CASE XXXIV.

F. H., aged 55. He had suffered from constipation for many years, and recently the pain and debility consequent on it had become distressing. In July, 1904, the ileum was divided and united to the sigmoid.

He improved greatly after the operation. Unfortunately he had acute obstruction, and died in January, 1905. No *post-mortem* examination was made.

CASE XXXV.

A. G., aged 40. For many years she suffered much misery from chronic constipation, pains in the abdomen and vomiting. Had been continually under medical treatment.

In July, 1907, the large bowel was removed as far as the rectum, with which an end-to-end anastomosis was effected. The pylorus, which was also fixed to the liver and gall bladder in the usual manner, was liberated. Her recovery was uninterrupted, and the result was excellent in every way.

CASE XXXVI.

M. L., aged 24. Had suffered all her life from severe constipation, producing violent attacks of abdominal pain and loss of flesh. She was perhaps the worst case that ever came under my observation from the point of view of pain. Between November, 1901, when she had her appendix removed, and October, 1903, she had had several operations for the liberation of adhesions, each giving only temporary relief. In October, 1903, the large bowel was removed to the splenic flexure, and the pylorus was freed from the liver and gall bladder. In October, 1905, the stomach having again become dilated, these adhesions having re-formed, they were divided, the pylorus was dropped, and gold leaf inserted to prevent the parts adhering again to one another. In July, 1907, the distension of the descending colon and sigmoid causing distress, these portions of the bowel were removed.

The patient improved greatly after this. Her general condition is now fairly satisfactory. She is able to get about, and only suffers from discomfort at intervals of three or four weeks.

CASE XXXVII.

Miss B. had for some time been under the care of a very experienced physician for chronic constipation. He felt that unless her condition was benefited in some way her unhappy life could not be prolonged materially by further medical treatment. In September, 1905, the large bowel was removed to the splenic flexure. She gained in weight, being 8 st. before the operation and reaching 9 st. 4 lb. some months after it. After a time the dilatation of the stomach, which had not previously been apparent, gave trouble, and in December, 1906, the pylorus was freed from the under surface of the liver. She improved for a time, but the dilatation of the stomach was soon as bad as ever. In March, 1907, gastro-enterostomy was performed, with complete relief of the stomach symptoms. After a time the descending colon and sigmoid gave trouble, and were removed in October, 1907.

She is now progressing very comfortably.

CASE XXXVIII.

E. C., aged 21. She was admitted on October 18th, 1907, in an extreme degree of exhaustion consequent on chronic constipation. Her condition was so critical that I hesitated to adopt operative measures. She was treated actively with drugs for nearly three weeks in the hope of improving her condition, but with little benefit. It was apparent that if anything was to be done it could not be delayed. The big bowel was removed to the lower limit of the sigmoid, where very great difficulties were experienced in effecting an end-to-end junction between the ileum and rectum, due in part to the degree of fixation of the large bowel and in part to the extreme thinness of the wall of the ileum.

Some days later the symptoms of obstruction developed, and the patient died six days after the operation. A *post-mortem* examination was not permitted, so I am unable to define the seat of obstruction. I may say it is the only case of this sort on which I have operated which proved fatal in this way. In the same difficult circumstances I would not again perform an end-to-end junction, but would try to obtain a larger aperture by means of a lateral anastomosis, an arrangement which is usually preferable.

CASE XXXIX.

Miss C., aged 28. Health deteriorating for eleven years. February, 1905: Extreme constipation with mechanical and toxic results of a very serious nature. Early in 1906 gastro-enterostomy was performed to relieve the frequent vomiting, without benefit. Her condition became progressively worse and her emaciation very great. In May, 1907, I removed the large bowel as far as the splenic flexure, and put the ileum into the rectum.

Since the operation she has gained weight steadily, and her complexion is clear and healthy instead of dirty brown as before. She eats heartily of ordinary food and has no indigestion. The result of the operation has been most satisfactory in this case. Her doctor, writing on November 15th, 1907, says she is marvellously improved, and reports that the patient declares she has not felt so well for ten years as she does now.

Lectures

ON

THE PASSAGE OF FOOD THROUGH THE HUMAN ALIMENTARY CANAL.

DELIVERED AT GUY'S HOSPITAL FOR LONDON UNIVERSITY
ADVANCED STUDENTS DURING OCTOBER, 1907.

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UNTIL recently almost all our ideas on the subject of the passage of food along the human alimentary canal were derived from experiments performed under more or less abnormal conditions in animals. But the discovery of the *x* rays in 1895 was soon followed by their employment in the study of the physiology of digestion. In the next ten years our knowledge of the movements of the stomach and intestines was greatly extended, mainly as a result of the work done on cats by Cannon and subsequently on man by Rieder and Holzknecht.

In 1905 Cannon made some observations on himself which suggested that auscultation, which had previously been used in the investigation of swallowing, might give some assistance in the study of the movements of the stomach and intestines.

The original investigations,* to which I shall refer in these lectures, were carried out by means of skiagraphy, auscultation, percussion, and palpation in normal individuals. They were done in the Guy's Hospital Physiological Laboratory, with the co-operation of Messrs. F. Cook, A. N. Cox, H. Gardiner, E. G. Schlesinger, and A. N. Todd, students of Guy's Hospital, with the exception of those in which skiagraphy was employed, these having been carried out in the Skiagraphic Department of Guy's Hospital, with the additional help of a number of other gentlemen. But the actual management of the *x* rays was entirely in the hands of Dr. C. J. Morton, Radiographer to Guy's Hospital, and on a few occasions of Mr. C. E. Iredell and Mr. E. W. H. Shenton, without whose aid the work could never have been accomplished.†

I.—SWALLOWING.

The reflex process of swallowing begins when a bolus of food has been brought by a voluntary effort on to the back of the tongue. Before it can be propelled into the upper end of the oesophagus it is necessary for all the other passages which open into the pharynx to be closed. The mouth is closed by the approximation of the dorsum of the tongue to the palate by the palato-glossal muscles. In order to shut off the naso-pharynx the soft palate is raised by the levator palati and the palato-pharyngeal muscles, which also render the posterior pillars of the fauces more prominent, and the uvula is lifted by the azygos uvulae so as to touch the posterior pharyngeal wall, which bulges forward owing to the contraction of the constrictors of the pharynx. The importance of the contraction of these muscles is well seen when they are paralysed in diphtheritic neuritis; if an attempt is made

*Towards the expenses of this research a grant was made by the British Medical Association on the recommendation of the Science Committee of the Association.

†For fuller details of the original investigations see a paper in the *Guy's Hospital Reports* for 1907.

to swallow, a large part of the food returns through the nose.

