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N. SENN, M. D., PH. D.,

MILWAUKEE, WISCONSIN;

ATTENDING SURGEON TO THE MILWAUKEE HOSPITAL; PROFESSOR OF THE PRINCIPLES OF SURGERY AND OF SURGICAL PATHOLOGY IN THE RUSH MEDICAL COLLEGE, CHICAGO, ILLINOIS.

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ATTENDING SURGEON TO THE MILWAUKEE HOSPITAL; PROFESSOR OF THE PRINCIPLES OF SURGERY AND OF SURGICAL PATHOLOGY IN THE RUSH MEDICAL COLLEGE, CHICAGO, ILLINOIS.

VOLVULUS constitutes a well-defined and definite anatomical form of intestinal obstruction. This term is used to designate that form of impermeability of the intestinal canal which results from twisting or rotation of one or more loops of the bowel about its mesenteric axis.

Frequency of its Occurrence.—Volvulus, as compared with some other forms of intestinal obstruction, is quite rare. In 1541 cases of obstruction from different causes, collected by Leichtenstern (Ziemssen's *Cyclopedia of the Practice of Medicine*, American edition, vol. iii.), and analyzed with special reference to the anatomical cause of the obstruction, after deducting 178 due to carcinoma, 33 cases only were due to twisting of the bowel, including twists of both the sigmoid flexure and the ileum. Upon another page the same author gives the result of his examinations of 76 cases of volvulus which he has collected, and of this number the lesion was found in 45 cases in the sigmoid flexure, in 23 cases

in the ileum, and in 8 cases in the jejunum and ileum combined.

Predisposing Causes.—Volvulus can only occur where the mesentery of the bowel is of abnormal length, and is, therefore, most frequently met with in the segments of the intestinal tract normally provided with a long mesentery, as the sigmoid flexure and the lower part of the ileum. That the relation of the length of the intestinal canal to the mesentery has something to do in the causation of volvulus has been well shown by Küttner ("Ueber innere Incarcerationen," *Virchow's Archiv*, B. 43, S. 478), who has ascertained from his anatomical researches that in persons who subsist almost exclusively on coarse vegetable food, as is the case with most of the peasants in Russia, the small intestine measure from twenty to twenty-seven feet in length, while in persons of German birth the length varies between seventeen and nineteen feet. The same author has also shown that volvulus is much more frequently met with in Russia than in Germany. As the mesenteric attachment to the posterior abdominal wall must be nearly the same in all individuals, as far as its extent is concerned, the occurrence of volvulus will be favored in proportion to the length of the intestinal canal. The nearer the two bars of an intestinal loop approach each other the narrower the mesentery, and, therefore, the greater the risk of rotation about its axis from causes which disturb the peristaltic movements. Sudden or gradual elongation of the intestinal canal from distention, as we observe it in cases of intestinal obstruction and peritonitis, furnishes

one of the mechanical conditions upon which the production of volvulus depends, by disturbing the normal relations which exist between the length of the intestines and their fixed points of attachment. It is not uncommon to find in post-mortem records of persons who have died of peritonitis, mention of volvulus as a secondary condition, and in cases of intestinal obstruction it is by no means rare to find the same condition as a secondary occurrence on the proximal side of the primary occlusion. I have met with volvulus in two of my abdominal sections, where this lesion could only be accounted for by attributing it to elongation of the intestines from distention. In one case it followed a strangulated hernia. The patient was a young man who had suffered for a week from a strangulated inguinal hernia. On opening the sac the strangulated loop was found to be gangrenous; the incision was therefore enlarged in an upward direction, and the bowel brought down until healthy tissue was reached. The part of the intestine leading downward was collapsed, while the portion on the proximal side was only moderately distended. As this amount of distention did not explain the general diffuse tympanites, it was deemed necessary to search for an additional cause of obstruction higher in the intestinal canal. The abdomen was opened by enlarging the incision in an upward direction. About one foot above the seat of strangulation, a mass of intestinal coils was found twisted upon their mesenteric attachments and firmly adherent. Above this secondary obstruction, the intestines were enormously distended

and very much congested. In this case the distention of the intestine, commencing at the internal inguinal ring, had caused elongation of the bowel, which in turn resulted in volvulus, giving rise to a speedy aggravation of the symptoms of obstruction. That the volvulus was not of long standing was evident from the fact that the adhesions were recent, and limited to the part of the intestine implicated in the twist. In the second case the volvulus formed after perforation of a typhoid ulcer. I examined the patient three days after the perforation had occurred, and at that time the symptoms pointed rather to volvulus than perforation and peritonitis. The abdomen was opened and the volvulus readily found. A number of loops of the small intestine had undergone a complete twist around the mesenteric axis, and showed evidences of strangulation, and were at the same time enormously dilated. The diffuse septic peritonitis which was present had been caused by perforation of a typhoid ulcer a few inches above the ileo-cæcal valve. The perforation was closed by suturing, the volvulus corrected, and the abdominal cavity flushed with a weak solution of salicylic acid. The patient never rallied fully from the shock and died a few hours after the operation.

