the animal will only drink about 6 oz. at once. There is the mechanical irritation of the meat also to be taken into account, but perhaps this is not of so much importance, because small clots are formed in the milk which will act in a similar manner. It was first demonstrated by Griffini and Vassale⁶ that after removal of a portion of mucous membrane by the knife the new mucous membrane was regenerated by proliferation of the glandular epithelium at the edge of the lesion, the cells growing over the raw surface, which they cover in a single layer. The glands are subsequently developed from this single layer of cells.

In my experiments on motor insufficiency I found that the delay in healing occurred in the early stages before the single layer of cells had developed, but that when once the base of the ulcer was covered with epithelium the regeneration of the mucous membrane was chiefly a question of time, but was also to some extent dependent upon the density of the fibrous base of the ulcer. From the clinical point of view, therefore, the important point in promoting the healing of ulcer is to exercise special care in the early stages of the healing, so that the single layer of cells covers the base of the ulcer as rapidly as possible, and when once that is accomplished, the chief difficulty is over. I have observed the healing of acute ulcer in 26 cats up to the stage at which the base of the ulcer is covered with a single layer of epithelial cells, because for the purposes of my inquiry it was sufficient to observe the healing up to this stage. Thirteen cats were placed on a meat diet, and 13 on milk. The animals were killed at various stages, and the ulcers of 20 of these animals examined microscopically. It was not necessary to examine the remaining 6 with the microscope, because they were in quite an early state and the condition obvious to the naked eye. The exact time of healing of course depends upon the size of the ulcer. The size of the ulcer varies in proportion to the strength of the serum, which in its turn depends upon the stage of immunization to which the goat has reached. In the present instance all the ulcers were produced by injection of the same dose of serum obtained from a goat at the same time, so that all the ulcers were of the same size. The serum, which is injected so as to cause a local oedema of the stomach wall, soaks into the mucous membrane and other tissues. The portion of stomach wall so exposed to the action of the serum is digested by the gastric juice and converted into a slough, which separates, leaving a clean ulcer.

The formation of the ulcer varies according to the condition of the contents of the stomach. When the animal is on a meat diet, so that the walls of the stomach are exposed to the prolonged action of the gastric juice, the slough is rapidly formed, and has separated by the fourth day in most cases, a clean ulcer resulting. In the case of animals fed on milk, however, the period of formation of the ulcer is longer. In two of the cases the sloughs had not separated on the seventh day, and in two other animals, killed on the eighth and eleventh days respectively, a small slough was still adherent to the centre of the base. Out of a large number of animals fed on a meat diet in previous experiments, I have never yet encountered an unseparated slough like this at so late a date. There is no doubt whatever that the condition of the stomach contents exercises a great influence upon both the forma-

tion and extension of an ulcer in whatever way it is produced, and we know that in the human being acute ulcer is initiated in several ways, but in all cases by the action of the gastric juice the different lesions are eventually converted into the same kind of ulcer. It is by no means uncommon for a sudden haemorrhage or perforation to occur after a meal, and this is not altogether due to the stretching and movements of the walls of the stomach, but also to digestion by the gastric juice. These experiments support the result which I gave at the beginning of this paper, namely, that an ulcer is produced more easily in the digesting than in the resting stomach. On account of the delay in the separation of the slough on a milk diet, I placed six further animals on meat for the first four days and subsequently on milk, so that the experiments would be more strictly comparable with those in which the animals were fed on meat all the time.

The microscopical examination of a lesion on the third day shows the overlying mucous membrane completely necrosed, the tissue being shrunken and unstained, and at the junction of the dead and living tissue an infiltration with round cells, chiefly leucocytes. The muscularis mucosae has a hyaline appearance and stains badly.

The submucous and muscular coats are thickened, infiltrated with haemorrhages, and contain much necrotic tissue having a hyaline appearance. There is commencing infiltration with cells around the edge which are invading the dead tissue.

After the slough has separated, the base of the ulcer is formed of the remains of the muscular coat or the sub-peritoneal tissue infiltrated with round cells. Towards the end of the second week the deeper layers of the base have become fibrous and the peritoneum is thickened, the superficial layers being formed of granulation tissue. At the end of the third week the whole base is formed of fibrous tissue in which strands of muscular tissue can be seen. This blends with the muscular and submucous layers at the edges of the ulcer.

