

CUSHING (H.W.)

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THE
"RIGHT ANGLE"
Continuous Intestinal
SUTURE

BY
H. W. CUSHING, M.D.

Surgeon to Out-patients at the Boston City Hospital

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I have for convenience classified intestinal sutures as follows:—

1. CONTINUOUS. — Gély; Gély, Packard's modification; Appolito; Appolito, Smith, J. Grieg, modification; "glovers'" or "herring-bone;" Dupuytren; Kürschner; Lembert; Lembert, two modifications; "Right Angle," buried; Bertrandi.

2. INTERRUPTED. — Jobert; Bishop; Lembert; Le Dran; Velpeau; Vezien.

3. COMBINED. — Czerny; Gussenbauer; Halsted.

4. THOSE REQUIRING ESPECIAL APPLIANCES. — Dedans; Neuber; Madelung; Béranger-Féraud; Reybard; Jobert, Senn's modification.

The ideal intestinal suture is the one which combines greatest rapidity in formation with maximum security from extravasation of intestinal contents. To fulfil these requirements, there must be exact adaptation of wound edges and an accurate apposition of serous surfaces. Also, simplicity in construction: since ease in application means rapidity in operating; and adaptability to general use demands a technique uncomplicated, readily understood, and requiring only such materials and instruments as are commonly at hand, or easily to be obtained.

A short experience with the above-mentioned types demonstrates that the "Continuous" sutures have a great advantage in regard to the ease and rapidity with which they can be inserted. The time spent in knotting a fine wet thread, with fingers sticky with blood, in an intestine which is more difficult to handle than a wet rag, is surprisingly long.

It is true that some of the "Interrupted" sutures are usually firm, accurate, and handsome; but the extra time required to tie twenty or thirty knots is a very important factor in the success of the operation, and is much greater than a surgeon, when his patient is rapidly approaching collapse, cares to consume if he can possibly avoid it. My experiments and observations at operations on the living subject favor the conclusion, that an intestinal wound can be closed from one-third to one-half more rapidly with a continuous suture than by any other form I am cognizant of. Its alleged dangers are, that it causes stenosis by diminishing the diameter of the intestine.¹ That from one portion becoming free in the intestinal canal in advance of the rest irregular tension results, by which the integrity of the recently united wound is endangered. Actual experience has failed to substantiate such assertions.

Many experiments, and an extended investigation of the best sutures now on record, convince me that the struggle for the first place is practically between the "Interrupted Lembert" and one I shall call the "Right Angle" Continuous: all others being out of the field, either on account of their complex character, or the length of time and especial appliances required for their formation, notwithstanding that several, when once set, are very satisfactory.

Of these two rivals, the "Interrupted Lembert" (Figs. 1 to 6) is so well known that a detailed description is unnecessary. When inverted so that the knots are buried (Figs. 5, 6), it has a much neater appearance than as usually set.

The "Right Angle" continuous suture is a modification of the Kürschner (Fig. 11), or the "Continuous Lembert" (Figs. 13, 14). The manner in which such a continuous suture can be varied is shown in Figs. 7 to 15. With the exceptions of the "glovers'" (Fig. 12) and the Kürschner, which penetrate the lumen of the intestine, the mucous membrane is not involved. A study of these possible variations (Figs. 16 to 21) resulted in the conclusion that the "Right Angle" was preferable to the others. It excels not

¹ Czerny.

only in neatness of appearance, but also in accuracy of wound union. It is not only a continuous, but also a "buried" suture. Attracted to this suture by this comparison, I have made extended tests of it in the living and dead intestine. The results of these experiments have developed the suture¹ shown in Plate I.

It is inserted for uniting longitudinal wounds, as in Figs. 22 and 23. The most satisfactory results are obtained in the human intestine by placing the points of puncture one-eighth of an inch (3 mm.) apart, and by burying the suture to the same extent in a direction parallel to, and three-sixteenths of an inch (4-5 mm.) distant from, the wound edge. The suture terminates in the tough, fibrous submucous layer, and is not intended to involve the mucous membrane or penetrate the intestinal cavity. Each part of the suture should be drawn tight, so as to accurately appose the wound edges before the next is set.

