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Author.

ON AN EXPERIMENTAL DEMONSTRATION OF
THE VALUE OF GASEOUS ENEMETA IN THE
DIAGNOSIS OF PERFORATIONS OF THE IN-
TESTINES, AND THEIR REPAIR BY THE RUB-
BER RING AND DECALCIFIED BONE PLATE
METHOD.

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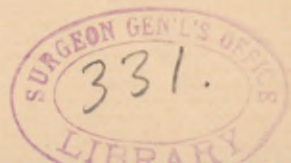
BY R. HARVEY REED, M. D., MANSFIELD, OHIO.

We do not claim any originality for the experiments we shall endeavor to show you this afternoon.

To Professor N. Senn of Milwaukee belongs the honor for all the originality pertaining to these experiments; but as we cannot have a Senn in every state to attend our meetings, the next best thing we can do is to repeat his interesting and important experiments, and by these means endeavor to impress on every member present here to-day their scientific importance and practical utility.

The first experiment will consist in etherizing a dog, and by rectal injections of hydrogen gas, show you that this gas can be passed the entire length of the alimentary canal, and be burned at the end of a stomach tube inserted into the dog's stomach.

The second experiment will consist in etherizing another dog, opening the abdominal walls, and making a perforated wound of the intestines, which we will again replace in the abdominal cavity, and by rectal injections of hydrogen gas we will be enabled to show you that the



gas will escape at the perforation of the intestine into the peritoneal cavity, and from there through a glass tube inserted into the abdominal wound, from which it may be readily burned.

We will then take the same dog and make a resection of the intestine, and unite the upper and lower ends of the same by the rubber ring method.

The third experiment will consist in etherizing another dog, after which we will shoot him through the abdomen, and then by applying the hydrogen gas test, demonstrate to you positively whether the bullet perforated the intestine or not; we will then repair the wounded intestine by Professor Senn's decalcified bone plate method.

By repeated experiments Professor Senn has demonstrated that pure hydrogen gas is absolutely harmless when injected into the intestinal canal, and he has also demonstrated by repeated experiments that it is innocuous when brought in contact with the peritoneal cavity.

By experiments on the cadaver he has demonstrated that it requires from eight to ten pounds pressure to the square inch to rupture the bowel at its weakest point, while it only requires from one-quarter pound to one and a half pounds pressure to the square inch to force the gas the entire length of the intestinal canal.

By taking an ordinary gas bag filled with hydrogen gas, you will find by the use of the manometer that two hundred pounds placed on the gas bag will register about three pounds on the manometer, which enables us to calculate very accurately the amount of pressure we are making on the intestinal walls by a given amount of weight on the gas bag.

Then by knowing the amount of pressure it requires to rupture the intestine, and the pressure it requires to inflate the entire canal, we have our bearings so firmly established as to easily avoid all points of danger from over pressure.

Now, gentlemen, here is what my friend, Dr. Baldwin, calls a "cur of low degree," which has been etherized.

I will now ask Dr. Craig to insert the stomach tube while I insert this rectal tube attached to the rubber hose of the gas bag, on which my assistant, Dr. Barker, is sitting.

The doctor will now turn on the gas, which you will notice has already commenced to distend the abdomen, and were you all close enough you would soon hear the gas pass the ileo-cæcal valve, which makes a hissing sound as it passes through.

It will take a moment for the gas to inflate the small intestines and stomach, when it will escape from the stomach tube.

If Dr. Larimore will now touch a match to the end of the stomach tube, I think you will find the gas escaping already. [A match was touched to the end of the tube and lit the gas, which burned several inches high.]

There, gentlemen, is positive proof that the gas has passed the entire length of the alimentary canal, notwithstanding the theories we have been taught concerning the ileo-cæcal valve.

The next step in our experiments will be to take the second dog, which I will ask Dr. Larimore and Dr. Hedges to etherize for me, after which we will open the abdominal cavity, and make a perforated wound of the intestine, and demonstrate to you that the hydrogen gas will escape from the abdominal wound.

[At this point Dr. Brundage of Xenia suggested that, owing to the lateness of the hour, the rest of the experiments, excepting the rubber ring operation, be dispensed with, as the audience would take it for granted that the gas would escape from the wound of the intestine without taking the time to actually demonstrate it. Dr. Reed said he was ready and willing to do whatever the audience preferred in the matter. After some general talk, it was

decided that the rubber ring experiment should be demonstrated on the dog, and that that should close the experiments.]

