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It must be obvious to the surgeon who has kept abreast of the advances made of late years in bowel-surgery, that perfection has not by any means been attained in respect to plates or rings for intestinal anastomosis.

In some respects Senn's bone-plates are best. But not every surgeon has these plates, in the various necessary sizes, constantly on hand. This is a mild statement, since but a month ago one of the largest surgical-supply houses in this city assured me that my order for Senn's plates was the first his firm had ever received. Then, too, they take a week or more to make, and cost \$2 per pair. Another drawback is their occasional obstruction of the anastomotic opening by sliding over it after some days; for they are absorbed with rather objectionable slowness.

These reasons, mainly, have led investigators to devise ready means of substitution, and the number of additional rings or plates already before the medical world is nearly a dozen.

Of these the most prominent are the following:

* In part, read at a special meeting of the Surgical Section of the New York Academy of Medicine, held April 27, 1891.



1. Abbe's catgut rings.
2. Brokaw's segmented rubber rings (of tubing filled with catgut threads).
3. Robinson's plates of fresh hide.
4. Matas' solid catgut (drum-snare) rings.
5. Davis' solid catgut plates; also his catgut mats.

Among all of these there is not one which can truthfully (after studying its method of preparation) be called an *emergency* method, save No. 2, which to this extent is the best, and sometimes No. 3. As the latter (raw hide) is not by any means always obtainable on a few minutes' notice, it can only at times enter this list.

All of the catgut methods save No. 4 have the double objection that they swell greatly in any watery solution—such as the semi-liquid fæces—and as Senn alleges have sometimes thus produced dangerous pressure at the point of ligation; and further, that they quickly soften within the gut and lose all rigidity. This anyone can prove by putting an Abbe ring (for example) in water at the bodily temperature for even one hour.

Let us now suppose a clinical case in surgery. Suppose we as surgeons are called on unexpectedly to deal with a strangulated hernia. Our medical brethren have—following their custom—delayed sending for the man with the knife until a late hour in the case. Suppose we find upon opening the sac, a loop of dead gut; not doubtful, but dead. Assume that the patient's general condition is a fair one—enough so to warrant a half hour longer under ether.

In such a case, which is common enough, most surgeons would prefer excising the dead gut and restoring sound continuity, rather than making an artificial anus.

But, now, which of the various plates and rings

can be prepared *in a few minutes* to meet this pressing want? Hardly Abbe's rings; made off-hand and without preliminary soaking and untwisting in warm water, they do not make smooth pressure and they twist badly. These particular objections do not obtain against his rings of course, if they have been previously prepared.

Not Matas' drum-snare rings—they must be boiled and otherwise prepared.

Not Davis' catgut plates, nor his catgut mats, obviously.

The Robinson plate of green hide could occasionally be quickly made. More often it would not be procurable.

The segmented rubber ring of Brokaw would meet our requirement fairly well as to speed, but is open to the objections mentioned as against any catgut method. Then too, this last plan is inferior to some *plate*, because apposing a narrower peritoneal surface than would a plate. If, (as has been suggested to overcome this objection) *several* of Brokaw's rings be made, each of such a size as to fit neatly inside the last, and all to be sewn together so as to make a mat with a central opening—this will take considerable time.

The field, then, seems open for a really good emergency plate; and the plate of *raw vegetable tissue* is the one which I have to recommend.

I have experimented for some months, and used many kinds of raw vegetable and fruit tissue. That which I like best, for several reasons, is raw potato.

During many weeks past, by the courtesy of Professor John G. Curtis, I have operated upon a large number of dogs in his physiological laboratory at the College of Physicians and Surgeons, and have experimented to a lesser extent at the N. Y.

Polyclinic ; and I present to you for your examination some dozen or so specimens taken from as many dogs upon whom the potato-plates have recently been used. My first dog died from faulty technique—the plates I made were too large for his diminutive guts. Since then I have had but one death from leakage, in simple excision of a loop of intestine followed by lateral anastomosis in this method ; and only two additional deaths from any cause whatever. The last sixteen dogs operated upon by the new technique have all lived until I chose to kill them after several days to several weeks in order to demonstrate the results.

