INTESTINAL LOCALIZATION.[1]

A STUDY ON THE CADAVER FOR THE PURPOSE OF DETERMINING TO WHAT EXTENT THE VARIOUS PARTS OF THE SMALL INTESTINE MAY BE IDENTIFIED THROUGH AN ABDOMINAL WOUND.

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It has always seemed somewhat strange to me that so little has been done in the way of a systematic study of the characteristics of the different parts of the small intestine and its mesentery for the purpose of assisting the surgeon to determine, when a loop of small intestine appears in an abdominal wound, what the approximate *position* of that loop is in reference to the rest of the intestine, and, incidentally, what the *direction* of the tube is in the loop,—that is to say, which end will lead to the duodenum and which to the ileocæcal valve.

It is, of course, true that in most abdominal operations such information concerning the position and direction of any loop of small intestine would be of no real service to the surgeon. He has no concern about the intestine except to get it out of the way by retracting or by gauze packing, which he naturally proceeds at once to do. In other cases, and especially in those where the intestine itself is to be the object of investigation or operative attack,—as, for instance, in cases of obstruction from any cause, or in connection with supposed perforation (pathological or traumatic), in anastomosis operations, in enterostomy where a fistula is to be made, or in cases where the intestine itself is taken as a guide to one end or the other,—any information of this kind, if it can be readily obtained without additional danger to the patient, must often be of great value.

[1] Read, in abstract, at the meeting of the American Surgical Association in Washington, May 14, 1903.

To be sure, all surgeons are familiar, in a sort of general way, with the characteristics of the upper and the lower parts of the bowel, and also know that in an incision in the upper part of the abdomen the upper part of the bowel is most likely to be met with, and in an incision in the lower part of the abdomen the lower part of the bowel. And yet it has seemed to me that a further study of the characteristics of the bowel and its mesentery at different points might enable the surgeon to localize an intestinal loop with more precision than formerly, and, at the same time, to determine which end is really the upper end of the loop and which the lower.

I have, therefore, during the past six months made a number of investigations on the dead body, with the idea of determining whether there were any points which would be of real assistance in this matter. I have tried to conduct these examinations on autopsied subjects, so far as conditions would allow, so that the tissues might be as nearly fresh and normal as possible. I have also used a number of cadavers in the dissecting-room at the Harvard Medical School. (I wish to acknowledge the kindness of Dr. Mallory, of the Boston City Hospital, and of Drs. Dwight and C. B. Porter, at the Harvard Medical School, who, for the purpose of these investigations, placed a large amount of material at my disposal.)

In some of the cadavers I examined the intestine and mesentery only for the purpose of familiarizing myself with their different parts, making careful note of such points as I thought might be of use in the matter of intestinal localization. I wished not only to verify for myself the general description of the parts as given in the books, but also to get any further information which a special study of them on the cadaver might furnish. I then tested the value of all the information thus acquired through various abdominal incisions in other cadavers. The number of cadavers used for both these purposes was about forty. In all this work thin rubber gloves were worn, not only for the sake of protecting the hands, but also for the purpose of simulating, so far as the sense of touch was concerned, actual operative conditions.

(A) ACTUAL TESTS IN LOCALIZATION OF LOOPS OF INTESTINE.

At first I did most of this work alone, but later was assisted by Mr. Everett Lee, a fourth-year student at the Harvard Medical School, who made a number of useful suggestions in the course of the work.

Tests were made through various abdominal incisions on sixteen different cadavers. Through each wound a loop of intestine was pulled out, and its characteristics noted. It was then localized by means of these characteristics, the direction determined, a tag attached bearing a number, after which it was dropped back again into the abdominal cavity. Another loop was pulled through the wound, and the same process repeated. Sometimes a number of loops, one after the other, were pulled through one incision, and at other times several incisions were made and a different loop pulled through each of them, each loop being, in every case, localized and tagged before it was dropped back into the abdominal cavity and before another loop was pulled out. A written record was kept of the estimated position of each numbered loop,—that is to say, its supposed distance from the upper or lower end of the intestine. Later the abdominal cavity was laid open, from ensiform cartilage to symphysis pubis, and the measure, starting from the end of the duodenum. The actual distances of the different tags from that point were recorded as soon as they were determined. The direction of the gut was indicated at different points by special pins, the ends of which were supposed to point, in the opinion of the examiner, to the ileocæcal valve.

I have on record 180 different localizations. These represent, however, about 125 different loops, as Mr. Lee and myself frequently localized the same loop independently of each other, such localizations on the same loop being recorded as two. The results of these 180 localization tests are given in the following table:

	Number.				
Localizations, correct	7	(about	4	per cent.)	
Localizations, with error of less than 1 foot	46	("	25	"	)
Localizations, with error of 1 foot or more, but less than 2 feet	38	("	21	"	)
Localizations, with error of 2 feet or more, but less than 3 feet	45	("	25	"	)
Localizations, with error of 3 feet or more, but less than 4 feet	16	("	8	"	)
Localizations, with error of 4 feet or more, but less than 5 feet	15	("	8	"	)
Localizations, with error of 5 feet or more, but less than 6 feet	7	("	4	"	)
Localizations, with error of 6 feet or more, but less than 7 feet	5	("	3	"	)
Localizations, with still greater error	1	("	0.5	"	)
Total number of localization tests	180				

The average error in the 180 tests was 2.03 + feet.

Seventy-five per cent. of all the localizations were, therefore, made with errors of less than three feet. In the early stages of this study, before all the determining factors could be made use of, the errors were more marked than later, when the tests showed a distinct improvement in this respect.

The following record is given as a sample of localization. The cadaver was that of a well-developed man, about fifty years of age. An incision was made in the median line, between the umbilicus and pubes. The hand was introduced into the abdominal cavity, and ten different loops from ten different regions pulled through the wound one after the other, each one, however, being localized (as to its distance from the end of the duodenum), tagged, and returned into the cavity before another one was drawn out.

Loop.	Localization.	Actual Site.	Errors.
1	6 feet	3 feet 10 inches	2 feet 2 inches
2	18 "	22 " 6 "	4 " 6 "
3	10 "	8 " 9 "	1 " 3 "
4	14 "	14 " 3 "	3 "
5	16 "	12 " 1 "	3 " 11 "
6	17 "	20 " 4 "	3 " 4 "
7	8 "	7 " 4 "	8 "
8	3 "	10 "	2 " 2 "
9	18 "	18 " 5 "	5 "
10	4 "	3 " 2 "	10 "
Total errors			19 feet 6 inches
Average error (about)			2 "
Estimated length of intestine			21 "
Actual length of intestine			22 " 9 "

I could give records showing much closer estimates and others showing much worse. On the whole, this record is about an average one.