The larynx is protected by the elevation of the hyoid bone by the mylo-hyoids, and of the larynx behind the hyoid by the thyro-hyoids. At the same time the posterior wall of the larynx is pulled forward from its resting position in contact with the posterior wall of the pharynx towards the base of the tongue by the external thyro-arytenoid and aryteno-epiglottidean muscles. Hence the food passes over the posterior surface of the epiglottis, the anterior surface of which rests—as it does when swallowing is not occurring—against the root of the tongue. This mechanism, which was discovered by Anderson Stuart, explains why extirpation or destruction by disease of the epiglottis has no effect on deglutition, a fact which was inexplicable on the old theory that the epiglottis folded over the glottis like the lid of a box, so that the bolus should pass over its anterior surface. As a final though rarely necessary protection the vocal cords are brought together by contraction of their adductors.

The upper end of the oesophagus, the walls of which are in contact with each other while at rest, becomes patent when the posterior of the larynx is pulled forward in the manner described above. It thus becomes for a moment the point of least pressure in the pharynx, so the bolus, when thrown backwards by the sudden elevation of the base of the tongue, enters it.

There has been much discussion as to the method in which the bolus, now arrived at the top of the oesophagus, passes down into the stomach. Until recently the view proposed by Kronecker and Meltzer¹ in 1880 was generally accepted. They had placed an indiarubber balloon in the pharynx and another in different parts of the oesophagus; the balloons were connected with a recording apparatus, so that the changes in pressure in the pharynx and in the oesophagus could be observed. It was found that within a second of the beginning of deglutition a rise in pressure was recorded by both tambours, that occurring in the oesophagus being only a fraction of a second later than that in the pharynx. The first short rise was followed by a more prolonged one, which occurred almost immediately afterwards in the pharynx, but from one to five seconds later in the oesophagus, the interval depending upon how far down the balloon was situated. Near the cardia the duration of the second rise in pressure was longer than near the pharynx. Kronecker and Meltzer believed that the first rise in pressure was due to the passage of the bolus over the balloons, so that less than a second was occupied by its journey through the oesophagus. The second rise they believed to be due to a wave of peristalsis passing down the oesophagus, which swept any adherent traces of food into the stomach. They thought that the actual passage of the food through the oesophagus was due to the rise in pressure produced in the pharynx by the rapid contraction of the muscles already mentioned, the food being shot down the oesophagus, and even through the cardia, owing to the pressure at the bottom of the oesophagus being lower than in the pharynx.

Doubt was first thrown on Kronecker and Meltzer's explanation of their experiments by observations made by Cannon and Moser² in 1898 on unanaesthetized animals. Bismuth subnitrate was mixed with their food; this salt is opaque to the x rays, and so the passage of the bolus during deglutition could be watched. They found that food passed much less rapidly down than was formerly believed, the descent taking four or five seconds in the dog. The rate in the upper part of the oesophagus was much greater than in the lower part; they were, however, unable to give any sufficient explanation of this. All their experiments were performed on animals, with the exception of a few inconclusive observations made on a girl.

Using Cannon's method, we have made repeated observations on swallowing in fourteen normal young men, and have found that no individual differences of importance occur.

I. Fluids.

Milk, with which bismuth carbonate had been thoroughly mixed in the proportion of about 2 oz. to half a pint, was swallowed. When the rays passed through the individual somewhat obliquely from side to side, the fluid was seen on the fluorescent screen as a dark shadow passing through the thorax in the clear space between the shadows thrown by the spinal column and the heart. In the vertical position the

fluid passes with great rapidity to the back of the pharynx and thence equally quickly down the upper part of the oesophagus. A mouthful of ordinary size occupies at any given moment between 1 and 2 in. of the length of the oesophagus.

When the fluid reaches the cardia, its rapid progress is arrested owing to the sudden diminution in the lumen of the oesophagus. The lower end of the column of fluid tapers to a point which must represent the cardiac orifice of the stomach, the upper limit becoming horizontal. At a comparatively slow rate the upper horizontal limit of the shadow descends, the lower part remaining unaltered in shape and position until the last trace of the shadow has disappeared. This means that the fluid runs through the cardia into the stomach at a comparatively slow rate, after travelling rapidly down the greater part of the oesophagus. Hence the cardiac orifice, even during the passage of fluid into the stomach, remains very small in diameter, and so offers a distinct obstacle to the onward passage of the food.

The average time which elapses between the commencement of the deglutition act and the disappearance of the last trace of fluid from the oesophagus is 5½ sec. It varies from 4½ to 8½ sec. in different individuals, and the interval may vary in one individual by as much as 3 sec. About one half of the total period is required for the fluid to reach the lower end of the oesophagus, the other half being required for its passage through the cardia.

Fig. 1 represents diagrammatically the position and size of the shadow at intervals of a second during the swallowing of milk containing bismuth carbonate.

Fig. 1.—Diagram to show position of shadow at intervals of one second during the swallowing of a mouthful of milk containing bismuth carbonate.

The slow passage of fluids through the last part of the oesophagus is of practical importance in connexion with poisoning by caustics. When strong acids or alkalis are swallowed the upper part of the oesophagus frequently escapes severe injury, but the lowest 2 or 3 in. are badly damaged, owing to the irritant being longer in contact with them.

In the horizontal position fluid passes along the oesophagus slightly less rapidly than in the vertical position, and a rather more prolonged delay takes place while the fluid passes through the cardiac orifice of the stomach. Sometimes a small quantity of the fluid follows more slowly, being seen on the fluorescent screen as a thin streak instead of the comparatively broad band present when the oesophagus is filled.

In the inverted position, with the head directed downwards, the influence of gravity becomes more obvious, as the fluid steadily ascends the oesophagus approximately at only one-third the rate it descends in the ordinary vertical position. Owing to its slower passage, the final delay at the cardia, though present, is less obvious. Sometimes a little fluid runs back from the stomach into the cardiac end of the oesophagus, whence it once again passes into the stomach.

II. Solids.

When solids are eaten, they are normally masticated and mixed with saliva until they become semifluid in consistency. Hence it is to be expected that their passage down the oesophagus would not differ greatly from that of fluids. A loaf of bread was baked, the flour of which had been thoroughly mixed with bismuth carbonate. When spread with butter and jam its taste could hardly be distinguished from that of ordinary bread. If properly chewed, the movement of the shadow during swallowing, whether the individual was standing or lying down, was identical in character with what has been already described in the case of fluids. There was, however, a somewhat greater tendency for small quantities to

be temporarily left behind, when they were seen on the screen as a faint streak which slowly disappeared.

The passage of a solid bolus down the oesophagus is quite different. This was observed by swallowing cachets filled with bismuth carbonate. If swallowed in as dry a condition as possible, the cachet passed down the oesophagus with extreme slowness. On one occasion the cachet took fifteen minutes to reach the cardia, although the individual who had swallowed it had no sensation of its passage, and believed that it had entered the stomach when it was still high up in the oesophagus.

If a cachet was well covered with saliva in the mouth before being swallowed, or if some water was drunk immediately before so as to moisten the oesophagus, it passed down much more rapidly, the time required varying between eight and eighteen seconds. If swallowed with a mouthful of water, or if, when slowly moving down the oesophagus, some water was drunk, the solid bolus reached the stomach as rapidly as fluids.

