restore the hearing to what it was before the infection, but, in certain cases, should even raise the hearing to a more efficient level.

The preservation and improvement of the hearing in mastoid operations demand early and careful operations and rapid convalescence. Lesions of the labyrinth capsule through intratympanic interventions, and especially by the radical operation, can undoubtedly provide the cause for a suppuration of the labyrinth. In such cases, meningitis is imminent and can be averted only by a timely labyrinth operation. Rapid convalescence is assured by following the rules to remove all diseased tissue and to operate as aseptically as possible and to leave no devitalized tissue, such as shreds of connective tissue or detritus in the wound in the shape of bone chips or threads of gauze.

WHEN TO OPERATE TO PRESERVE HEARING

We have learned that in a dense mastoid the suppuration does not tend to resolution, but to continuation and to the development of the dangerous complication of mastoiditis. We have also learned that in a pneumatic cellular mastoid, inflammation goes on either to abscess formation or to resolution. We have learned that in mastoids partly dense and partly pneumatic, with the dense areas occurring near the antrum, the behavior of infection is identical with that of the wholly dense mastoids. These observations show that with inflammation of the antral region shown by inspection, palpation, skiagram, etc., a mastoid operation is indicated in all but the pneumatic bones, and in them when mastoid abscess has been formed. That is, in the pneumatic mastoid, operation should be delayed until the formation of abscess; in the dense mastoid, suppurative inflammation of the mastoid is sufficient indication for mastoid operation, and we should not wait for abscess formation.

The conditions of the ear on inspection favoring operation are fluctuation in the mastoid region, edema over the mastoid region, edema of the osseous canal wall, localized sagging of the inner end of the canal wall, bulging of the tympanic membrane, purulent discharge, pain on pressure in the mastoid region, perforation of Shrapnell's membrane, septic appearance of the patient, and eye-grounds indicating intracranial extension. The nature of the bacterial infection is of interest. In order of their increasing virulence are the staphylococcus, pneumococcus, *Bacillus pyocyaneus*, streptococcus and *Streptococcus mucosus* (or *capsulatus*). The last is extremely virulent and at the same time the symptoms are latent. Mastoid operation is indicated in *Streptococcus mucosus* (*capsulatus*) infection if the ear shows any of the objective symptoms of mastoid infection, and also if the discharge from the ear continues three or four days after the commencement of approved surgical and antiseptic treatment of the middle ear. In obscure cases the differential blood-count is of value. General symptoms favoring mastoid operation are rise of temperature to 100 or more, subnormal temperature (98 or less) or rectal temperature.

The skiagram of the mastoid region favors operation when it shows collections of pus and obscuring of the mastoid cells, or when it shows a mastoid antrum walled about with diploetic or dense bone. Of course, a combination of these conditions points still more strongly to the desirability of a mastoid operation.

In these days there is little excuse to delay operation in purulent middle-ear inflammation after incision of the drum-membrane, if the purulent discharge persists for four or five days in conjunction with a solid mastoid

as shown by skiagram. In these early operations the hearing is preserved.

In otology, as in all other branches of medicine, it becomes constantly more important to consider the modification and adaptation of certain stereotyped operations, according to the needs of the individual case. Conservation of parts is the watchword. In mastoid surgery, the preservation of hearing is assured by two things: (1) the preservation of the parts of the mechanism of hearing and (2) the avoidance of cicatrices and adhesions through rapid convalescence.

Now that we have achieved the preservation of life in mastoid operations, we must cooperate for the next triumph, the preservation of the hearing in all cases. And I believe that, in the main, the preservation of hearing will be accomplished through the health of the nasopharynx.

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THE INFLUENCE OF GASTRO-ENTEROSTOMY ON GASTRIC AND DUODENAL ULCERS

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It is generally conceded that gastro-enterostomy exercises a favorable influence on open ulcers of the stomach situated in the antrum or at the pylorus, and on open ulcers of the duodenum. By this is meant that it establishes conditions favorable to the healing of ulcers which have resisted all other known forms of internal treatment. It is likewise recognized that this procedure has no effect on ulcers situated in parts of the stomach other than those just mentioned. It is furthermore admitted that the good effects of gastro-enterostomy on ulcers in the antrum, pylorus or duodenum are not always a lasting one; that recurrence or recrudescence of the ulcer takes place in at least 45 per cent. of the cases. It is well to state these facts at the outset, and with the lessons taught by them proceed to change or modify the operation of gastro-enterostomy as applied to the cure of gastric or duodenal ulcer.

