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1890

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THE COMPARATIVE MERITS OF THE VARIOUS "AIDS" THAT
HAVE BEEN RECENTLY SUGGESTED IN THE PER-
FORMANCE OF THESE OPERATIONS.*

By RUDOLPH MATAS, M. D.,

Visiting Surgeon Charity Hospital; Demonstrator of Anatomy, Medical Department Tulane
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*Reprinted from the August, 1890, number of the New Orleans Medical and
Surgical Journal.*



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Notwithstanding the fact that Dr. Senn first acquainted the surgical world with the results of his numerous and important discoveries in the domain of intestinal surgery at the Ninth International Medical Congress, held September, 1887, it may be said that their full import and value was not generally realized until the conclusion of the memorable series of papers on this subject, which appeared in monthly series in the *Annals of Surgery* during the first half of 1888. It was only in the latter part of that year, after the enormous magnitude of the work done was laid in detail before the public, that distinct evidences of a thorough understanding of his ideas and methods, and of their clinical application by others, began to appear on record. So that it may be truly stated that the general work of clinical

* Read before the Orleans Parish Medical Society, June 30, 1890.

and experimental corroboration was not seriously started until the beginning of 1889. Since January, 1889, to the present date, May 20, 1890, a short period of only seventeen months, the interest developed in the subject of intestinal surgery has been simply extraordinary, and the work being done in the way of testing, comparing, and modifying Senn's methods, both at the bedside and in the laboratory, is comparable only to a surgical revival which has hardly a parallel in the unparalleled history of abdominal surgery. In fact, the published evidences of clinical as well as experimental confirmation* of Senn's researches have accumulated in such rapid and impressive succession, that no better acknowledgment, no more eloquent tribute, to the solid and enduring merit of this investigator's splendid work could be desired.

Of the new and revolutionizing ideas and practices which we owe to Dr. Senn, perhaps none have elicited more attention and have been productive of more fruitful results than his improved method of performing the old and formerly difficult operation of intestinal anastomosis* and enterorrhaphy.

By the introduction of the decalcified bone plate, he has reduced an unusually difficult and fatal procedure to the category of the simplest and most practical operations. It is by this eminently practical and useful turn that he has given to what was originally an unpractical and at best a hazardous procedure, that the attitude of the general surgeon toward many formidable and hopeless pathological conditions of the intestinal tract has been revolutionized; it is mainly for this reason that we, who are actively engaged in the field of surgical labor, have

* "By an intestinal anastomosis we understand a condition of the intestinal canal where, on account of an obstruction or complete occlusion, the intestinal contents are directed into a segment of the bowel below the seat of the obstruction or occlusion, through a fistulous opening between the bowel above and below the seat of partial or complete occlusion. The idea of establishing such a communication between the bowel above and below the seat of obstruction originated with Maisonneuve, who, without testing the new procedure first on animals, operated on two cases; but as the result in each case was fatal, he seems to have become discouraged and abandoned the operation, and never published the communication on this subject which he had in preparation. In the Surgical Society of Paris, his proposition met with violent opposition from his contemporaries, who argued that the excluded portion of the intestine would become the seat of fecal accumulation, which, even if the operation were a success, would subsequently destroy the life of the patient. For a long time the operation was completely forgotten, until E. Hahn, of Berlin, very recently alluded to it again in commenting on his two cases of excision of the colon where circular enterorrhaphy could not be performed and where an artificial anus was established. Both patients recovered from the operation, but all attempts to close the preternatural opening proved futile."—Senn, *Annals of Surgery*, January-June, 1888.

eagerly welcomed it as a new and powerful aid in our work of intervention against disease.

Perhaps no illustration of the altered aspect of the surgical mind and of the improved situation brought about by the application of the new method of securing anastomosis could be offered than by instituting a comparison between the operation of gastro-enterostomy before and after the introduction of the Senn method. From the date of Wölfler's first operation, on September 27, 1881, to May 14, 1889, a period of over eight years, Mr. Herbert Page, of London,* was able to collect the reports of thirty-eight cases, furnished by different operators and performed by the tedious and unaided Czerny-Lembert stitch. If we exclude two fatal cases from Page's table, in which pylorotomy was done conjointly with gastro-enterostomy, thirty-six cases of pure gastro-enterostomy will remain to be studied. Of these thirty-six cases, fifteen were fatal, directly or indirectly, as the result of the operation. Collapse was the most frequent cause of death. The mortality, therefore, by the old, unaided stitch method is 42.8 per cent.

That this is the correct statement of the mortality of the old operation (by unaided suture), even when performed by the most experienced operators, is confirmed by the most recent contribution of Von Hacker, of Vienna.† This report embodies twenty-one cases of gastro-enterostomy, operated by Wölfler's and Von Hacker's methods. Of the eight cases operated by Wölfler's method, four recovered and four died; of the thirteen operated by Hacker's method, seven recovered and six died. This amounts to about 47 per cent, and confirms the correctness of Page's estimate, and, furthermore, proves the fatality of the old operation even when it is performed by the most experienced hands. On the other hand, I have not had much difficulty in procuring the records of eighteen cases of uncomplicated gastro-enterostomy, performed by different operators in this country and Great Britain, with a mortality of three cases, or about 16 per cent. These operations have been performed in the course of the last eighteen months, and all,

*Proceedings Royal Medical and Chirurgical Society of London. *British Medical Journal*, May 18, 1889. Vol. 1, pp. 1114-15.

†Transactions Imperio-Royal Society of Vienna, Correspondence *Semaine Medica* May 3, 1890.

with the exception of four cases, with the aid of Senn's decalcified bone plates, the other four cases having been operated by the Senn principle, only that catgut rings were substituted for the bone plates. I have purposely avoided the cases of gastro-enterostomy which have been complicated with pylorotomy, as in Bull's recent successful case and Tuholske's fatal case. I have also excluded Rawdon's interesting case, in which, after pylorotomy for malignant disease, this operator performed a direct gastro-duodenostomy, with the aid of decalcified bone plates, the case ending in complete recovery. The collection of gastro-enterostomies alone is large enough, however, to show, first, the increased confidence with which operators have attacked these otherwise hopeless cases, and second, to emphasize the immense superiority of the present improved and aided gastro-enterostomy over the old operation, when regarded from the standpoint of the immediate operative results alone.

Furthermore, the present estimate of the mortality of gastro-enterostomy, as performed on the human subject, clearly confirms the anticipations held out by the same operation as performed on dogs, the mortality of the operation in dogs being at present about equal to that in man. Thus, out of four dogs operated by Senn, two by Jessett, three by Brokaw, and two by Dr. Michinard and myself, in all eleven cases, there were two deaths, or a mortality of about 11.2 per cent.

Without attempting to discuss in this communication the merits or demerits of simple gastro-enterostomy as a surgical expedient for the relief of pyloric cancer or other conditions of the stomach, I have endeavored to review, if only briefly, the work done in this restricted field during the last eighteen months, because it is thereby more convenient for me to illustrate the progress accomplished and to bring into relief the new life that has been introduced into the practice of intestinal operations by the introduction of the new technical improvements due to Senn. To review the whole field of their application and the experimental work that has been done to test or confirm the advantages of the Senn method would be to review the field of intestinal if not abdominal surgery, and to consume your time with considerations which would prove burdensome, since the work has been done ably enough by others, and,

indeed, too recently, as a glance at the bibliographic index which is appended will sufficiently attest.

Notwithstanding the fact that the consensus of surgical opinion, as gleaned from the preceding brief summary of the contributions of the past eighteen months in the restricted field of gastro-enterostomy, is unanimously favorable to, and confirmatory of, the superiority of Senn's method of performing anastomosis, there are still some points connected with this operation and with that of enterorrhaphy, in its general and special applications which are still open to discussion, and being debatable can be profitably presented to this meeting for consideration. The points referred to mostly involve questions of technical detail and do not affect the fundamental feature of Senn's method, which, in its essence, consists in securing *rapid, extensive, and firm* serous apposition of the confronted intestines with the aid of intra-intestinal decalcified bone plates which being held together in apposition, by sutures which transfix the intestinal walls, act in the manner of intra-intestinal clamps, which have the final advantage of being digested and absorbed.

In order that these points may be brought out in a manner more favorable for discussion, I will draw up a series of propositions which will be followed, whenever necessary, with appropriate commentaries, based on the evidence furnished by clinical and experimental work.

In explanation of my personal opinions on this subject I will state that they are based largely on a series of incomplete experiments on dogs, which for some months past have been jointly conducted with my friend, Dr. Paul Michinard, and which have thus far enabled us to study most of the applications of the operation of anastomosis, as it has been suggested for the relief of disease in man. While our experiments were not directed solely to test the value of Senn's method or its modifications, still we have directed special attention to them, and we have obtained certain results which we believe will warrant the conclusions that we have arrived at.

PROPOSITION 1.—The operation for securing intestinal anastomosis, as performed with the aid of the decalcified bone plate, is decidedly superior to the old and tedious method

which secures the same result with the unaided Lembert or Czerny-Lembert stitch.

PROPOSITION 2.—The superiority of Senn's method of securing anastomosis lies (1) in the economy of sutures which it allows, thus saving time; (2) in the large serous surface which it brings in contact, thus facilitating rapid adhesion; (3) in the excellent basis which the intra-intestinal support affords for the ready application of the otherwise slow Lembert stitch.