In this cadaver work I used mostly actual measurements from one end or the other for the sake of greater accuracy in localization and for the purpose of comparing results. One may use equally well, proportions such as "thirds," "quarters," or "fifths." Thus, one may say that such and such a loop occupies the upper or lower part of the upper, middle, or lower third, or that it is about so and so far from one end or the other, or from the middle point of the gut. Obviously, any method may be used in indicating the site of a given loop, provided it is sufficiently accurate for the purpose in hand.

It will, perhaps, appear strange that I have, thus far at least, made no mention of the terms "jejunum" and "ileum." My reason for this is that, as we all know, there is no dividing line between them. In fact, although the jejunum is usually described in the text-books (*e.g.*, Quain) as being the upper two-fifths and the ileum the lower three-fifths, some German anatomists (*e.g.*, Merkel) speak of the upper three-fifths as jejunum and the lower two-fifths as ileum. The middle one-fifth is, therefore, jejunum or ileum, according to the anatomical authority one prefers to follow. These terms, however, are so firmly rooted that they will probably always be used by surgeons; but they can never mean anything more than to convey a very general idea as to position, for the term "jejunum" merely means the upper part of the bowel, and the term "ileum" the lower part of it.

(B) ACTUAL TESTS IN THE DETERMINATION OF DIRECTION IN GIVEN LOOPS OF INTESTINE.

The attempt to determine the direction of the gut was made in ninety different loops in fifteen different cadavers. In eight the direction proved to be wrong; in eighty-two (or 91 per cent.) it was right.

(C) CHARACTERISTICS (ANATOMICAL AND OTHERWISE) OF THE SMALL INTESTINE, WHICH MAY BE USED ON THE CADAVER FOR DETERMINING THE POSITION AND DIRECTION OF ANY GIVEN LOOP OF INTESTINE.

I may as well state here my regret that I have been able to find no infallible characteristic sign to indicate any one particular point of the bowel, except at the two ends where the bowel is fixed.

Almost all the characteristics of the different parts of the intestine undergo changes as we pass to other parts of it, and even these transitions vary with the individual. The changes are usually gradual, and not abrupt, and for this reason we cannot say that a change takes place at such and such a point. This makes localization difficult enough; but when we realize that a bowel (I refer only to that part of it which has a mesentery, *i.e.*, from the end of the duodenum down) may be anywhere from fifteen feet to thirty feet in length, and that, before our incision, we have no means whatever of knowing what this length will be, our problem becomes enormously complicated. And yet, when we have so many things to help us,—even if none of them are positively distinctive,—we may be able to localize a loop near enough for practical purposes by a combination of them. A knowledge of these various combinations means, of course, a certain amount of practice and experience, though not so much as one would suppose.

1. *What Part of the Small Intestine may We expect to meet in Any One of the Various Abdominal Incisions?*—This naturally brings up the subject of the disposition of the intestine in the various regions of the abdominal cavity. The studies of Treves,[1] Henke,[2] Sernoff,[3] Weinberg,[4] and Mall[5] are exhaustive and valuable from an anatomical stand-point, but in the way of assisting the surgeon in practical work they have not very much to offer. Generally speaking, however, it is well to bear in mind that Mall, in a systematic examination of the arrangement of the mesenteric loops in forty-one cadavers, found what he called a normal arrangement in

twenty-one of them. By consulting his diagram, it will be seen that in this normal arrangement the principal sweeps of the mesentery are first to the left, then to the right, then to the left iliac region, and, finally, into the pelvis and up again to the ileocæcal valve. There are, however, many variations from this normal standard. When one realizes the extreme mobility of the small intestines, one is not surprised to see with what ease they may be pushed to any part of the abdomen, and to this fact, more, perhaps, than to any other, is to be attributed the different positions in which the same coils are found in different cadavers. While the different coils may have in the same body their favorite places of rest, it is evident that they are easily changed by change of posture of the individual or as a result of pressure applied from one direction or another. Tumors may push the intestines to any part of the abdominal cavity. An enlarged stomach may push them all into the pelvis, and an enlarged colon may press them to one side or the other. In one cadaver with ascites I found, as one would expect, that there were no coils at the back of the abdominal cavity or in the pelvis. Dr. Mixter tells me of a case of his in which, on opening the abdominal cavity, he found that most of the small intestine had passed upward into the pleural cavity through a rent in the diaphragm. I have noticed in a few cadavers, where there was great emaciation and where the abdominal wall was represented by a concavity instead of a convexity, that most of the small intestines were in the pelvis.

As I shall, from time to time, refer to the root of the mesentery for various points in this paper, and as its position has something to do with the arrangement of the various intestinal loops, I insert here a brief description of it.

The mesentery springs from the posterior wall of the abdomen along a straight line six inches in length, which starts above on the left side of the spinal column at the point where the duodenum ends, about on a level with the body of the second lumbar vertebra, and is continued obliquely downward and to the right, to end in an indefinite way at a point about opposite the sacro-iliac synchondrosis. I have been able to find no

