THE

AMERICAN GYNÆCOLOGICAL

AND

OBSTETRICAL JOURNAL.

MAY, 1896.

WHAT IS THE BEST METHOD OF MAKING AND OF CLOSING THE CŒLIOTOMY INCISION?*

By George M. Edebohls, A. M., M. D., New York.

In presenting this short paper to the Society this evening the writer has a twofold object. The first is to elicit a comparison of views as to the preferable method of making as well as of closing the cœliotomy incision; the second is to afford the writer an opportunity for recantation.

To begin with the recantation. A little over three years ago (November 15, 1892) the writer presented to this Society a paper entitled The Prevention of Hernia after Incision of the Abdominal Walls. In this paper he warmly advocated the use of the buried permanent suture, silkworm gut being the material of preference, and thought he had found in its successful use the solution of the question of how to prevent hernia after abdominal operations. To accomplish this object, primary aseptic burial of the silkworm gut was, of course, an essential, suppuration in the wound, as after the employment of any method of suture, rendering the obtainment of a cicatrix firm enough to resist intra-abdominal pressure a problematical matter. Now while, with comparatively rare exceptions, able to obtain this necessary primary union, the writer in the course of time found that the suppurative possibilities did not invariably terminate with the discharge of the patient, say three to four weeks after operation, with an aseptical-

* Read before the New York Obstetrical Society, February 18, 1896.

ly healed wound. In a number of cases suppurating sinuses, leading to or from a buried silkworm suture, formed three months, six months, a year, and in one case even two and a half years after primary aseptic burial of that selfsame suture. Some of the patients returned to the operator, who, let us hope always in a duly meek and apologetic spirit, removed the offending suture or sutures with resultant closure of the sinus. In some the disagreeable task fell to the lot of the house surgeon ; in others still, at their far-away homes, the family physician kindly officiated at the resurrection of the buried permanent (?) suture, while he probably thought some thoughts not in the nature of benedictions upon the operator ; for the removal of the buried suture of silkworm gut is often a task of difficulty and patience, especially in women with thick adipose investments. Especially troublesome did this removal prove in three or four cases of nephropexy, in which the kidney had been sutured to the deep parts of the thick lumbar portion of the abdominal parietes by buried silkworm gut. For this among other reasons the writer now uses chromicized catgut to secure the kidney in nephrorrhaphy.

Proof was thus forthcoming, in the course of time and in the shape of resurrected buried sutures, that aseptic burial and primary union did not always end the matter. The aseptically buried silkworm-gut suture did not always remain as an innocuous and encapsulated foreign body in the tissues, but in a proportion of cases—estimated in my experience at between five and ten per cent. of all sutures thus aseptically buried at the time of operation—the suture at a more or less remote period caused suppuration, and, either with or without extraneous help, found its way to the surface and was discharged.

Now even this disagreeable side effect might possibly have been endured if only ALL those patients in whom the suture remained permanently and aseptically buried could be guaranteed absolute exemption from hernia : but time and experience, alas ! destroyed my illusions in this respect also. I have had two cases in which hernia, in the shape of a diastasis of the recti muscles along the whole length of the wound, followed median cœliotomy incisions closed by the buried suture of silkworm gut, embracing fascia, muscle, and peritonæum. In one case three out of eight buried sutures used were removed four weeks after operation; in the other case all the sutures remained aseptically buried. Now this is what happened : The tissues forming the margins of the original wound on one side, the fascia and muscle, had gradually pulled away from the embrace of the suture, the latter cutting through on one side to the median line. A hernial aperture

was thus established extending the whole length of the cicatrix, its margins being formed by retracted muscle and fascia on either side. All the loops of the buried silkworm-gut sutures were felt hanging intact in a row in the muscular and fascial border of one side of the hernial aperture. A subsequent radical herniotomy performed upon each case verified this palpatory diagnosis.

This experience is but confirmatory of that recorded by others, that in those, fortunately rare, patients in whom there is an absence of the power of firm healing of divided tissues, no method of suture and no suture material will guarantee against hernia after median cœliotomy. If the divided tissues at the end of five to six weeks have not united firmly enough to remain united without further aid than that afforded by the solidity of union, a hernia will result, any form of permanent buried suture or abdominal supporter to the contrary in any wise notwithstanding.