When two or three cachets were swallowed at intervals of a second, each could be seen slowly travelling down the oesophagus. On several occasions the steady progress of one or more of the upper cachets was suddenly interrupted, and they moved a short distance upwards as if reversed peristalsis was occurring. The cause of this was probably the production of a strong contraction of the circular muscle fibres between the lowest two cachets, so that the bottom one was pushed onwards, whilst the upper ones were pushed a short distance upwards.

If the movements of deglutition were performed with the mouth empty whilst a cachet was on its way down the oesophagus, its progress was generally hastened. On a few occasions, however, the cachet was seen to ascend a short distance, as if the act had pulled the oesophagus bodily upwards.

When swallowed in the inverted position a cachet passed along the oesophagus at about the same rate as in the upright position. But when it had once reached the cardia it appeared to have considerable difficulty in entering the stomach. Instead of continuing its forward progress, it was observed to move frequently backwards and forwards, sometimes actually disappearing, apparently into the stomach, only to reappear in the oesophagus a second or so later. On one occasion, for example, the cachet reached the cardia in twenty-three seconds, but it was not until four minutes had elapsed that it entered the stomach to reappear no more.

There is no doubt that the rapid passage along the oesophagus observed in the case of the bread corresponds much more closely to what occurs when ordinary solid food is swallowed than the slow passage of the cachets. But the latter is of interest as indicating what probably happens when solid food is swallowed without being properly masticated. It suggests that the feeling of pressure in the chest experienced after a hurried meal may be due to the distension of the oesophagus caused by the presence of solid lumps of food, which only pass very slowly downwards.

In the light of these new observations it is not difficult to explain the results of the experiments of Kronecker and Meltzer. The first rise in pressure observed by them in the pharynx and oesophagus during swallowing must have been due to the lifting of the larynx and the contraction of the muscles of the tongue and pharynx, as this would compress the air present in the pharynx and at the same time pull on the oesophagus. The second rise in pressure would be due to the passage of the food down the oesophagus over the indiarubber balloons. The time relations agree with this explanation, and the more prolonged rise in the lower than in the upper part of the oesophagus would be caused by the slow entry of the food into the stomach after it reaches the cardia.

There can be little doubt that the passage of the food through the oesophagus is due to a peristaltic contraction of the oesophageal muscles, and not, as Kronecker and Meltzer believed, merely to the greater pressure in the pharynx than in the bottom of the oesophagus. It is only the top of the oesophagus which is opened by the forward movement of the larynx, the greater part having its walls in contact with each other, so that the rise in pharyngeal pressure would only be able to shoot a bolus through the first one or two inches of the oesophagus. When the peristaltic wave passing down the oesophagus reaches the cardiac sphincter, the latter relaxes, but the relaxation is only sufficient to allow the food to pass comparatively slowly into the stomach.

Kronecker and Meltzer maintained that the two sounds heard on auscultation of the oesophagus during swallowing corresponded to the changes in pressure recorded by the balloons in their experiments. As very few accurate observations have been made on these sounds, and the accounts given of them by different writers are contradictory, we have thoroughly investigated their character and their relations under various conditions in four healthy young

men. The new facts we have discovered have received confirmation by a less detailed examination of a number of other individuals.

1. *Fluids.*—When a mouthful of water is swallowed two sounds are produced. The first sound is sharp and short, and is heard most loudly when the stethoscope is placed under the chin; it is less loud in the front of the neck, and can also be heard with less intensity over the spine and sometimes over the chest. The sound, wherever heard, occurs simultaneously with the contraction of the mylo-hyoid muscles and the lifting of the larynx. Hamburger,³ who first described this sound, listened to it over the dorsal spine, and believed that it was due to the passage of the fluid past the level auscultated. But the situation in which it can be heard and the points where it is heard loudest, as well as its time relations and the skiagraphic observations, which will be described later, render this view untenable. The same may be said of Kronecker and Meltzer's belief, that the sound is produced by the actual entry of the food into the stomach. It is much more probable that the sound is caused by the impact of the fluid against the posterior pharyngeal wall when it is thrown across the pharynx by the sudden elevation of the back of the tongue. This explanation is borne out by the character of the sound, especially when it is heard with the stethoscope placed under the chin; it is exactly what would be produced by a volume of water coming suddenly into sharp contact with a resistant wall. Moreover, when the swallowing act is performed with the mouth empty, no sound is heard except under the chin and in the neck; there it is quite faint and entirely different in character to that heard when fluids are swallowed, and is no more than the sudden contraction of the muscles could themselves produce. The sound gains in loudness with increase in the volume of fluid swallowed, until it reaches its greatest intensity with the amount which corresponds to an ordinary mouthful. If the individual is sitting or standing the sound is louder when the head is inclined forward than backward—no doubt because in the former case a stronger contraction of the muscles concerned is required to propel the fluid in a direction against gravity, and consequently the impact of the fluid against the posterior pharyngeal wall will be more violent. Corresponding with this, the first sound is louder when the individual is in the prone than in the supine position; in the latter it is frequently inaudible, except at the neck and under the chin.

The second sound varies considerably in character and time relations according to the position of the individual examined. When he is standing or sitting it is best heard in the epigastrium and along the left costal margin near the epigastric angle. It is also audible, though rather less clearly, over the spine, the point of greatest intensity being generally over the tenth dorsal vertebra. When a number of observers listened over different parts of the spine and in the epigastrium simultaneously, it was found that this second sound occurred at exactly the same moment wherever it was heard, so that it would seem to be produced at one point only, from which it is transmitted in various directions.

In character, it can best be described as a trickling sound. Its average duration, which is between two and three seconds, does not depend on the amount of fluid swallowed. Moreover, when instead of a single mouthful a considerable quantity of fluid—half a pint for example—is drunk at once, no second sound is heard at all. The second sound begins from four to ten seconds after the first sound, which marks the initiation of the act of deglutition. Thus the normal time for the occurrence of the second sound is not the same in all individuals, so that the statement sometimes made that, if the sound be heard later than six or seven seconds after the beginning of deglutition, a stricture is probably present, is quite incorrect. In no one individual was the interval found to vary more than two seconds in repeated observations. The interval is to some extent proportional to the height of the individual, and it appears to increase slightly with an increase in the amount of water drunk.

When the stomach is empty no second sound is heard until about half a pint has been drunk. The sound also disappears when the stomach is distended. In some individuals three-quarters of a pint suffice to make the second sound disappear, but if no solids have been eaten it reappears already within a quarter of an hour, probably

owing to the rapidity with which fluids leave the stomach.

In the horizontal position the second sound differs remarkably according to whether the individual lies prone or supine. In the prone position its character is identical with that of the sound heard in the vertical position. The interval between the first and second sounds is, however, almost constantly one second longer than it is in the vertical position, owing, no doubt, to the removal of the influence of gravity.