A resected intestine is united by the same suture, but formed as follows: It is begun at one side of the mesenteric attachment by an inverted Lembert suture,² which is tied, and the free end (Fig. 24, *a*) left pendent from the knot.³ The resected edges are now united by the "Right Angle" suture, which is inserted in the same manner as in a longitudinal wound commencing at the point of union already made, crossing the mesenteric attachment (Fig. 25), and continued along parallel to the resected edges of the gut,

¹ Reported at the meeting of the Surgical Section of the Suffolk District Medical Society, held May 5, 1886.

The Process of Repair after Resection of the Intestine and Intestinal Suture. J. Collins Warren, Trans. of the Amer. Surg. Ass., May 12, 1887, pp. 142, 144, 146, 151.

² Wölfler. Resection of the Pylorus.

³ By commencing the intestinal suture at one side of the mesenteric attachment (as above described), that portion of the wound is united first, and at a time when it is most accessible. Since this is the most difficult point to unite securely, and therefore the one at which subsequent extravasation of intestinal contents is most apt to occur, the advantage of this is self-evident. The danger from not closing this portion of the wound accurately cannot be too greatly emphasized. Also, when completing the suture, the operator can make the last few punctures and tie the final knot in full view, at a point easily accessible, instead of at one so concealed and difficult of access as that portion of the wound about the mesenteric border, the site commonly selected for completion of these sutures. This advantage will be readily appreciated by those who have followed the usual method.

till the free end (Fig. 24, *a*), at the point of commencement, is reached. The union of this end (*a*) to that bearing the needle by a square knot (Fig. 26) completes it. The free ends are now cut close to the knot,¹ which sinks out of sight between the approximated serous surfaces. When completed, the resection wound has the appearance shown in Plate I. The mesentery is now united by inverted Lembert sutures, interrupted, set on each peritoneal surface (Fig. 27).² This makes the neatest closure, the wound having the appearance above referred to (Fig. 6; Plate I., Fig. 1).

If rapidity in operating is imperative, the mesenteric wound can be closed with the ordinary form of interrupted suture.³

Such is the character and technique of the "Lembert," the most popular suture of to-day, and the "Right Angle Buried Continuous." Both have advantages to support their claim to the title of "best." Both have disadvantages which weaken such claims. The following comparison is, I believe, a concise and just statement of their true value: —

INTERRUPTED LEMBERT.

DISADVANTAGES.

1. Large number of separate knots, causing a *marked loss of time*. A most serious objection.

¹ If silk, $\frac{1}{10}$ inch (2 mm.) long.

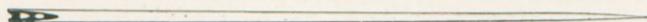
² A very thin mesentery is best sutured by the ordinary interrupted suture.

³ A continuous suture is unsafe for this purpose, since it is liable to relax and allow the mesenteric wound to open, as was demonstrated at the autopsy of a patient whose mesentery was united in this manner.

Fine white silk "Machine twist," J. D. Cutter & Co., aseptic by boiling, and preserved in alcohol-sublimite solution, is the suture I have found most satisfactory.

The best needle is a "self-threading" or "patent-eyed" one of German manufacture.

NATURAL SIZE.



ENLARGED THREE TIMES.

Trade name: "Nähnadeln mit federndem Oehr, Halblang, 8." This is a round sewing-needle, $\frac{1}{10}$ inches long. By having this ground flat like a "Hagedorn" I obtained an instrument which combines all the advantages of the round needle usually recommended, and is far superior to it, from the ease with which it traverses the intestinal wall.

2. The sutures separate during distention of the intestine.¹ The inverted edges become narrower by this stretching, and are then in danger of everting and prolapsing outward between the sutures. Fæcal extravasation thus becomes possible.

3. The numerous knots cause more extensive adhesive inflammation and adhesions, which can cause subsequent danger by intestinal strangulation.

ADVANTAGES.

1. It is the simplest and most easily understood suture known; the chief reason for its popularity.

2. It also closes the wound (if properly applied) very accurately and firmly.

“RIGHT ANGLE” CONTINUOUS.

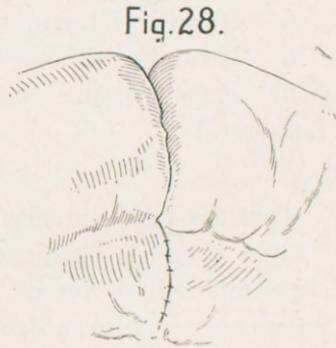
DISADVANTAGES.