Nieberding ("Beiträge zur Darmocclusion nach Ovariotomie," *Centralblatt f. Gynäkologie*, No. 12, 1889) has recently called attention to another cause of volvulus. He has reported a case which occurred in Bumm's practice, where, after an ovariotomy, a volvulus of the small intestine occurred which proved fatal after a few days. During the operation the

omentum, which was adherent to the cyst, was separated and a portion excised. The necropsy showed that the raw surface of the omental stump had formed an adhesion to a loop of the small intestine, and above the fixed point a volvulus was found. He reported another and somewhat similar case which had come under his own observation. A large cysto sarcoma of the left ovary was removed, in a woman twenty-nine years of age. Before closing the wound it was noticed that the omentum was so short that the intestines could not be covered by it in the region of the incision. At the end of the second day symptoms of acute obstruction set in, the temperature remaining normal. As the symptoms increased in gravity and the ordinary treatment proved fruitless, the wound was opened and a loop of intestine was found adherent to the left margin of the incision, and after this was separated a volvulus was detected. The bowel was untwisted and its contents forced into the segment further down, beyond the seat of obstruction, the detached loop pushed beyond the reach of the abdominal wound, and the abdomen closed. The day after the operation the intestinal canal appeared to be permeable, and gas escaped per rectum, but evidences of peritonitis set in and the patient died with symptoms of collapse. From the foregoing considerations it is apparent that the following three mechanical conditions favor rotation of the intestine about its mesenteric axis:

1. Long mesentery.

2. Physiological or pathological elongation of the bowel.

3. Intestinal adhesions to the abdominal wall.

Exciting Causes.—Among the exciting causes of volvulus Küttner mentions, as the most important, unequal distribution of intestinal contents and exaggerated peristalsis. He never observed peritonitis in any of his cases, even if life was prolonged for five or six days. He asserts that the complicated forms of knotting of the intestines, which are still described in the text-books as rare but distinct forms of obstruction, are only varieties of volvulus. Grawitz (*Virchow u. Hirsch's Jahresbericht*, B. 1, 1876, S. 284) asserts that the immediate cause of volvulus is to be found in an accumulation of intestinal contents above a constricted portion of bowel; that the distended portion of intestine above the seat of constriction undergoes elongation, and that this elongated portion then rotates around its axis. Henning ("Beiträgezur Kenntniss der Pathogenese des Volvulus," Dissertation, Berlin, 1883) firmly ligated the intestines of animals, and injected water above the seat of obstruction. In the small intestine, the distended and elongated coils above the ligature always showed a tendency to rotate upon their vertebro-mesenteric axes, thus producing a volvulus. In the large intestine, on account of the shortness of the mesenteric attachment, the same experiment caused rupture of the bowel before a volvulus could be produced. These experiments furnish positive evidence that volvulus of the large intestine cannot occur when the mechanical conditions described as predisposing causes are absent. Henning collected a number of cases of volvulus,

scattered through the literature on this subject, where, in the post-mortem description of the twisted bowel, it was distinctly stated that the lumen of the intestine was narrowed by some form of acquired or congenital stenosis, which is only another proof in support of the statement that elongation of the bowel constitutes one of the most important conditions in the causation of this form of intestinal obstruction.

Spontaneous Reposition.—We have reason to believe that a violent peristalsis not infrequently produces a volvulus, but when the bowel and its mesentery are of normal length spontaneous reduction occurs as soon as the peristaltic wave has passed. Such a condition gives rise to abdominal pain and a temporary disturbance of the fecal movement. In animals, when I produced volvulus artificially by twisting an intestinal loop completely around its axis and fixing it in this position by suturing, I was never able to produce obstruction, and usually found, subsequently, that partial reposition had been effected by gradual yielding of the sutures and adhesions. The conditions are entirely different when both the intestine and the mesentery are abnormally long, under which circumstances spontaneous reposition seldom if ever takes place. In such cases the mechanical obstruction caused by the twist is soon followed by dynamic obstruction in the segment of bowel constituting the volvulus, caused by the pathological conditions arising from the strangulation. The mechanical constriction which takes place at the point of rotation produces

paresis, venous engorgement, œdema, and gangrene. These secondary conditions are followed by distention of the intestine and accumulation of intestinal contents, which cannot fail to aggravate the mechanical difficulties which initiated the obstruction.