I have to thank Drs. F. J. Brockway and H. G. Myers for kindly aid rendered in many ways during this work, which is still being continued. But I have cause to feel satisfied that plates cut from raw potato are abundantly worthy of trial; and that they are probably, considering all things, the best of the aids to anastomosis, whether for emergency work or for that performed after deliberation.

By their help, and with the new technique later to be described, a simple enterectomy with lateral anastomosis is, on dogs, almost sure of recovery.

For use upon the human gut the plates should be made about one-third inch in thickness ; or for added rigidity even a trifle more. The calibre abundantly allows this. In the smaller and thicker-walled bowel of dogs, they should be rather thinner, say one-quarter inch. To prevent the thread from cutting through, we should have it very coarse, make a large knot, and before sewing through the plate sew through a scrap of rubber cut from a drainage tube; or, lacking this, a minute bit of cloth. The plates should be cut so long that the opening shall be about *twice the normal diameter of the gut to be operated*

upon. This is in the line of safety, because a long slit insures easy passage of fæces from the first, and consequently avoids strain on the sutures. And also, experience shows that an ultimate contraction of the new hole to even half its original size may

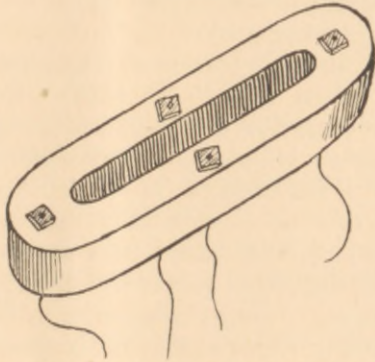


FIG. 1.—The potato plate ready for use (threads short and needles omitted).

occur—may even be expected. It is not claimed for the potato plate—nor I think for any plate or ring save (possibly) Senn's—that it can safely be trusted to coapt peritoneum by its four or six stitches alone, without additional sutures outside. Indeed, I believe that the best that should be said of any of these aids is that after their application the necessary sutures—Lembert or other—can be much more speedily and neatly applied; and speed is a tremendous factor in success in bowel work.

Still, the raw potato plate is very rigid, and retains rigidity considerable longer than any of the catgut methods.

This is easily proven. Put the raw potato plate, together with the rings, for comparison, into simple warm water; into warm water *plus* pepsin and hydrochloric acid; and into warm water *plus* ex-

tract of pancreas and alkali. The vegetable plate will remain fairly firm long after the others have become flabby and useless.

Experience shows that it is best not to immerse the potato in carbolic solution before use, as when this is done the plate softens more quickly, at the same time turning pink.

Regarding the question of digestibility, I have specimens taken from the middle of the small gut in dogs showing that at the end of forty-eight hours the potato plate is intact, though shrunken and soft. At the end of three days, is also broken here and there. At the end of five days, has utterly disappeared. It seems probable that in similar regions of *man* its digestion would be quicker; since man is omnivorous, while the digestive fluids of the dog are presumably those meant for a carnivorous diet mainly.

In one specimen, from a dog killed thirteen days after using these plates, in lateral anastomosis of colon to colon, the potato was found broken, shrunken and softened, but still in place. A ball of hair on the proximal side, allowing fæces to pass only with difficulty, may have been a partial cause of slow removal in this instance; though the region—the colon—would perhaps sufficiently account for it.

In another singular case, one of lateral enterotomy in the middle of the small gut, the plates were found after twelve days, shrunken and somewhat *hardened*, but broken into several pieces. In this animal too, a ball of hair was present and may have protected them somewhat from contact with intestinal juices.*

* It has occurred to me that if the fleas which so regularly infest street dogs were killed, the dogs would not have the same incentive to gnaw their hide, and would not thus accumulate the hair which, collecting in the bowel, so annoys experimenters. A bichloride bath once or twice should prove effective.

In a case of gastro-enterostomy (dying from my failure to cover in at one point an anchor-stitch) the stomach-plate was found entirely gone at the end of three days. Its intestinal fellow was represented by but a few scraps, stained yellow with bile.