1. Not quite so readily learned.

2. “Causes moderate constriction when used to unite resection wounds, if much intestinal distention.” Probably a theoretical danger. I have found no record of such a complication with a continuous suture.

My own experiments on the living intestine confirm this. The continuous suture has been successfully used in living human intestine.² This tension is an advantage, since the “constricting” circle is during distention more deeply buried (Fig. 28), thus approximating more extensively the inverted serous surfaces through

whose union mainly fæcal extravasation is averted. With the Lembert the reverse is true.³



¹ From 2-3 to 6-7 mm. Reichel. Deutsche Zeitschr. f. Chir., Bd. xix, 230, 287.

² Rydygier. Berl. Klin. Wehnschr., 1882, 577.

³ Interrupted Lembert, Disadvantages. 2.

3. Danger of septic infection, and suppuration along the track of the suture while being cast off into the intestine. Theoretical. I can find no record where this has happened to a continuous suture; and experiments on animals show that sutures may be partly thrown off and hang free in the intestine without causing septic inoculation of the wound, which has united long before the suture is thus freed, which requires from two to three weeks.

ADVANTAGES.

1. It is the smoothest, neatest suture, thus reducing adhesive inflammation to a minimum.

2. With some practice it can be applied easier.

3. It can be applied *more rapidly than any other suture.*
Of great importance.

One of many trials is the following:—

Resection of human ileum.

Lembert suture required fifteen minutes.

Continuous "Right Angle," two experiments, five, nine minutes.

I have united a resected ileum in the living human subject in eight and two-thirds minutes.

4. The greater the tension, the closer the edges of the wound are approximated.

5. It can be interrupted at any point, if desired.

6. It can be reinforced by another superimposed, if any point seems insecure, either by itself or an "Interrupted Lembert."

CONCLUSIONS.

That the most satisfactory suture, in all respects, is the "Right Angle" Continuous, reinforced by a similar one superimposed, or by an "Interrupted Lembert," if isolated points only require to be secured.¹

If the suture is properly made, this reinforcing will be, as a rule, unnecessary.

¹How far Senn's method of protecting intestinal sutures with omental grafts (Annals of Surgery. Reprint. 1888. P. 77) will render these superimposed sutures unnecessary, I cannot say from personal experience. It is a suggestion worthy of trial.

These conclusions have been formulated from data obtained by an extensive review of the literature of the subject, from careful and extended experimentation with living cats and dogs, practical tests and experiments with various sutures in dead human intestine, and from personal observation of intestinal resections during four years of hospital-work.

The reasons for the above conclusions are, —

1. This suture does not involve the mucous membrane.
2. The intestine is closed by a suture, which acts so that the greater the tension to which it is subjected the closer it is drawn.
3. It can be inserted more rapidly than any other.
4. It is impervious and efficient.
5. It is simple.

To the surgeon who has not investigated the subject, I would recommend the "Interrupted Lembert." He is *less* liable to go astray, and successful results are possible. But I would also tell him that some day his success will depend on whether he can complete his operation within a limited number of minutes. It will be a close race for a patient's life between shock and his skill. The advantage he will then gain with the "Right Angle" suture at his command will well repay the comparatively small amount of time and patience it cost him to acquire it.

PLATE I.—THE “RIGHT ANGLE” CONTINUOUS
INTESTINAL SUTURE.

Human Ileum. Natural size. The specimens from which this plate was prepared were subjected to considerable manipulation before and while being photographed. This explains the exposure of the suture at two points in Fig. 2.

FIGURE 1. Resection wound closed with “Right Angle” suture. Wound of mesentery united with “inverted Lembert” (interrupted). The resection suture is terminated at a point one-fourth of an inch above the mesenteric border of the intestine.

FIG. 2. Longitudinal wound, closed by same suture.

FIG. 3 shows Fig. 1 from inside. Intestine has been cut open at about one-fourth its circumference from its mesenteric attachment, thus showing the manner in which the resected wound edges are inverted and apposed; also the accuracy of apposition at the site of the mesenteric insertion. The exposure of the suture at two points on the upper side of the wound is an apparent one only. The suture was not visible in the specimen from which the plate was taken.