While the dog is being etherized we will utilize our time by describing the ring, which consists of the simplest form of ordinary black rubber.

The one I have here is made from a common rubber nipple, which has been cut in segments about half an inch in length. These segments were cut lengthwise and reduced in calibre to suit the intestine for which they are intended.

The rings are reunited by continuous catgut sutures. [Shows different sized rings ready prepared.]

You will readily observe by having the rings prepared in this manner that the catgut sutures, which hold the ring together and really make it a ring, will soon become absorbed, converting the ring into a straight piece of rubber, which will be readily passed per rectum without the least danger of obstruction.

We will now proceed with the operation by opening the abdominal cavity along the median line, and, after resecting some six or eight inches of the ilium, reunite the divided ends.

I will now tie the mesenteric arteries close to the border of the section of the ilium to be removed.

This being done, I will separate the mesentery from that portion of the ilium, being careful to keep my incision between the ligatures and the border of the intestine, and thus avoid any hemorrhage.

Before we proceed any further, we must satisfy ourselves positively which is the upper end and which is the lower end of the intestine, for in this operation it is absolutely necessary to know this, and observe that the proper relation of the bowels be carefully maintained in uniting them. This is not necessary, however, in the

decalcified bone plate method, which is a strong argument in its favor.

By examination, I find that this is the upper portion of the bowel, around which I will throw this broad rubber band, which is simply a piece of rubber such as you would use for your pocket diary, which I have cut open, and also cut a slit near the one end, which readily enables me to pass it around the bowel, and by pushing the end through this slit and drawing it tight, prevents all extravasation without injury to the intestine, and when the operation is over, it is easily and quickly removed.

This narrow rubber band I will place around the lower end of the bowel in the same manner as the first, which will not only prevent extravasation, but serve as a mark to designate between the upper and lower portions of the intestinal tract, the upper one having the broad rubber band around it, and the lower one having the narrow band around it.

We are now ready to remove the segment of intestine between these rubber bands, which I will now do with the scissors.

The next step in the operation is to insert this rubber ring into the upper end of the intestine, so that the lower edge of the ring and the cut end of the bowel are just even; and fix it there by a continuous catgut suture "whipped" over and over, as it were, the two ends.

Having done this, I will next carry a needle, armed with a catgut, through the wall of the intestine and upper end of the ring, and out through the lower opening of the ring and bowel, and back again and out through the upper end of the ring and intestine, about a line from where I entered, and by tying the ends of the catgut together, I fix the upper end of the ring in the bowels.

Having thus fixed the rubber ring in the upper end of the intestine, we are now ready to invaginate the lower end of the bowel, which I will now do with my forceps,

and turn the serous surface in about half or three-quarters of an inch.

My assistant will now hold the lower end of the bowel so as to prevent the return of the invaginated portion, while I take my forceps and carefully grasp the upper portion of the bowel and rubber ring, and insert them into the invaginated portion of the lower end of the intestine.

You will observe that the contraction of the cut end of the bowel makes this procedure somewhat difficult, owing to the dilatation of the upper end by the rubber ring and the reduction of the calibre of the lower end by the invagination.

Having inserted the upper end into the lower, the next step is to fix it there by two sutures passed through both the upper and lower portions of the intestine and also the rubber ring.

These sutures should be passed one on each side of the intestine, as it were, and not on the mesenteric border or dorsem of the bowel, so to speak, and should be of catgut, and simply carried through both the upper and lower portion of the bowel and include the rubber ring, and then carried out again through the same, say half an inch from where you entered, and the two ends of the suture tied together.

Owing to want of time, I will not wait to introduce both of these sutures, as my object is to demonstrate the general principles of the operation rather than the technique; hence I shall only take the time to insert the one suture.

Having united the two ends of the intestine, the last step is to cut off a small piece of the omentum, which we will select from the least vascular portion of the omental apron, and throw it around the intestinal splice like a ferule, and fix it there by two or three catgut sutures along the mesenteric border of the intestine.

Then remove the rubber bands from around the upper

and lower portion of the bowel, and after cleansing the peritoneal cavity, close the abdominal wound and the operation is complete.

I will now ask you to take the trouble to come down and examine what we have done for yourselves, and if any part of the operation has not been made plain, I will try to make it so. [The members then came down and examined the results of the operation.]

By this method you will observe that a resection of the intestine can be made, performing an enterorrhaphy, as I have done to-day, or an ileo-colostomy, or a lateral implantation operation, with little danger of extravasation, the operation being much easier and more rapidly performed than any of the old methods of uniting the bowel by the Czerny-Lembert suture, and with much less danger of fecal extravasation.