Symptoms and Diagnosis.—Primary volvulus is of sudden occurrence, and when located anywhere above the ileo-cæcal valve it is usually attended by severe pain and other symptoms of acute obstruction. Vomiting is a prominent symptom in volvulus of the small intestine, but is often entirely absent when the colon is the seat of the twist.

Poppert ("Zur Frage der chirurgischen Behandlung des Ileus," *Archiv f. klin. Chirurgie*, B. 39, S. 207) reports a case of volvulus of the sigmoid flexure, which had become twisted 180° around its mesenteric axis, where vomiting never occurred from the beginning of the attack to the fatal termination. He also refers to the statement made by Roser, that in cases of volvulus of this portion of the colon vomiting is a late symptom, or may be entirely wanting. Treves found that this symptom was absent in three out of twenty cases of volvulus which he collected.

In Poppert's case it was shown during life, by the introduction of an elastic tube through which the organ was washed out, that the stomach was empty or nearly so. In volvulus of the sigmoid flexure the pain is often referred to the umbilical region and not to the seat of the obstruction. A circumscribed area of tenderness over the surface corresponding to the circumference of the twisted

loop is an early and well-marked symptom. A volvulus once fully developed gives rise to complete obstruction, the violent peristalsis above the seat of obstruction only aiding in rendering the occlusion more complete. Diffuse peritonitis is never met with in cases of volvulus unless it has developed in consequence of gangrene or perforation. Localized plastic peritonitis is, however, of frequent occurrence, commencing in the twisted mesentery and extending from here to the intestine. Such adhesions in cases where a number of loops are implicated in the volvulus, or where knotting of the intestine has taken place, frequently offer serious difficulties in effecting reposition, and after successful reposition tend to reproduce the volvulus unless provision is made by special measures against such an occurrence. The occurrence of gangrene of the twisted loop is announced by a small, rapid, feeble pulse and other symptoms indicative of septic intoxication. Professor von Wahl ("Ueber die klinische Diagnose der Darmocclusion durch Strangulation oder Achsendrehung," *Centralblatt f. Chirurgie*, No. 9, 1889) has recently called special attention to an important diagnostic sign in cases of strangulation and volvulus. Schweninger's experimental investigations have shown that meteorismus first takes place in the constricted or twisted loops of the bowel, and von Wahl has in a number of cases been able to make a positive diagnosis of volvulus by percussion, by which he located a circumscribed area of tympanites, which, on opening the abdomen, was found to correspond to the site of the twisted and dilated

intestinal coil. As this circumscribed tympanites is one of the earliest symptoms, it should be sought for and its significance recognized before general tympanites sets in, as at that time a correct diagnosis is most important in enabling the surgeon to adopt timely measures for successful treatment. As volvulus occurs usually in some portion of the colon or the lower portion of the ileum its exact location can be readily determined by rectal insufflation of hydrogen gas. This diagnostic measure is of the greatest importance and value before general tympanites has set in. If the volvulus is located at the sigmoid flexure, only a small quantity of gas can be introduced, and after the distention of the colon below the seat of obstruction the localized tympanites due to the volvulus will be found a little higher up in the abdomen, the twisted loop of the bowel having been pushed in an upward direction by the distended colon. If the cæcum is the seat of the volvulus the insufflation can be continued until the entire colon is fully distended, but the gas cannot be forced into the small intestine. The effect of the insufflation under such circumstances will be to widen the abdomen without increasing its prominence. If the volvulus is situated above the ileocæcal valve the gas will rush from the colon into the ileum with an audible blowing or gurgling sound, and the distention of the lower coils of the small intestine will cause the hypogastric region to become more prominent. In recapitulation it may be said that the most important symptoms and signs upon which a probable or positive diagnosis can be

based are the following: 1. Suddenness of attack. 2. Absolute obstruction. 3. Localized area of tympanites. 4. Permeability of intestinal canal to rectal insufflation of hydrogen gas as far as he seat of obstruction.

Prognosis.—A fully developed volvulus—that is, a half to two complete twists—occurring in a portion of the intestine predisposed to such an occurrence by congenital or acquired causes, is never corrected without direct mechanical assistance, and, if left to itself, invariably results in death from intestinal obstruction, gangrene, or septic peritonitis in a short time. The acuteness of symptoms, and the immediate danger to life, increase as the volvulus approaches the upper portion of the intestinal canal. Death results either from exhaustion owing to the incessant vomiting and defective nutrition, or from the pathological changes which occur in the twisted portion of the bowel; the latter consisting in gangrene affecting the entire loop, or from circumscribed gangrenous spots at the point of greatest pressure, resulting in perforation and septic peritonitis. As the gangrene is the result of pressure or strangulation, its rapid occurrence may be expected when the twist is tight—that is, when the intestinal loop has been rotated once or twice around its mesenteric attachment. Death from any of these causes may occur in a few days, and life is seldom prolonged for more than a week.