Remarks.—To any one familiar with the practical application of both the unaided Czerny-Lembert method of practising enterorrhaphy and the Senn method, the truth of these two propositions will appear too axiomatic to require further demonstration or illustration. In my "Remarks on Circular Enterorrhaphy, etc.," published in the Louisiana State Medical Society's Transactions for 1889, p. 345 (vide this journal for 1889), I then stated: "The efficiency of Senn's discs has now been too often demonstrated, both experimentally and clinically, to require for them more than a simple allusion as a most valuable and time-saving device in the performance of intestinal anastomosis." Since that time, April, 1889, the clinical and experimental evidence that has accumulated only serves to confirm this statement, and to emphasize the fact that the principle of intra-intestinal support, which is the most essential feature of the Senn method, has permanently thrown the weight of technical advantage on the side of this method over the old unaided method. The statistics of the new gastro-enterostomies already referred to in the preliminary remarks alone prove this. There are some new points however, which are connected with the manufacture of the bone discs and their mode of application which should be referred to under these propositions, especially since the object of this paper is to compare the relative merits of this decalcified bone plate with the substitutes that have been offered for it. In his latest paper, "Two Cases of Resection of the Cæcum for Carcinoma, with Remarks on Intestinal Anastomosis in the Ileo-Cæcal Region," *Journal American Medical Association*, June 14, 1890, Senn states:

"After having tried all kinds of material, organic and inorganic, absorbable and inabsorbable, for making the apposition

plates, I have finally settled on decalcified bone as the most suitable material. In preparing the plates the compact layer of an ox's femur or tibia is cut with a fine saw into oval plates, $\frac{1}{4}$ of an inch in thickness, $2\frac{1}{2}$ to 3 inches in length, and 1 inch in width. The plates are then decalcified in a 10 per cent solution of hydrochloric acid, changed every twenty-four hours, until they have been sufficiently soft, so that they can be bent in any direction without fracturing. After decalcification they are washed and immersed for a short time in a weak solution of caustic potash, so as to remove the acid. Until quite recently I dried the plates between two pieces of tin, so as to keep the plates from warping during the drying process. The central opening and perforations for the threads were made after the plates were dry. Experience has taught me that it is unsafe to use material for plates which, when exposed to the fluids of the intestinal canal, will imbibe a sufficient amount of fluid to increase to two or three times in thickness, as such increase in the thickness of the plates may cause a sufficient degree of pressure to cause gangrene of the parts included between them. This happened in at least two of my gastro-enterostomies. Since then I have not dried the plates, but keep them after decalcification in a solution of equal parts of alcohol, glycerine, and water, which keeps them in a pliable, soft condition, and such plates undergo no change in size after their introduction into the stomach and intestine until they are gradually removed by absorption and disintegration from the third to the tenth day. After the acid has been removed the central oval opening can be readily made with a sharp penknife, and the four perforations around it for threads are made with a fine drill, and after the plate is threaded it is kept ready for use in the solution first mentioned.

"Any one conversant with the manner in which the plates are threaded can keep them in the solution until they are needed. When the plates are to be used they are worked in a 2 per cent carbolic acid solution and the threads or sutures attached by threading two fine sewing needles, each with a piece of aseptic silk, twenty-four inches in length, which are tied together; the knots become the ends of the end sutures, while the middle of each thread holds a needle and becomes the terminal part of the lateral or fixation sutures. The fastening of the threads upon the plate is done by the lock stitch by another thread passing through the perforations in the shape of a loop and fastened at the back."

Dr. Senn now uses three different sizes of the plates. The largest size is used in gastro-enterostomy, the second for intestinal anastomosis, and the smallest plates are in-

tended to be used in operations on children in cases of congenital stenosis of the intestines, invagination, and other forms of intestinal obstruction, where it becomes necessary to make an intestinal anastomosis. As a rule the central opening in the plate should correspond to the lumen of the organ which has become partially or completely obliterated by the cause which has produced the obstruction. Thus in gastro-enterostomy the perforation in the plate should be as large as the lumen of a normal pylorus. In ileo-colostomy it should correspond in size with the lumen of the ileum. I have the pleasure of exhibiting to you the three different sizes of bone plates made for Dr. Senn, and which I have just received from the Messrs. Schorse & Co., 302 Chestnut street, Milwaukee, who make them after the directions given by Dr. Senn. These plates are preserved in a moist state, ready threaded, with four straight, self-threading Hagedorn needles to each pair. The price for each pair is \$2.00, exclusive of express charges. The cost of these plates is, therefore, an item worthy of consideration, not so much in private practice but in conducting experiments. Of course with some patience and practice they can be made almost as nicely as by the experienced manufacturer, and for practising the operations for which they are used, on animals, it is plain that ordinarily the operator must secure plates that will be less expensive. For this reason the suggestion recently made by Stamm, of Fremont, Ohio, is a good one, *i. e.*, to cut out plates from the incompletely ossified scapula of the veal, which are very quickly decalcified and make very efficient substitutes for the bone plates made from the hard femur or tibia of the adult animal. I show you two plates made by myself after Stamm's suggestion, and which I can assure you have not given me much trouble to prepare. There are other considerations of a critical character to be made on the Senn plate, but these will follow more appropriately after the following proposition:

PROPOSITION 3.—The decalcified bone plate is not indispensable to the successful performance of the aided (Senn's) operation of anastomosis, and other organic material, especially catgut, can be safely used in its stead to secure the ready coaptation of the serous surfaces.

Remarks.—This is probably the most debatable proposition of the series. In order to appreciate the reasons for these differences, it will be necessary to review briefly the history of the substitutes that have been offered for the Senn bone plate. Abbe, of New York, was the first surgeon who criticised the bone plate as aid material, in an article in the *New York Medical Journal*, for March 23, 1889. In this paper Abbe reported a case in which intestinal anastomosis was successfully performed with the aid of the bone plates, and suggested the substitution of "rings made of the heaviest catgut, quite as firm and absorbable as the softened bone." Abbe objected, that (1) the plates can not be easily improvised and are not always readily procured; (2) that the size and lumen of the plates is constant, narrow, and can not be readily adapted to special cases, owing to the variable size of even the normal intestines; (3) the rings if not thoroughly decalcified may not be absorbed, and may give rise to obstructive symptoms like any foreign body.

Notwithstanding the recent modifications of the bone plate, as described by Senn and already referred to under proposition 4, it is certain that Abbe's objections still hold with as much force at the present moment as when they were first urged, and as simplicity, when combined with equal efficiency, is always a desideratum worthy of encouragement, we will at once inquire into the results accomplished with the Abbe substitute and those that were offered subsequently by others. The question as to the relative merits of the decalcified bone plate and its substitutes we shall reserve for a later moment, when Dr. Senn's answer to the objections that have given birth to these substitutes will also be considered and commented upon. At present the question is, what are the substitutes offered for decalcified bone and what is the evidence in favor of their efficiency and safety?

I now show you a ring made after the first Abbe model,*

*The latest instructions given by Abbe to make his catgut ring (*Medical News*, June 1, 1889), are as follows: A moderately heavy catgut is chosen; taken from alcohol or juniper oil; it is wound loosely on a test-tube, and soaked in hot water. It soon kinks up, and were it not on a tube, could hardly be unraveled. After a while it is straightened out, allowed to untwist, wound again loosely, and soaked in hot water once more until it ceases to twist. It is then ready to make up into rings, which will lie perfectly flat. Eight or ten turns over two pins, stuck in a cork, two inches apart, will make a bundle somewhat smaller than a lead pencil. These may be tied at four places, to secure the strands parallel while being wound around like a cable, with a continuous piece of the same catgut. The threads, armed with needles, are attached in the manner shown in the figure.

and which is certainly not difficult to improvise. Abbe applied his ring in several experiments on dogs, and succeeded perfectly in obtaining intestinal anastomatic communications with them. He subsequently repeated the operation in a successful case of enterectomy, substituting his catgut rings for the bone plates (*Medical News*, June 1, 1889), thus securing clinical evidence in proof of the efficacy of his rings. Since that time the Abbe ring has been used by McBurney, of New York, in a gastro-enterostomy for cancer of the pylorus, the patient dying twelve hours after the operation (quoted by Abbe, *Medical News*, June 1, 1889). It has also been used in two successful gastro-enterostomies by Dr. Weir, of New York (one for malignant pyloric stenosis and the other as a substitute for Loretta's operation, *Medical News*, December 14, 1889, and *New York Medical Record*, 1889). Once also, by Dr. Manly, in a colectomy for malignant disease, lateral enterorrhaphy having been performed with Abbe's rings (*New York Medical Journal*, April 19, 1890), and more lately by Dr. Bull in a complete pylorectomy, in which the connections between the stomach and duodenum were permanently discontinued and communication between the stomach and intestine reestablished by performing gastro-enterostomy with Abbe's rings (*New York Medical Record*, April 19, 1890). This case ended in the recovery of the patient.

Therefore, if we sum up the cases recorded, we will find that the Abbe catgut ring has been used in the human subject:

- Once by Abbe, recovery.
- Once by McBurney, fatal.
- Twice by Weir, recovery.
- Once by Manly, fatal.
- Once by Bull, recovery.

In all, six cases, with two deaths.