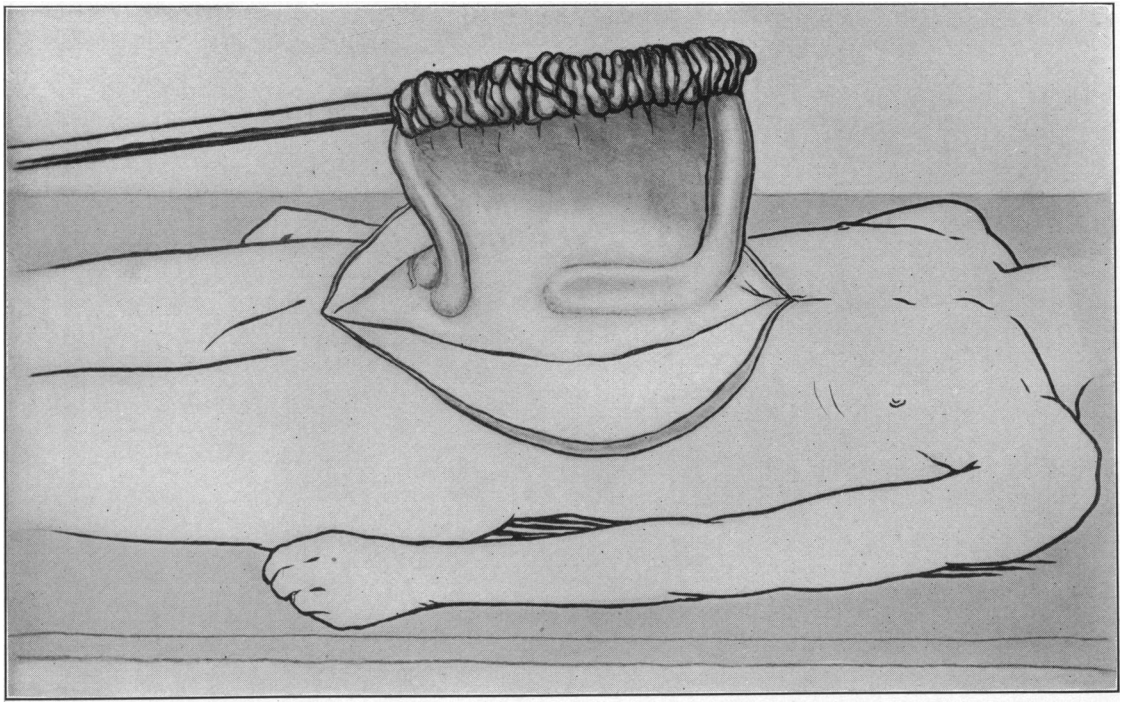

FIG. 1.—Showing the small intestine puckered up on a rod. (Drawn from a photograph.)

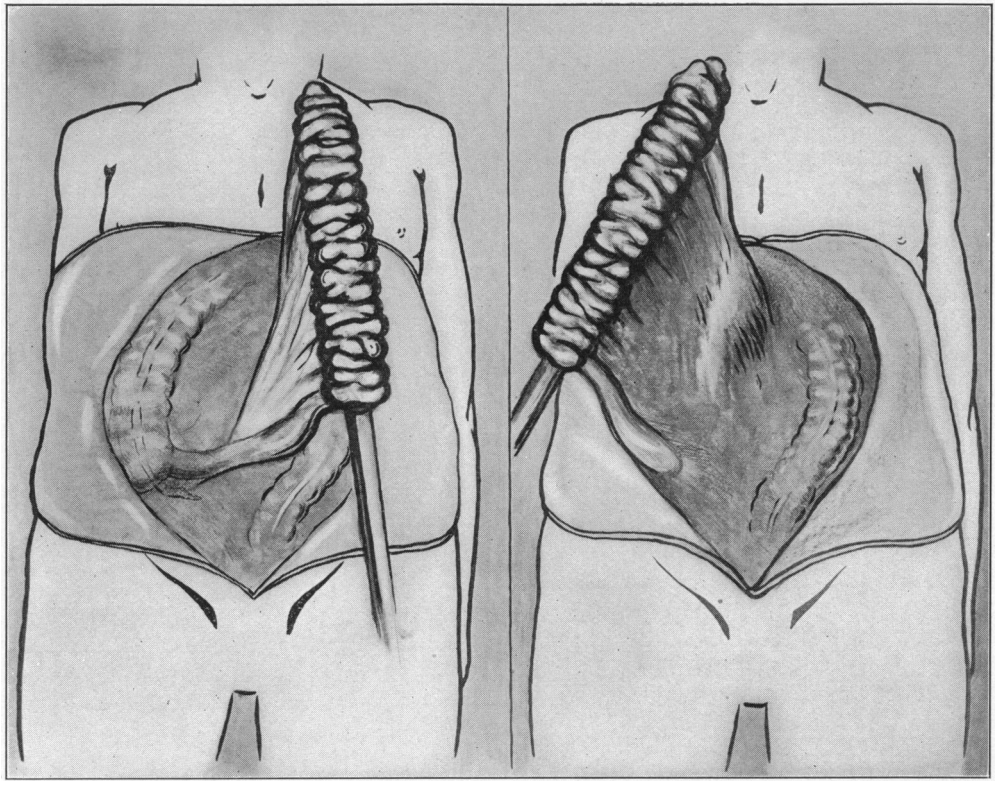

FIG. 2.—Showing the right fossa of the abdominal cavity and the oblique attachment of the mesentery. (Drawn from a photograph.)

FIG. 3.—Showing the left fossa of the abdominal cavity and the oblique attachment of the mesentery. (Drawn from a photograph.)

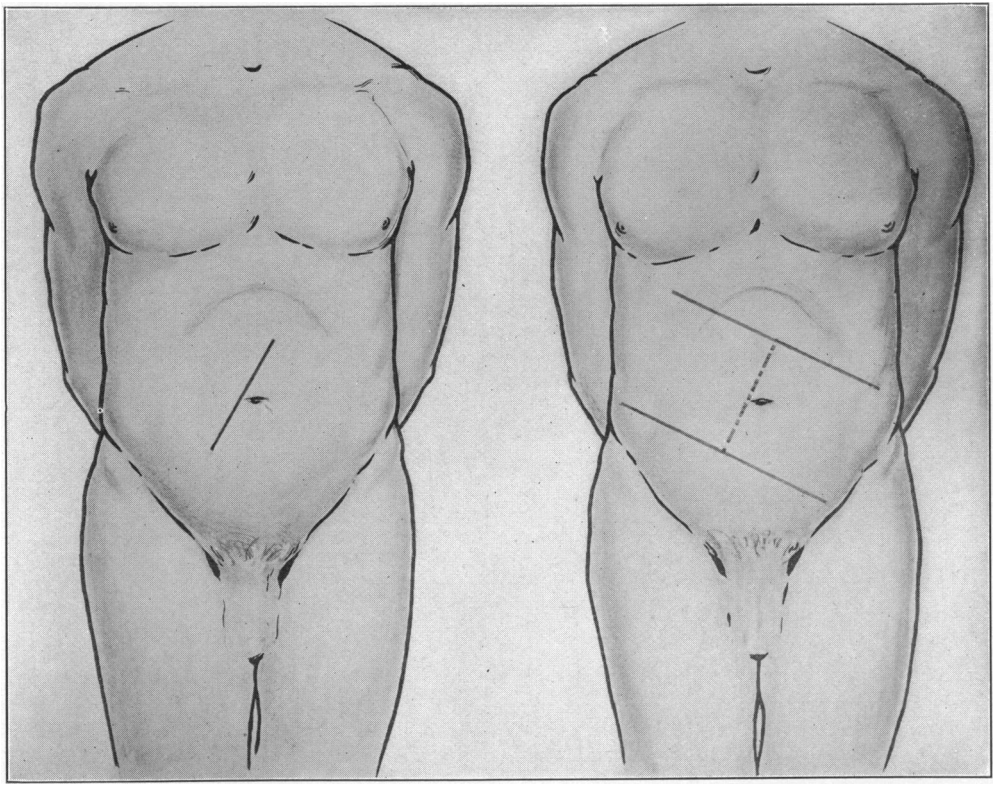

FIG. 4.—Showing approximately the line of the mesenteric root as traced on the abdominal wall.