In the supine position the single trickle is replaced by a series of sounds, which are loud and best described as squirts. They are generally felt and sometimes heard by the swallower himself. The number of squirts is generally from two to five, but occasionally only one can be heard. They do not vary with the size of the mouthful. Each lasts about one second; the first of the series generally occurs three or four seconds after the first deglutition sound, and the last may begin as much as eight seconds later. The squirts can be heard when the stomach is quite empty and when it is distended, although at these times the trickle of the vertical and prone positions is inaudible. It was found, by lying with the shoulders and legs supported but the trunk free, that both the trickle observed in the prone position and the squirts in the supine position can be heard whether the stethoscope is placed in the epigastrium or over the tenth dorsal spine.

When an individual lies on his left side, the second sound of deglutition is similar to that of the prone position; when on his right side, it is the same as in the supine position. In the position between prone and left lateral, the sound is the same as prone and left lateral; between supine and right lateral it is the same as supine and right lateral. Between left lateral and supine it is generally mixed in character; between right lateral and prone it is generally mixed, but more like left lateral and prone than supine.

As the position is gradually changed from the vertical to the supine, a squirt sound is found to precede the trickle when an angle of about 36 degrees with the horizontal is reached. At an angle of about 22 degrees the trickle disappears, the normal vertical sound being now completely replaced by the supine sound. In the inverted position, with the head downwards, as a rule no second sound was heard at all. On two occasions, however, sounds somewhat similar to those characteristic of the supine position were heard.

With the body in the vertical position, the oesophagus as it enters the stomach points downwards, forwards, and towards the left. Hence in the vertical, prone, and left lateral positions the end of the oesophagus points downwards; in the inverted, supine, and right lateral positions it points upwards. Whatever the cause of the different sounds may be, these anatomical relations may perhaps explain why the same sounds should be produced in the vertical, prone, and left lateral positions on the one hand, and in the supine, right lateral, and occasionally in the inverted positions, on the other.

I believe that the two different types of second sounds—the “trickles” and the “squirts”—have not previously been distinguished. They are of some practical importance, as an observer, who is only familiar with the trickling sound heard in the vertical position, would be very likely to regard as pathological the squirts heard in a patient who had to be examined lying on his back in bed.*

2. Solids.—The first sound of deglutition in the case of solids is identical with that already described as occurring when a swallowing movement is performed with the mouth empty. It is inaudible in the epigastrium and over the spine below the second dorsal vertebra; even in the neck and under the chin it is faint. It therefore appears to be due merely to the contractions of the muscles concerned in the first stage of deglutition.

*Meltzer, who speaks of a “squeezing murmur” heard near the xiphoid cartilage six to seven seconds after the commencement of the act of swallowing, as the normal deglutition sound, describes a “squirting murmur” occurring immediately after the beginning of the act of swallowing as “a trustworthy symptom of insufficiency of the cardiac orifice.” It seems probable that this is nothing else than the normal sound heard in the supine position, so that Meltzer must have diagnosed insufficiency of the cardia in all patients whom he examined when lying on their backs. For he adds that “either one or the other murmur can be heard in all but very few cases.”—*Centralt. f. d. med. Wissensch.*, 1883, No. 1. Quoted without comment by Sahli (*Diagnostic Methods*, English Trans., 1906, p. 690).

The second sound is frequently absent in all positions, but occasionally an ordinary fluid sound is heard, which is presumably due to the solid being so well mixed with saliva that it practically becomes fluid in consistency.

From the character of the second sound we thought at first that it must be due to the trickling of the fluid from the oesophagus through the cardia into the stomach. But the time relations recorded above threw great doubt upon this idea. The shadow disappears from the oesophagus from $4\frac{1}{2}$ to $8\frac{1}{2}$ seconds after the commencement of swallowing; as half of this time is occupied by the passage of the fluid into the stomach, the second sound should begin from 2.5 to 3.5 seconds after the first sound, if the suggested explanation were correct. But it actually begins from 4 to 10 seconds after the first sound, so that its commencement appears to correspond in time with the final disappearance of the fluid from the oesophagus. This was proved, in fact, to be the case on a number of occasions on which I listened to the deglutition sounds at the same time as observations were being made by means of the x rays; it was constantly found that the sound only began *after* every trace of fluid had entered the stomach.

It is thus not easy to find an explanation for the production of the second sound. At present I can only suggest that it may be associated with the fall in pressure in the bottom part of the oesophagus and the rise in pressure in the stomach when the fluid passes through the cardia. These may force gas from the stomach into the oesophagus and so produce the sound.

The swallowing reflex is initiated by the contact of food with the mucous membrane at the back of the tongue. The impulse travels up the superior laryngeal nerve, the electrical stimulation of which gives rise in animals to the complete act of deglutition. The swallowing centre is in connexion with the vagus nucleus. The efferent impulses pass down the recurrent laryngeal nerves to the upper third of the oesophagus, and in the trunks of the vagi to the lower two-thirds and the cardiac sphincter. Mosso⁴ found that complete transverse division of the oesophagus in various situations does not interfere with the regular transmission of the wave of contraction from the pharyngeal to the gastric end, so that the normal activity must depend on impulses reaching successive parts of the oesophagus.

It is possible, however, for swallowing to occur to some extent independently of the central nervous system. The muscular coat of the upper third, which is supplied by the recurrent laryngeal nerve, is composed of striated fibres in man and certain animals; that of the lower two-thirds is composed of unstriated fibres. If the vagi are cut below the origin of the recurrent laryngeal nerves, swallowing may be only temporarily impaired, because the unstriated muscle fibres, as in all other situations, are capable of a considerable amount of automatic activity. If, however, the nerve supply to the upper third of the oesophagus is simultaneously destroyed swallowing becomes permanently impossible, as striped muscle loses its tone and all power of contraction when separated from its nerve supply. If only one recurrent laryngeal nerve is left it is sufficient to enable swallowing to continue. These facts, the knowledge of which we owe to observations made by Reid of Edinburgh in 1839, and to a series of investigations with the aid of the x rays, carried out on cats by Cannon⁵ and published in 1907, are of some practical importance. They explain the fact that loss of the swallowing reflex is clinically always a sign of a bilateral lesion, as either both superior laryngeal or both recurrent laryngeal nerves must be paralysed in order to prevent the occurrence of deglutition. Moreover, when such paralysis does occur it is often possible to introduce food into the stomach if a tube be passed into the upper thoracic region of the oesophagus, as the paralysed striated muscle is there replaced by the still active unstriated fibres.

Stimulation of the vagi with certain precautions causes the cardiac sphincter to relax. Hence in the “fusillade discharge” of the swallowing centre the contraction of successive parts of the oesophagus is followed by relaxation of the cardia. The destruction of this mechanism is probably one factor in the production of the temporary dysphagia which occurs after section of the vagi below the origin of the recurrent laryngeal nerves. The subsequent recovery seems to be due to a diminution in the tone of

the cardia, peristaltic waves passing along the oesophagus being then sufficient to force a bolus into the stomach without any further relaxation of the sphincter.