It is thus clinically and experimentally proven that Abbe's catgut rings can be effectually substituted for the bone plates.

If I should adopt the order in which the various substitutes for the Senn bone plate have been presented to the medical public, I should next claim your attention with a discussion of solid catgut ring, made of the heavy commercial gut known as "drum-snare" material, which I thought of independently,

and demonstrated to my classes in the Medical Department of Tulane University in 1888-'89, and in the New Orleans Polyclinic, session of 1890, before the publication of Abbe's paper. Brokaw, of St. Louis, who published an account of his segmented rubber ring shortly after the appearance of my paper, claims that he had experimented with a ring made of solid catgut eight months before the publication of my paper, which would make the date of his experiments appear two months earlier than my own. Since his ring is widely and favorably known, and has been applied both experimentally and clinically next in point of frequency after the Abbe ring, I shall give it immediate consideration, reserving an account of my own ring for the end of this part of the discussion, in which I desire to refer to some criticisms that have been made of it and also to present some of the experimental evidence in proof of its practical utility, etc. The Brokaw ring, made of segments of rubber drainage tubing and threaded with catgut strands, is now well known, and will require no further description than the exhibition of the specimen which I have placed in the collection before you. Though this ring was devised originally and independently by Brokaw in a paper read before the St. Louis Medical Society, September 21, 1889 (*International Journal of Surgery*, November, 1889), and even earlier, we find a suggestion of a similar ring in Abbe's lecture on Anastomosis before the Philadelphia County Medical Society, May 8, 1889, in which Abbe says:

"I devised a ring of rubber, made in segments fastened by catgut, which would fall apart after a few days, but abandoned that when I made a stiff one entirely of catgut," etc. (*vide Medical News*, June 1, p. 590).

The credit of utilizing drainage tubing and of experimentally showing the utility and practical value of this ring is entirely Brokaw's, however, and the experimental and clinical confirmation of its value gives it a distinct place as a worthy and really valuable substitute of the Senn plate; and as far as adaptability to clinical requirements and rapidity of construction are concerned, I do not hesitate to say that it is equal, if not superior, to any of the substitutes that have been offered for the Senn plate.

This ring has been used, according to Brokaw on dogs in fourteen cases of intestinal anastomosis, with three deaths; circular enterorrhaphy has been performed with it in fourteen cases, with seven deaths; duodeno-cholecystotomy, three cases and two deaths. In various other operations on dogs it has also been employed with perfect success. Dr. Benjamin P. Shimwell, of Philadelphia (*Medical News*, April 12, 1890), has largely experimented on dogs with these rings, and decidedly prefers them to Abbe's rings, which he considers to be theoretically good, but practically imperfect. The objection to them is that, like Senn's plates, they can not be made quickly in an emergency." In addition to this experimental proof of the efficacy of the Brokaw ring we find that two cases have been reported in which these rings were used in the human subject. One, a case of gastro-enterostomy for pyloric cancer, reported by Dr. Carson, of St. Louis (Brokaw, *Int. Journal of Surgery*, November, 1889), which ended successfully, and another, a case of pylorectomy for cancer, in which, after closing up the pyloric end of the stomach and duodenum separately, a gastro-enterostomy was performed. This patient died twenty-six hours after the operation, from causes which do not reflect on the merits of the ring used in the anastomosis (*vide* Tuholske, of St. Louis, *Medical News*, May 10, 1890).

We may conclude from this evidence that, as in the case of the Abbe catgut ring, the claims for the Brokaw's segmented rubber and catgut ring as a substitute for the decalcified bone plate are fully substantiated by experimental and clinical evidence.

The ingenious catgut mats and solid catgut plates suggested and described by Dr. Davis, of Birmingham, Ala., next claim our consideration, especially since this observer has largely and successfully experimented with this material on dogs. This author reports seventy-nine anastomotic operations with the catgut plates and mats, though with what percentage of results I am unable to state, as I have not read the author's original contribution to the Southern Surgical and Gynecological Society, which met in 1889, and this percentage is not detailed in the author's extensive article in the *Annals of Gynecology* for August, 1889, which I have con-

sulted. These "mats" have been tried clinically in a case of malignant disease requiring ileo-colostomy. Though the patient died of exhaustion twelve hours after the operation, the autopsy revealed nothing which could affect the merit or value of the mat. The mats have also been tried in a case of jejunio-ileostomy, which also ended fatally, and too early to permit judgment on the final efficacy of the mats.

The mats are ingeniously made, and doubtless could be utilized as successfully as Abbe's, Brokaw's, or my ring, in cases demanding anastomosis; still the great objection to them is that they are not easily made in an emergency as the other more substantial catgut substitutes which have been suggested. The catgut *plates* would appear *a priori* to be especially fitted for the work required of them. They are made of solid catgut sheets, and can be very quickly cut or punched out when the catgut sheets are at hand; furthermore, they present a large, flat surface for serous confrontation and adhesion, and in this way more closely resemble the Senn decalcified bone plate than anything else yet suggested. They are at present open to the objection that catgut compressed into plates is not easily procured, as I know by my complete failure to obtain it notwithstanding my direct application to Mr. Snowden, Dr. Davis's catgut manufacturer; but furthermore, as Senn has recently shown (in his paper on Resection of the Cæcum, etc., *loc. cit.*), because the plate is so hygroscopic that it becomes rapidly too soft and non-resistant to serve as an aid, and swells to such proportions that it endangers the vitality of the intestinal wall by exercising too much pressure at the suture points.

In completing the list of substitutes that have been offered for the Senn bone plate, I need only mention the solid rubber discs which were successfully employed by Penrose, of Philadelphia, in experiments on dogs (*vide* discussion following Abbe's paper, Philadelphia County Medical Society, May 8, 1889, *Medical News*), and the rings made of decalcified *bone* drainage tube threaded with catgut, and the prepared arteries also threaded with the same material that have been suggested by Brokaw, of St. Louis, in a paper in Philadelphia *Medical News*, for 1889. These substitutes have not been tried clinically, but there is no reason to doubt their efficiency. They

are certainly worthy of being counted among the resources of the surgeon in cases requiring anastomosis.

I have thus passed in review the different substitutes that have been offered by others for the decalcified bone plate; now permit me, in justice to myself, to say something in regard to the solid catgut ring made of "drum snare" gut and already referred to as the ring originally suggested and demonstrated by myself before the Louisiana State Medical Society, at its meeting in this city on April 10, 1889.

The ring which is exhibited in the collection before you is the same as the one which Dr. Paul Michinard and myself have tried quite extensively in the experiments on dogs which we have jointly conducted during the last few months. It is quite different from the ring originally presented to the Louisiana State Medical Society last year. While it is made of the same "drum snare" material, it differs from very essentially in the fact that I now employ the catgut after it has been boiled, and, consequently, the tendency to kink and twist which characterizes the original twisted material is permanently and effectually removed. At the time when I first demonstrated the *technique* of circular enterorrhaphy and of anastomosis, with the aid of these rings, before the State Society, I had only experimented with the rings on the cadaver, and had not had occasion to observe the effect which prolonged immersion of the thick catgut in a watery medium has in disfiguring the rings. For this reason, I am much indebted to Brokaw for this criticism with which he summarily disposed of the ring and put it, metaphorically, *hors de combat*. This criticism led me to experiment and study considerably the hygroscopic properties of catgut, and on the conditions which modify them. In order to prevent the absorption of water, I tried the effects of preparatory saturation with various fixed and volatile oils, of varnishes, such as damar, copal, and gutta-percha; these simply retarded absorption, but in the end totally failed to prevent it, and with the failure came the inevitable coiling and distorting kink or twist; a tanning process was tried, chromicizing, etc., but all this failed, until I resorted, finally, to the simplest expedient which is always effective with thread-catgut, and that was, to boil the gut in water until it had com-

pletely uncoiled itself and had absorbed water to the fullest extent of its hygroscopic capacity. This result, much to my satisfaction, was accomplished by very few minutes' immersion in boiling water, when the gut swells to three times its original diameter and is reduced to one-third of its original length. Thus three feet of drum snare will, after two or three minutes' boiling, contract to one foot; and the cord which originally was about $3\frac{1}{2}$ millimeters in diameter will swell to 6 millimeters. After this result is obtained, the gut will remain permanently shortened, but will dry very rapidly and become as hard as wood. It may be then immersed indefinitely in water, and it will simply soften to the consistence of a solid rubber band, but will never show a disposition to become distorted by kinking or coiling. With a material thus prepared it is easy to make rings of any desired size, by simply cutting and shaping them; furthermore, they are made to retain their shape by simply inserting the free ends in a small piece of rubber tubing, which, acting as a clasp, is sufficient to keep the ring in shape; in order to secure the tubing permanently it will be safer to tie the ring to the tubing with silk thread. The ring is then ready to be mounted with the fundamental or perforating sutures, which should consist of four threads six or eight inches long, each holding a round milliner's needle of convenient size, and tied at equidistant points on the circle. When the ring is to be used it should be placed in a towel previously wrung out of a hot carbolized or aseptic solution, in which it will rapidly soften and swell to its maximum dimensions, and in this condition will be made to slip easily through a comparatively narrow slit in the intestine. It is preferable to use the ring soft because it then has attained its maximum hygroscopic diameter and there is no risk of subsequent swelling within the intestine; furthermore, while soft and of a rubber-like consistence, it is still sufficiently resisting to secure the ready coaptation of the opposed serous surfaces. When thus softened, a large ring can also be used to secure coaptation after partial enterectomies of the intestinal convexity for multiple gunshot wounds, as Brokaw first suggested; though it appears to me that the application of aids in these cases is, if not superfluous, at least not essential.