FIG. 5.—Showing the two oblique lines (black) drawn at right angles to the two extremities of the line (dotted) of the mesenteric root. The upper, middle, and lower compartments here indicated contain in most instances the upper, middle, and lower thirds of the small intestine, respectively.

very satisfactory illustrations to demonstrate this mesenteric root, and have, therefore, devised a method of my own, which I think, for the purposes of this paper at least, will show it very satisfactorily. This method has the additional advantage of simplifying the intestinal tube by causing it to conform to a straight line (Fig. 1).

A rod has been pushed into the intestine through an opening in the gut about six to eight inches above the ileocæcal valve, and the entire intestine, barring the upper and lower few inches, is drawn over its tip and puckered up on the rod in exactly the same way that an earth-worm is put upon a hook. Two ligatures are then placed on the ends, and it is found that, without using undue force, the twenty feet of intestine, more or less, can be made to occupy a space of not more than one foot in length.* When the intestine is held up on the rod, and placed so that the axis of the rod is parallel with the axis of the oblique line of the mesenteric root, the mesentery may be inspected with great ease. Looked at in this way, the mesentery forms a sort of partition, as it were, with the puckered intestine fringing its upper edge. It thus divides the abdominal cavity into two large fossæ, of which the left is much the larger (Figs. 2 and 3).

The correspondence between the different parts of the small intestine and the oblique attachment of the mesentery is made evident here, and it becomes more obvious why the upper part of the intestine would be most apt to occupy the upper part of the abdomen and the lower part of the intestine the lower part of the abdomen.

* It is astonishing with what ease this can be done when the abdominal cavity has been freely laid open. In fact, so readily is it accomplished under these conditions as to suggest the possibility of introducing into the gut (when freely exposed in an operation) a rigid tube for purposes of inspection of the inside of the gut or for the removal of gas or other intestinal contents. The tube cannot be pushed into the gut, but the gut must be pulled up over the end of the tube. To what extent the mechanical part of this procedure can be accomplished on the living subject through an ordinary abdominal wound may be easily determined on the cadaver. It is, of course, uncertain to what extent the shock and danger of infection, in connection with such a procedure, would prevent its use.

I have found that, in normal conditions, the upper six feet or so of the tube is generally confined to the left hypochondriac region, occupying a deep fossa there under the ribs, and in such a position that its coils would not usually be encountered through any of the ordinary abdominal incisions. The middle part of the intestine usually occupies the middle parts of the abdomen, while the lower part of the tube is generally in the pelvis and in the right iliac fossa. In order to roughly indicate on the outside of the body the positions ordinarily occupied by the upper, middle, and lower thirds of the intestine, I have found that two straight lines running obliquely across the abdomen at the two ends of and at right angles with the line of the mesenteric root will roughly divide the abdomen into three regions, each of which will contain in most bodies about one-third of the intestinal tube, the upper third being in the first region, the middle third in the second region, and the lower third in the third region, as shown in the diagrams. (Figs. 4 and 5.)

It will thus be seen that an incision anywhere above the first line will probably disclose loops belonging to (or near) the upper third of the intestine; anywhere between the first and second lines, loops belonging to the middle third, and anywhere below the second line, loops belonging to the lower third. This appears to be a pretty good general rule in intestinal topography, to assist us in determining, while making our incision, what part of the bowel we are likely to meet with first. We should not forget, however, that there are occasional and marked exceptions to this rule.

2. *The Length of the Intestine.*—There seems to be no relation whatever between the length of the intestine and the age or sex of the individual. So far as I know, all who have written on the subject bear witness to this. Therefore, we have no means of knowing, before we make our incision, whether we are to meet a long, a short, or a medium intestine. Treves attributes these variations to physiological influences, and this explanation, though somewhat vague, has been pretty generally accepted by those who have investigated the subject.

It is not at all clear why there should be such great variations in the length of the tube in different individuals. Of the subjects examined by me the shortest intestine was fifteen feet, and the longest twenty-nine feet, the average being about twenty-one feet. Almost all the measurements were made *in situ* with the aid of a tape measure.

I have recently noticed in three or four cases where the intestine was very long that the mesentery was also of unusual length, and that the vasa recta (or the little straight vessels running from the mesenteric loops to the intestine) were much longer than the average. I have also noticed in a few cases where the intestine was short that the mesentery and vasa recta were also inclined to be short. Occasionally I have been able to estimate, with some success, the approximate length of the bowel by localizing the first loop presenting, and determining—by putting the mesentery gently on the stretch and by examining the vasa recta—whether the mesentery and vasa recta were longer or shorter than the average at this part of the tube. If longer, I made an estimate that the intestine was above the average,—that is, more than twenty-one feet; and, if shorter, I considered that it was probably below the average, or less than twenty-one feet. This point I speak of, incidentally only, as a matter of general interest. But, having tried it in so few cases, I cannot say whether this test for determining the length of the intestine from the length of the mesentery and the vasa recta in any one loop is at all reliable.

The small intestine is described in the books as being thicker and of greater diameter in its upper than in its lower part. Other general characteristics of the different parts of the tube are occasionally alluded to.

The statements which I shall make in reference to the characteristics of the intestine and mesentery are based almost entirely upon the results of the examinations I have made on the cadaver. I should like to say, however, that on account of the extreme variability of the different characteristics of the intestine in different individuals, a larger experience may

later necessitate an appreciable modification of some of these statements.

3. *The Size of the Intestine.*—The diameter of the gut is greatest above, and gradually diminishes in size as we go down the tube. When we reach the lower third or so, the size remains about the same throughout. (The size may vary so much in life, however, with contraction or distention that, as a means of distinguishing one part of the gut from another, a knowledge of different diameters, given in actual measurements, would not be of much value.)

4. *The Thickness of the Intestine.*—The upper part of the small intestine is normally thicker than any other part. This thickness is principally due to the presence of large and numerous valvulæ conniventes and to the great development of the muscular layers. As we pass down the tube we observe that it gradually gets thinner and thinner until we reach the lower third of the gut, where it remains about the same, thickening up again, however, in the last two or three feet.