Treatment.—As violent peristalsis is not only one of the causes of volvulus, but seriously aggravates the local and general conditions after the accident

has occurred, one of the first indications of treatment should be to place the bowel as nearly as possible in a condition approaching physiological rest. No food should be introduced into the stomach, and thirst should be quenched by small pieces of ice. If the vomiting is severe, or if this symptom is absent and there is reason to believe that the stomach is not empty, washing out of the organ by means of a flexible tube is indicated, and this simple procedure is often followed by immediate and great relief. The peristalsis is quieted by the administration of some preparation of opium, and if this is not retained by the stomach morphia is administered hypodermatically. The bowel below the volvulus is evacuated by copious injections, which should be given while the patient is placed in Hegar's position. The patient is to be nourished exclusively by rectal enemata. Are there any known means by which reposition can be effected without opening the abdomen? Jonathan Hutchinson, whose views concerning the utility of laparotomy in the treatment of intestinal obstruction are, to say the least, exceedingly pessimistic, in a recent publication ("Records of Intestinal Obstruction, with Especial Reference to Symptoms and Treatment," *Archives of Surgery*, vol. i., No. 1) again calls attention to the value of his method of performing abdominal taxis in the treatment of intestinal obstruction, irrespective of a probable or positive anatomical diagnosis. His method is described as follows: "The first point in abdominal taxis is the full use of an anæsthetic, so as to obliterate all muscular

resistance. Next (the bowels and bladder being supposed to be empty) the surgeon will forcibly and repeatedly knead the abdomen, pressing its contents vigorously upward, downward, and from side to side. The patient is now to be turned on his abdomen, and in this position to be held up by four strong men, and shaken backward and forward. This done, the trunk is to be held uppermost, and shaking again practised directly upward and downward; whilst in this position copious enemata are to be given. The whole proceedings are to be carried out in a *bona fide* and energetic manner. It is not to be merely the name of taxis, but the reality, and patience and persistence are to be exercised. The inversion of the body, and succussion in this position, are on no account to be omitted, for they are possibly the most important of all. I do not think that I ever spend less than half or three-quarters of an hour in the procedure."

As Mr. Hutchinson mentions no exceptions, as far as the nature of the obstruction is concerned, we have reason to believe that he advises taxis as above described in the treatment of volvulus. Taxis has a limited field of useful application in some forms of intestinal obstruction, but in the treatment of volvulus it must be looked upon not only as a useless, but also as an exceedingly dangerous, performance. It is difficult to conceive in what manner such gymnastic exercises could effect reposition, while it is easy to understand in what manner the different movements would increase the rotation. Furthermore, volvulus is rapidly followed by text-

ural changes which weaken, and, finally, destroy, the intestinal walls; and hence taxis, as advised and practised by Mr. Hutchinson, would expose the patient to the imminent risk of producing a rupture of the bowel, without promising the shadow of a hope that reposition would be accomplished. Only one mechanical measure suggests itself to me as offering any inducements in effecting the reposition of volvulus, short of laparotomy. Rectal insufflation of hydrogen gas has already been referred to as a diagnostic measure. In some cases of volvulus the rotation of the bowel around the vertebro-mesenteric axis is often less than one complete circle, and before the loop has become considerably changed by the twist a reduction might be effected by dilating and elongating the bowel below the seat of obstruction, thus bringing the same causes to bear which have produced the displacement, but in an opposite direction. This method of reduction should be practised with great care, in the manner described in my work on *Intestinal Surgery*, page 12, and is, of course, only applicable in recent cases, before the appearance of general tympanites and before the bowel has undergone serious tissuec-hanges in consequence of the strangulation. If this comparatively harmless procedure fails in accomplishing the desired object, laparotomy should be performed at once, as every hour of delay increases the danger and diminishes the prospect of a favorable issue by operative interference. Statistics show a fearful mortality of operations done for the relief of obstruction from volvulus, simply because they were per-