While studying the hygroscopic condition of catgut, I dis-

covered that the only kind of heavy catgut that will stand boiling without disintegrating or spoiling, is the cheapest (five cents per foot) catgut first recommended by me, *i. e.*, the crude commercial drum snares used for tightening drums, and not the heavy gut strings used for the bass violin, which Brokaw and others have erroneously regarded as identical with the above. The finer varieties of gut which are used as bass or violin strings are subjected to a sort of waxing process which totally unfits them for boiling, by disintegrating and making them totally worthless for any purpose. Not knowing this peculiarity, I recommended them in my first paper, owing to their apparent similarity to snare material, but since I have discovered my error I withdraw my recommendation and would warn those who should be tempted to try them against their use.

Having thus modified my original ring, I believe that the objections against it have been removed, and the experimental evidence that I have secured in the operations performed by Dr. Michinard and myself proves that they can be used as effectively as any of the catgut substitutes of the Sepn bone plate. We have used this ring twice in gastro-enterostomy after pylorotomy; once in entero-enterostomy; once in ileo-colostomy; once in circular enterorrhaphy after colectomy, and once in circular enterorrhaphy after enterectomy.

We have had a perfect success in one of the gastro-enterostomies after pylorotomy, the animal living at this present date. In this case, a preliminary gastro-enterostomy was performed about two months ago; the secondary pylorotomy was performed over two weeks ago, the existence of a large and perfect gastro-duodenal fistula was verified, and an extensive resection of the pylorus and a portion of the duodenum and stomach performed; the stomach was completely isolated, and closed at the former pyloric end, and the pyloric end of the duodenum inverted and also closed. The animal made an excellent and uninterrupted recovery, and is to-day eating like any other dog, and shows no dyspeptic or digestive disturbances.

In the other gastro-enterostomy and pylorotomy, which was performed before a large class of students and under very disadvantageous circumstances, death followed twenty-four hours after the operation from hæmatemesis and hernial eversion from the rupture of the abdominal stitches after vomiting. In this case, no extravasation was found in the peritoneal

cavity; the catgut ring in the stomach was found undergoing rapid absorption, and would soon have undergone complete digestive disintegration; the anastomotic communication with the jejunum was perfect in so far as coaptation was concerned, but the peritoneal exudate was scant. The hemorrhage came from the mucosa, which had been trimmed at the pyloric end of the stomach too far below the serous section, and consequently was not efficiently compressed by the sutures.

In the entero-enterostomy, over four inches of intestine were removed; the two ends were inverted and closed into cul de sacs, and the continuity of the intestine restored by performing lateral anastomosis. The animal reacted well from the operation and appeared to be in excellent spirits and playful, when on the third day it died suddenly. Much to our regret, the animal was carted away in the garbage wagon before we could determine the cause of death by an autopsy.

The ileo-colostomy was very interesting in its results, and ended in recovery. As the sequelæ are given later on in the the paper, the details are omitted here.

In the circular enterorrhaphy after colostomy, the resection was imprudently carried to excess. The whole transverse colon was excised; the ascending colon was united to the rectum directly as in circular enterorrhaphy, *i. e.*, lumen to lumen, and coaptation effected with my solid catgut rings. The animal stood the operation badly and expired twenty-four hours after; at the autopsy the rectum was found in a gangrenous condition from venous asphyxia, due probably to ligature of a hemorrhoidal or mesenteric vein; the circulation through the connected intestines was perfect and the joint showing no leakage; the rings were *in situ* and showing no sign of disintegration. The plastic exudate about the sutures was wanting, notwithstanding abundant scarification during the operation.

In addition to the preceding we have performed various other anastomotic operations, over ten cases in which the results have satisfied us that solid catgut ring made of boiled drum-snare material can be effectually substituted for decalcified bone plate.

Clinically, I have not had an opportunity of testing the value of my rings, and know of one case only, operated by Dr. J. D. Bloom, assistant house surgeon Charity Hospital, in which circular enterorrhaphy was performed with their aid after the resection of a large piece of gangrenous intestine, due to hernial strangulation. In this case the man was brought in an almost moribund condition to the hospital and the operation

had to be performed simply as a matter of duty. The man died a few hours after the operation, too early to test the merits of the rings.

We may now sum up in the order of their publication the various modifications that have been offered for the decalcified bone plate of N. Senn (International Medical Congress, September 5, 1887).

1. Rings made of catgut strands; Abbe, New York Surgical Society Proceedings, June 9, 1889.

2. Rings made of solid catgut, drum-snare material; Matas, Transactions Louisiana State Medical Society, April 10, 1889.

3. Solid rubber discs; Penrose, Transactions Philadelphia County Medical Society, May 8, 1889.

4. Mixed rubber and catgut rings; segmented rubber rings; Brokaw, St. Louis Medical Society, September 21, 1889.

5. Solid catgut plates and catgut mats; Davis, Proceedings Southern Surgical and Gynecological Association, August, 1889; *New York Medical Record*, November 30, 1889.

6. Rings made of decalcified bone drainage tube threaded with catgut; Brokaw, *Medical News*, 1889.

7. Rings made of ox arteries threaded with catgut strands; Brokaw, *Medical News*, loc. cit.

We have now completed the list of substitutes that have been offered for the decalcified bone plates originally introduced by Senn, and we believe that the evidence here collected substantially proves the correctness of our third proposition.

The important question that is now asked by the practical surgeon is: Do these substitutes constitute a real advance, an improvement, on the Senn plate; are they really superior to it? Should they be preferred by the operator in all cases to the bone plate, or are they merely *sucedanea* which should be utilized only when the decalcified plate is not ready at hand? Or are there special indications for the use of either the bone plates or the substitutes?

Senn himself has most recently answered, or at least partially answered, these questions at the late meeting of the American Medical Association, held at Nashville, May 21, 1889, in his important paper already referred to, "Remarks on Intestinal Anastomosis, etc.," loc. cit. He says:

“ Objection has been made against the bone plates to the effect that they are not always at hand when needed. But like catgut, silk, drainage tubes, and other essential materials used in the treatment of wounds, they should be kept on hand, ready to be used in an emergency. The different kinds of rings devised by Abbe, Matas, and Brokaw, as substitutes for the bone plates, lack some of the most important advantages possessed by the plates. Catgut is a material which, when brought in contact with the alkaline secretion of the intestinal canal, becomes, in a few hours, so soft and macerated that it can not be relied upon as a support. All ring supports bring into apposition only a small area of serous surface, and the pressure is not *equally distributed*.* Davis catgut mats are superior to the catgut rings, but the material of which it is composed is so highly hygroscopic that, when acted upon by the intestinal contents, they swell up rapidly and become as soft as rag in a few hours. I immersed one of the plates which Dr. Davis kindly sent me in a warm solution of common salt, and in three hours it had increased to three times its former thickness, and had become so limpid that in the same condition in the intestinal canal it would furnish little or no support in maintaining uninterrupted apposition. The same objection applies to the catgut rings and catgut mats as to the dried bone plates, that when used in the dry state they increase rapidly in thickness from the imbibition of fluids, and, as the sutures are unyielding, the pressure thus produced may become a cause of pressure gangrene.

“ An extensive clinical experience and numerous experiments on animals have satisfied me that thus far no better material has been suggested for making approximation plates than decalcified bone. Decalcified bone plates kept moist in an antiseptic solution do not increase in thickness by imbibition of fluids when used in the stomach or intestinal canal, and they serve as an efficient mechanical support in bringing together and maintaining accurate coaptation of large serous surfaces which it is intended to unite in establishing an intestinal anastomosis. The decalcified bone plates can be relied upon in maintaining equable surface pressure upon the tissues interposed between them for at least three or four days, which is

* The italics are mine.—R. M.

the time required in obtaining a sufficiently firm union by cell proliferation from the apposed serous surfaces. Indestructible and unabsorbable material should never be used in the preparation of the approximation plates, as such substances in the stomach or intestines, where they are used, may cause irritation, or even ulceration and perforation; or they may pass on and become impacted in the narrowed portion of the bowel. Dr. Stamm, of Fremont, Ohio, made plates of the thin portions of the scapula of a calf, and used them in a gastro-enterostomy for carcinoma of the pylorus. The patient died forty days after the operation, and at the necropsy the plate inserted into the stomach was found unchanged in the viscus."