II.—THE MOVEMENTS OF THE STOMACH.

The foundation of our knowledge of the movements of the stomach was laid in 1679 by Wepfer,⁶ who vivisected wolves, dogs, and cats, and observed peristaltic movements passing over the organ. Except for some similar observations by Schwartz and Haller in the eighteenth century, no further advance was made until the publication in 1833 of the epoch-making work of William Beaumont,⁷ a surgeon in the United States army. Whoever desires to investigate any of the problems connected with the physiology or pathology of gastric digestion should first read this remarkable book, in which the author describes his researches on the stomach of Alexis St. Martin. Otherwise he is likely to find, as many recent observers have done, that his "discoveries" had already been made by Beaumont three-quarters of a century ago.

It was on June 6th, 1822, that Alexis St. Martin, a healthy French Canadian, 18 years old, was accidentally wounded in the chest and abdomen by the discharge of a musket at Fort Mackinac. He was immediately seen by Beaumont, who treated him with such skill and perseverance for over a year that finally the thoracic wound healed soundly, and the patient was restored to his former good health, although a gastric fistula, the mouth of which was protected by a valve of mucous membrane, was still present. Through this fistula gastric juice could be obtained, and the appearance of the mucous membrane and the movements of the stomach could be studied. Beaumont engaged St. Martin as a domestic servant, and in May, 1825, began his experiments on gastric digestion, which he continued with intervals for eight years.

The more recent researches into the gastric movements fall into two groups. First, Hofmeister and Schütz⁸ examined the movements of the excised stomach of dogs placed in a moist chamber kept at the body temperature. The organ continued to be active for rather more than an hour. Soon afterwards Rossbach,⁹ working along the same lines as Wepfer two centuries before, watched the exposed stomachs of curarized dogs. Finally, Pawlow and his pupils,¹⁰ with the aid of oesophageal, gastric, and duodenal fistulae, made a number of important observations on the movements of the stomach in the course of their investigations on the "work of the digestive glands."

The second group of modern investigations was inaugurated by Cannon¹¹ in 1896. He watched the changes in shape of the shadows cast by x rays of the stomach of cats which had been given food mixed with bismuth subnitrate. These experiments were the first performed under strictly physiological conditions, and they led to the first great advance since Beaumont's time in our knowledge of the gastric movements. The method introduced by Cannon was later employed on man by Rieder¹² and Holzknicht,¹³ who showed that most of the results obtained by his experiments on cats could be applied to human physiology.

In the empty condition, the pear-shaped fundus, which forms the upper third of the stomach in man, contains gas, the rest of the organ passing obliquely to the pylorus in the form of a collapsed tube, which corresponds in position to the lesser curvature of the filled stomach. Its muscular coat is in slight tonic contraction, so that the mucous membrane is thrown into folds.

When food reaches the cardia of an individual who is sitting or standing, it runs down the mucous membrane of the inner aspect of the pear-shaped fundus to the point where the gastric walls are in contact with each other. Succeeding mouthfuls collect here until sufficient is present to overcome by its weight the resistance produced at the entrance to the body of the stomach by the cohesion of the mucous membrane, after which it gradually passes down to reach the pylorus without the aid of peristalsis (Holzknicht). If food is taken in any other position it reaches the pylorus more slowly. Thus, if only a small quantity is given to a patient lying on his left side or on his back, it causes the fundus to bulge, but it does not even touch the entrance to the collapsed part of the stomach (Holzknicht).

An ordinary meal will, of course, soon work its way to the pylorus, whatever position is assumed; but it is interesting to note that the very small feeds often given to

bedridden patients will, unless the erect or semi-recumbent position is assumed, remain in the fundus, where, as will be shown later, they can undergo no gastric digestion. Only when two or three such feeds have been taken will sufficient material be present to reach the entry into the body of the stomach. Hence it would appear that if a patient is unable to sit up it might be better to give meals of moderate size at intervals of some hours instead of frequent very small feeds.

Over a century ago Sir Everard Home noticed that the normal stomach is divided during digestion into two parts by a "transverse band." This division is due mainly to the active contraction of circular muscle fibres, as it is rarely visible *post mortem*. But occasionally there is in the same situation a narrowing which is independent of muscular contraction; this is well seen in three specimens in the Guy's Museum, in which not a trace of a scar is present to account for the production of the hour-glass shape. The depth of the constriction varies considerably, and my observations after bismuth meals have shown that it is sometimes remarkably well developed in individuals with healthy stomachs. Thus, in one case of mine it was so deep that the x-ray examination led to a diagnosis of hour-glass stomach due to a gastric ulcer being made, though at the subsequent operation Mr. Rowlands found that the symptoms must have been due to a duodenal ulcer which he discovered, the stomach being quite healthy (Fig. 2). The hour-glass shape was

evidently due to muscular contraction, as it was seen to come and go during the operation.¹⁴

Modern research has demonstrated that the transverse band is not merely of anatomical interest, but that it divides the stomach into two parts, which are functionally quite different from each other. By introducing a tube connected with a manometer into different regions of the stomach of normal individuals, Moritz¹⁵ and more recently Sick¹⁶ have shown that the tone of the gastric muscles is so regulated, whether the organ is full or almost empty, that the minimum intragastric pressure remains steadily between 6 and 8 cm. of water. In the antrum pylori the pressure rises three or four times

Fig. 2.—Case of duodenal ulcer simulating hour-glass stomach. Bismuth breakfast at 9.45 a.m.

60 cm. of water; but no corresponding changes occur in the fundus, the pressure showing only irregular variations of 2 to 5 cm. This corresponds with the fact demonstrated by the x rays that the peristaltic waves, which occur in the pyloric division of the stomach, are never seen in the cardiac division, the latter acting as a storehouse for the food, which it steadily does out to the active antrum pylori in such a way that the contents of the latter remain almost constant in volume, whilst the contents of the former steadily diminish after the conclusion of a meal.

No mixing of the contents of the two parts of the stomach occurs. Thus on a number of occasions I have observed that if food mixed with bismuth carbonate is eaten shortly after a meal containing none of the salt, a rounded shadow just under the left half of the diaphragm is seen, whilst the pyloric part of the stomach remains invisible. After some time the first part of the meal passes into the duodenum, and the food containing the bismuth gradually replaces it in the pyloric part of the stomach, which therefore becomes visible.