Until the epithelium has grown over the base the most superficial layer is formed of more vascular and cellular tissue. This is the invariable course of events in every animal fed on milk, but in those fed on meat the granulation tissue on the surface of the base and extending to various depths is liable to become necrotic. It may be only in a part of its superficial extent or in the whole of it. In this case the growth of the epithelium over the base is completely prevented, and when the whole superficial extent is involved the epithelium has merely commenced to grow at the edge of the ulcer and the whole is completely unhealed at the end of three weeks. The size of such an ulcer is always much smaller than the original ulcer owing to contraction of the fibrous tissue in the base. This necrosis of the granulation tissue of the base of the ulcer occurred in three out of five animals which were fed on meat and which were killed from the fourteenth to the twentieth day. The ulcers of eight animals fed on milk were examined during the same period, and in not a single case was there any sign of such necrosis.

This is the essential difference between the healing in the two cases, the granulation tissue of the base is unable to withstand the prolonged action of the gastric juice and undergoes necrosis, with the result that the healing is delayed and the base of the ulcer becomes more dense from increased formation of fibrous tissue.

I will next consider the regeneration of the mucous membrane. As soon as the edges of the mucous membrane are separated from the slough and all the necrotic portions of glands have been removed by the gastric juice, the cells lining the ducts and bodies of the glands, which are apparent on the raw surface, commence to proliferate and cover this surface with a single layer of, at first flattened, and later cubical, cells.

In this way the edge becomes smooth and rounded. On section this edge is composed of short, irregular glands separated by a considerable cellular stroma, the surface being covered by a layer of cubical cells, which is continued in a single layer on to the surface of the ulcer. Not uncommonly the edge has been inverted by retraction of the muscularis mucosae, and in this case the epithelial cells are compelled to grow round the angle between this inverted edge and the base of the ulcer. This, however, appears to offer little or no obstacle to their growth. By the tenth or eleventh day in the case of milk-fed, and by

the thirteenth and fourteenth in the case of meat-fed animals, the layer of epithelial cells has extended a little way over the base of the ulcer.

On the twentieth day the base of the ulcer was completely covered in four milk-fed animals, and almost completely in three others.

Of the animals fed on meat the layer of cells had only extended a short distance over the base on the fifteenth day, and of three cases examined on the twentieth day one had a large uncovered area in the centre, and in the other two the base was completely uncovered owing to its superficial layers having undergone necrosis. The earliest time at which I have seen primitive glands develop is the tenth to the fifteenth day. They appear at first as little pouches, invaginated, as it were, from the layer of cubical cells.

These results, therefore, confirm those of my experiments dealing with motor insufficiency, and show that the delay in healing in that condition is merely an exaggeration of that which occurs under normal circumstances when a diet is administered which remains for a long period of time in the stomach, the fault being in both cases in the base of the ulcer rather than in the overgrowing epithelium.

The conclusions to be drawn from these experiments are as follows:

1. The theory with regard to the part played by the gastric juice in the production of gastric ulcer receives further confirmation, because ulceration is the more rapidly produced in proportion as the gastric juice is allowed a longer period of contact with the wall of the stomach.

2. The epithelium grows over the base of an ulcer more rapidly when the animal is given a milk diet than when it is given a meat diet. In the case of a milk diet the base of a moderately sized ulcer is usually completely covered by the twentieth day, whilst in the case of a meat diet the same sized ulcer would in most cases be uncovered in the centre at that time.

3. Frequently, in the case of meat-fed animals, the ulcer is completely uncovered on the twentieth day, the granulation tissue of the base of the ulcer having become necrotic. Such an ulcer may be only one-fifth of the size of the original ulcer owing to the contraction of the fibrous tissue in the base, although healing has only commenced at the edge.

4. In the treatment of a case of ulcer of the stomach the following principles should be observed:

- (a) During the early stages of the healing of acute ulcer the patient should be given a food which does not stay long in the stomach and which does not excite a copious flow of gastric juice.

- (b) The period of treatment in bed should be at least three weeks.

- (c) The starvation diet of the older physicians is not necessary, because the general nutrition suffers too much, and because ulcers heal well on some diet such as the above.

- (d) In the case of acute ulcers which are extending, or chronic ulcers, healing cannot be expected to occur in three weeks, because the ulcer must first be got into a suitable condition for healing, and then, owing to its size and thickness, the healing must take some weeks longer to be completed, so that the treatment in bed is to be conducted like that of simple acute ulcer, but extended over a period at least twice as long.