formed too late. Oettingen (Dissertation, Dorpat, 1888) has collected five cases of volvulus treated by the formation of an artificial anus, with the result that all the patients died. Of the cases treated by laparotomy, six recovered and thirteen died. The cause of death in these cases was generally due, not to the operation, but to pathological changes in the bowel, caused by deferring surgical interference too long. Laparotomy, undertaken early in the treatment of this form of intestinal obstruction, will show better results in the future. If reposition of the twisted bowel is accomplished by direct measures at a time when the general tympanites is not excessive and the twisted loop has not undergone irreparable tissue-changes, the prospects of a speedy recovery are as good as after any other intra-abdominal operations which now present more encouraging statistics. Early diagnosis and early treatment by laparotomy are the requirements which will insure success in the treatment of volvulus. Treves, in his paper on "The Operative Treatment of Intestinal Obstruction" (*British Medical Journal*, August 29, 1885), claims that this form of obstruction is only aggravated by forcible rectal injections, as such a procedure will tend to tighten rather than to relax the twist. Of the operative treatment, he says that simple laparotomy is an unpromising procedure, but that in the future he will make the incision in the median line, puncture the gut, and attempt its reduction; if this fails, or the result appears unsatisfactory, he will evacuate the involved gut through an opening in the summit of the flexure, unfold the

volvulus, and establish an artificial anus, using the opening first mentioned for that purpose. The advice here given I should like to modify by the following suggestions: 1. Never to puncture the gut. 2. Substitute intestinal anastomosis for the formation of an artificial anus. 3. Evacuate not only the twisted loop, but also the bowel for some distance on the proximal side. The strictest antiseptic precautions are urgently indicated in the surgical treatment of volvulus, more particularly if the operation is performed before gangrene or perforation have occurred, as in such cases the surgeon has to deal, in the majority of cases, with an aseptic peritoneal cavity. The stomach and intestine below the seat of obstruction should be thoroughly evacuated before the anæsthetic is administered.

Incision.—A median incision should always be preferred, even if it has been determined beforehand that the volvulus is located at the sigmoid flexure. The first incision is made sufficiently long to permit the introduction of the hand for the purpose of making a brief manual exploration of the abdominal cavity, with a view to determine the existence and exact location of the volvulus. If the cæcum is found distended, it is proof positive that the volvulus is located at the sigmoid flexure. A brief examination of the sigmoid region, if the volvulus is located here, will show that the bowel composing the volvulus is more distended than the remaining portion of the colon, and the twist in the mesentery can usually be felt and recognized without any difficulty. In cases of volvulus above the

ileo-cæcal region, the colon will of course be found collapsed and empty.

If the probable diagnosis of volvulus has been confirmed by this manual exploration, or if, after the examination of the most important landmarks in determining the location of the obstruction, no positive conclusions can be reached, no time should be lost in enlarging the incision sufficiently to permit of ready evisceration. As the intestines are usually found greatly distended, it is of the greatest importance to support them well and to keep them covered with moist warm aseptic compresses, so as to prevent injury, especially at the points where they come in contact with the sharp margins of the abdominal incision. The twisted portion of the bowel, on account of its greater degree of distention, will be among the first loops to escape, and it is thus made easily accessible to direct treatment.

Reposition of Volvulus.—Intra-abdominal reposition of a volvulus is not a feasible procedure, hence the necessity of making a large incision and bringing the twisted bowel within reach of sight and direct manipulation for the purpose of dealing more efficiently and safely with the displacement. The danger incident to a few moments' exposure of the intestines is more than counterbalanced by the risks which attend attempts at replacement through a small wound with the abdomen often distended to its utmost by dilated intestines with congested and fragile walls. Reduction is easily accomplished in recent cases without adhesions, and it is not difficult if the adhesions are of recent date. The intestinal

loop is rotated in an opposite direction from that of the twist until the unfolding is completed. As a rule, the segment of bowel of which the volvulus is composed contains but little solid or fluid matter, but is distended to its utmost by gas which has been generated within it by putrefactive or fermentative changes since the accident occurred. If there is any difficulty encountered in the unfolding of the distended loop it is advisable to empty the bowel by an incision at least an inch in length, made parallel to the intestine and on its convex side, as through such incision not only the twisted portion but the intestine above the seat of obstruction can be emptied of its contents—a matter of great importance in such cases. After the bowel has been washed out with a warm solution of salicylated water further escape of intestinal contents is prevented by an assistant compressing the wound during the time the surgeon is engaged in correcting the twist. I believe it is absolutely necessary to incise the bowel in every instance where the abdomen is opened for the purpose of reducing a volvulus. Before the incision is made, it may be necessary to place the patient on his side to enable the operator to draw the bowel beyond the rest of the intestinal coils, so that after the incision has been made the intestinal contents can escape into a receptacle without coming in contact with the prolapsed intestines. This position is to be maintained until the intestinal contents which have accumulated about the seat of obstruction can be poured out through the incision. This pouring-out process is accomplished