The thickening of the lower part of the tube is presumably due to an increase in the muscular elements, the food being at this point distinctly more solid and, therefore, more difficult to force onward. In certain cases of chronic obstruction the thickness and size of the tube are greatly increased, as I have had occasion to observe recently in a case of obstruction due to cancer at the ileocæcal valve. Presumably the increased thickness in such cases is largely due to hypertrophy of the muscular walls of the gut. Great distention by gas increases the apparent size of the gut and diminishes the thickness of the walls.

5. *The Color and General Vascularity.*—The upper part of the bowel in normal conditions is bright pink or red, and exhibits great numbers of branching vessels of good size. The color as we go down the tube gradually fades out to a gray or pinkish or yellowish gray, and the vascularity grows less and less marked.

6. *The Valvulæ Conniventes.*—In the upper part of the bowel the valvulæ conniventes are large and numerous. They

can always be felt, and generally seen as pinkish or whitish rings, more or less complete, about the gut. They gradually diminish in number, but especially in size, as we pass down the tube, until a point is reached, which I have found to be about fourteen or fifteen feet from the end of the duodenum, beyond which they can seldom be felt or seen. Though the distance to which the valvulæ conniventes extend varies somewhat, this variation has, apparently, nothing to do with the variations in the length of the tube.

7. *Contents of Intestine.*—Mention is made of the contents of the intestine only for the sake of completeness. The different parts of the intestine show food in the various stages of intestinal digestion. The consistency increases somewhat towards the lower end of the tube.

8. *Resistance at the Two Ends of the Bowel.*—It is hardly necessary to call to mind the fact that when one end of a loop which is high up in the bowel is gently pulled upon and meets with a resistance, the loop is probably close to the duodenum; and also that, when one end of a loop low down in the bowel meets with a resistance in the ileocæcal region, the loop is probably a short distance from the valve.

9. *General Vascularity of the Mesentery near the Bowel.*—Opposite the upper part of the bowel the mesenteric vessels are distinctly larger than opposite any other part of it. These vessels grow smaller and smaller as we pass downward until the lower third of the gut is reached, where they remain about the same size as far as the ileocæcal valve. The arrangement of the mesenteric vessels has some features which intimately concern the subject in hand, and which I shall describe with some detail. Diagrammatically speaking, the main branches of the superior mesenteric artery unite with each other by means of loops, which are called for convenience "primary loops;" in some parts of the tube, "secondary loops," and even, occasionally, "tertiary loops" are superimposed upon these. From these loops little straight vessels—the vasa recta already referred to—run to the bowel, upon which they ramify,

alternating, as a rule, as to the side of the intestine which they supply. The mesenteric veins are arranged in a manner somewhat similar to the arteries.

10. *The Loops of the Mesenteric Vessels.*—Opposite the upper part of the bowel there are only primary loops. Occasionally a secondary loop appears, but it is small and insignificant as compared with the primary loops, which are large and quite regular. As we proceed down the bowel secondary loops become more numerous, larger, and approach nearer to the bowel than the primary loops in the upper part. As a rule, secondary loops become a prominent feature at about the fourth foot. As we continue further downward, the secondary loops (and, possibly, tertiary loops) become still more numerous and the primary loops smaller, the loops all the time getting nearer and nearer to the gut. Opposite the lower part of the gut the loops generally lose their characteristic appearance, and are represented by a complicated network.

11. *The Vasa Recta.*—Opposite the upper part of the intestine the vasa recta are from three to five centimetres long, when the loop of small intestine to which they run is lifted up so as to put them gently on the stretch. They are straight, large, and regular, and rarely give off branches in the mesentery. In the lower third they are very short, being generally less than one centimetre in length. Here they are less straight, smaller, less regular, and have frequent branches in the mesentery.

For the points concerning the general arrangement and variations in the loops of the mesenteric vessels and the vasa brevia in the different parts of the mesentery I am indebted to an article in the *Reports of the Meeting of the Association of American Anatomists,* 1897, by Dr. Thomas Dwight, Professor of Anatomy at Harvard. Dr. Dwight kindly called my attention to this article and also to three museum specimens prepared to illustrate these points.*

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* Dr. Dwight republished his observations in an article in the Anatom. Anzeiger, Band xxiii, 1903.

12. *The Thickness and Translucency of the Mesentery.*—Both of these conditions vary markedly in different subjects,—the more fat present, the more opaque the mesentery; the less fat, the more translucent the mesentery. The thinnest part of the mesentery is that portion which is adjacent to the upper part of the intestine. As we proceed down the gut the adjacent mesentery becomes thicker and thicker, due, apparently, to the deposition of fat and to the presence of a ligament of fibrous and plain muscular tissue which is said to aid in the support of the lower coils of intestine. Thus, in the upper part of the mesentery and intestine we have the thinnest part of the mesentery opposite the thickest part of the tube; and, farther down, the thickest part of the mesentery opposite the thinnest part of the tube.

The translucency varies enormously. In some cases the mesentery in the upper part is as transparent as a thin sheet of mica, and even in the whole course of the tube it may transmit some light. In other cases it is quite opaque, especially below, where in adipose subjects there is often so much fat that the vessels cannot be seen, or they may be represented—on the cadaver, at least—by mere depressions.

One feature, however, I have found of some value in all the cadavers examined in reference to this point. If one raises a loop from the uppermost part of the intestine, and holds it in such a position that the light will shine through the mesentery, one will notice, in that part of the mesentery close to the gut, little transparent spaces between the vasa recta. Some of these "lunettes," as I call them, are almost always present opposite the upper part of the gut even in the thickest mesenteries. I have found, as a rule, that they gradually grow smaller, become streaked with fat, and disappear at about the eighth foot. They may, however, in exceptional cases, persist to the end of the gut.

13. *Tabs of Fat close to the Mesenteric Border of the Intestine.*—If we examine that part of the mesentery adjacent to the lower third or so of the gut we will usually find, except in the thinnest subjects, little masses of fat which project from

the mesentery towards the bowel, or even extend upon it. In one very fat subject I found these tabs present from one end of the intestine to the other.

The accompanying drawings taken from actual specimens present pictures, which, according to my experience, are fairly characteristic of the different parts of an intestine and adjacent mesentery, where the tube is about the average length, and where the vessels are not obscured by fat. (Figs. 6–11 inclusive.)

