The 1936 Year Class Prize in Surgery (for 1965), 1966.

E.W. BARNES. BSc.
1965-66.

THE USE AND ABUSE OF GASTROINTESTINAL SUCTION IN THE TREATMENT OF INTESTINAL OBSTRUCTION.

INTRODUCTION

With the development of man's thinking about the physiological processes of the body and in this instance in particular these processes in the stomach and the intestines, there followed technicalogical advances both to test the hypothesis proposed and to offer relief of symptoms to the afflicted.

Previously to 1744 when Boerhaave described the use of a flexible tube passed into the stomachs of children who had taken poison and were unable to swallow antidotes because of convulsions, the profusion of theories were only rivalled by the ingenious but rather impractical methods of direct observation. For example, voluntary vomiting with or without an emetic employed by Reuss in 1760. Boerhaave's Report in 1744 was followed by Heysham in 1780 and John Hunter in 1790, both describing methods for the introduction of tubes into the stomach both for the administration of medicines and food.

Alexander Monroe III (1797) writing his inaugural thesis in 1797 describes how his father, Alexander Monroe II, passed flexible tubes of coiled wire, covered with leather into animals for the relief of spasm of the oesphagus caused by the fermentation of food. To him, is ascribed the first suggestion that the contents of the stomach could be aspirated by a pump at the external end.

This report was followed up and papers by Renault (1802) of its application in animals and Philip Syng Physick (1812) of its use in three month old twins, who had taken an overdose of laudonum - one recovered. Hereafter, followed glowing reports in the Lancet and other journals of the use of the "new" instrument and it was left to technicalogical advance to improve on the theory.

The first tubes used in gastric work, were of eelskin and whale bone. With the discovery of rubber and its subsequent development, this was rapidly substituted. Philip Syng Physick used a rubber uretheral catheter for gastric lavage in 1812 and Jukes wrote more about gastric rubber tubes in 1812. The older tubes tended to be very thick and stiff, but with the "co-operation" of the patient, a more pliant tube could be passed.

With the gastric tube becoming routine, the American J.C. Hemmeter of Baltimore (1896), described the passage of a stomach shaped balloon with a groove along the lesser curvature through which a rubber tube was passed into the duodenum.

In 1911 came the report of Kappis of the application of continuous suction to the end of a duodenal tube for the treatment of paralytic ileus. Ward of San Francisco is ascribed with the first discussion of the necessity of continuous drainage of the gastrointestinal tract.

Since this time the use of continuous suction in the treatment of gastrointestinal obstruction has been championed by Wangensteen (1931) and it is used, rightly or wrongly, in every ward to-day. The advances have been in the development of non-irritant materials for the tubes used and the use of stylets for the introduction of the tubes to the desired site. The most recent progress being a description by Leonard and Wangansteen (1965) of a method of operative intestinal decompression by means of a long coiled spring intestinal tube.

INTESTINAL OBSTRUCTION - CLINICAL FEATURES.

It has been customary to arrange intestinal obstructions into three groups, simple obstruction i.e. a physical block to the onward passage of the intestinal contents beoynd the site of obstruction with the distension of the lowel proximal to it. Secondly, strangulated obstruction in which there is impairment of circulation of the bowel involved to a greater or lesser extent. As the strangulation progresses, the bowel wall loses its continuity leading to gangrene and perforation with local and generalised peritonitis. Thirdly, there is neurogenic obstruction - but a consideration of the clinical and patho-physiological features shows that there is no clear line of demarkation between these three varieties.. For example, in the case of a simple obstructive lesion the bowel proximal to the lesion may be so distended that a secondary neurogenic paralysis will set in and may even last well passed the operative relief of the simple obstruction. This proximal distention invariably affects the blood supply and a degree of strangulation will be evidenced.

Although, as noted above, pathologically the differences between the three types referred to above is minimal, for clinical purposes a differentiation must be made. For strangulation requires immediate operation and the prolonged use of suction is definitely contraindicated. Simple mechanical occlusion is best treated initially without operation and neurogenic obstruction usually does not require operation at all.

The general condition of the patient is in no way characteristic of the early stages. In both simple mechanical obstruction and strangulation there is pain, but in strangulation, the pain tends to be more severe during the bouts of colic and in the intervals between attacks. In strangulation also a diffuse pain persists but is less severe. Often in strangulated lesions, the pain will be referred to the back in the lumbar region.