For two and a half years, beginning with May, 1892, and ending with December, 1894, I closed practically every wound of the abdominal parietes which I had occasion to make by means of buried silkworm-gut sutures. The occurrence of late suppuration in the wound in between five and ten per cent. of cases, together with the experience of two herniæ, in spite of the support afforded by buried permanent sutures, have led me to abandon the method entirely, except where purely fibrous tissues, as in the radical operation for umbilical hernia, for example, are to be brought together and maintained in apposition.

I have embraced this opportunity to repudiate in as public a manner as I once championed it, and before the same Society, the buried *permanent* suture. It accomplishes no more than the buried suture, which will maintain its integrity for six weeks or thereabout and then disappear by absorption, without the attached possibilities of suppuration months and years after operation. To those whom my paper of three years ago perhaps influenced to adopt the buried permanent suture I owe an apology, which is herewith humbly tendered, for whatever trouble they may have experienced on that account. As showing, however, the various degrees of the *tenax propositi* in various men, I might cite the instances of two warm personal friends, both eminent gynæcologists. Both adopted the buried permanent suture after my advocacy of it. One promptly gave up its use after a few months, led by the same experience as regards suppuration against which I struggled for two and a half years; while my second friend is to-day still using the method, in spite of my personal appeals to him to cease, and claims to derive satisfaction from its employment.

Having decided to abandon the buried permanent suture for the closure of the cœliotomy incision, the writer for a while felt somewhat embarrassed for a substitute. Previous to taking up the buried permanent suture I had tried about all the various methods and suture materials in vogue at the time, and had felt that there were shortcomings inherent to each method. In fact, this very feeling of dissatisfaction with the various methods of closing the abdominal incision had led to the adoption of the buried permanent suture.

We all know that two requisites are absolutely essential to a satisfactory up-to-date closure of the cœliotomy incision. The first of these is accurate and nice approximation and coaptation of homologous structures, so that the cut edges of peritonæum, muscle, fascia, and skin on one side of the wound will each heal to the same tissues of the opposite side. The second requisite is retention of the parts in apposition until firm union has occurred—union strong enough to withstand intra-abdominal pressure without yielding. This will require, to be on the safe side, from five to six weeks; if by the end of that time the organic union of the tissues is not sufficiently strong to be self-supporting, no suture and no abdominal supporter, no device of any kind, will prevent diastasis in the line of union and the formation of a hernial aperture.

To retain the parts in apposition for from five to six weeks, two principal methods can be employed: Through-and through sutures, embracing all the tissues and tied upon the skin, to be removed in from five to six weeks; or buried animal sutures, which will disappear by absorption at the end of that time. Or a combination of these two principles may be practiced. The through-and-through suture has two principal disadvantages: First, it is difficult, if not impracticable, by means of it alone to secure *accurate* coaptation of homologous structures throughout the entire depth and extent of the wound. Secondly, we generally discharge our patients three to four weeks after a cœliotomy, and it is desirable to have them leave with wounds definitely healed, and requiring no further attention in the way of dressings and removal of sutures.

The buried animal suture, so prepared as to maintain its integrity for about six weeks and then to disappear by absorption, is the desideratum. The writer, after much experimentation, has succeeded in learning how to chromicize catgut so that it will satisfactorily meet these requirements. Kangaroo tendon is the chief rival of catgut as a buried animal suture. Some two years ago I employed kangaroo tendon systematically for a time, using it both for buried and for

superficial suturing. My supply was obtained from Dr. Marcy, of Boston, the enthusiastic advocate of the kangaroo tendon for buried sutures. As compared with catgut, I found kangaroo tendon to possess these disadvantages: 1. Its very high price. 2. The uneven thickness, not only of different strands, but of the same strand at various parts of its length. 3. Limitations of use imposed by length of strands. Kangaroo tendon can not be obtained of sufficient length, say a metre, for a fairly long running buried suture. The great advantage claimed for the kangaroo tendon is its longer resistance to absorption. This is, however, only a relative advantage, which disappears entirely after one has learned how to chromicize catgut so that it will last a desired length of time. I have used only the non-chromicized kangaroo tendon, and have made comparative tests of absorption by using it alongside of non-chromicized catgut, *of the same thickness*, in the same wound of the same patient. The result showed an increased resistance to absorption of not more than twenty-five per cent. in favor of the kangaroo tendon; that is, if a given thickness of catgut was absorbed in say eight days, kangaroo tendon of the same thickness would disappear in ten or eleven. To make kangaroo tendon last sufficiently long for our purposes, say about six weeks, it must be chromicized, and if we must chromicize, let us chromicize the preferable suture material of the two, the catgut.