14. *Direction of the Stretched Mesentery.*—If a loop of intestine appearing in an abdominal wound is gently drawn out of the wound in such direction as to pull away from the known line of the mesenteric attachment in the back part of the abdomen, we can often, by noting the direction of the line of resistance, get an approximate idea as to the part of the mesenteric root which resists, and this will probably give us some suggestion as to what part of the intestinal tube our loop occupies. This test is, of course, of more value through those incisions which make it possible to pull our loop at right angles to the mesenteric root, than through incisions where we are obliged to pull obliquely. In using this test it is sometimes worth the while to run the finger down the mesentery, along the line of resistance, towards the mesenteric root. This line can, however, seldom be followed to the mesenteric root itself, for when traction is made upon any part of the intestinal tube the deeper parts of the mesentery apparently move as a whole, and the line of resistance in the mesentery, which is generally evident near the intestine, divides into two or more lines in the deeper parts of the mesentery.

In median-line incisions we can, by pulling the loop of intestine downward, generally determine with a good deal of certainty whether the line of resistance from above is from the median line of the body or from the left or right of it. The more the line of resistance from below upward inclines to the left, the nearer is the loop to the duodenum; and the more it inclines to the right, the nearer it is to the ileocæcal valve.

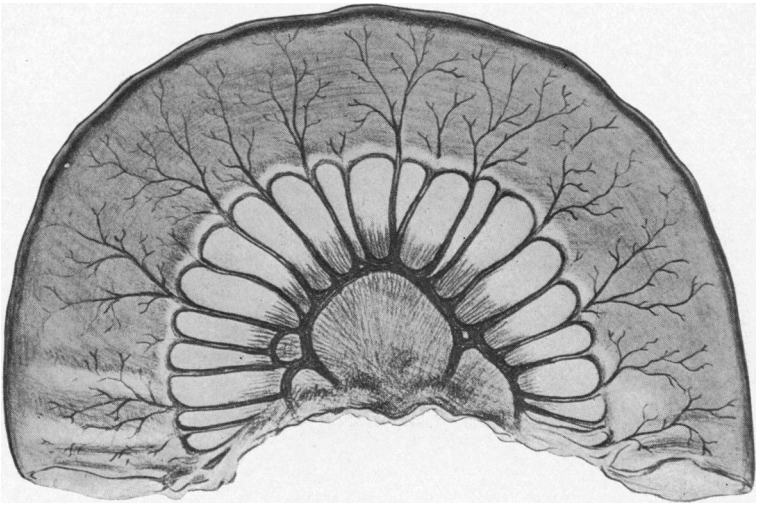

FIG. 6.—A loop of intestine, the middle of which is exactly three feet from the end of the duodenum. The gut is of large size. The mesenteric loops are primary, and the vasa recta large, long, and regular in distribution. The translucent spaces (lunettes) between the vessels are extensive. Below, the mesentery is streaked with fat. The veins, which had a distribution similar to the arteries, are for simplicity omitted from this and from the subsequent drawings. (The subject from which the specimen was taken was a male of forty years, with rather less than the usual amount of fat. The entire length of the intestine was twenty-three feet.)

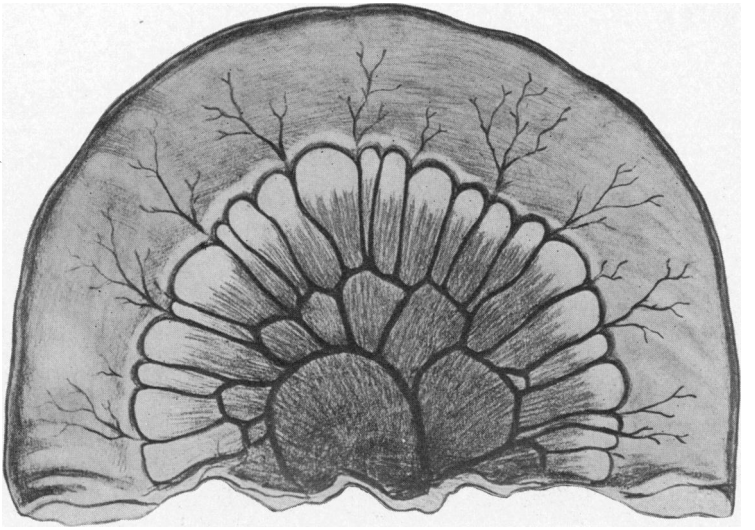

FIG. 7.—A loop of intestine at six feet. As compared with Fig. 6 the gut is somewhat smaller. The vascularity of the intestine and mesentery is less. Secondary loops are a prominent feature. The vasa recta are smaller. The lunettes are also present, but are not so large as in Fig. 6. (The subject was a male of about thirty-five years, with an average amount of fat. The entire length of the intestine was twenty feet.)

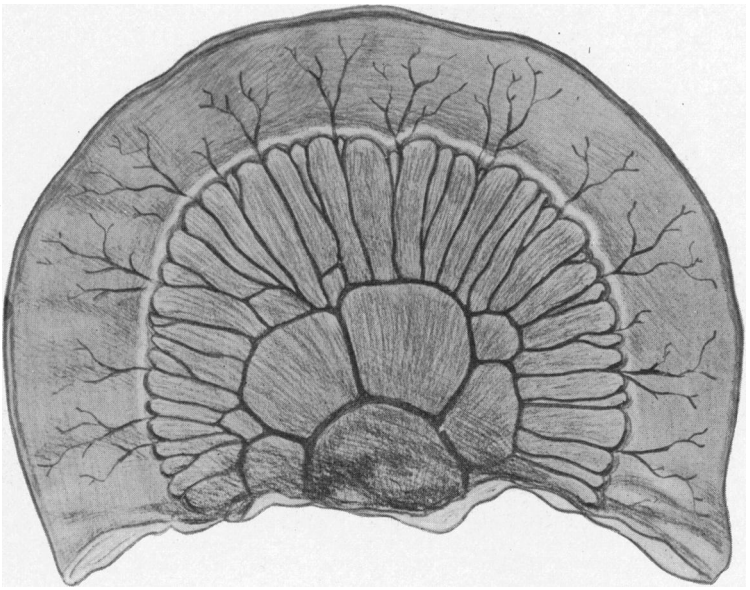

FIG. 8.—A loop of intestine at nine feet. The secondary loops are large; the vasa recta are somewhat irregular and show branches. No lunettes are present, and the mesentery is streaked with fat, and is, therefore, somewhat opaque. (The specimen was taken from the same subject which furnished Fig. 6.)