by seizing the highest loop which it is deemed necessary to evacuate, and, by raising it, pouring the contents by the force of gravitation from loop to loop until the incision is reached. I even deem it an excellent plan not only to evacuate as much as posible of the intestinal contents, but also resort to irrigation of the bowel through the incision with a weak warm solution of salicylic acid. Such thorough evacuation of the bowel at and above the seat of obstruction accomplishes three desirable objects: 1. It facilitates the replacement of the intestines into the abdominal cavity. 2. It directly unloads the distended paretic intestine, and thus favors the return of peristaltic action. 3. It exerts a potent influence in preventing putrefactive and fermentative changes in the intestines after the operation. Before the bowel is returned the incision is closed in the usual manner by Czerny-Lembert sutures. If one or more circumscribed points of gangrene are found they should be buried by suturing over them healthy peritoneum when the bowel is returned, with a fair expectation that after removal of the strangulation the gangrene will not extend. If large portions of the intestines or the entire loop show evidences of gangrene, enterectomy has become an unavoidable evil. If, as is usually the case in such instances, the patient is in a collapsed condition, no time should be lost in the restoration of the continuity of the intestinal canal by circular enterorrhaphy, as the same object is attained in a much shorter time by closing both ends of the intestine, and mak-

ing a lateral apposition by means of decalcified perforated bone disks.

Intestinal Anastomosis.—Cases may occur where it will be found impossible to unfold the volvulus without tearing the bowel, and the question arises, Is it best to resect and suture the ends of the intestine, or to leave the volvulus and establish a communication between the intestine above and below the obstruction? Mr. Hutchinson (op. cit.) reports such a case. A soldier, aged forty-six, in good health, who was in bed in the hospital, after removal of a fatty tumor, two days after operation complained of pain in the back and abdomen. He had not left the bed since the operation. The following day the pain was less; slightly nauseated; constipation; injections and laxatives produced no effect, excepting to increase the sickness. On the fifth day after the attack the retching and vomiting were persistent and distressing. On the seventh day the abdomen was distended and coils were visible. The symptoms became more and more threatening, until death occurred on the tenth day after the commencement of the attack. I will append the report of the autopsy and criticism as given by the reporter:

"*Autopsy.*—Three inches above the ileo-cæcal valve a coil of small intestine was found twice twisted round a portion of the mesentery, and the canal of the bowel was thus completely obstructed. There were no recent inflammatory changes about this part of the intestine, but from the dense and contracted condition of the bowel where twisted, it must have been for some time narrowed at this point. When I moved aside the coils of intestine which lay in front of the obstruction, more or less adhe-

rent amongst themselves by means of old and tough peritoneal bands—and when I endeavored to, and after some sorting of the parts, succeeded in unrolling the twisted canal, *I was glad not to have attempted the operation during the life of the patient, for it would have been impossible.* [Italics my own.]

"*Criticism.*—It seems not improbable that in this case some old adhesions favored the formation of the twist. It may be alleged that an early operation would have found the unravelment not so difficult; but then it must be remembered that the early symptoms were but slightly marked. The case was not considered a serious one until seven days had passed. It is in order to illustrate the vagueness of the early symptoms that I have quoted this case."

I cannot appreciate the reasons for self-congratulation on the part of Mr. Hutchinson for not having made an attempt to save the life of this patient by surgical interference. The result might have been better, and certainly could not have been any worse. The time will come, and is not far distant, when as much blame will be attached to a surgeon who will look on as an idle spectator at the bedside of a patient whose life is in danger from intestinal obstruction, as now falls upon an obstetrician who permits a parturient woman to die undelivered. In the case above quoted I cannot see any cogent reasons why unravelment in the hands of such an able and careful surgeon as Mr. Hutchinson is known to be, would not have succeeded, if not equally well, during the life of the patient as in the post-mortem room. But supposing that unravelment would have been found impossible or impracticable, two plans of treatment were still left for the operator to pursue,

and either of them might possibly have become a life-saving measure. As the bowel presented no evidences of gangrene, resection was not to be thought of, but the continuity of the intestinal canal might have been restored by intestinal anastomosis with permanent exclusion of the volvulus from the fecal circulation. Or, if the operator had no faith in this procedure, he could at least have made an artificial anus above the seat of obstruction. An intestinal anastomosis between the intestine above and below the volvulus by means of decalcified perforated bone disks can be done in a few minutes, and at once restores the continuity of the intestinal canal. If such a procedure is chosen in the treatment of an irreducible volvulus, it becomes necessary to make provision for a permanent outlet of the contents of the isolated segment of the intestine which constitutes the volvulus, as the obstruction of both ends of this portion may prove to be permanent. This can be accomplished by making a second anastomosis between the apex of the volvulus and an adjoining intestinal loop in preference to a loop below the seat of obstruction. Such a procedure will establish with but little additional risk a permanent fistulous opening between the twisted portion of the bowel and the fecal circulation, and will prevent any danger that might arise from over-distention and perforation should the obstruction caused by the volvulus remain permanent. In making intestinal anastomosis the lateral apposition with the bone-plates should be preceded by thorough evacuation and disinfection of the intestine. As a matter of precaution a con-

tinuous suture, embracing the serous and muscular coats, can be applied around the margins of the disks, thus obliterating the grooves between their margins. In order to hasten plastic adhesions the serous surfaces which are to be coaptated should be freely scarified.