I have use in my work for the two smallest sizes only (Nos. o and oo) of chromicized catgut, which I invariably chromicize and sterilize personally. As the proper preparation of the suture material is so important a factor in the method of closing the cœliotomy incision which I now employ and here advocate, I will first describe the process of chromicizing and sterilizing catgut as I practice it.

Buy the raw material, catgut Nos. o and oo, in coils five metres long, of an importer of jewelers' supplies. Avoid the fine, white, smooth, alluring catgut sold for surgical use. The smoothness and finish are obtained at the expense of strength of material, the sandpapering process thinning and weakening the catgut in spots, and the chain is no stronger than its weakest link. Cut and remove the small pieces of catgut tied around each coil to keep it in shape.

Place the catgut in ether to extract fat. It may be left in the ether for any length of time—days and weeks—until convenient to proceed with the further steps of preparation.

Remove the catgut from the ether, and allow it to dry thoroughly.

To chromicize to the desired degree, place the catgut for thirty hours in the following solution: Bichromate of potash, 1.5 grammes;

carbolic acid, 10 grammes; glycerin, 10 grammes; water, 480 grammes. Dissolve the bichromate of potash in the water, then add the carbolic acid and glycerin.

Before placing the coils in the solution arrange them upon a central core or cylinder, of nearly the diameter of the interior of the coil, to prevent entangling and snarling of the catgut as it swells and becomes twisted in the solution.

After thirty hours remove the catgut *with and upon the core* from the bichromate-of-potash solution, and immediately wind it upon a frame, stretching it pretty taut. I use a wooden frame, resembling a curtain-stretching frame in miniature, one metre in length, which is the length I find it convenient to have catgut sutures. The catgut is stretched upon the frame for the twofold purpose of convenience in drying, and to prevent the curling and kinking which obtain when catgut has been soaked in water and dried without stretching.

The drying must be done at a temperature not exceeding 40° to 45° C. If higher temperatures are risked, the moist catgut may gelatinize; it then becomes so brittle as to be absolutely worthless. The drying should be thorough, and the process should extend over a space of time of several days. If the least moisture remains in the interior of the catgut, it will surely gelatinize and render brittle and worthless the catgut when raised to high temperatures in the process of sterilization to follow. This thorough drying after chromicizing is, I repeat, *absolutely essential* to obtain a useful product.

In chromicizing catgut, bear in mind that nothing is easier than to overchromicize so as to make it practically non-absorbable. The difficulty lies in chromicizing it to last just the required time, and the method just detailed is the result of much and somewhat costly experimentation. Catgut No. 0, chromicized as above, will resist absorption for about six weeks.

The chromicized catgut is now ready for the process of sterilization. Various methods of sterilization are at our disposal, of which the writer has tried only two: dry sterilization at a temperature up to 280° F., and sterilization by boiling in absolute alcohol under pressure. Of the two he prefers the latter, as having yielded him stronger and more satisfactory material, without thereby meaning to impugn the value of dry or of other forms of moist sterilization.

After the chromicized catgut is *thoroughly* dry it is cut into pieces one metre in length. These pieces are rolled on a finger into small coils which need not be tied, and which are packed nicely into one-ounce glycerin jelly jars, about twenty coils to the jar. Absolute

alcohol (Squibb's 99.8 per cent.) is poured over the catgut in each jar until full, a properly fitting rubber washer is placed inside the metal cap, and the latter is screwed down fluid-tight. The glycerin jelly jars are then placed standing in a large anatomical jar* containing from two to four ounces of absolute alcohol.

Two, or even three layers of the glycerin jelly jars may be placed on top of each other in the anatomical jar. The cover of the latter is now also screwed down air- and fluid-tight, and the whole is ready for the sterilizer. I have always used an Arnold sterilizer, in which the large anatomical jar, filled and sealed as above, is placed, and the sterilizer started. The boiling point of alcohol is 78° C. The atmosphere of steam at 100° C. and the firm closure of the small jars, as well as of the large anatomical jar, secures the boiling of the catgut in absolute alcohol under pressure. The arrangement probably also diminishes the danger of explosion and of ignition of the alcohol vapors. The catgut is boiled in absolute alcohol under pressure for five hours, when the cover of the Arnold sterilizer is removed, and the anatomical jar with its contents allowed to cool gradually. The alcohol, of course, will keep on boiling until the temperature falls below 78° C. Readjustment of some of the rubber washers and filling some of the jars with absolute alcohol, to replace that lost in the process, and your catgut is ready for use.