As we do not know the etiology or pathogenesis of gastric or duodenal ulcer, it is difficult to state definitely how or in what manner our therapeutic procedures exercise a healing influence on them. This is not quite true of the effect of gastro-enterostomy; for the creation of a new opening between the stomach and uppermost part of the jejunum can exercise an influence on antral, pyloric or duodenal ulcer in only two ways: either by side-tracking the food contents of the stomach away from the pyloric area into the jejunum, or by permitting a reflux into the stomach of such contents as are contained in the jejunum proximal to the seat of the new anastomosis.

Gastro-enterostomy favorably affects ulceration of the stomach by one of these means alone or by both together, and it is decidedly worth while to discuss this subject in its minutest detail. This discussion will help to correct erroneous ideas that some may have as to the movement of gastric contents after gastro-enterostomy, and may help us to understand why ulceration in some parts of the stomach is benefited by gastro-enterostomy, whereas it is not at all favorably influenced when it is located in other parts of the organ, and finally why

ulcers that have presumably healed after gastro-enterostomy recur several months or years later.

As to the movements of the gastric contents after gastro-enterostomy, it is an almost general opinion of medical men, surgeons as well as internists, that after gastro-enterostomy there is a change in the course which the food takes in going from the stomach into the intestines; to wit, that all the gastric contents leave the stomach through the new opening, and practically nothing passes through the pylorus into the duodenum. It is thought that the stomach is normally a passive reservoir during digestion, and that the creation of a new opening at the most dependent point of the organ causes the gastric contents to gravitate through it into the small intestine. The operation of gastro-enterostomy is thus looked on as a drainage operation, and the surgeon has been enjoined to make the new stoma at the lowest point of the stomach, and to place the patient in the upright position immediately after recovery from the anesthetic, thus to facilitate emptying of the stomach by gravity. Let us see how much of this is true. In the first place, the stomach as long as it retains its normal tone is never a passive reservoir; on the contrary, when food is present within the viscus the cardiac end is always exerting a positive pressure on it, and the pyloric end is the seat of continuous peristaltic movement. Furthermore it is impossible to make the new opening at such a point in the stomach that in the changing positions of the organ the opening will always be at its most dependent part, and, finally, it has been experimentally proved that the hydrostatic conditions in the abdominal cavity are such that gravity drainage from the stomach is impossible. As a proof of this last statement it has been experimentally shown that when a gastro-enterostomized stomach is filled with water, the latter does not run out by itself even though the animal is in an upright position. It is also most important to remember that material never moves along any part of the alimentary canal unless the pressure is greater on one side of it than the other. Kelling¹ has determined experimentally and I have found in the human subject that the chyme always takes its normal passage through the pylorus if the latter is patent rather than through any artificial opening. In view of these facts we must conclude that if the pylorus is patent the new anastomotic opening serves no purpose for drainage or for side-tracking of the gastric contents into the jejunum. All of the gastric contents pass through the pylorus when it is patent in spite of the fact that we have a wide, sufficient communication between the stomach and the jejunum. Only when the pylorus is closed do the contents of the stomach pass through the anastomotic opening into the jejunum, and the tighter the closure of the pylorus the more completely do the contents pass through the new anastomotic orifice.

How can we apply these considerations to the question of the influence of gastro-enterostomy on gastric ulcer? If the ulcer is situated in the pyloric end of the stomach, at the pylorus or in the first portion of the duodenum, there is invariably attendant on the ulcer a spastic condition of the pyloric muscle which more or less completely closes this orifice. It is unnecessary for us at present to speculate as to whether the spasm is primary to the ulcer or whether the ulcer produces the spasm, though it is my opinion that the spasm of the pylorus is a purely reflex result of the presence of the ulcer. In substantiation of such an assumption I would

simply recall the fact that an ulcer or fissure of the anus is invariably attended with a spasm of the sphincter muscle of the rectum; that a fissure at the angle of the mouth is invariably attended with a spasm of the orbicularis oris; and that ulceration at the ileocecal orifice causes a spasm of the muscular fibers at this part of the intestine.

It might also be mentioned here that when the ulcers in the stomach are not situated at or near the pylorus we do not find any such spasm of the pyloric muscle, which is exactly in accordance with ulcerative conditions situated at a distance from the anal sphincter, oral sphincter or ileocecal orifice.

To come back then to the subject under discussion, I have stated that ulcers situated in the pyloric region are invariably attended with a spastic condition of the pyloric muscle which more or less completely occludes the pyloric orifice. When such spasm is present the effect of gastro-enterostomy is exactly the same as when the pylorus is organically closed by stricture or by tumor, and in such a case the gastric contents after gastro-enterostomy no longer pass through the pyloric orifice, but are more or less completely evacuated through the new anastomotic orifice. The ulcerated area of the stomach is thereby guarded from the constant irritation of food, and healing is thus favored.