Shortening of Mesentery.—After the reduction of a volvulus has been accomplished by operative measures, it is desirable to protect the patient in the future against a possible recurrence of the same accident in the same place. As an elongated mesentery plays the most important *rôle* in the production of volvulus, this can be done in a few moments with certainty and safety by shortening the mesentery. Resection of the mesentery is out of the question, as such a procedure would in all probability result in gangrene of a corresponding portion of the intestine. Shortening of the mesentery, however, can be effected by folding the mesentery upon itself in a direction parallel to the bowel and suturing the apex of the fold to the root of the mesentery. By this method the floating bowel is firmly anchored and a recurrence of the volvulus is made impossible. The indications for flushing the abdominal cavity and for establishing drainage are the same as in laparotomy for other forms of intestinal obstruction. As a contribution to the statistics of the surgical treatment of volvulus I will append the following case:

Volvulus of the sigmoid flexure; laparotomy; recovery.—The patient was a man, sixty-three years of age, carpenter by occupation, who was placed under

my care at the Milwaukee Hospital by his medical attendant, Dr. Walbridge, October 13, 1889. It was ascertained that he was of good habits, good general health, well nourished, but with no tendency to obesity. With the exception of occasional attacks of constipation, which readily yielded to mild laxatives, he had never been sick. The present attack was not preceded by constipation. In the morning of October 6th, while walking around in his room, he was suddenly seized with a severe pain in the middle and lower part of the abdomen. He sought rest in the recumbent position and the pain gradually subsided. At this time the appetite was impaired, but there was no nausea or vomiting. Toward evening he felt somewhat distressed in the abdomen, a circumstance which he attributed to flatulency, as he felt relieved after loosening his clothing. The following morning he awoke free from pain, but on rising the pain returned. He remained quiet all day and suffered only an occasional attack of colicky pain. He rested well during the night, and on the third morning he was again free from pain. He ate a light breakfast and started to resume work at his shop. On his way, however, the pain returned. On reaching his destination the severity of the pain increased and he returned home. The pain yielded to rest, but the abdomen became more distended. The fourth day he was again able to be about. As the bowels had not moved since the beginning of the attack he took a dose of rhubarb in the evening. As the cathartic did not act by the following morning he took an enema, which brought away a small quantity of fecal matter. The following two days the pain became more severe and the distention of the abdomen greater, with nausea, but no vomiting. He did not consider himself sufficiently

ill to call a physician until October 12th, when Dr. Walbridge was called, who, after examination, diagnosticated some form of intestinal obstruction, and sent the patient to the hospital to be placed under surgical treatment. Examination at this time showed that the temperature was normal; pulse 90, soft, and compressible; copious eructations, but little nausea and no vomiting. According to his statement he had not had a proper movement of his bowels since the attack, and no flatus passed per rectum. Abdomen enormously distended and tympanitic over the entire surface; contour of intestinal coils visible at a number of places. It was evident that the obstruction was located low down in the colon, probably in the sigmoid flexure, and it was surmised from the history of the case and the symptoms presented, that it was caused either by a volvulus or a circular carcinoma. Laparotomy was advised, and as the patient at once gave his consent, it was performed the following day, October 13th, about noon. After he came into the hospital the nurse administered two ounces of castor oil in one dose without any appreciable effect being produced.

Operation.—As the patient was suffering at the same time from a chronic bronchial catarrh, chloroform was used in place of ether as an anæsthetic. The temperature of the room was kept at 85° to 90° F. The most careful antiseptic preparations were made, and during the operation rigid aseptic measures were carried out. The abdomen was opened by a median incision half-way between the umbilicus and pubes, and sufficiently large to permit introduction of the hand. Intra-abdominal manual exploration showed in the first place that the cæcum was greatly distended, consequently the examination was continued by exploring the sigmoid region. Below