By examining sections of the frozen stomach of animals after they had been given foods of different kinds, Grützner¹⁷ discovered that when new food enters the partially-filled stomach it passes into the centre of the mass present in the fundus and displaces what is already there outwards. He also tested the reaction of the layers of the food and found that, at a time when the contents of the pyloric half were uniformly acid, only the outer layer

of the fundus was acid and so probably the seat of gastric digestion, the central part being alkaline and therefore still undergoing salivary digestion. The important fact that salivary digestion can continue for a considerable time in the stomach was also proved by Cannon and Day,¹⁸ who found that after a meal of starch had been given to a cat, an equal percentage of sugar was present in the cardiac and pyloric divisions of the stomach in half an hour, but 80 per cent. more was present in unit volume in the cardiac half than in the pyloric half at the end of an hour, thus showing that the food in the middle of the fundus remained unmixed with the acid gastric juice, which had stopped the action of the ptyalin of the saliva in the pyloric end.

These observations show that the order in which the chief courses of a dinner are arranged is physiologically suitable, as the part containing most carbohydrate comes last, and so remains for a time in the fundus where salivary digestion can continue, whilst the part rich in proteids passes quickly to the pyloric end of the stomach, where peptic digestion begins early and salivary digestion soon becomes impossible. The great importance of thorough mastication and the consequent efficient impregnation of the food with saliva is at once explained by these facts. When a farinaceous meal is bolted, only a very superficial layer of the masses of food can be digested by the saliva. The carbohydrate is then very liable to undergo bacterial fermentation with the production of flatulence and all its unpleasant results. This is prevented when salivary digestion can occur, as dextrin, the first product of the digestion of starch, is less easily decomposed by bacteria than starch, and maltose and dextrose, the final products of salivary digestion, are soluble and readily diffuse into the pyloric end of the stomach, where the presence of hydrochloric acid prevents the occurrence of bacterial decomposition.

The pyloric part of the stomach has a much thicker muscular coat than the cardiac part. The significance of this was first realized when it was found by Beaumont to be the seat of peculiar movements, which are never observed on the proximal side of the transverse band. On attempting to pass a long glass thermometer through the fistula into the pyloric portion of St. Martin's stomach during the later stages of digestion, the bulb was grasped at the transverse band by the stomach walls and drawn towards the pylorus so strongly that it required "a pretty forcible grasp to prevent it from slipping from the hand, and being drawn suddenly down to the pyloric extremity." In half a minute relaxation occurred, and the tube could be easily withdrawn.

In 1890 these observations received confirmation by Rossbach, who watched regular peristaltic waves passing from the centre to the pylorus in the exposed stomach of a dog. But Cannon was the first to study the exact nature of the movements of the pyloric part of the stomach under strictly physiological conditions. A few minutes after a cat has finished a meal of bread a constriction appears near the middle of the stomach, which deepens as it slowly progresses towards the pylorus. The waves recur at such intervals that three or four are always present simultaneously.

Holzkecht has described the movements as they occur in man in great detail, and his description accurately corresponds with what I have myself observed on a few occasions. About two inches from the pylorus the constriction which, steadily increases as it progresses reaches such a depth that the antrum pylori may be completely separated from the rest of the stomach. The part of the antrum cut off then begins to diminish in size in every direction, owing, perhaps, to the contraction of longitudinal muscle fibres in addition to the further progress of the peristaltic wave.

In man the peristaltic waves occur at regular intervals of fifteen to twenty seconds. The rhythm can occasionally be distinguished by auscultation as well as by means of the *x* rays. Cannon,¹⁹ listening over his own pylorus, heard loud, rattling, explosive sounds which occurred regularly every twenty seconds. They were most obvious after food of a spongy nature had been taken, and when he lay down on his back or left side. Though we have repeatedly tried to confirm this observation, we have only rarely succeeded. On one occasion I heard sounds answering to Cannon's description which recurred five times at intervals of twenty seconds; in another individual

I once heard similar sounds recur four times at intervals of eighteen seconds. I have also twice listened to the abdomen of individuals who had taken a special frothy meal, as recommended for the purpose by Cannon. In the case of one of them I heard a series of sharp pops repeated with perfect regularity every seventeen seconds for about five minutes; in the other I could distinguish no rhythmical sounds.

The peristaltic contractions of the pyloric division of the stomach serve a double purpose. Many of them, especially in the early stages of digestion, when they reach the pylorus, find it closed, so that a central reflux occurs, and the food is caused to circulate, with the result that it is broken up and thoroughly mixed with the gastric juice. The second function is to pass the contents into the duodenum whenever the pylorus opens. The strength of the peristalsis increases slightly as digestion progresses.

It does not vary appreciably according to the nature of the food so long as the quantity and consistency are unaltered. But the consistency of the food is probably of considerable importance. Thus the observations of Beaumont on introducing a large thermometer through a gastric fistula showed that mechanical stimulation can by itself excite peristalsis. Insufficiently masticated food must in the same way increase peristalsis, with the result that the muscles of the pyloric half of the stomach do the work which should have been performed by those of the jaws. The mechanical irritation of the mucous membrane thus produced is in all probability an important factor in the pathogenesis of the dyspepsia so often associated with insufficient mastication, whether from habit or from deficient teeth. The production of simple ulcers and of cancer of the stomach, both of which occur with far greater frequency in the region of the stomach where peristalsis is active than in the comparatively quiescent cardiac portion, is probably often in part due to the same cause.

Rieder and Holzkecht have both observed with the *x* rays that abdominal massage considerably increases the strength of the peristalsis in man. These experimental results afford a rational basis for the treatment of atonic dilatation of the stomach by means of massage. Exercise immediately after meals has, on the other hand, been definitely shown to delay the discharge of food from the stomach in both animals and man.

The pylorus is surrounded by a very strong ring of muscles, the sphincter pylori. This is normally in a condition of tonic contraction, variations in which regulate the passage of the gastric contents into the duodenum. The channel which connects the stomach with the duodenum is about $\frac{1}{2}$ in. long, and so narrow, even when it is relaxed, that either no shadow is cast by the *x* rays of bismuth passing through it (Holzkecht), or, as I have once observed, a very fine line joins the antral and duodenal shadows, when the latter is seen to be growing at the expense of the former. If the relaxed pylorus were less narrow, gravity and siphon action would be sufficient to empty the stomach, as the pylorus is normally almost if not quite its lowest point. But with a narrow pylorus peristalsis is required not only for mixing the food with the gastric juice, but also for pressing even finely-divided particles through it; in the case of larger particles and articles such as coins, which sometimes pass through, very strong peristalsis is required to overcome the resistance.

Cannon²⁰ found that if equal quantities of suet, lean beef, and rice, each prepared so as to have a similar consistency, be eaten by cats, the carbohydrate meal begins to leave the stomach within a quarter of an hour, whereas the proteid and fat meals do not begin to leave it for half an hour or even an hour. Carbohydrates, moreover, leave the stomach rapidly, no trace of a meal of rice or potatoes being left in a cat's stomach after three hours. Both proteids and fats leave more slowly, some being still present six hours after the meal, though egg albumen behaves like carbohydrates, and not like other proteid foods in this connexion.