Chromicized catgut prepared in this way does not decompose or change in absolute alcohol; the combination of the chromic acid with the catgut is an organic one, and is not affected by the alcohol. Catgut thus chromicized and sterilized remains strong, sterile, and unimpaired in quality for years.

I have been thus prolix in describing the details of the processes of chromicizing and of sterilizing catgut, because I found that only by faithfully adhering to them have I been able to obtain the satisfactory suture material which I now possess. Even some of those engaged professionally and in a mercantile way in the preparation and sterilization of suture material have admitted to me their inability to produce a satisfactory sterilized chromicized catgut.

Each lot of catgut thus prepared is first subjected to bacteriological test, and, if found perfectly sterile, as it invariably has been, is kept under lock and key to prevent possible tampering with. At an

* The one-ounce glycerin jelly jars and the anatomical jar here referred to are those manufactured and sold under that name by Whitall, Tatum & Co., of Philadelphia and New York.

operation the quantity of catgut estimated as probably being wanted is taken out of the jars. No catgut, however, after being once removed from the jars is again put back.

The clinical test has proved almost equally satisfactory. For instance, since my return from vacation in September last, a period of four months and a half, I have used absolutely nothing but catgut for ligatures and as buried sutures in all of my abdominal work, both hospital and private, and have not had a death from any cause, and no deep infection. Two cutaneous stitch abscesses following shortening of the round ligaments, both occurring in the same one of the two hospitals with which I am connected, are the only untoward occurrences I have had. They were both probably ascribable to some little slip in antisepsis and not to the suture material.

I will now proceed to describe the method, which I have practiced for more than a year past, of making and of closing the cœliotomy incision. In the first place, I have given up trying to make the cœliotomy incision exactly in the median line, but, with a number of other operators, prefer to make it through one of the recti muscles, a little to one side of the median line. The purpose is to get bare muscle surfaces on either side of the wound which, when brought together by suture, will help by the strength of their union to make the cicatrix just that much stronger. If I have perchance hit the median line exactly, not exposing any muscle, I deliberately, before closing the wound, split the sheaths of the recti on both sides by incising them along the entire length of the wound (Fig. 1). The incisions are made along the inner edges of either muscle, and extend somewhat into the substance of the muscles themselves, so that when completed we have presenting toward each other at the median line two large muscular surfaces each lined anteriorly and posteriorly by cut fascia. Instead of a single fascial margin on either side to approximate and depend upon for union, we have, after this flap-splitting process, two fascial margins plus a large muscular surface on either side, with greatly increased strength of the resultant cicatrix. The rule, then, in making the cœliotomy incision, is either to incise through one of the recti, or, if we have failed in this, then to open the sheaths of the recti on either side so as to xpose large muscular surfaces and two fascial edges on either side for union.

The edges of the wound are thus prepared for union to the greatest advantage with a view to strength of the resultant cicatrix. We need not concern ourselves for the present with superficial fat and skin; in their union does not lie strength. The problem is how to

approximate in the best manner the muscular and fascial layers of the wound so as to secure accurate coaptation of homologous parts, and how best to retain them in approximation long enough for union sufficiently firm for all purposes to be consummated.

The writer's preference for the buried suture of forty-day catgut having been already sufficiently set forth, it merely remains to add that he is convinced that the running suture is to be preferred to the interrupted suture, and for the following reasons: By means of the running suture it is possible to bring together homologous structures more accurately and, I believe, more quickly than by interrupted sutures. In the next place, the number of buried knots is decreased—indeed, is generally limited to one knot. This is a somewhat important matter, as no doubt the knot is the most undesirable thing about the buried suture, the bulk and local aggregation of suture material rendering knots foreign bodies, the presence of which in great number the tissues resent by an attempt at extrusion.