To sum up, the advantages claimed for the vegetable plate are as follows :—

1. It may be made a *real* emergency method, being by far the speediest of all. I have made a pair of plates, with threads in place, and ready for use, in ten minutes.

2. The potato can be procured anywhere without delay, and without cost.

3. It is a *plate*, and safer than a ring, because keeping in contact a wider peritoneal surface than a ring can do.

4. A very long ellipse, which is best, is easily made and maintained ; some fleshy roots other than potato may by their length permit plates to be cut with extremely long apertures. This, however, can rarely be needed.

5. Unless withered and shrunken potatoes are used, there is no tendency whatever to swelling, with its consequent danger from pressure—as against the catgut methods.

6. It is rigid and remains so a longer time than the catgut rings. I generally soak the peeled potato for an hour or two before use, because although with a sound potato the plate does not perceptibly swell nor change size, *it grows even harder in water for a time* ; while in air, by drying, it becomes more flexible and soft

7. One of the dangers of the bone-plate is its slow absorption, with possible sliding so as to obstruct the new opening. If a plate, by its presence, will aid speedy application of a line of sutures, and

will then keep the denuded surfaces quiet and in contact for just a few hours, that is all we want of it. And the sooner thereafter it disappears, the sooner a possible source of danger is removed. If surgeons will only remember to *scrape well with a knife* the surfaces to be coapted, they need not ever fear a lack of rapid plastic exudation. To aid perfect quietude of the guts during this period—the critical one—I would insist upon the invariable use of as large a hypodermatic injection of morphine as the patient can safely bear.* This should be given just before the anæsthetic.

Regarding the application of these or any other plates or rings for lateral anastomosis of gut to gut, preceded by excision of a portion, the following is the technique which I would recommend as being the best. I give it in detail; in part it is new.

Assume that the dead or diseased region is cut away, being careful to sacrifice what is even suspicious; that the gut is temporarily closed with (in emergency) boiled tapes, ten inches at least from each open end; and that thorough irrigation of the mucous surfaces has cleansed them of all apparent filth. (Mem.—The human gut can easily be turned mucous side out, over a finger, for a very considerable distance; thus aiding rapid cleansing). Our needles, after threading, are tied by a single knot in the eye, to prevent loss of time by accidental

* This free use of morphine has unquestionably helped to secure my large percentage of success in dogs. They are peculiarly insensitive to morphine in any moderate amount; and in even small dogs I regularly begin by a hypodermatic injection of a grain to a grain and a half of sulphate of morphine. Following this they need but little ether—sometimes none—and vomit less than otherwise. Such dose seems hardly to affect them more than ten minims of Magendie's solution would affect a man. (Here let me remark that by free use of analgesics I have always avoided causing suffering in the dogs subjected to experiment.)

unthreading. The four threads are each about nine inches long, from the plate to the needle; no longer, to avoid tangling. Following Carson's suggestion they may be two black and two white; although I have never had the least delay or confusion with threads all black. The needles should all have their points buried in bits of potato, each at least the size of a pea. Now—

1. Seize a needle with the needle-holder so that it shall be in the long axis of the holder. Begin with

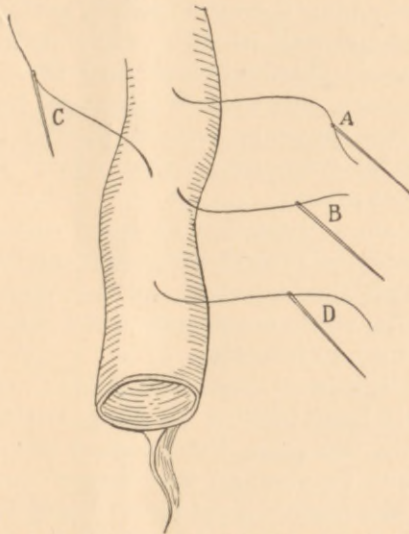


FIG. 2.—A plate in place and ready to tie to its fellow.

the one marked A. in the accompanying diagram, (Fig II.) Pass the needle several inches (about six, in operation upon the small intestine) into one of the open gut-ends, bringing it out *through* the potato on its point and then through the gut-wall at the desired place, which should also be directly opposite the mesentery. Draw its thread through for a few inches. Now, with one or two fingers in-

serted within the intestine, seize and withdraw the scrap of potato on the thread (or else invert the gut over the finger, thus exposing it). Break the potato off the thread. Now pass needles B and C in the same way. After each thread is passed it should be held by an assistant, tense against the wall of the gut on the side where it belongs, and the next needle should carefully run along the opposite wall; this to avoid tangled threads.