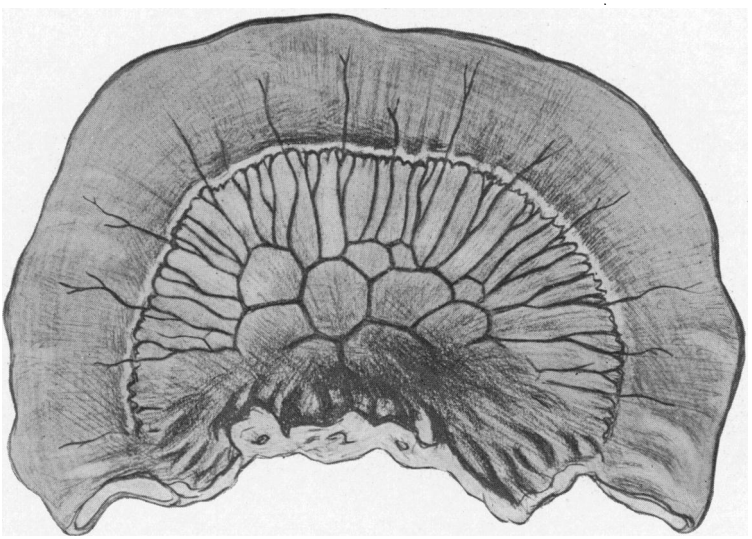

FIG. 9.—A loop of intestine at twelve feet. The vessels are smaller. The primary loops are lost in the fat, but secondary and even tertiary loops are visible. The vasa recta are shorter, more irregular, and branching. (The specimen came from the same subject which urnished Figs. 6 and 8.)

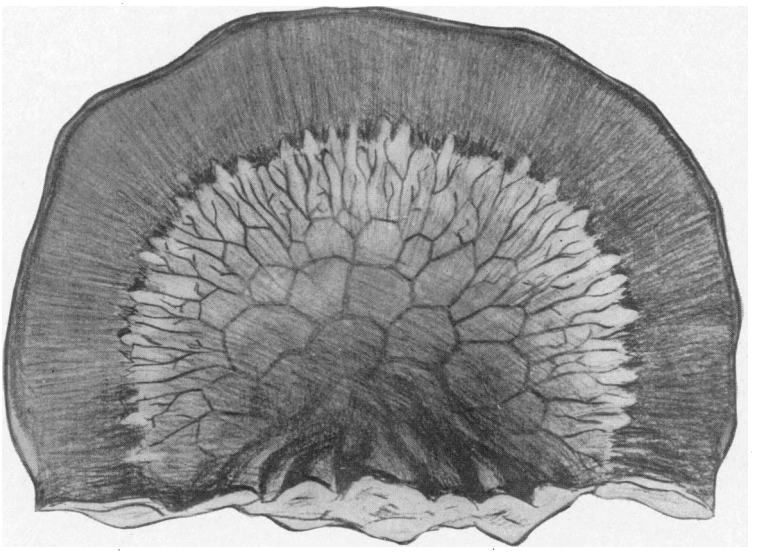

FIG. 10.—A loop of intestine at seventeen feet. The mesentery is opaque, and small tabs of fat begin to appear along the mesenteric border of the gut. The vessels are represented by a somewhat complicated net-work, and are seen with difficulty in the thick fat of the mesentery. (The specimen came from the subject which furnished Figs. 6, 8, and 9.)

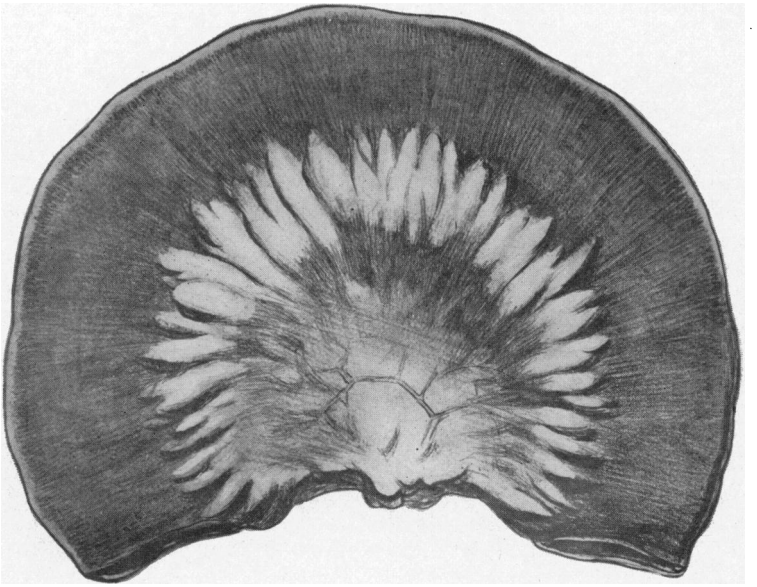

FIG. 11.—A loop of intestine at twenty feet. The gut appears to be thick and large. The mesentery is quite fat and opaque, and large and numerous fat tabs are present. The vessels, which are complicated, are seen with difficulty, and are represented by mere grooves in the fat. (The subject was a stout woman, and the entire length of the gut was twenty-one feet.)

For the purpose of summarizing the points already described for localizing an intestinal loop, the following table, showing roughly the usual characteristics of an intestine, which is twenty-one feet long (the average), is here inserted.

15. *Determination of Direction.** — In order to understand the method of examination by which the direction of any given loop of intestine may be determined, it will be necessary to revert to Figs. 1, 2, and 3, which show the intestine puckered up upon the rod and held parallel with the mesenteric root.

When the mesentery is followed down with the finger on the left side of the intestine the finger must enter the left fossa, and cannot get into the right fossa without first crossing over the intestine. On the other hand, if the right side of the mesentery is followed down to its root, the finger can only go into the right fossa. One side of the mesentery, therefore, leads to the left fossa only, and the other side to the right fossa only.†

The side of the intestine, therefore, corresponding with the left fossa is the left side, and the side of it corresponding with the right fossa is the right side.

Now, let us suppose that the surgeon has between his fingers a loop of bowel, and wishes to determine its direction. He knows that one side of the loop is the left side of the intestine, and that the corresponding side of the mesentery, if closely followed down to the mesenteric root, will conduct him

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* Occasionally on the living subject visible peristalsis may indicate the direction, though one can hardly be sure that the peristalsis is not reversed. It has been suggested (by Senn, I believe) to apply salt to the intestine for the purpose of stimulating the peristaltic waves, and thus ascertaining the direction.