FIG. 4 shows Fig. 2 from inside. Intestine is cut open along the mesenteric border and turned back, thus exposing the mucous surface. Shows the amount of inversion of the wound edges, and the manner in which the edges are apposed.

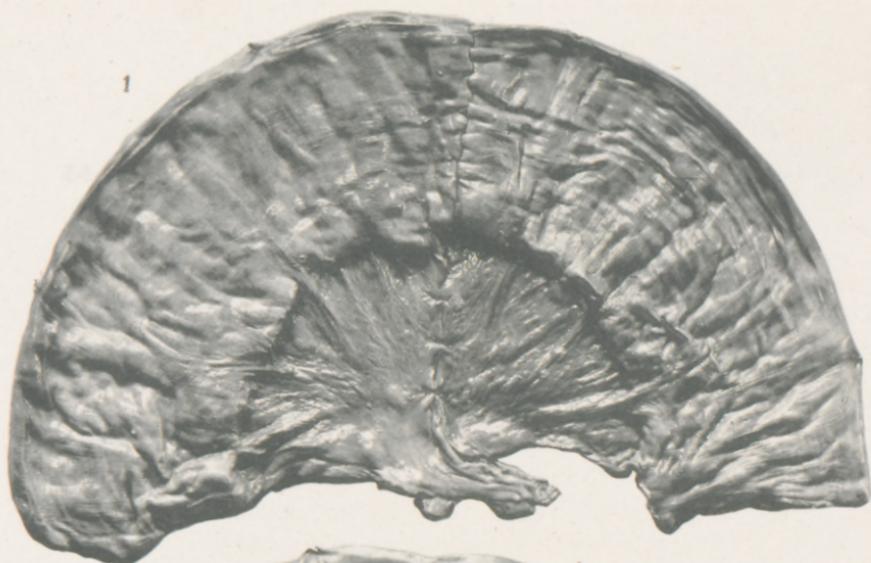


Fig. 1.

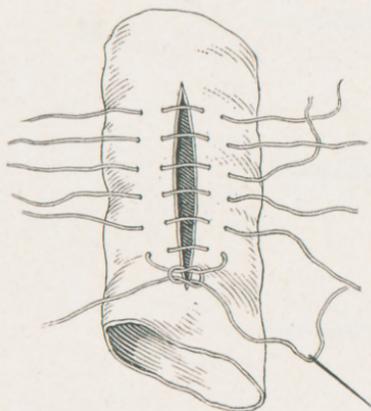


Fig. 2.

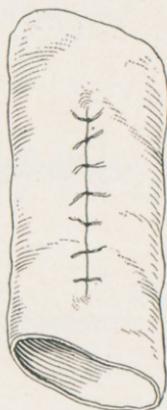


Fig. 3.



Fig. 4.

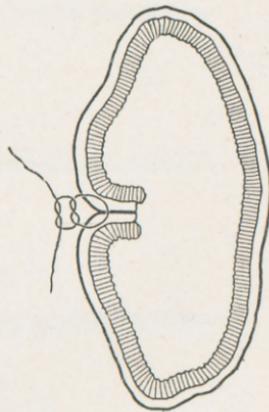


Fig. 5

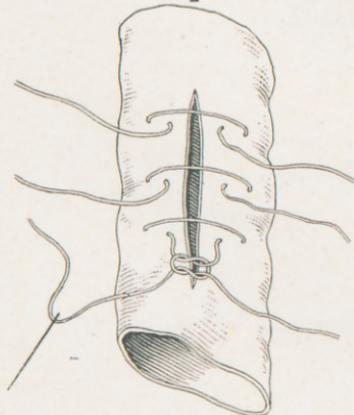


Fig. 6 .

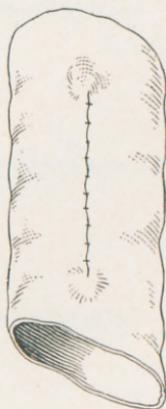


Fig. 7.



Fig. 8.



Fig. 9.

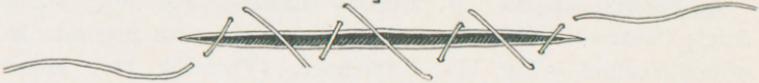


Fig. 10.