It would, of course, be easy to vary the technique here, by detaching the bit of potato with the fingers through the gut-wall when the right point is reached by the needle, instead of sewing through it, etc. But in that case, these pieces might get between the plate and the mucous surface of the bowel and cause irregular pressure in that way. Hence the direction just given.

In the small intestine of dogs, owing to thick and comparatively rigid gut-walls, and to the absence of *valvulae conniventes*, the pieces on the needle-points, while a convenience, are not so necessary as in human intestine.

2. Pull lightly on threads A, B and C, while pushing the plate from behind, drawing it thereby into place within the gut. Push rather than pull, to avoid oblique tension on the thread and possible cutting of the plate. Next pass D, and draw it also taut.*

3. Go through the same steps with the other plate and the other gut-end. Always leave at least

* I am not at all sure that it would not be an improvement in technique to do away with the two *side* threads connecting the plates, and retain only the two *end* ones. The anchor-threads are unquestionably an element of danger, and this is reduced one-half by the plan suggested. Of course, the plates would then not be held firmly together at the sides; but after all, we rely for our protection mainly upon the surrounding lines of suture, placed later.

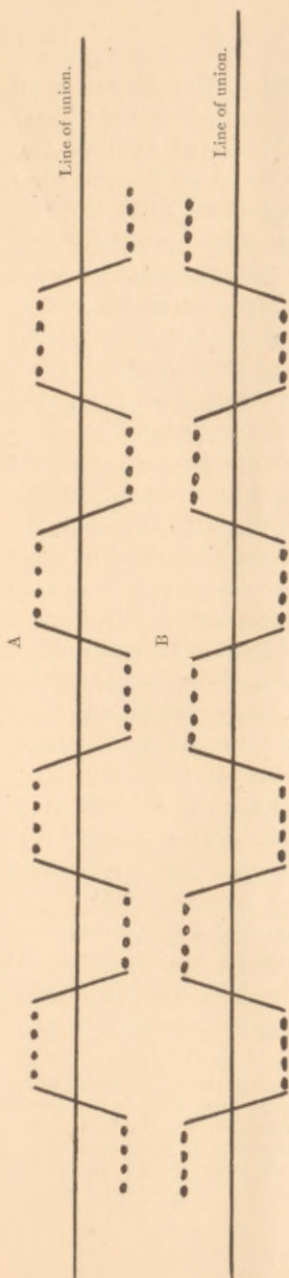


FIG. 3.—A, First row; concealing carefully the four anchor stitches. The dotted lines indicate the concealed portion of the suture. B, Second row, nearly one quarter inch further from plates; concealing carefully the first row. Note that where A ascends B descends, and *vice versa*. The stitches in the sketch are, for clearness, drawn rather less than the actual number to the inch.

a full two inches between the plate-end and the gut-end in each instance.

4. Wipe off the threads with a cloth wet in some antiseptic solution.

5. Scrape *lightly but thoroughly with a scalpel* the surfaces to be coapted. This is a most important step; and the scraping is better in every way than scratching with a needle, as a means of insuring rapid plastic exudation over the entire coapted region. The scraping requires but a few seconds. Upon the living gut each stroke is followed instantly by a somewhat congested surface, differing strikingly in appearance from the unscraped; so that it is easy to know when the desired region has been so treated.

6. Tie the four anchor-(plate) threads each to its appropriate fellow, being careful to draw snugly, but not to force the pressure. The open ends should first be pointed in opposite directions. (This

Abbe has recommended, although he has also obtained satisfactory results with the ends directed alike.)