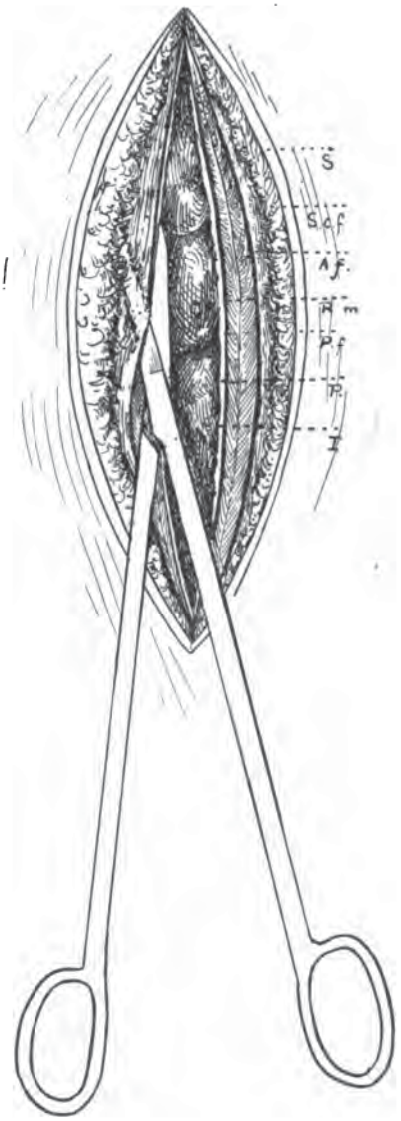

FIG. 1.—Fascial sheath of the rectus muscle divided, and muscle itself superficially incised (flap-splitting) along the whole length of wound, on one side. On opposite side, scissors in act of slitting sheath of muscle. *S.*, skin; *S. c. f.*, subcutaneous fat; *A. f.*, anterior fascial edge; *R. m.*, rectus muscle; *P. f.*, posterior fascial edge; *P.*, peritonæum; *I.*, intestines.

One of the great objections I advanced, when reading the paper quoted in the beginning of this article, against the use of buried catgut for closing incisions of the abdominal wall was the unreliability and instability of the buried catgut knot. I have since learned how to tie catgut so that it will remain tied, even under tension, when buried in the tissues. I would here express my obligations to Dr. Horace T. Hanks, from whom I learned this useful bit of knowledge.

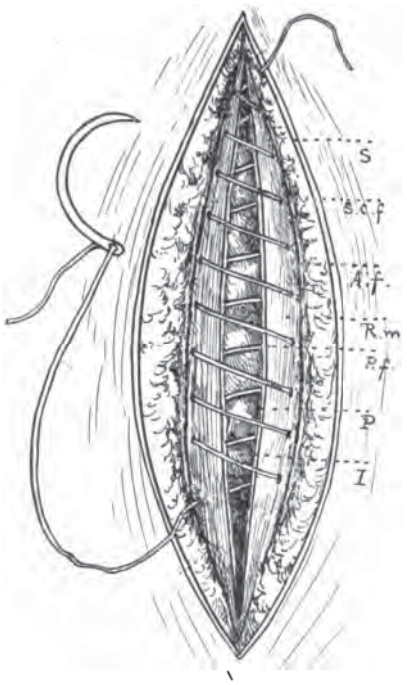

FIG. 2.—Showing deep tier of buried running forty-day catgut suture, nearly completed, but not drawn tight. The suture embraces peritonæum, the posterior edge of the divided fascia, and muscle.

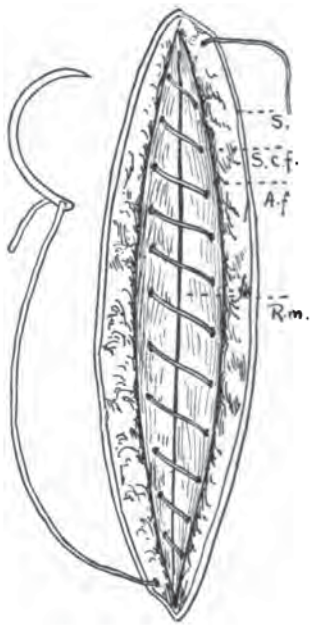

FIG. 3.—Deep suture tier completed, coaptating peritonæum, posterior fascial edge and muscle of one side to their homologues of the opposite side. Both free ends of the suture are seen emerging from from the surface of the anterior layer of fascia, on opposite sides, one at the upper, the other at the lower angle of the wound.

A single turn is first made and drawn tight; this is prevented from slipping by the assistant grasping it with forceps until the operator completes the second turn by a friction or double knot, made by interlacing the two ends twice before drawing taut (see Fig. 4). In other words, the first half of the knot is tied as a single and the sec-

ond half as a double or friction knot, exactly reversing the more common order. As catgut is somewhat elastic, it should be drawn *very* tight in knotting.