In reply to Dr. Senn we would state that the danger of pressure gangrene from secondary swelling of the catgut is precluded by the rubber tubing in the Brokaw ring which does not materially increase in size, and by the fact that a preliminary immersion in a watery medium will also obviate this risk without seriously affecting the firmness of the material in my solid catgut ring; furthermore, the experimental and clinical evidence accumulated in favor of the Abbe, Brokaw, Davis, and the author's ring would prove that these substitutes are really efficient, and can be successfully and advantageously utilized in practice. Still, the other points urged by Dr. Senn are well taken, in my estimation, and it would be unreasonable to deny (1) that the exceeding rapidity with which catgut is absorbed, and (2) the smaller surface that rings of all descriptions bring together for adhesion, make them inferior to the decalcified bone plate,* which should be regarded, if from these standpoints alone, as the superior material in all cases of enterorrhaphy, excepting, perhaps, in those instances of circular resection of the bowel in which *lumen to lumen* enterorrhaphy is aimed at. It should be remembered that in the performance of intestinal suture, whether for anastomosis or for circular enterorrhaphy by the direct method, the great merit and advantage claimed for the *aided* methods over the unaided, simple stitch procedures is in the greater rapidity as well as security with which the aided methods can be executed. The time-

*As my colleague, Dr. Parham, has suggested, this objection can be partially overcome by nesting the rings into each other, thus forming a simple and substantial mat, which would be held together by silk or catgut threads. These mats would be easier to make and would be more resisting than the Davis mats.

saving advantage rests on two points: (1) That a minimum number of stitches is needed when the aids are employed, and (2) that a *firm basis* is given the operator by the use of an intra-intestinal support which allows of a more rapid stitching than when no such support is employed. Now, the decalcified bone plate combines these advantages in addition to those previously referred to in proposition 2 and elsewhere, and for this reason is the best material, when rapidity of execution as well as safety are the main desiderata, as by the use of these plates the surgeon need not be so particular in perfecting the external serous suture once the apposition of the plates has been thoroughly effected by the transfixion stitches. On the other hand, it can be urged that since this peripheral security (Lembert) stitching is needed in all cases, that the time lost in applying a few more stitches will not seriously affect the result in most instances, and that consequently the aids made of more digestible and absorbable material can be advantageously employed as ephemeral supports in expediting the ordinary Lembert suture.* With this view I fully concur, and believe that by accomplishing this result alone the technique of intestinal suture has been very much advanced by the introduction of the various aids referred to.

As a result of the preceding considerations we may, therefore, draw the following propositions:

PROPOSITION 4.—While the various substitutes, Abbe's, Brokaw's, Davis's, and the author's, can be successfully substituted for the decalcified bone plate, the latter is the preferable material, the others being regarded in the light of *succedanea*, to be remembered in emergencies and special conditions.

PROPOSITION 5.—That where the digestive and absorbent surfaces are especially active, as in operations in the upper portions of the gastro-intestinal tract (stomach, duodenum, and jejunum), it is especially indicated to use less absorbable material—decalcified bone; and

PROPOSITION 6.—Highly absorbable material (catgut) can

* That the need for this intra-intestinal support as a basis for suturing has long been felt by surgeons is well demonstrated by the numerous devices which have been suggested *ad hoc*, and used by surgeons long before the introduction of the Senn plate. These cylinders of gelatine, of dough (Hohenhauser), the trachea of animals, cartilaginous cylinders, decalcified bone cylinders (Neuber), Treves's inflation rubber bag, etc., all emphasize this want.

only be used with safety in the above-mentioned territory when the ring or plate is used as a mere technical aid, not as a durable intra-intestinal support, but as a means of expediting and perfecting the peripheral Lembert or continued stitch.

Remarks.—That the absorption of the aid material bears a direct relation to the digestive activity of the region in which it is placed, is well illustrated in the operations performed by Dr. Michinard and myself. In one dog, twenty-four hours after gastro-enterostomy, the solid catgut ring in the gastric side had been almost wholly disintegrated and absorbed; in another canine, twenty-four hours after colectomy with circular enterorrhaphy, the two solid catgut rings used were found intact, and showed no trace of digestive action or disintegration.

PROPOSITION 7.—That absolute reliance is not to be placed on fixed or definite periods for the formation of plastic peritoneal exudation, and that while this protecting exudation takes place in two, four, and twelve hours, it may be very remarkably retarded.

Remarks.—This is illustrated by the case of a dog (apparently in excellent health), in which we performed ileo-colostomy with the aid of my solid catgut rings. At the autopsy, *one week* after, no visible trace of plastic exudation could be discovered, notwithstanding the fact that the animal appeared to have recovered perfectly from the operation. In this case the anastomotic communication between the bowels failed to form, notwithstanding very thorough scarification of the serosa; the incisions in the bowels having closed by muscular contraction around the everted mucosa and final agglutination of the serous edges. The rings had completely disappeared, and with them the transfixion sutures; the intestines were held together in confrontation by a few interrupted Lembert stitches, about which there was not the least appearance of exudation.

This animal was reoperated to verify the anastomosis, and had it not been for this revelation we would have credited this case to the list of the successful anastomosis. In order to control the operative results, it is important in experimentation that even after the apparently perfect recovery of an animal that a second examination be made in order to verify the result, which may be quite the reverse of the expectation.

PROPOSITION 8.—Gastrostomy: This operation is much simplified and expedited by the adoption of the ring principle, and, as at present modified, could be advantageously substituted for the older and unaided stitch methods hitherto adopted in its performance.

Remarks.—This operation may be performed with the aid of one ring, as originally suggested by Prewitt, of St. Louis, Mo., and as it has been tried on dogs successfully by Brokaw. With the aid of two rings I believe the operation can be performed with as much rapidity and greater security. The stomach is drawn out through the usual abdominal incision and an incision made into it sufficiently large to admit a ring two to three inches in diameter. This ring should be made of rubber drainage tubing packed with catgut strands, or with solid catgut drum snare material, after my model; large decalcified bone plates (Senn's) could also be used, were it not that the incision required to introduce them in the stomach would be too large. From six to eight apposition double threads, armed with one milliner's needle each, should be attached to the rubber tubing, not to the catgut contained in the tubing, as in the ordinary ring, but to the rubber itself; strong silk should always be used. Each needle is now passed through the walls of the stomach, traction being made to see that the ring rests well in place, and the stomach is pushed back into the abdominal cavity. The needles are then passed through the whole thickness of the abdominal walls and tied as in the manner of a quill suture to an external segmented rubber ring or one made of solid catgut after my model. Finally, as suggested by Brokaw, the margins of the opening in the stomach should be stitched to the skin of the abdominal incision. By Prewitt's method the transfixion threads are simply tied in pairs over the skin of the abdominal surface. In either case, the feeding may be commenced immediately after the operation.

This operation has never been tried clinically, though it has been successfully performed on dogs.

In cases of carcinoma of the stomach not fitted for gastrectomy, Bernay's operation by which the growth is curetted through an incision in the stomach, will be greatly expedited by resorting to this method of securing the stomach to the

abdominal incision, where the organ will remain adherent and always accessible for secondary repetitions of the curetting treatment.

PROPOSITION 9.—The operation of pylorotomy has been much simplified by the introduction of Senn's method, and judging by the present outlook the mortality of this most formidable procedure will be much diminished in future; the greater probability of operative success will in future encourage the surgeon to earlier and more radical interference in these desperate cases.

Remarks.—The continuity of the gastro-intestinal tract may be established after pylorotomy by either of the two methods recently suggested, viz: By direct gastro-duodenostomy, with the aid of Senn's plates; or by the closure of the gastric and duodenal ends, thus severing completely the normal gastro-duodenal connection and creating an artificial pylorus by the formation of a gastro-enterostomy with the aid of Senn's plates. The reason for preferring Senn's plates in this operation has already been stated, and the conditions under which more absorbable material can be substituted for these plates have been already stated elsewhere.

The recent case reported by Mr. Rawdon, of Liverpool (*vide* Bibliography, *et supra*), will illustrate the manner in which the decalcified bone plates are to be used when direct gastro-duodenostomy is aimed at after pylorotomy:

“The patient, male, aged fifty-six, was admitted to the Royal Southern Hospital, Liverpool, with well-marked symptoms of pyloric stenosis of some weeks' duration, and a small tumor was felt in the abdomen under the left rectus, a little above the umbilicus. Mr. Rawdon opened the peritoneum by a median incision about four inches in length, commencing one inch below the ensiform cartilage. The tumor proved to be a mass of carcinoma involving the pylorus and pyloric end of the stomach. There were no abnormal adhesions, and the parts were drawn out through the abdominal incision, when it was found that a third of the stomach had to be removed. The vessels coursing along the greater curvature were secured at the point where the line of incision was required, and the duodenum and the vessels immediately connected with it were compressed by a ligature of rubber tubing. The affected portion of the stomach was now excised, only one or two vessels in its walls requiring a ligature; the omental connections were

gathered up, transfixed, and the rubber tubing constricting the duodenum was removed, and two or three arteries were secured. The stomach wound was closed with continuous sutures of fine silk, except one inch at the greater curvature, which was left open to admit of the introduction of one of Dr. Senn's plates of decalcified bone. A second plate, cut circular, was passed into the duodenum and placed so as to lie across it, with the coats of the bowel overlapping the plate. The openings of the stomach and duodenum were now brought into apposition, and the corresponding ligatures on the two plates tied together, so that direct communication was established between the two viscera.

The parts were returned into the abdomen, and the wound closed in the usual way. The operation was completed in less than an hour; the patient made an uninterrupted recovery. He was supported by nutrient suppositories during the first week; he was then allowed a little pancreatinized cow's milk, and gradually returned to his ordinary diet. At the present time he is able to eat heartily without pain or other discomfort.