7. Run at least one line of sutures around the plates, being extremely careful to cover in and hide completely the four anchor stitches; also, though the threads must enter the muscular coat to avoid danger of tearing out, yet the utmost caution must be exercised never to penetrate the lumen of the gut with any thread, save the four plate-threads which must necessarily go directly through the wall. *Here, if anywhere, the beginner will cause a fatal result. He will insert his needle too deeply.**

If preferred, the line under discussion may be of interrupted sutures: in which case Halsted's square stitch is unquestionably the best, if not tightened too much. Personally I like much better than any interrupted, and can apply nearly equally quickly, *two* lines of continuous suture, three stitches or less to the inch. It is not wise to attempt more than three to the inch. If the thread dives beneath the peritoneum for a shorter space than one-third inch, then, as it must to avoid penetration go very superficially, it is likely to cut out when tightened.

Fig. III. shows the method which I have now employed in about twenty cases. The second line should entirely conceal the first line, just as the first hides the anchor-threads.

Extremely simple as this method is (a basting-stitch) and doubtless well known to many surgeons as a stitch, I have not found it described among intestinal sutures. Those resembling it most nearly are,

* The sewing-material may be silk, cotton or linen thread—almost any kind (first made aseptic) save catgut. As ordinarily prepared, it is possible that catgut might be absorbed too soon. The needles should be ordinary, long, slender sewing-needles: *not* surgical ones, with cutting edges. The use of a thimble will favor speed.

so far as I can ascertain, the spiral suture of Nunciati and the method of Gély.*

I prefer it for two reasons: First, *speed*. Running as it does parallel with the plate-edges, it is much more quickly applied without danger of sewing too deeply than is the Lembert (in which the needle is made to enter at right-angles with the line of proposed union), or for that matter than any interrupted. Two rows can be applied in nearly the same time as one interrupted. Second, *safety*. It would be almost difficult by this particular plan to draw the thread so tightly as to threaten sloughing. Also, if the old technique be used (that in which the side of the gut is opened to give entrance to the plate), then by this stitch one is less likely than by the Lembert to drag out, while passing it, the gut-edge from between the plates, accidentally. The second row of this continuous line should be so applied that where in the first row it went *above* the line of union, it now goes *below*. (See Fig. III.) Passing both rows with speed and safety will be notably facilitated if an assistant first presses the plates firmly together, drawing the gut tightly and smoothly over them meanwhile.

To continue our new technique—

8. Run into one open gut-end, a thin strip of wood—like cigar-box, or perhaps pasteboard—as wide as the potato-plate. This is to cut against.

9. Now we make our opening through the apposed and sealed gut-walls. To do this, insert a scalpel or a sharp-pointed bistoury into the other open

* Since the publication of this article in the *Medical Record* I have received from Dr. H. W. Cushing, of Boston, a reprint in which he describes, and recommends as best, this same suture. I am pleased to know that, working independently, we have reached the same conclusion. The priority, however, belongs with Dr. Cushing.

gut end, and cut through between the plates, carefully, making as long an anastomatic opening as the plates will allow. The strip of wood opposite prevents cutting too deeply.

In dogs, a special knife is needed for this stroke, which must in them be made blindly, guided by sense of touch and position of handle. I use on them a gum-lancet sharpened on both borders as well as its hatchet edge. But in human gut, fortunately, it is easy (the wall being much thinner), to slide the two inches of open end along and—an assistant holding the end open with thumb-forceps—then make the cut with an ordinary knife, *seeing the whole length of the stroke*. If preferred for safety, the blade may be wrapped with adhesive plaster or thread down to a half inch from its point.

Should bleeding follow, it could easily be controlled by forceps; but this is unlikely to happen, both because the cut is made directly opposite the mesenteric attachment where the vessels are smallest, and also because the moderate pressure of the plates would tend to check it.

By the action of the powerful circular muscles, as soon as anæsthesia is ended, the line of incision gapes as widely as the plates permit.