A mixture of proteid and carbohydrates leaves the stomach in a manner intermediate between that of either taken separately. Fat, when added to proteid or carbohydrate, causes delay in the emptying of the stomach. This may be one cause of the indigestibility of pork and veal compared with mutton and beef. Proteid, taken after carbohydrate, leaves the stomach at the normal

rate, but carbohydrate taken after proteid leaves more slowly than when taken alone.

Beaumont suggested that the "compound fluid of gastric juice and aliment, or chyme, by its acquired acid properties," effects its discharge into the intestine. It is still generally said that the pylorus opens as soon as free hydrochloric acid appears in the stomach. But there is very little evidence for this statement, and there is no doubt that when water is drunk on an empty stomach it runs out before an appreciable amount of gastric juice has been secreted. Moreover, in patients with achylia gastrica there is often no undue delay in the emptying of the stomach. It is more probable that a neuromuscular mechanism exists, similar to that occurring at the cardia in swallowing, which causes the pylorus to relax each time a peristaltic wave reaches it, unless it is closed by a special reflex.

The reflexes, which cause the pylorus to close instead of to relax on the arrival of a peristaltic wave, depend for the most part on stimuli to the duodenal mucous membrane, as Hirsch²¹ and von Mering²² discovered independently by means of artificial duodenal fistulae, through which they were able to watch the entry of the gastric contents into the intestine. They believed that the stimulus was mechanical, being produced by the entry of food into the duodenum. But Pawlow and his fellow-workers showed that the stimulus is mainly chemical. Injection of gastric juice or 0.1 per cent. of hydrochloric acid through a fistula into the duodenum caused the flow of gastric contents through the pylorus to cease, but water and neutral or alkaline saline solutions had no such effect.

The result of this chemical reflex is that no more of the acid contents of the stomach enter the duodenum until the part which arrived last is neutralized by the pancreatic juice and bile, the secretion of which is called forth by the presence of acid in the duodenum. This mechanism is of great importance, as it keeps the reaction of the small intestine below the opening of the common bile duct alkaline, and so allows digestion by the pancreatic ferments to proceed, and at the same time it protects the mucous membrane from the liability to ulceration, which is associated with the acid reaction of the contents of the stomach and the first part of the duodenum.

Pawlow found that the stomach empties itself abnormally slowly if the neutralization of the gastric contents is prevented by the escape of the pancreatic juice through a fistula; this may be one cause of the digestive disturbances which follow obstruction to the common bile duct in man. On the other hand, Tobler found that if the acid contents of the stomach were allowed to leave the duodenum by a fistula as soon as they had passed through the pylorus so as to prevent its reflex closure, the gastric digestion of meat continued for a shorter period and was consequently much less complete than under normal conditions.

Von Mering discovered that injection of milk into the duodenum caused the passage of the gastric contents through the pylorus to cease until it had disappeared from the upper part of the intestine. He looked upon this as a mechanical reflex, but Pawlow has proved that it depended on the presence in the milk of fat, which he showed produces the same reflex as hydrochloric acid when it comes into contact with the duodenal mucous membrane. But the presence of fat in the duodenum does not produce such a tight closure of the pylorus as that caused by hydrochloric acid. Thus, although injection of oil into the duodenum causes the regular jets of gastric contents, which would otherwise occur each time a peristaltic wave reaches the pylorus, to cease, single drops still issue without intermission from the pylorus. The closure of the pylorus is also not sufficiently tight to prevent the regular production of a reflux of oil mixed with bile and pancreatic juice into the stomach.²³ The result of this is that food containing sufficient fat to inhibit the flow of gastric juice remains a long time in the stomach, where it may be partly digested by bile and pancreatic juice.

Advantage has recently been taken of this remarkable occurrence by giving a small quantity of oil by mouth when the stomach is empty in order to obtain a specimen of the pancreatic juice and bile, when it is desired to find whether they are normal. For the oil inhibits the secretion of gastric juice, and as soon as a little reaches the

duodenum it excites the flow of bile and pancreatic juice, with which some of it regurgitates into the stomach. This also explains the success which has attended the treatment of gastric and duodenal ulcers by the administration of cream and oil, as recommended by Senator and others in Germany and recently tried by me with excellent results. In patients who are able to take sufficient quantities, much more nourishment can be supplied than by means of nutrient enemata, and at the same time the contents of the stomach and duodenum are kept alkaline, so that an ulcer has a better chance of healing than when nutrient enemata are alone given, as the latter have recently been shown to excite a flow of gastric juice.

The passage of food through the pylorus is not, however, regulated by reflexes from the duodenum alone. Similar reflexes are produced when the mucous membrane of the stomach comes into contact with substances which, owing to their physical or chemical properties, might injure the duodenal mucous membrane. Thus, Cannon with the x rays observed that the presence of a solid pellet in the food delayed the emptying of the stomach, as the pylorus closed for a time after a peristaltic wave carried the pellet against it. The result is that indigestible masses remain in the stomach until all the fluid and semi-fluid contents have left, so that more time is given to the gastric juice to soften and the gastric peristalsis to break up the insufficiently chewed food.

By a similar protective mechanism fluids at higher or lower temperatures leave the stomach less rapidly than fluids at the body temperature, so that there is time for them to reach the body temperature before they enter the duodenum (Joh. Müller²⁴). Moreover, Otto²⁵ has shown that pure water and anisotonic saline solutions remain longer in the stomach than isotonic solutions, so that the former can become isotonic by osmosis, diffusion and admixture with the gastric juice before passing through the pylorus. Lastly, Moritz²⁶ found that beer leaves the stomach much more slowly than water.

These facts show that the stomach has a function which is generally not recognized; it protects the duodenum from abnormal stimuli by retaining food until it is changed so as to be less injurious to the delicate intestinal mucous membrane. Proper chewing will spare the stomach most of its work; it will divide the food into fine particles, dilute it, and bring it to the body temperature.

When an ulcer is situated in the pylorus, or just on the gastric or duodenal side of it, the stomach frequently dilates and stasis of food occurs, even before any cicatricial contraction has taken place. This is generally said to be due to reflex spasm of the pylorus. More probably it is due to reflex inhibition of the relaxation which normally occurs on the arrival of a peristaltic wave, and is therefore no more a condition of spasm than the condition produced by the presence of acid or fat in the duodenum. It is, indeed, doubtful whether spasm of the pylorus ever occurs.

Note on the Administration of Bismuth Salts for the Skiagraphic Examination of the Stomach and Intestines.

Until recently it was believed that bismuth salts could not be taken safely in doses larger than half a drachm, or at most a drachm. This idea seems to have been handed down from the period when bismuth compounds were generally contaminated with arsenic, the poisonous action of which was erroneously ascribed to the bismuth. Rieder was the first to show that large doses of pure bismuth salts can be taken without danger. We have given bismuth carbonate in amounts varying between 1 and 2 oz. on about fifty occasions, without ever observing the smallest ill effect, with one unimportant exception, when an individual experienced slight nausea, which only lasted a short time, after taking 2 oz. of the salt in milk. On no single occasion was constipation or any other disturbance in the normal activity of the alimentary canal produced, so that the time relations obtained by means of the x rays, which are described later, can be looked upon as normal and uninfluenced by the bismuth meals. The bismuth is best taken well stirred up in a bowl of bread and milk, when it is not at all unpalatable. It may also be taken in the form of bread made from flour which has been mixed with bismuth carbonate.