Fig. 11.



Fig. 12.



Fig. 13.

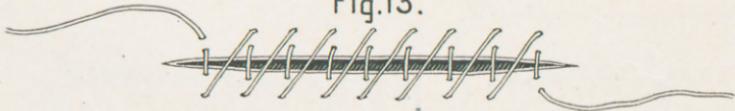


Fig. 14.

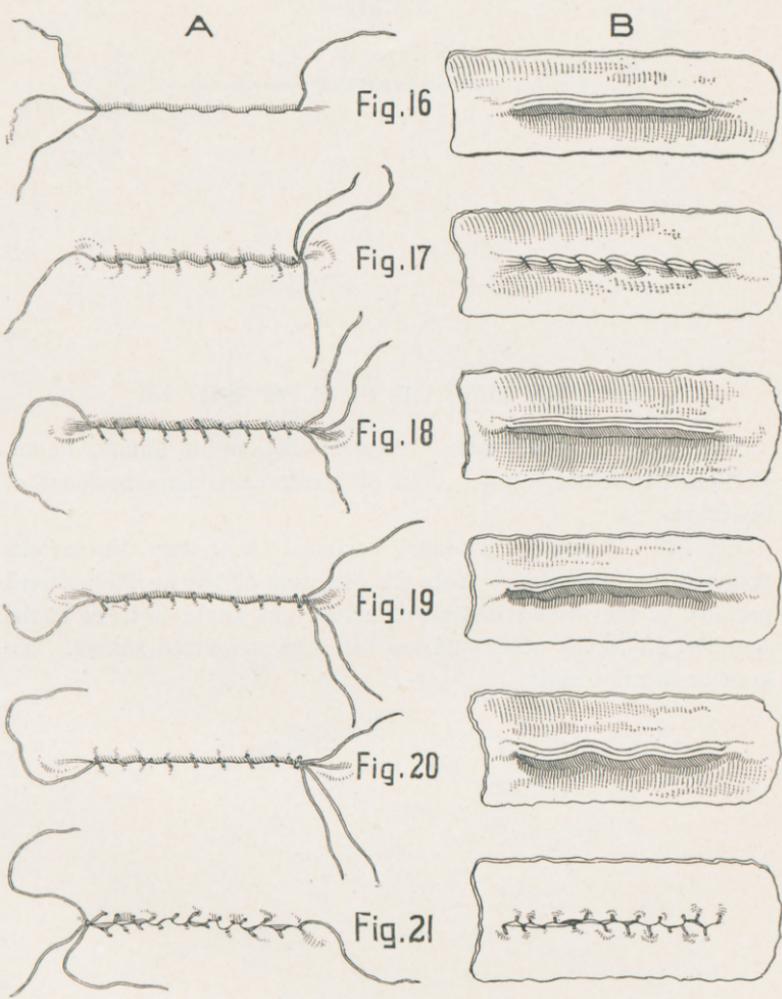


Fig. 15.



DESCRIPTION OF FIGS. 16 TO 21.

A. Serous surface. B. Mucous surface. Fig. 16. "Right Angle" suture. (Vide Fig. 15.) Shows the most accurate even wound closure. — Fig. 17. Kürschner. (Vide Fig. 11.) Mucous membrane included. The puckering and irregularity, especially of the mucous surface, more marked than in others except "glovers'." (Fig. 21.) — Fig. 18. Lembert. (Vide Fig. 14.) Shows a somewhat puckered wound. — Fig. 19. Variation of the Lembert. (Vide Fig. 7.) Mucous surface closely resembles Fig. 16. Serous surface, apposition not so even as by "Right Angle." It is not so easily inserted as "Right Angle." — Fig. 20. Variation of Lembert. (Vide Fig. 9.) Wound more irregular, except Figs. 17 and 21. — Fig. 21. "Glover's." (Vide Fig. 12.) Most unsatisfactory of all, not only in regard to irregularity of closure, but also since it inverts the peritoneal surface so that it is exposed on the inside, and everts the mucous membrane so that it protrudes on the outside of the intestine. A dangerous and faulty union, which readily leaks under tension.