- (e) Since in many cases of gastric ulcer there is hyperacidity of the gastric juice, and when the gastric juice is acting destructively hyperacidity increases this destructive tendency, this high degree of acidity should be controlled by the administration of alkali. This is not so necessary in acute ulcer as in the more chronic forms, because the few estimations that have been made of the gastric secretion in acute ulcer show that it is not hyperacid, and I have found experimentally that the effect of acute ulcer is to diminish the secretion in the early stages, and that the latter becomes normal as the ulcer heals.⁷

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THYROID GRAFTING AND THE SURGICAL TREATMENT OF EXOPHTHALMIC GOÏTRE.

BY

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So long as the causation of exophthalmic goitre and myxoedema was regarded merely as being an excess or deficiency of thyroid secretion the treatment of these conditions was comparatively simple, being merely the removal of thyroid excess or the making good of thyroid deficiency. But we know now that the matter is of far greater complexity. Not only have the parathyroids to be taken into consideration, but the possibility of abnormal, as well as excessive, thyroid secretion has to be borne in mind. Further, there are the interactions of the various glands with internal secretion to be reckoned with, and the organic changes in nervous and cardiac structures brought on as the result of prolonged functional disturbance. In a severe case of exophthalmic goitre we have, therefore, (1) to lessen the thyroid secretion, (2) to counteract the thyroid toxicity, and (3) to add some source of normal secretion. In cretinism and myxoedema the thyroid-therapy has recently been supplemented or replaced by thyroid grafting, and we are indebted to the personal suggestion of Sir Victor Horsley for the idea of applying this procedure to the cure of a severe case of exophthalmic goitre:

The patient, F. S., aged 19, had suffered for over twelve months with typical Graves's disease, with protruding eye-balls, goitre, dyspnoea, and tachycardia. For this she had been treated by Dr. Michell Clarke by various medicinal remedies, together with the x rays, without any amelioration. In September, 1909, we removed the right lobe and isthmus of the gland under novocain (subcutaneous) anaesthesia, with very marked improvement of her symptoms. But this improvement disappeared at the end of ten days, coinciding with the healing of the drainage track, from which a rather profuse discharge had been taking place. By December, 1909, all her previous symptoms except the exophthalmos were as pronounced as ever, the respirations often being over 100 and the pulse 190 per minute. On December 21st, 1909, the greater part of the left lobe was removed, fragments being left at the upper and lower poles. It was hoped that thereby a sufficiency of thyroid, together with the parathyroids, had been retained.

On December 26th, 1909, she developed a very severe attack of typical tetany, which lasted for four days and nearly proved fatal. She was treated by calcium lactate, morphine, saline infusions, and thyroid extract. In spite of continued thyroid medication she had three or four slight attacks of tetany during the next few months, but on the whole her condition was improved. The dyspnoea and accelerated pulse, with orthopnoea, continued, however, and her condition was very far short of cure, the exophthalmos being the only sign which definitely disappeared after the first operation.

From December, 1909, until June, 1910, her face and hands became somewhat puffy, and the menstruation, which had been free, almost ceased. She often suffered during this time from severe headache, which she attributed to the absence of menstrual flow. It was evident, however, that psychical excitement had a good deal to do with her symptoms, because although the respirations were 100-120, and the pulse 100-140 when awake, they were only 16 and 88 respectively when asleep. On June 1st, 1910, we grafted a piece of thyroid from another patient, who had a small adenoma, into her neck. The graft was about 2 cm. x 1 cm. x 1 cm. in size, and we were fortunate enough to identify two well developed parathyroid bodies which were separately implanted. The grafting was performed under novocain anaesthesia into the left side of the neck under the sterno-mastoid muscle. During the same day as the operation nothing special was noted, but much to our astonishment the next day (June 2nd, 1910) she had well marked tetany; that is to say, the hands were clenched in the characteristic attitude, the arms pronated, and the whole trunks and limbs were absolutely rigid. Chvostek's sign was also well marked, the facial muscles contracting when a light tap was made over the seventh cranial nerve.

This condition continued for twelve days, but it was very remarkable that in spite of the extreme tetany, the patient's general condition remained perfectly good, and she slept soundly at night. During sleep the contractions were to a large extent relaxed. These features strongly suggested a functional origin for the condition, and I asked Mr. Green Armytage if he would try the effect of hypnotism upon her. This he kindly did, with the most gratifying results. She readily succumbed to the hypnotic sleep, and the next day she could roll bandages and feed herself. By June 17th she was up and about, and her