The other improved method of performing pylorotomy with the aid of gastro-enterostomy is well illustrated by the following successful case of Bull, of New York:

The operation was performed on a woman aged twenty-nine, suffering from carcinoma of the greater curvature and posterior wall of the stomach. The abdomen was opened by a median incision, and the gastro-hepatic and gastro-colic folds, the tumor, together with the pylorus and about one-quarter or about one-third of the pyloric end of the stomach, were then removed. The cut end of the duodenum was sutured so as to form a blind pouch, the stomach treated in like manner, and an anastomosis made with the jejunum near its commencement, by means of Abbe's catgut rings. The operation lasted three hours and a half. There was a serious fear of prostration at the end of the second hour, but at its close the patient rallied. All food by the mouth was withheld till the fourth day; no untoward symptoms were observed; on the seventh day the temperature and pulse were normal, liquid food had been taken freely, and the bowels had acted spontaneously. The patient's subsequent progress was in every way satisfactory, and on the twelfth day, the day of the last report, she was considered to be out of danger.

In regard to the special indications for these two operations it is difficult at present, in view of our very limited clinical experience with either, to formulate such rules as would assist the surgeon in deciding which should be accorded the preference in any given case.

Mr Jessett (*British Medical Journal*, May 10, 1890), has recently commented upon these two operative procedures.

This investigator found, in his experimental work, that the portion of the duodenum that was surrounded by peritoneum was so very short that it would have been impossible to have done the operation successfully.

The same difficulty would apply in most cases to the human being, as the first portion of the duodenum is only two inches long, and not more than two-thirds of this is completely surrounded by peritoneum, leaving, after allowing for a small portion which must of necessity be removed with the pylorus, only about one inch to deal with. This would be hardly enough to allow of a bone plate being introduced without putting a considerable drag upon the parts to be united. When, however, the pylorus becomes obstructed, and the stomach dilated, it seems to have the effect of elongating this first portion of the duodenum. "In such a case," says Jessett, "the plan put into practice by Dr. Rawdon is undoubtedly, to my mind, the best mode of operating." Should, however, this portion of the duodenum not be elongated, then the operation of invaginating and closing separately the divided gastro-duodenal ends, and creating a new pylorus by means of a gastro-enterostomy, as in the case of Dr. Bull, would be the preferable operation.

The first method thus far has one case, Rawdon's, on its list, and this was successful. The second method has two cases, Bull's and Tuholske's, one successful and one fatal.

PROPOSITION 10.—The operation of gastro-enterostomy by the Senn method is especially indicated in cases of cicatricial or non-malignant stenosis of the pylorus, as a more advantageous substitute for Loretta's stretching operation, Hahn's pyloric intubation, or the Heineke-Miculicz pyloro-plasty.

Remarks.—This proposition has been made very plain by Dr. Weir, of New York, who, in a successful case operated with Abbe's catgut plates (*Medical News*, Philadelphia, vol. lv. 666, 1889), has proved this to be a most rational procedure in such cases.

PROPOSITION 11.—It is the opinion of the writer, based on anatomical examinations and experimental evidence, that in gastro-enterostomy, the method of Wölfler, which aims to

secure the jejunum to the stomach, over the colon and great omentum, is a dangerous procedure which subjects the anastomotic connections to unnecessary strain, and, furthermore, physiologically excludes an unnecessary length of most active intestine. The method of Curvoisier and Von Hacker, by which the jejunum is connected to the stomach directly, after tearing or cutting a passage through the bloodless area of the transverse meso-colon, under the meso-colic arch of Riolan, is more commendable from the anatomical, physiological, and operative standpoints.

Remarks.—From experimental evidence and frequent operations on the cadaver, I am convinced that the tendency to form an obstructing eperon in the attached bowel is greater by Wölfler's method than by the trans-meso-colic operation. Contrary to the opinion of several writers, this operation is very easily performed on dogs, and judging by my experience on the human cadaver, there is no reason to doubt that the anastomosis can be performed just as quickly as by the supra-colic route. It is easy to understand that when the mobility of the stomach is lost by excessive infiltration or adhesion, that Hacker's procedure should be more difficult of execution. In such cases Wölfler's method could be resorted to. The mortality by either method, as already referred to in the earlier part of this paper, is about equal, *i. e.*, nearly 50 per cent; but this is by the slow stitch methods; the new statistics are not available on this point, but it will doubtless be proven when further reports accumulate that the immediate operative dangers of gastro-enterostomy will not be increased by Hacker's trans-meso-colic method, whilst the post operative results will be much bettered.*

United clinical and experimental evidence condemn emphatically the method of Leucke, who, to expedite the operation of gastro-enterostomy, unites the first presenting portion of small intestine to the stomach. The surgeon should always *assure* himself that it is the jejunum that he is attaching to the stomach, and not another intestine. Repeated practice on the cadaver, and a free exposure of the parts, are much better

*Mr. Jessett, in his most recent contribution to the subject, July 12, 1890 (*vide* index), thoroughly concurs with this view.

and more reliable than Hahn's rules for finding the upper jejunum.

PROPOSITION 12.—*Circular Enterorrhaphy*.—The operation of circular enterorrhaphy is, in the light of *present* experimental and clinical experience, most promptly and securely performed by the invagination and complete closure of the divided intestinal ends with the aid of a continued or interrupted Lembert stitch, the continuity of the intestinal canal being reestablished by the formation of an anastomotic opening with aid of Senn's decalcified plates, or the catgut ring substitutes. (Senn's method.) (*Vide* plates, Nos. 7, 8, 9, 10, which illustrate the operation as performed with Brokaw's rings or the author's, and plates Nos. 16 and 17 [ileo-colostomy], with Senn's bone plates.)

Remarks.—This method is particularly indicated in all cases in which the opposed intestinal diameters are different, such as in cases of intestinal obstruction in which the gut on the proximal side is much dilated and wider than on the distal side. The lumina being disproportionate, it would be difficult to unite the divided bowels mouth to mouth, and the only practically good method of promptly restoring the intestinal circulation after enterectomy would be by the anastomotic method. On the other hand, in cases of circular resection in which the opposed bowels are symmetrical, and the lumina equal, the quickest and simplest method of restoring the continuity of the bowels would be by circular enterorrhaphy by the author's method. *Vide* plates Nos. 11 and 12, illustrating the application of the author's catgut-snare ring. When the indications for this method are met (*i. e.*, equal lumina in confrontation), it is difficult to conceive of an easier method of performing anastomosis. Certainly, it is the most rapid and secure method that the author has practised on the cadaver, and it is impossible to understand what would be the serious objections against its adoption on the living subject. Unfortunately this method can not be tested experimentally on dogs, unless very large animals are operated upon, though even in large animals of this species it is impossible to overcome the great anatomical obstacles in the way of its performance. In the dog the muscularis of the intestine is relatively much

thicker and stronger than in man; so that immediately after circular division of the intestine the divided bowel contracts so thoroughly and spasmodically that it is even difficult to introduce a ring very much smaller than the intestinal lumen at the divided point. Furthermore, the elongated conical projection formed by the severed bowel end offers an insuperable barrier to the even coaptation of the confronted surfaces. After attempting this method on dogs, Dr. Michinard and myself promptly abandoned it as unpractical in this animal, in which even circular enterorrhaphy by the unaided Lembert method is extremely difficult and disadvantageous. It is not surprising, therefore, that Brokaw, in his fourteen experiments, should have met with a mortality of 50 per cent, though this experimenter, like ourselves, believes in the clinical excellence of this method. He very correctly says (*St. Louis Courier of Medicine*, p. 395, vol. ii, June, 1890): "This is without doubt the most rapid method of performing circular enterorrhaphy, and while my experiments upon the dog, with this method, were not as satisfactory as I had hoped (50 per cent died), on man the results will be far better; the amount of stenosis would not be more than by circular suturing with the unaided Lembert or Czerny-Lembert. In man for anatomical reasons, the apposition threads can be passed nearer the cut margins of the bowel. In man there would not likely be any formation of enterolithis; a liquid diet for a time would do away with that danger, which was the cause of death in several of my experiments," etc.

The details of the technique of this method are made plain enough by the illustrations, so that no further explanation is needed; besides these, however, the descriptive text is fully given in the author's "Remarks on Circular Enterorrhaphy," *loc. cit.*, April, 1889, in which this procedure was first presented to the profession (*vide* this journal, July, 1889). While the value of the experimental test is denied this method, in dogs, at least, the author feels satisfied that it has a great future before it, if is only tried in the operating room on the human subject.

PROPOSITION 13.—Enterorrhaphy after partial enterectomy for multiple gunshot and other injuries of the intestinal con-

vexity, may be, in special cases, advantageously performed by the aided method.