Let us now go a step further. After healing of the ulcer takes place the spasm of the pyloric sphincter muscle relaxes; the pylorus again becomes patent; the stomach contents no longer pass through the new anastomotic orifice, but through the patent pylorus. Is it any wonder then that if the original cause of ulcer still exists, the traumatism produced by the food constantly passing across the old ulcerated area at the pyloric orifice should favor a recurrence or recrudescence of an apparently healed ulcer?

Furthermore, as the tendency is a strong one when the pylorus is patent for the new stoma to contract and even close spontaneously, we cannot assume that the creation of a new opening between the stomach and bowel acts as a prophylactic against the possible recurrence of an ulcer.

If the ulcer is located in the stomach elsewhere than at its pylorus or the first portion of the duodenum—that is if it is situated on the lesser curvature, near the cardiac or in the fundus portion of the stomach—we cannot expect gastro-enterostomy to have any influence on it for with such an ulcer not only is there no side-tracking of the gastric contents through the new stoma, since the pyloric orifice is not the seat of a reflex spastic closure but even if there was a complete diverting of the food into the jejunum, such a condition would not protect the ulcerated area in the body of the stomach or cardiac region from the constant irritation of the food passing over it. In such cases the new stoma soon contracts and closes without having produced any effect on the ulcerated area.

Therefore we must conclude that gastro-enterostomy can accomplish good only in such ulcers as are situated in the antrum, pylorus or first part of the duodenum—ulcers that are always attended with pyloric spasm in consequence of which the pyloric orifice is closed. In virtue of such pyloric closure the operation of gastro-enterostomy is able to divert the food contents from the ulcerated area and thereby afford to it rest and freedom from irritation; when gastro-enterostomy does not afford such protection from trauma to the ulcerated area, as when it is situated in other parts of the stomach, it will have no favorable influence on the healing process.

1. Ann. Surg., 1907.

Let us now turn to the second method in which gastro-enterostomy may favorably influence a gastric ulcer, namely, by reflux of duodenal contents proximal to the site of the anastomosis into the stomach. It would be hard to say that such reflux is present in all cases after gastro-enterostomy, but in almost all the cases in my experience such reflux was present, as proved by the fact that bile and pancreatic juice could always be evacuated from the stomach by means of the stomach-tube. It was formerly thought that the presence of bile and pancreatic fluids in the stomach was evidence of a vicious anastomosis between the stomach and the intestine, but clinical experience has long since taught us that the presence of bile and pancreatic juice in the stomach after gastro-enterostomy is the rule rather than the exception, and that the stomach bears such reflux of contents very well. The contents of the duodenum and jejunum proximal to the site of the anastomosis are chiefly bile and pancreatic juice, and the secretions of the duodenal and jejunal walls. Such contents are strongly alkaline in character. This strong alkalinity neutralizes the hyperacidity of the gastric contents which is attendant on most cases of gastric ulcer, and there can be no question that immediate relief of this distressing symptom is affected by gastro-enterostomy. It is not at all unusual for patients to state immediately on recovery from the anesthetic that the hyperacidity from which they suffered prior to the operation had been relieved, and it is reasonable to assume that this relief is due to the neutralization of the hyperacid gastric contents by the reflux of the strongly alkaline contents through the anastomotic opening.

Does such neutralization of gastric contents promote the healing of the ulcer? If this were the case we would expect that occasionally an ulcer situated at sites other than the antrum, pylorus or first part of the duodenum would be favorably affected by gastro-enterostomy, for surely the entire contents of the stomach are neutralized, and there is no reason why ulcers at the lesser curvature, cardiac end or fundus of the stomach should not be as favorably influenced in this way as are ulcers in the pyloric region. In the absence of such beneficial influence on ulcers other than in the pyloric region we cannot assume that the reflux of intestinal contents into the stomach with the attendant neutralization of a coexisting hyperacidity is the cause of healing.

There is one other way in which gastro-enterostomy may favorably influence gastric ulcer, and I do not bring it forward prominently because of the insufficient experimental and clinical data on which my theory would rest.