Worder, Sailer, and Pancoast²⁷ report six cases in which alarming symptoms of poisoning were observed after two to four ounces of perfectly pure bismuth subnitrate had been given for diagnostic purposes. But the symptoms, which came on from one to four hours after the bismuth had been

given, whether by mouth or rectum, were probably produced by the acid, and not by the base of the salt, as no similar accidents have occurred when the carbonate has been given, and the symptoms were quite unlike those generally produced by acute poisoning with heavy metals. The reporters of these cases suggest that some nitrite was formed by intestinal fermentation from the subnitrate, as the symptoms (nausea, cyanosis, prostration, full bounding and rapid pulse, fast respiration) were similar to those of nitrite poisoning.

Mr. Finnemore, Pharmacist to Guy's Hospital, has kindly investigated the question for me from the chemical standpoint. He writes: "Two grams of bismuth subnitrate were added to 50 c.c. of 0.25 per cent. HCl (to represent the gastric juice) at a temperature of 38° C. In eight minutes a portion was filtered off, and only a trace of HCl was found in the filtrate; in fifteen minutes no HCl was present. On testing the filtrate, however, it was found that HNO₃ was present, and on titration it was proved to be nearly of the same strength as the HCl originally employed. The reaction which occurs is

If insufficient HCl is present in the stomach to act on all of the very large doses of bismuth nitrate given, the residue of the salt would be converted by the alkaline juices in the intestines into the oxy-carbonate with simultaneous formation of sodium nitrate. The nitric acid would be rapidly absorbed and would circulate as sodium nitrate, and all the sodium nitrate formed in the intestines would also be absorbed. From four ounces of the subnitrate of bismuth one ounce of sodium nitrate would be formed. It has been proved that when large doses of nitrates are taken, a small proportion is excreted as nitrite. Hence it is quite conceivable that when half an ounce, or an ounce, of sodium nitrate is absorbed into the circulation, sufficient nitrite would be formed from it to give rise to serious symptoms of poisoning.

In view of the fact that two ounces of bismuth carbonate produce no constipation in normal individuals, it becomes a matter worthy of further investigation how the ten grains (one ninety-sixth part of the dose!), so often given with apparent success in cases of diarrhoea, can act.

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(To be continued.)

ON A SPECIAL FORM OF DILATATION AND DISPLACEMENT OF THE STOMACH.*

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[Dr. Short commenced his paper with some preliminary remarks on the monotonous, if not unsatisfactory, treatment of flatulent dyspepsia, and then drew attention to a particular form of the disorder which occurs in young or youngish people, which seemed to him to be a distinct condition amenable to treatment. He then proceeded as follows:]

The condition to which I wish to draw attention is associated especially with periodic attacks of severe pain—pain of a very acute type—relieved if the patient can vomit, but usually accompanied by an inability to vomit. In the intervals between the painful attacks discomfort, and especially flatulence, occurs, the latter making its presence known, not only by distension, but also by audible rumblings. There is also a want of proper assimilation of the food taken, as evidenced by loss of flesh, debility, and great depression of spirits, verging at times on melancholia. In investigating a large number

of such cases I have found that the condition present is dilatation, with displacement downwards of the stomach, and in this paper I propose to deal with the causes, diagnosis, and treatment of this particular form of dyspepsia.

It will probably conduce to simplicity if I describe a typical case and then take the main points in detail.

Miss B., aged 28, came to see me, complaining of severe palpitation with a feeling of distension occurring periodically, and associated with acute pain in the pit of the stomach. She was a clever, well-educated woman, and was manageress in the warehouse of a wholesale printing and stationery business. The nature of her work entailed long hours of standing and hurried meals. She was very depressed mentally, and was becoming almost melancholic. The attacks of palpitation were not always accompanied by pain, but on some occasions great difficulty of breathing was experienced, with cough and wheezing in the chest. The painful attacks were so severe that at times she had been known to roll about on the floor of the warehouse. No vomiting had occurred at any time. The attacks were always worse after her periods. Between the attacks she was fairly well, but was gradually losing flesh. The proprietor of the business—herself a woman—thought the case might be one of hysteria and sent her to a gynaecologist, who reported that nothing abnormal could be found in the uterus and appendages. When I saw her the stomach was much distended, and examination showed the lower border to be an inch below the umbilicus. It was dilated, but not excessively. After a course of treatment presently to be described she entirely recovered.

This is a fairly typical case of the kind I am taking as my subject to-day. I have notes of 28 more or less similar cases, all of which have been benefited if not cured by treatment.

CAUSES.

Dilatation due to pyloric obstruction or to the atonic gastrectasis of old people is not dealt with in this paper.

Sex and Age.—The condition I refer to occurs in both men and women, usually below 40 years of age, and frequently between 20 and 30. In one of my cases, a young man aged 22, the lower edge of the stomach was found to be 2 in. below the umbilicus.

Carious Teeth.—The most common cause I have found to be absence or inefficiency of the molar teeth. From this cause the stomach gets overloaded with improperly-masticated food. If the want of molar teeth is associated—as it often is—with rapid eating and large meals at infrequent intervals, the condition is even more likely to occur.

Erect Posture.—Add to these, long hours of standing commencing directly after meals, and the conditions suitable for the production of the complaint are all present. It is in young men and women who serve in shops, young wives who are on their feet nearly all day, clerks and salesmen and others following similar avocations, that these special conditions are fulfilled.

Ill-health and general debility are also conducive, but usually are the results and not the actual cause. When present, however, they help to form the vicious circle.

Neurasthenia.—It has been stated that neurasthenia and allied states are the cause of dilated stomach. Without denying that such may occur in rare instances I can certainly state that I have not met with a case in which the first symptoms have not pointed to insufficient assimilation of food preceding the nervous symptoms. I believe that in by far the greater number of cases the neurasthenia is the result and not the cause of the dilatation. Quite recently I have examined the stomach of a gentleman who was placed in a private asylum on account of severe melancholia, and found that the lower border of the stomach was 4 in. below the umbilicus. The greater part of it was in the left iliac fossa. In several of the cases that are included in my paper the extreme depression of spirits was the cause of their seeking advice and the stomach symptoms were put by the patients into a secondary position.

SIGNS AND SYMPTOMS.

In addition to the continual flatulence and occasional pain the patient feels miserable. There is a dragging-down feeling as if something has given way, and several patients have volunteered the statement that after food their stomach felt to them to be too low, and to be "dragging their insides downwards."

If they should be fortunate enough to be able to vomit, the distressing symptoms are greatly relieved,

* Abstract of a paper read before the Birmingham Branch.