the sigmoid flexure the colon and upper portion of the rectum were found completely empty and collapsed. The sigmoid flexure could be distinctly felt, and was enormously distended and twisted around its mesenteric axis. The twist in the mesentery could be distinctly felt. No time was lost in useless attempts to effect reduction. The incision was enlarged in an upward direction to three inches above the umbilicus. As the intestines escaped they were covered with hot, moist aseptic compresses and carefully supported by two assistants. The small intestine was greatly distended and extremely vascular; the visceral peritoneum had lost its glistening appearance. The colon had become so much distended and elongated that the transverse portion, in the shape of a horse-shoe, was found displaced in a downward direction to near the pubes. The sigmoid flexure was twisted around its mesenteric axis one complete twist. The twisted portion of the mesentery was the seat of a limited plastic peritonitis which had resulted in adhesions. The part of the bowel constituting the volvulus measured at least eighteen inches in circumference, and its walls appeared to be of the thinness of parchment paper. Reposition was very easily effected by simply turning the bowel in an opposite direction to that of the twist until the normal position was restored. Peristaltic action appeared to be almost completely suspended, both in the large and small intestine. It would have been mechanically almost impossible to return the intestines into the abdominal cavity without producing serious injury, perhaps complete rupture of the bowel, hence an incision an inch in length was made into the colon, where the distention was the greatest. The incision was made parallel to the long axis of the bowel and

directly opposite its mesenteric attachment. The part of the bowel which had been twisted contained, besides gas, only a very small amount of fluid fecal matter. The incision did not empty more than this part of the bowel. As a large amount of fluid feces had accumulated above the seat of obstruction, this was evacuated by the "pouring-out process," previously described, and in this manner almost the entire colon was emptied. The incised portion of the bowel was drawn well forward, and held in this position by an assistant during the entire time required for unloading the bowel, and thus soiling of the intestines and abdominal cavity was prevented. As far as could be readily done the intestine was subsequently washed out with warm salicylated water. The wound was closed with two rows of silk sutures. The mesentery of the volvulus was at least eight inches in length and was shortened more than one-half by the method described above. Replacement of the intestines was now accomplished without any difficulty, and after drying the peritoneal cavity with sponges wrung out of warm sterilized water the external incision was closed in the usual manner. No drainage. The customary antiseptic compress composed of iodoform gauze and salicylated cotton was applied and the abdominal walls well supported with adhesive strips. Outside of the adhesive strips a layer of common cotton was applied, and over this a snugly fitting binder. Duration of operation nearly an hour and a half. The patient recovered rapidly from the immediate effects of the operation. At 8 o'clock in the evening temperature was 100.5° F., pulse 110. Free movement of bowels; feces liquid, dark colored, and of a very offensive odor. Complained of no pain but a sensation of soreness in the abdomen.

October 14. Temperature 99.5° F., pulse 90. During the night had four fluid passages of the same offensive character. So far, the patient had not been allowed any food by the mouth. Thirst was relieved by giving water in small quantities and frequently repeated. In the evening the patient felt so well that during a brief absence of the nurse he got out of bed and walked around the room.

15th. Temperature and pulse normal. Imprudence on part of patient did not seem to have resulted in any harm. From this time on the patient was allowed liquid food, and after the lapse of another week was placed on the ordinary hospital diet. With the exception of a small parietal abscess the recovery was not marked by any untoward symptoms. The patient left the hospital three weeks after the operation in perfect health.

Conclusions.

1. The predisposing causes of volvulus are either congenital or acquired, and consist in elongation of certain segments of the intestine, abnormal length of mesentery, and adhesions.

2. Irregular distribution of intestinal contents and violent peristalsis are the most important exciting causes.

3. Volvulus is most frequently met at the sigmoid flexure and the lower portion of the ileum.

4. Secondary volvulus on the proximal side of other forms of intestinal obstruction is not a rare occurrence; it is also frequently developed during an attack of peritonitis.

5. As a rule, the symptoms are more acute and

intense if the volvulus is located above the ileo-cæcal region.

6. Vomiting in cases of volvulus of the sigmoid flexure is not a constant symptom.

7. The most important physical sign of volvulus is a circumscribed area of tympanites which corresponds to the location of the volvulus, but this sign is only of value before general tympanites has set in, and, therefore, enables the surgeon in many cases to make an early and positive diagnosis.

8. All cases of volvulus should be treated by laparotomy if reposition cannot be accomplished by rectal insufflation of hydrogen gas.

9. Reposition should not be attempted without evisceration.

10. Evacuation of intestinal contents by a free incision should be practised in every case where general distention of the intestines is present.

11. Enterectomy becomes necessary if any considerable portion of the intestinal wall has become gangrenous.

12. Irreducible volvulus should be treated by establishing intestinal anastomosis with permanent exclusion of the seat of obstruction from the active fecal circulation.

13. Recurrence of volvulus can and should be guarded against by shortening the mesentery by folding it upon itself parallel to the long axis of the bowel and suturing the apex of the fold to the root of the mesentery.