Remarks.—Brokaw and Davis have suggested that in injuries of the intestines which permitted of the closure of the wound without producing obstructive stenosis of the intestinal lumen, but which could not be closed without a partial sacrifice of the intestinal wall, that a large multi-segmented catgut-rubber ring (Brokaw) or catgut plates (Davis) could be utilized to approximate the pared surfaces of the wound, as is shown in the illustration. Brokaw describes the method of suture as follows: "After trimming and enlarging the wound with scissors, an oval ring made of eight segments of tubing, with an aperture of two and a half inches, is placed in the bowel. Six apposition threads should be used with this ring, one at each end and two on each side, so arranged that when tied the ring is held bent upon itself. The ring is introduced into the bowel, the end apposition thread passed, then the lateral; the ring is doubled upon itself, and the end thread tied first, next the lateral apposition threads. To prevent eversion of the margins of the wound, particularly at the point of flexure, a single provisional catgut suture is used in drawing the margins of the wound in the bowel together." (*Vide* fig. 13.) Davis tells us that the same result can be accomplished quite as readily with his catgut plates. On the cadaver I have tried a large, solid catgut "drum-snare" ring, and found that it could be just as easily used as the Brokaw ring, after previous softening in water. I only once tried the method on dogs, but gave up the attempt because the spasmodic contraction and narrowing of the intestine in this animal after irritation makes it absolutely impracticable to effect coaptation after partial enterectomy by the use of these aids. In fact, I am somewhat astonished that other observers should affirm that their experimental work with this operation "has been highly successful." I must frankly confess that, in the light of my individual experience, I think little advantage is gained by the ring aids in partial enterectomy of the *small* intestine. The indication for this method of suturing will be found in the wounds of the large bowel (cæcum, colon), where, owing to the greater size of the bowel, the rings can be manipulated with greater advantage. For partial enterectomy of the small in-

testine, the Lembert stitch will, as a rule, be found to be still the simplest and most expeditious method of suture.

PROPOSITION 14.—*Linear Enterorrhaphy*.—In simple *linear* incisions into the convexity of the bowel (stab wounds, enterotomy), requiring suture, greater security and rapidity can be gained by the *aided* method.

Remarks.—In wounds seriously compromising the mesenteric attachment of the bowel, it is imperative (and the teachings of experience absolutely command this), that resection be practised, but in incised wounds involving the free surface of the bowel the suturing can be quickly effected by the skilled application of the "aid" principle in the manner of a quilled suture; the aids representing the quills being made of decalcified bone (Brokaw) or bars of my solid catgut drum-snare material. If the last material is used, a piece is cut of the length corresponding to that of the wound in the bowel. Threads of fine and well chromicized catgut or aseptic silk are now attached to the solid catgut rod at half an inch or less distance from one another. These threads are now mounted each with a needle as small as can be conveniently used. With two rods thus prepared, the approximation is easily effected. After the rods are introduced into the intestine the needles are made to transfix the bowel by passing from within outward, about one-quarter of an inch from the margins of the wound; the second mounted rod is applied in the same manner, traction is made upon the threads to see that the rods rest well in place, the central threads are now tied, and lastly the distal threads. A few extra Lembert sutures will add to the security of the suture. (*Vide* figs. 14 and 15.) Brokaw, to whose ingenuity we owe the suggestion and technical details of this mode of application of the aid principle, recommends rods made of decalcified bone, or short sections of rubber tubing, the last being the most accessible material and possibly the safest in the upper digestive tract, where the disintegrating forces are most active. This modified "Brokaw" suture is a decided improvement on the suggestion made primitively some years ago by Beranger Ferard (*vide* Stimpson's *Operative Surgery*, p. 353, 1885 ed.), who used rods or strips made of cork, which were mounted with pins. These cork rods were placed in the intestines, one on each side of the wound, and

parallel to it and the pins forced through from within outward two or three millimeters from the edge. They are then turned so that the points face each other, and the pins of each driven into the other by pressure through the sides of the intestine. The cork rods and pins were to be eliminated with the fæces. The irritant effect of the pins fixed in the cork rods during elimination can well be imagined. The improved quill suture of Brokaw is therefore very noteworthy and should not be forgotten by practical surgeons, who will at once recognize its special advantages.

PROPOSITION 15.—*Ileo-colostomy*.—Intestinal anastomosis by making ileo-colostomy with perforated decalcified bone plates must now be accepted, not only as an established surgical procedure, but as the operation of election in the treatment of the following conditions: (1) Irreducible ileo-colic invagination without perforation or gangrene; (2) cicatricial stenosis in the ileo-cæcal region; (3) carcinoma of the cæcum, with or without excision of the diseased portion of the bowel (Senn).

Remarks.—In no other part of the alimentary tract do the disadvantages of the unaided stitch methods appear greater, and nowhere have the new methods proved more beneficial. Hitherto, in cases of malignant or other disease which frequently obstructs the ileo-cæcal valve, the surgeon has been compelled to resort to the formation of an artificial anus, and only in exceptional instances have attempts been made to restore the freedom of the intestinal circulation at one sitting, and these as a rule have proved disastrous failures. Only those who have experimentally or clinically tried to restore the continuity of the bowel tract after resection of the ileo-cæcal region can fully appreciate the difficulties and the dangers of the technique by the unaided methods, the results of which, in fact, forbid, as a *chirurgia prohibita*, the intervention of the surgeon. The aided methods have completely altered the face of this question, however, and the misery of the artificial anus in such cases will now, under the ægis of Senn's innovation, be probably consigned to the recollections of the past. With the prospects of a greatly reduced mortality the reluctance of the surgeon to undertake these formidable cases will cease and more courageous aggressiveness will mark his conduct in the future.

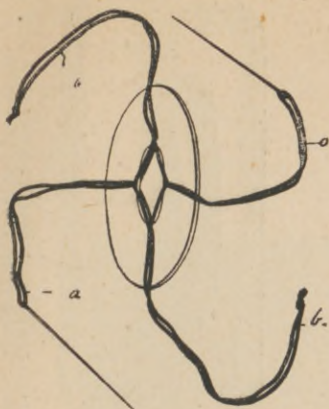


Fig. 1—Senn's Decalcified Bone Plate.

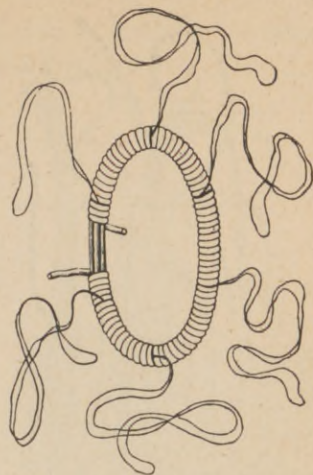


Fig. 2—Abbe's Catgut Ring made of Heavy Catgut Thread.

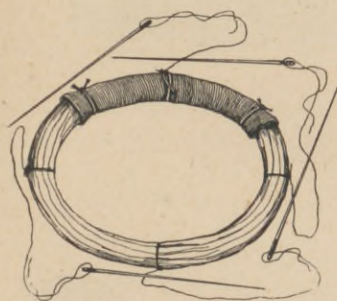


Fig 3—Author's Solid Catgut Ring made of Boiled Drumsnare.

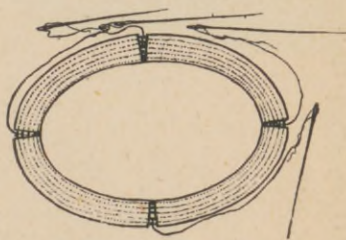


Fig. 4—Brokaw's Ring made of Hollow Rubber Segments (Drainage Tubing) Threaded with Catgut Strands.



Fig. 5—Davis' Catgut Mats.

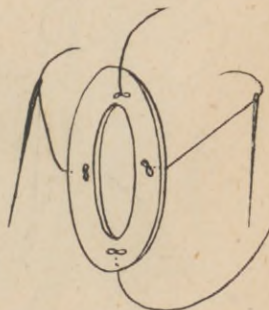


Fig. 6—Davis' Solid Catgut Plates.

CIRCULAR RESECTION (Illustrations after Brokaw) WITH "AIDED" ANASTOMOSIS.

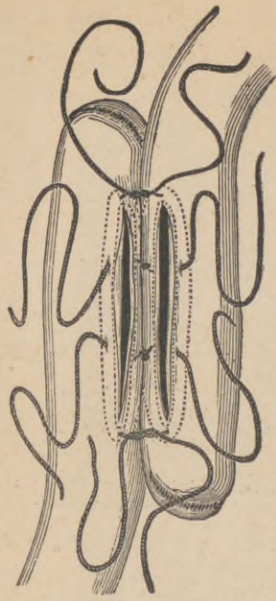


Fig. 8—The Bowels Approximated and the Anastomotic Openings in Confrontation.

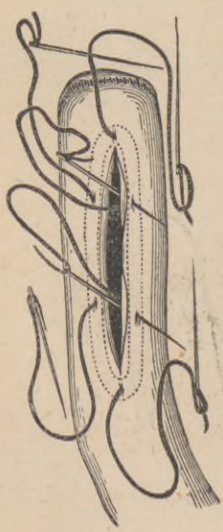


Fig. 7—Fixing Ring in Divided Intestine; the Bowel has been Previously Inverted at Cut End and Formed into a *Cut de Sac*.

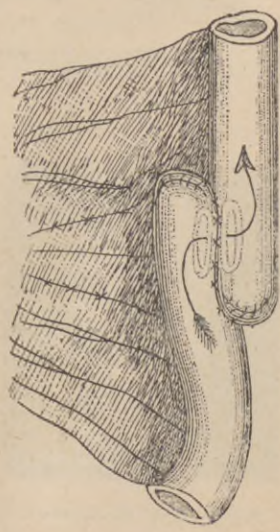


Fig. 9—Diagrammatic Representation of Intestinal Circulation After Completion of Anastomosis and Enterorrhaphy.