DESCRIPTION OF FIGS. 22 AND 23.

Fig. 22. Diagrammatic. Actual size, as in human ileum. Peritoneal surface. *a-b*. Plan of suture at commencement of insertion.

Fig. 23. Ileum. Peritoneal surface. A. Suture in various stages of its formation. Note the direction of the needle inserted parallel to the wound instead of at a right angle to it, as in the Lembert and many other sutures. B. The completed suture. No knot or suture visible.

Fig. 22

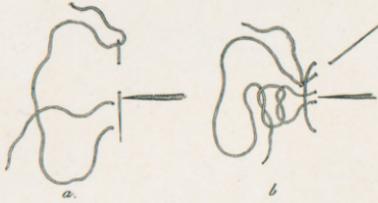
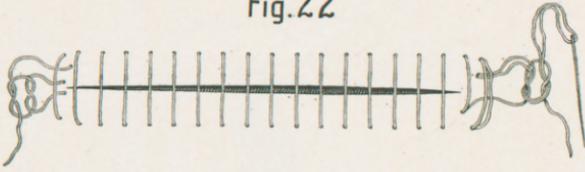


Fig. 23

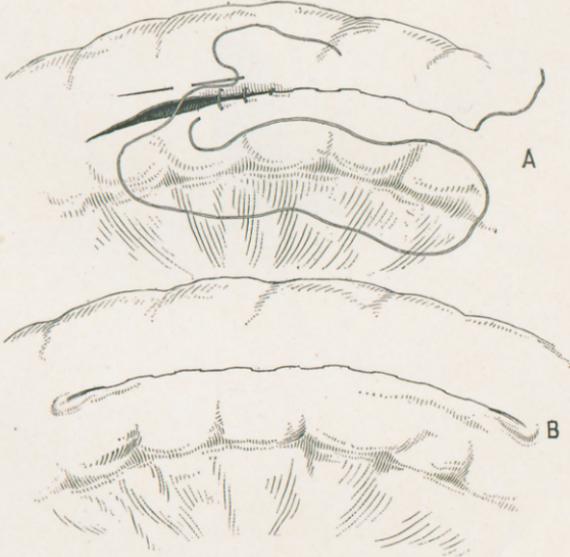


Fig. 24

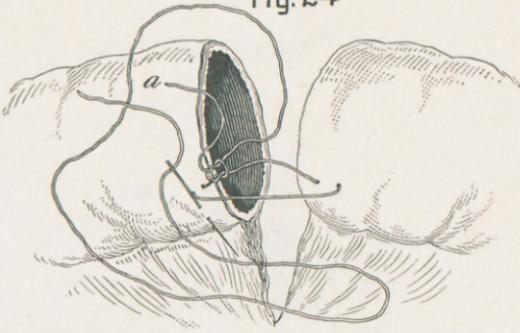


Fig. 25

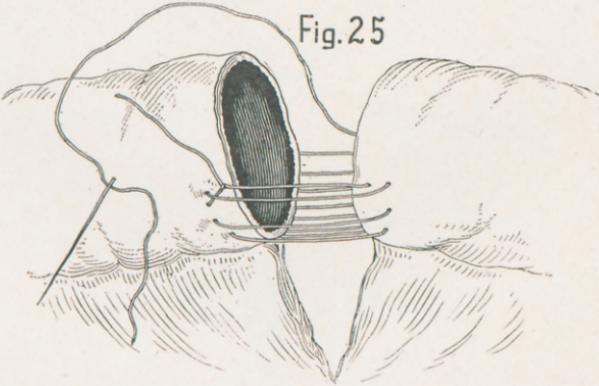


Fig.26.

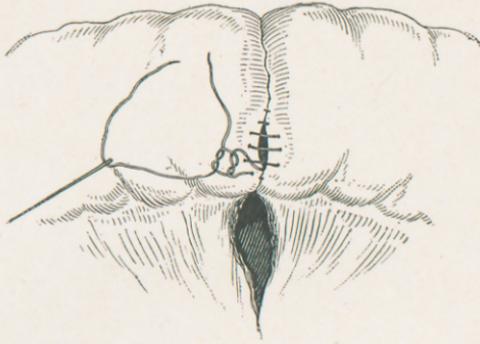


Fig.27