10. Remove the knife and also the strip of wood. Irrigate. If the cut is properly made, the water should run freely into one end and out of the other. Under gentle hydrostatic pressure, closing the outlet-end with finger and thumb for a few moments, the line of suture should not leak if properly made. *This is a valuable means of safeguard and should never be neglected.*

11. Now scrape the peritoneum, and then invert one free end with a pair of dressing-forceps, carrying the intussusceptum far enough in to touch the

plate. Close the peritoneum over the inverted end with two rows of the kind of running suture already described. (One row would perhaps suffice here. The long intussusceptum proves a decided protection against leakage. In dogs I have never had the least

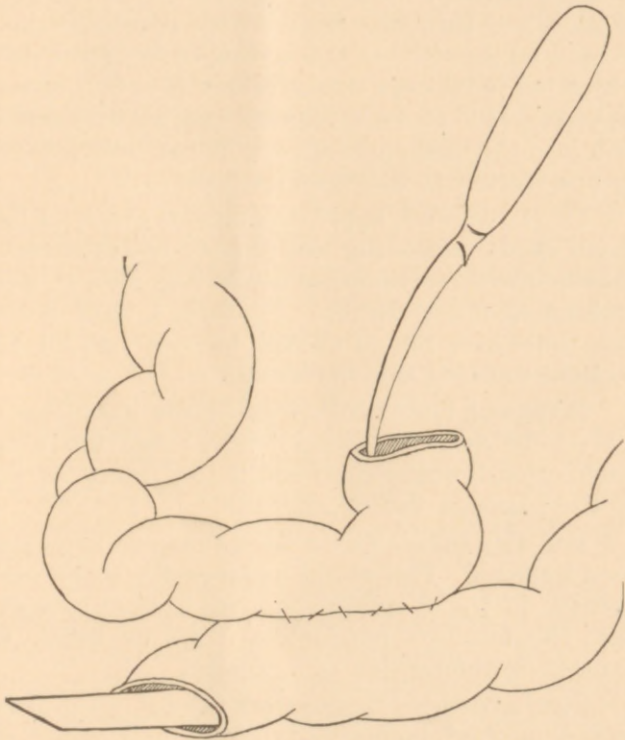


FIG. 4.—The suturing about the plates is completed; the anastomotic opening is being made; in short lines the outer row of sutures is indicated roughly. (When properly tightened, the sutures cannot easily be seen, of course.)

trouble with the ends, using one row only.) If the surgeon, after inverting the end and before withdrawing the forceps, will transfix gut and intussusceptum with one or several needles, to be left in place

until the sewing of the ends is completed, he will find this step much facilitated.

12. Do the same with the other end.

13. Take a stitch or two between the blind ends and the gut against which each should rest, first scraping lightly. This prevents possible forcing of another loop into this angle, with resultant undue tension on the stitches at the plate ends; an accident which led to leakage in one of my first experiments on dogs. It is also a safeguard against intussusception into the new opening, which has been observed by one worker in this field (Robinson).

14. If desired, apply an omental graft. I have never used these, being well pleased with the results obtained without them, and wishing, also, to avoid prolonging the operation. Further, I have desired that these new plates should have a crucial test, without unusual aids to union.

It takes a long while as you have doubtless observed, to describe these details; but the actual application is quite brief, and indeed more so than by the plans in use heretofore.

For the sake of clearness, fourteen steps have been itemized. This is not unnecessary elaboration. Success in the operations is a question of care even unto the minutest particulars. Life or death will hang upon the tension of a thread.

I have, without haste, done lateral anastomosis by this method, including tying off mesentery and excising several inches of gut—in a half-hour, counting from the first stroke in the belly-wall to knotting of the last suture in the belly-wall. Of this period about twenty minutes were devoted to the bowel itself. I have no doubt that this time could in case of need be shortened several minutes.

The following points will be noted as new in the technique just advised for use with any plates or rings :—

- a. The method of inserting the plates and making the anastomotic opening.
- b. The method of suturing.
- c. The method of denuding peritoneum to hasten plastic exudate.*
- d. The method of protecting the sutures at the plate-ends, by causing adhesion of the blind ends to the adjacent bowel.
- e. The method of retaining the inverted ends—by transfixion with needles—while sewing the ends.

The first has the following advantages, readily appreciable by anyone who has tried other plans :

Safety to patient, in that the peritoneal surfaces are apposed and sutured *before* being opened ; hence less danger of septic infection in the line of stitches.

I have compared this method, too, by actual trial with that whereby Senn prepares a double row of Lembert stitches, then opening the side of the gut for entrance of the plates as usual, etc. The method herein given is unquestionably safer regarding infection.