As stated at the outset of the paper, we have no exact knowledge of the causation and pathogenesis of gastric ulcer. Recently, however, several experimental workers have advanced the theory that gastric and duodenal ulcer are due to infective states of the stomach and duodenum; that given a minute or gross defect in the gastric mucosa produced by trauma or other cause, such minute or gross defects will grow into ulcerations, provided the stomach contains pathogenic bacteria. If this theory proves to be true we could understand how gastro-enterostomy exerts additional good influence on gastric ulcers, for with a closed pylorus and thereby a closed stomach cavity, the pathogenic bacteria in the stomach rise to a high degree of virulence, and thus keep active the ulcerating process. The establishment of a new gastro-enteric opening by facilitating discharge from, and emptying of, the stomach will also diminish the virulence of its contained bacteria, and so promote a healing of the ulcerated area. There is no question whatsoever that

when such infective processes exist in conjunction with ulcers, as has happened in my experience, the symptoms of the ulcer and the evidences of the infection have been relieved by gastro-enterostomy.

To sum up: Gastro-enterostomy is of value only in pyloric, antral or duodenal ulcers that are attended with pyloric spasm, and it has absolutely no value in ulcers situated in other parts of the organ, though immediate relief from the distressing symptom of hyperacidity is effected by gastro-enterostomy in all cases of gastric ulcer, wherever the ulcer is situated.

Furthermore, since when the pylorus becomes patent, the gastro-enteric orifice tends to contract and close, the tendency of recrudescence or reformation of ulcer is always present, provided the primary exciting cause still exists.

It is now worth while to see whether or not we can prevent the recurrence or recrudescence of those ulcers that are favorably influenced by gastro-enterostomy: The high percentage of recurrence, the tendency to malignant degeneration of the ulcer, has led surgeons and internists alike to the conclusion that it were better to excise the ulcer, or to do pylorotomy in place of gastro-enterostomy. There can be no question as to the advisability of excising an ulcer that is favorably situated in the antrum, pylorus or duodenum, not so much to prevent recurrence of the ulcer, for it has not been the experience that excision alone protects against recurrence, but rather to prevent a possible malignant degeneration of the ulcerated area.

For the time being, however, we are concerned chiefly with the thought of how to prevent the recurrence or recrudescence of healed or healing ulcerations in the pyloric region. It has been clinically found that pylorotomy is a far greater safeguard against recurrence than is gastro-enterostomy or excision alone, but pylorotomy has a mortality of from 12 to 14 per cent. under the most favorable conditions, whereas gastro-enterostomy has a mortality of from 1.5 to 2 per cent. under similar circumstances, and the conscientious surgeon must always be in doubt when facing an ulcer of the stomach whether it is not more advisable to do a simple gastro-enterostomy with its low mortality, than a pylorotomy with its much higher death-rate. Is there not a way in which we can obtain the same good effect of lasting cure by gastro-enterostomy as by pylorotomy?

This we can answer in the affirmative, by the operation of gastro-enterostomy with pyloric exclusion.

This consists of gastro-enterostomy practiced as usual, with the addition of an exclusion of the antrum, pylorus and duodenum by means of a purse-string ligature of heavy linen thread passed round the stomach just proximal to the antrum, and tied snugly enough to occlude the stomach at this point, without constriction of its walls or its circulation. Instead of a ligature we can enfold, by means of several layers of suture, the stomach wall at the selected point, and thereby exclude the antrum, pylorus and duodenum from the rest of the stomach cavity.

This operation of pyloric exclusion I have practiced many times since 1901, for various conditions; for bleeding ulcers situated in the pyloric region, for duodenal fistula or accidental wound of the duodenum, and for simple or callous ulcer in the pyloric portion of the stomach. I have practically never seen any bad results from such occluding ligature or occluding set of sutures. In one case in which a ligature was applied by a colleague it cut through the gastric wall, either because it had been tied too tightly or because the gastric wall at

the site at which it was applied was infiltrated and brittle. The passage of such an occluding ligature does not in any way increase the mortality which is attendant on gastro-enterostomy, nor does it materially increase the time of the operation. It takes but a few minutes to pass such an occluding ligature. It effectually and permanently excludes the antral end of the stomach and duodenum from the passage of stomach contents through them.² In the presence of such a ligature all the contents of the stomach must pass through the gastro-enteric orifice. As such an occlusion is a permanent one, the gastro-enteric orifice does not close, and therefore there can be no recrudescence or recurrence of ulcer as when simple gastro-enterostomy is established and the pylorus becomes patent. Von Eiselsberg has modified this operation of mine by completely dividing the stomach proximal to the antrum, and closing both ends with a double row of sutures. I can find no advantage in such modification. On the contrary, it carries with it the additional risk of infection, and thereby tends to increase the mortality connected with gastro-enterostomy.