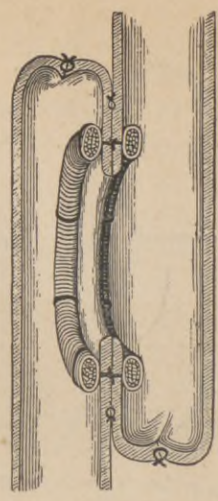


Fig. 10—Vertical Section Representing Anastomotic Connections and Intestinal Interior.

CIRCULAR RESECTION WITH "AIDED" CIRCULAR ENTERORRHAPHY.

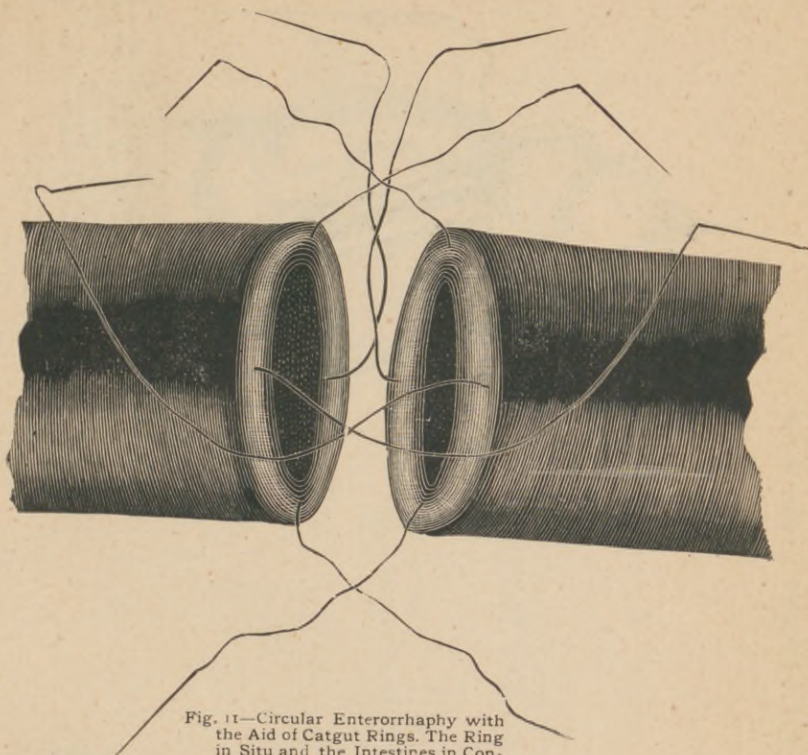


Fig. 11—Circular Enterorrhaphy with the Aid of Catgut Rings. The Ring in Situ and the Intestines in Confrontation (Author's Method).

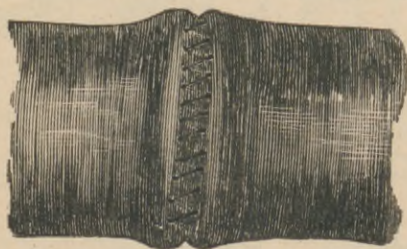


Fig. 12—Complete Approximation with the Continued Lembert Suture after Adjustment of Rings. Circular Resection of Bowel by Direct Lumen to Lumen "Aided" Enterorrhaphy (Author's Method).

ILEO-COLOSTOMY (After Senn).

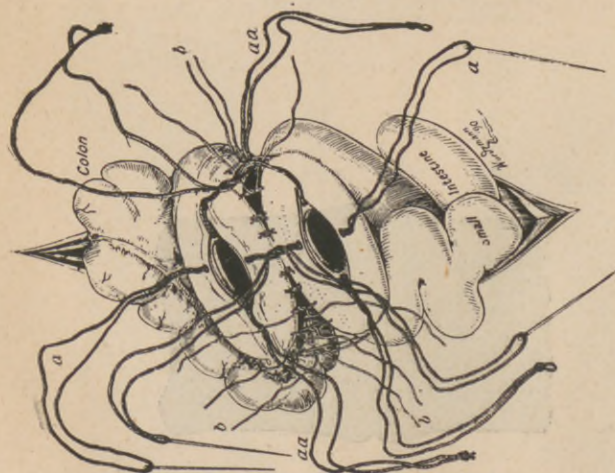


Fig. 16.—Ileo-Colostomy without Resection of Caecum, showing Plates in position, one in the Ileum, the other in the Colon, (a) lateral or transfixion Sutures passed through the margin of the wound (a a) and Ligatures hanging out of Wound, (b) posterior row of Superficial or Lembert Sutures.

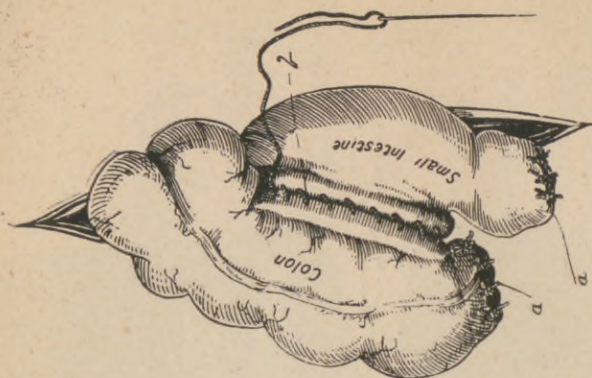


Fig. 17.—Ileo-Colostomy as seen after Resection of the Caecum. (a) Closed ends of the Colon and Ileum directed downwards; (a) Serous surfaces over Anterior Margins of Plates united by a number of Stitches of the continued Suture.

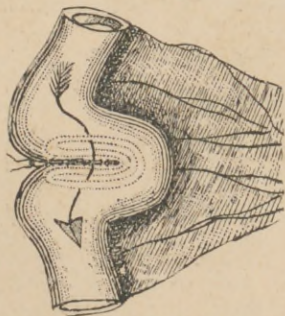


Fig 13—(After Brokaw). Enterorrhaphy with Aid of Single Ring after Partial Enterectomy.

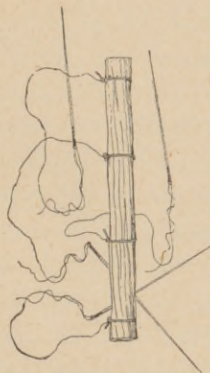


Fig. 14--Author's Solid Catgut Rod, armed with Transfixion Needles. To be used as an Intra-Intestinal Quill Suture.

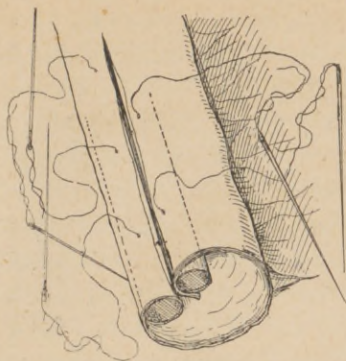


Fig 15--Vertical Section of Intestine, Showing Catgut Rods in Situ; Transfixion Sutures through the intestinal wall. (Brokaw's Modified Suture for Linear Enterorrhaphy.)

The aided methods which are at present offered the surgeon are (1) lateral implantation and (2) lateral apposition by means of absorbable perforated plates or its substitutes. Lateral implantation may be done by Senn's original method, or by Brokaw's method, but both of these are inferior to the operation of anastomosis by means of the bone plates as illustrated in Figs. 16 and 17. This method is unquestionably the easiest, most rapid, and secure. It is the method adopted by Senn in his two recent and remarkable cases of resection of the cæcum for carcinoma (one recovered completely and the other succumbed six days after the operation from peritonitis, caused by deep ulcers of the excluded portion of the colon). The anastomosis here is, in principle, effected in precisely the same manner as an aided anastomosis in other portions of the intestine, only that when it is coupled with resection, additional and special precautions as to drainage and anchoring the sutured bowel and mode of closing the abdominal incision, which is here lateral and not median, are required. All the technical details have been so thoroughly and recently described by Dr. Senn that I will limit my reference to them by simply pointing to the excellent illustrations furnished by this writer, which gives a clear idea of the operation.

Finally, I would add that the experimental work by Dr. Michnard and myself completely confirms the experience of other operators: first, on the value and necessity of serous scarification to obtain prompt exudative reaction in the part of the peritoneum; second, on the value of omental grafting, though we believe that the valuable influence of the epiploon in securing the suture joint after enterorrhaphy is not as readily procurable in the operations on man as it is on the dog.

CONCLUSION.

In the preceding propositions and accompanying remarks much has been said which is doubtless well known to the investigator and special reader who is *au fait* in all the details and developments of intestinal surgery. But the new art or school of aided enterorrhaphy, which has been founded by the imperishable labors of Senn, has not yet celebrated its fourth anniversary, so that it can scarcely be called old.

The modern rapid "aided" method is quickly superseding the old; in this country and in England no progressive surgeon could admit his ignorance of the methods without blushing. In conservative Europe it is otherwise, though a crisis is impending which will end in a reaction that will be equivalent to a revival in continental methods of intestinal surgery. In the meantime, the work is ever progressing, and the finale has not been reached; new indications, modifications, and details in the technique must be perfected before they finally crystallize; hence the work of the reviewer who surveys the field, confirms or rejects the modification and the methods, is still in order, as his work serves to strengthen and diffuse progress, if only by the ventilation of the most advanced ideas and results. This has been the aim of the author, and he will be amply satisfied if his efforts have aided in accomplishing this last result.

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