By this method you are enabled to bring two broad surfaces of the peritoneum together and fix them there, while the rubber ring, by its elasticity, keeps the intestinal walls from collapsing, and keeps the upper and lower portions of the intestine held firmly together, preventing extravasation and facilitating rapid union, which is usually completed in from 36 to 48 hours.

The ferule of omentum not only acts to doubly strengthen the splice made in the intestine, but it soon becomes firmly adhered to the intestine and prevents extravasation, should a defect occur at any point in the splice.

The catgut sutures soon become absorbed, which is not until the two ends of the intestine are firmly united, when there is no further use for the rubber ring, which is passed per rectum as a straight piece of rubber.

I regret that want of time will prevent my showing you the decalcified bone plate operation, for I think time will demonstrate it to be the better of the two operations when put to the crucial test for the repair of the intestines.

As already mentioned, in this operation it makes no difference in performing an ileo-colostomy whether the operator knows which is the upper or lower end of the bowel.

All that is required is to ligate the mesenteric arteries, remove the desired portion of the intestine, invaginate both the upper and the lower ends of the bowel and close them while invaginated with a continuous catgut suture; then make a slit, say an inch long, in each intestine about an inch from the end, on the opposite side of the bowel from its mesenteric border; then by inserting one of the decalcified bone plates into each slit [passes fac-similes of the decalcified bone plates around],* and fix it there by transfixing the sides of the slit with the two sutures armed with the needles, and bring the two sutures, not armed with the needles, out at the ends of these slits.

After you have fixed both ends of the intestine alike, you have nothing to do but carefully approximate slit to slit and tie the lower two sutures together, then each of the two end sutures together, and lastly, the upper two sutures together, and you will have an artificial channel established between the upper and lower ends of the intestine, which is firmly braced with these bone splints which hold the serous surfaces of the intestine firmly against each other until union is complete, when the bone splints are digested, and the ligatures are passed per rectum, while the continuity of the bowel is established with only a slight "jog in it," as our civil engineers would call it.

In the majority of instances I prefer the decalcified bone plate operation, because of its simplicity and efficiency.

By this operation you can make a resection, or by an implantation operation "side track" any desired amount

* For description of bone plates, see "Some New Operations in Abdominal Surgery," etc. Columbus Medical Journal, Vol. VI., No. 7, page 301.

of the intestinal tract, and allow it to undergo physiological atrophy; or, as in a case I saw a few days ago in the Milwaukee Hospital, in which there was a cancer of the pylorus, where Professor Senn had, by the bone plate method, divided the duodenum below the cancer and attached the lower portion of the bowel to the greater curve of the stomach, the operation proving successful, the speaker having seen the patient and talked with her during her convalescence.

Before closing these remarks, allow me to say that my friend, Dr. William Mackie of Milwaukee, has just written me that on the eve of his return home from the meeting of the American Medical Association at Cincinnati, he was called to a case of gun-shot wound, where he had occasion to use the hydrogen gas enemata for diagnostic purposes, and found it as reliable in the human as in the dog, this being the first case on record in which it was used for diagnostic purposes on the human subject.*

The practical importance of these discoveries made by Professor Senn is of such moment to the profession, not only from a scientific but a medico-legal aspect, that I trust the imperfect attempt I have made here this afternoon to reproduce them will at least be sufficient to interest you all enough to procure and read for yourselves his masterly production on "An Experimental Contribution to Intestinal Surgery, with Special Reference to the Treatment of Intestinal Obstruction," read before the Ninth International Medical Congress, and published in the *Annals of Surgery*; also his paper on "Rectal Insufflation of Hydrogen Gas an Infallible Test in the Diagnosis of Visceral Injury of the Gastro-Intestinal Canal in Penetrating Wounds of the Abdomen," read in the section of surgery at the Thirty-ninth Annual Meet-

* Since my return from the State Society, I received the report of Dr. Mackie's case in the *Medical News*, Vol. LII., No. 23, page 628.

ing of the American Medical Association,* and after reading and studying those wonderful contributions to intestinal surgery, you will, if not satisfied with their practical value, repeat his experiments for yourselves until you *are* satisfied, and then prepare yourselves with the necessary equipments to apply these simple and reliable methods for the saving of human life in your own practice.

* Since delivering the above lecture, Professor Senn's paper on "Rectal Insufflation of Hydrogen Gas," etc., has been published in The Journal of the American Medical Association, Vol. X., No. 25, page 767.