As previously stated, I have found the occluding ligature always safe and easily applied. I am accustomed to pass a heavy Pagenstecher thread behind the stomach, just proximal to the antrum, then to thread this ligature on a curved needle, take one or two stitches through the peritoneum and muscularis of the anterior wall of the stomach, just to prevent the ligature from sliding, and then slowly tie the ligature, being careful to bring the mucous walls of the stomach together, but not to constrict the circulation of the organ. The mortality of this operation is exactly the same as that of gastro-enterostomy. It has all the advantages and none of the disadvantages of pylorotomy. It is the only way in which, on the basis of preventing the passage of food through the patent pylorus, we can prevent the recrudescence or reformation of gastric ulcer.

In closing this paper I especially wish to emphasize the following points:

Simple gastro-enterostomy can influence pyloric or duodenal ulcer only when there is an attendant pyloric spasm. In the absence of the latter all the food passes through the patent pylorus, even though a gastro-enterostomy is present and so the ulcerated area is not protected from trauma.

The reflux of duodenal contents into the stomach is a natural attendant on gastro-enterostomy, and serves to alleviate the distressing symptom of hyperacidity, but it does not favor the healing of the ulcer.

Gastro-enterostomy will not protect against a recurrence of the ulcer. Barring the question of malignant degeneration of a healed or healing ulcer, excision of an ulcer has no particular merit over a gastro-enterostomy toward preventing recurrence or recrudescence.

Pylorotomy does protect against recurrence, but it has an attendant higher mortality. Gastro-enterostomy with pyloric exclusion favors the healing of the ulcer, and has the same value in preventing recurrence as has pylorotomy, with the great advantage over the latter of a very low mortality.

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2. Shown by x-ray bismuth plates and secondary operations.

SOME FEATURES OF THE THEORY AND PRACTICE OF MEDICINE DURING THE SEVENTEENTH CENTURY

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(Concluded from page 820)

HARVEY AND SYDENHAM

Of the theory itself of the circulation I shall not have to speak in detail. The children of to-day in the intermediate grades of the public schools know better than the great teachers of anatomy whom I have mentioned the course of the blood from the left ventricle through the arteries, capillaries and veins back in a circle to the right ventricle and through the lungs. Indeed, they know it better than Harvey himself knew it, for even to him a complete demonstration was denied, since it was not until 1661 that Malpighi observed with a microscope the passage of the blood through the capillaries, whose continuity with the arteries and veins Marchetti finally proved by injecting them. Harvey affirmed his conviction that such a communication must exist, but it was on this ultimate demonstration that his discovery finally rested.

The effect of Harvey's publication on his own life and on his practice possesses but little interest for us now. How he was buffeted and abused and reviled is a matter of personal record that I, fortunately, shall not have to transcribe. Something of the same feeling, though far less bitter and less enduring, was expressed 245 years later toward Lister, when he first announced his belief in wound-infection. His own university (the University of London) regarded him as a heretic, and the earliest recognition that he received came to him from the countrymen of Pasteur and from those of Virchow. The whole miserable story concerning Harvey is better forgotten.

The effect, however, on the theory of medicine was startling enough. The whole structure was shaken and much of it was destroyed. The theory of "natural spirits," of "vital spirits" and of "animal spirits" disappeared from medical terminology, though the phrases remained embalmed in current speech. The doctrine of the humors, once so predominant, gradually faded into insignificance; Galen was discredited, and the tyranny of authority was forever broken; the four elements, earth, air, fire and water, and their four conditions, hot, cold, moist and dry, began to give place to a new conception of the working of the body, and physiology, the study of vital functions, came for the first time under experimental observation. Picquet, at Montpellier, in 1647 traced the lacteals to the receptaculum chyli and demonstrated that the thoracic duct empties into the left subclavian vein; Peyer and Brunner discovered the intestinal glands; Schneider proved that the nasal mucus came from the membrane lining the nostrils and not from the brain through the cribriform plate; Wirsung found the duct of the pancreas; Highmore described the structure of the testicles and the seminal ducts, and Needham studied the functions of the ovaries. The tourniquet was invented by Morel during the siege of Besançon in 1674, and the obstetric forceps was invented by Peter Chamberlain about 1630. The progress that medicine made in the seventeenth century was marvelous. The discovery of the circulation was found to be the key to whole departments of medical knowledge.

The respiration still remained a mystery. It had been thought that as the heart and stomach possessed an

The Rectum Not a Fecal Storehouse.—The rectum is not normally a fecal storehouse, although through habit it often becomes so, especially in the female. Examination of the male for service in the army shows the rectum usually empty.—William J. Mayo in *American Journal Medical Sciences*.