Everyone knows who has done this work the constant annoyance (greater of course in dogs than men) from rolling out of the cut edges, largely due to the action of the powerful circular muscular layer. This nuisance is hereby done away with, as is also the dangerous tendency to sepsis, as well as loss of time, from pulling out the cut edges from between the plates, unintentionally, while passing the line of protecting sutures. *All work about the plates should*

* Since publishing this article I have learned with much interest that Dr. John D. S. Davis, of Birmingham, Ala., in 1889, advised this same method of denudation.

be definitely concluded before the anastomosis is made.

Speed is also gained through avoiding loss of time in the various annoyances mentioned.

Among the greater advantages of this new technique is the opportunity to test readily by irrigation the perfection of our barrier of sutures and plates. This is of course impossible by the old plan. Just as it is advisable to do this after suture of the urinary bladder, so it is here. The time to discover a possible leak is at this moment, rather than on the autopsy-table.

I take it quite for granted that most surgeons will agree with me that the day of circular enterorrhaphy (save for very exceptional cases,) is past. Work in that line is work almost thrown away. This plan has not, so far as I am aware, a single advantage over lateral anastomosis; and it has several fatal defects.

I was sorry to see a very able experimenter, in an article in the *Annals of Surgery* for February, spending time over what he calls a "stove-pipe" method; whereby the distal end is deprived of its mucous surface for half an inch or more, and then the proximal end is inserted, a long rubber tube being within both.

This, while easy on the thick gut of dogs, is not easy on the very thin human intestine. In the lower half of the small gut of man the entire thickness of all six or seven anatomical layers composing its wall is so trivial that a newspaper placed within can be read through these layers.

Furthermore, any circular method necessarily, from the very beginning, makes a smaller opening than the normal; and even this is bound to shrink. Such methods, too, threaten leakage at the deadly

mesenteric junction. They are difficult where removal of a considerable length—more than a few inches—leaves sound ends of different calibre. By any “stove-pipe” method—such as Jobert’s or Robinson’s, mistaking the proximal for the distal end would be fatal; and though Nothnagel’s salt-test seems an unsafe guide, we do not wish in a herniotomy, to start at the cæcum and handle perhaps ten or fifteen feet of gut to make sure which end is proximal! By-the-bye, if much is removed the proximal end can be recognized by its being, in in any part of the bowel down to the rectum, the larger in calibre (that is, of course, comparing large with large and small with small gut). This fact, too, is against any “stove-pipe” plan, since the big end would have to be inserted into the little one. No time is saved by the circular enterorrhaphy as compared with the lateral anastomosis just described. And finally, by the latter method, it makes no difference thereby which is the proximal end, or what the relative calibres.

Of late the German school of surgeons have made what I believe to be a distinct backward step in casting aside all plates, rings, etc., and trusting solely to suturing without such aids. Their objection thereto is certainly a weighty one. The threads whereby such plates or rings are connected have passed first through a fæces-poisoned mucous membrane and then the peritoneum. This fact, together with the liability to subsequent infection by capillarity, cannot be denied.

But a point upon which I insist in the present paper is that these plate-stitches *must be covered in* by the continuous or interrupted layer or layers outside, which latter do *not* enter the lumen of the gut. And if this is done, the relative danger of infection

is but trivial ; since, if suppuration should occur at the primary stitch-holes, the pus, following the direction of least resistance (the softened plates not opposing) re-enters the interior of the gut.

In everything we do as surgeons and physicians we have to choose the lesser evil ; and it is I firmly believe a lesser evil to use plates by the technique which has just been described than to attempt to do without them, thereby necessitating a longer operation with its perils. Speed, let me repeat, is a tremendous factor in success in peritoneal work.

I have conscientiously tried almost all methods that have appeared in the journals during the past five years, in my operative surgery classes. In that time I have certainly demonstrated enterorrhaphy upon human cadavera by one or another method at least one hundred and fifty times ; and in addition have experimented considerably on dogs. And I am satisfied that the method herein advocated, in all its details, is the safest of any with which I am acquainted.