In uniting the cœliotomy incision, made as above described, by the buried running suture of chromicized forty-day catgut No. 0, the following method is employed :

Beginning, let us say, on the left side of the upper end of the wound, at from one half to one centimetre from the fascial margin, the needle, at the first thrust, is carried through fascia, muscle, and peritonæum (Fig. 2). Emerging on the opposite (right) side, peritonæum and muscle only are embraced in the suture, the fascia not being included. The suture is then continued as a running suture, embracing peritonæum and muscle only on both sides of the wound until the lower end of the wound is reached. The last loop embraces muscle and peritonæum only on the left side, while on the right it is carried through peritonæum, muscle, and fascia (Fig. 3). The deep suture is now completed, and the catgut is carried back as a running suture, whipping together the fascial edges until the upper end of the incision is reached, where it finally emerges from the fascia on the right side. The two ends of the suture are tied together over-the-fascia in the manner already described, constituting the only buried knot. Whipping the edges of the skin together by small over-and-over stitches, or by the subcutaneous suture of ordinary catgut, completes the closure. The fat is not sutured ; it falls into juxtaposition and takes care of itself. After pressing out any air that may have been imprisoned in the fatty layer while suturing the skin, the dressings are applied.

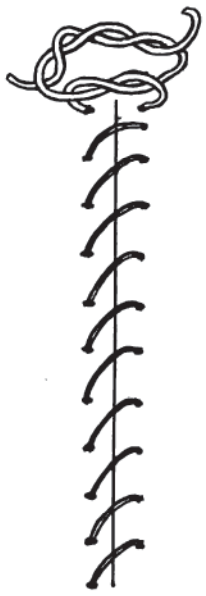

FIG. 4.—Fascial wound closed by superficial tier of buried running suture. Skin and fat are not represented in this cut. The knot is represented as loosely made to illustrate proper manner of tying buried catgut, a single turn in the first half, and a double turn in the second half of the knot.

One catgut suture, a metre in length, and consequently one knot, will suffice to close an incision five inches or less in length. Should the incision exceed five inches in length it is closed in two sections, calling, of course, for two buried knots.

If the recti muscles have been laid bare by slitting their sheaths

along the inner border, so as to make two fascial borders on each side, one anterior and one posterior to the muscle, then the posterior layer of fascia is included with the muscle and peritonæum in the deep tier of the buried running suture.

In case it be desirable or necessary to perform ventral fixation of the uterus in closing the cœliotomy incision, the spot is first ascertained where the fundus uteri fits comfortably against the abdominal wall. When that point of the incision is reached by the deep running suture uniting muscle and peritonæum, three loops of the suture, in addition to joining these tissues, are made to secure the uterus by being carried into and across the fundus. These three sutures, or rather three loops of the same suture, are arranged in such a way that the middle one pierces the uterus just between the points of origin of the tubes, the upper one being carried through the fundus a little behind and the lower one a little in front of this point.

The method of closing the cœliotomy incision by the running buried suture of forty-day catgut, applied in the manner advocated, is believed to possess these advantages:

1. Accurate coaptation of homologous structures.
2. The use of minimal quantities of buried suture.
3. Avoidance of all superfluous buried knots.
4. The suture is nowhere interposed between two raw surfaces which should unite.
5. The presence of the suture only so long as it is actually needed.
6. Removal of sutures becomes unnecessary.

I have confined my remarks to the median cœliotomy incision as being the one most frequently practiced by gynæcologists. The principles enunciated are, however, applicable with equal advantage to wounds made in other parts of the abdominal wall.

The scars obtained by this method of making and of closing the cœliotomy incision are characterized by palpable thickness and solidity, not only on the discharge of the patient from hospital, but months afterward. After employing it exclusively for the past fourteen months I have yet to learn of a case of hernia following its use. I allow my patients to get up in from two to three weeks after a cœliotomy, according to the nature of the particular case.

The method of making and of closing the cœliotomy incision above advocated is novel, as far as the writer's knowledge goes, only in the practice of invariably slitting the sheaths of the recti muscles along their inner edges and along the whole length of the wound, whenever the incision of the abdominal wall has come to fall between those

muscles. That this is by no means an unimportant matter becomes apparent when we reflect that, in place of a single fascial margin on either side, we have, after slitting the sheaths of the recti and slightly splitting the muscles themselves, two fascial margins and a broad muscular surface on either side available for union with their homologues of the opposite side. Months after operation, when wound exudates have entirely disappeared, the finger run down the median line of the abdomen from sternum to pubis will gain the distinct impression that the cicatrix constitutes the thickest, firmest, and probably strongest part of the median line.

The systematic and precise method of applying the buried running catgut suture, as detailed above, is also believed to possess advantages.

59 West Forty-ninth Street.