† It is, I think, a point worth noting that in case we have to wash out the abdominal cavity, the mesentery on the two sides of any loop of small intestine will conduct the tip of the irrigating tube to the bottom of the two fossæ. We can thus at once flush out the great right and left cavities from the bottom in a manner which must certainly be an improvement over the old custom of pushing the irrigating tube aimlessly into different parts of the abdominal cavity.

into the left fossa; he also knows that the other side of the bowel is its right side, and that the mesentery on that side will conduct him into the right fossa. Now, if his finger goes into the great fossa on the left side of the abdomen, after having closely followed the mesentery down to its root and arranged his loop to be parallel with that root, he then knows that the left and right sides of the intestine face to the left and right sides of the abdomen respectively, and that the end of the loop which points downward is the end nearest the ileocæcal valve. He can determine the direction of the gut in a similar way in case his finger enters the right fossa. All this would seem very simple were it not for the twists in mesentery and intestine, which tend to mislead one. A little practice will usually enable one to recognize a twist in the mesentery. This should be untwisted by rotation of the gut, after which the direction is determined by another palpation of the mesenteric root.

It is now over a year since the possibility of thus determining the direction in any loop of bowel by reference to the root of the mesentery occurred to me. In fact, I tried it practically in a number of operations, as well as on cadavers, at the Boston City Hospital. I supposed at that time that the idea was a new one. Soon after this, however, when reading Dr. Woolsey's book on "Surgical Anatomy," I saw the point alluded to. I then wrote to Dr. Woolsey to ascertain whether it was original with him, and, if not, where the idea came from. He kindly replied at once to my letter, saying that he did not remember where he had come across it, but that he was quite sure he did not devise it himself. He also stated that he had used the method in class instruction in surgical anatomy and in operations on the living subject for several years. Since receiving Dr. Woolsey's letter I have seen the point briefly referred to in another recent work on anatomy. I think it is, however, of sufficient practical value to deserve a little more emphasis than seems to have been given to it.

There is one other method for determining the direction of a loop of bowel. This I have tried with apparent success in

TABLE SHOWING USUAL CHARACTERISTICS INTESTINE OF TWENTY-ONE FEET.

Usual Position in the Abdomen of the Different Thirds of the Intestine.		Upper Third.	Middle Third.	Lower Third.
		Left Hypochondrium.	Probably in Middle Section of Abdomen.	Probably in Pelvis and Right Iliac Region.
Intestine	Average length of intestine	1 2 3 4 5 6 7	9 10 11 12 13 14	15 16 17 18 19 20 21
	Size	Large		Small ... Small.
	Thickness	Thick		Thin ... Slightly thicker.
	Translucency	Opaque		Translucent ... Less translucent.
	Vascularity	Large vessels and far apart		Small vessels and near together
	Color	Bright pink or red		Pinkish or yellowish-gray
	Valv. conn. (felt)	Large and numerous		Cannot usually be felt beyond 14th–16th foot.
	Contents	Food in various stages of intestinal digestion.		Increasing consistency
	Resistance at two ends of intestine.	At duodenum		At ileocæcal valve.
Mesentery	Thickness	Thin		Thick.
	Translucency	Transparent or translucent		Opaque.
	Lunettes	Usually to eight feet or beyond		None.
	Tabs of fat	None		Usually begin at about 14th foot and become more and more prominent.
	Size of vessels	Large and far apart		Small, close together.
	Vasa recta, length	Long (3–5 cm.)		Short (1 cm. or less).
	Vasa recta, regularity in course and distribution.	Regular		Irregular
	Vasa recta, number of branches to mesentery.	Few, if any		Often obscured by fat. Many branches
	Mesenteric loops	Primary. Secondary usually begin at about fourth foot.		Complicated
	Part of mesenteric root indicated by stretched mesentery.	Upper part	Middle part	Lower part
	Point of resistance in reference to median line.*	To left of median line	To right of median line.	

* Only of value through incision the median line.

a number of cases, but have not yet given it sufficient trial to vouch for its reliability. If one takes one end of the loop between the thumb and forefinger of the right hand and the other end between the thumb and forefinger of the left hand, and places the loop so that it lies parallel with the mesenteric root, one can then, while drawing in a direction away from the mesenteric root and pulling gently first with one hand and then with the other, usually tell (if the other parts are retracted) whether the loop is twisted or not. If there is a twist, it can usually be seen in the stretched mesentery. If seen, it can be untwisted, and when one is satisfied that there is no twist, then that part of the loop which points downward is nearest to the ileocæcal valve. I have also noticed a few times that the end of the loop which proved to be the upper end seemed to pull from a higher point than that which proved to be the lower end, but of this I cannot, as yet, speak very definitely. This method has the advantage that it is not necessary to manipulate the mesenteric root in order to determine the direction of the loop.

CONCLUSIONS. — The results of the tests given would seem to justify the statement that the approximate localization of a loop of small intestine and the determination of the actual direction in that loop are quite possible—at least, on the cadaver. The conditions of the intestine in life, especially when modified by physiological changes or by extreme distention, adhesions, acute inflammatory conditions, ascites, tumors, etc., may be so different from what we find in the normal abdomen of the cadaver, that it is somewhat uncertain to what extent the methods of which I have spoken would be of use in operations on the living subject. It is quite obvious, also, that, in certain cases where there is danger of spreading contamination, anything like a thorough examination of the deeper parts of the mesentery would not be justifiable. And yet, even from the limited experience I have thus far had in applying these tests to the living subject, I cannot help feeling that the same general results may be obtained in actual operations as on the cadaver, provided, of course, that proper allowances are

made for the changed conditions.* It does not seem probable that localization of the different parts of the intestine can ever be very exact, but even if it is only approximate, it is certainly better than no localization at all.

If the imperfect outline of the subject just presented, which is intended to be merely suggestive, proves to be the means of calling the attention of surgeons to the desirability of continuing this study, and in this way enabling them to acquire fuller and more definite information which proves to be of use on the living subject, I shall feel well repaid for my work.

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[2] His, Archiv., 1891.

[3] Zur Kenntniss der Lage und Form des mesenterialen Theiles des Dünndarmes und seines Gekröses. Internat. Monatschr. f. Anat. und Physiologie, Band xi, 1894.

[4] Internat. Monatschr. f. Anat. und Physiologie, Band xiii, 1896.

[5] Development of the Human Intestine and its Position in the Adult. Bulletin Johns Hopkins Hospital, 1898, Vol. ix, p. 197.

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* Since writing the above, I have on several occasions localized loops of intestine on the living subject, sometimes by one combination of characteristics and sometimes by another, according to the case. The combination of characteristics by which one localizes an intestinal loop will, naturally, vary in different cases. Knowing in any given case, from the situation of the incision, the part of the intestine I am most likely to meet with, and, from the habit of the individual, the amount of fat which is apt to be in the mesentery, I first get all the information I can by examining the intestine itself, and then verify or correct my conclusions, so far as possible, by reference to the mesentery.