The chief clinical distinction between these two groups is the presence or absence of rebound tenderness. In strangulation the rebound tenderness is due to inflammation of the serous coat; although at least two cases are noted where tenderness is absent, firstly it is lacking in interssusception, the strangulated loop being protected by the sheath ; and secondly tenderness is often completely absent in cases in which a femoral hernia of long standing becomes strangulated. So important is this need to distinguish strangulated from non-strangulated, that Hill et al (1942) suggested aspiration of the peritoneal cavity with a fine needle in cases of doubt; the withdrawal of blood stained fluid being pathogmanonic of strangulated lesions. Richardson (1920) noted the appearance of this blood stained fluid in a report of 135 patients of whom 21 had strangulated obstructions. Hill had experimented with the method on dogs and only one patient was so examined. Due to the presence of gas distended bowel in these cases paracentresis is not without risk and this diagnostic method bas not a wide clinical application in man.

As suction is started to relieve the distention either with a view to continue it as a main line of treatment or as a preparation of the patient for surgery, the effect of this decompression has an almost diagnostic effect on the pain. If the suction drainage relieves the pain after two hours, it can be considered that the obstruction is due to simple mechanical factors. If the pain persists it is almost invariably due to strangulation or closed loop obstruction both of which require operative intervention. The above remarks are a generalisation of the problem and suction decompression can often lead to a false sense of security with the relief of the symptoms.

X-ray diagnosis and differentiation has improved rapidly over the last twenty years, even so Siben et al (1963) in a review of 480 cases of intestinal obstruction found that there was an overall mortality rate of 10.5%. When strangulation was present 21.4% died whereas in simple obstruction imortality rate was 7.3%. Early diagnosis is one method of combating these fatalaties. In a large series of cases it was found that 35% of severe strangulated obstructions never presented gas and fluid levels characteristic of intestinal obstruction.

The observation that reduced fluid and gas transport is part of the picture of strangulated obstruction was utilised by Dixon et al (1964) to examine this problem with radiology. Vest in 1962 had examined a similar problem with dogs and patients. In a small series of dogs a form of experimental obstruction was produced with strangulation and without. With the aid of oral sodium diatrizoate (Hypaque) it is found that the passage of the water soluble contrast medium is approximately equal in both normal dogs and those with experimental obstruction without

strangulation i.e. 1½ to 4 hours. In the case of strangulated obstruction it was prolonged to 24 hours. A similar series of 6 patients confirm these results.

In the experiments of Dixon et al (1964) dogs were also used 28 in all with various combinations of closed loop obstruction, strangulated closed loop obstruction and strangulated simple obstruction. All methods being produced by a closed abdomen snare technique. Transport of barium from the stomach and the duodenum was markedly diminished after 10 hours of vascular occlusion. This change was not noted in cases of simple obstruction. Clinically the test was made at that date on 3 patients, all of whom were diagnosed correctly. The underlying mechanism of the method is considered to be that some necrosis and loss of viability of the bowel wall precedes this alteration in peristalsis. As little alteration is noted before the 10 hour minimal period, this would tend to exclude any neurogenic or reflex causation.

A method, of as yet academic interest, was reported by Gearkirk et al (1964). With the distention that follows obstruction the venous outflow is reduced leading to an increase in capillary permeability, oedema and heamorrhage into the blowel wall and mesentry further compromising the circulation until the arterial inflow is impaired. The use of isotope - tagged molecules, radioactive serum albumin in this study, is found to underline this reduction and exudation. An experimental method is described for the production of a gradually progressive strangulated obstruction in dogs. Utilising this preparation it was possible to demonstrate a high concentration of isotope over the strangulated loop with a scintillation counter. In a limited number of clinical cases there appeared to be a good correlation between the compromised circulation and the localised concentrations of isotope. It should be noted however, that in one of the patients, who was subsequently found to have a 2" segment of bowel incarcerated in a hernia sac, the rapid progression from oedema to necrosis was so fast that little fluid was produced resulting in an inability of the counter to detect the radioactivity.

Obstruction of the colon is seen radiologically less frequent that obstruction to the small bowel. The incidence being in the ratio of 1:5 or 1:6. Due to the anatomical liability of the colon to rapid and often fatal distention with perforation and peritonitis the treatment is in most cases operative. Scout films of the abdomen and a barium enema are two very informative procedures often particularising the lesion into neoplasm, volvulus, diverticulitis etc.

EFFECTS OF DISTENTION ON THE BOWEL WALL

In man observation indicates and in the dog experiments confirm the impression, that the site of the obstruction has an important bearing upon the effects of the distention. The serious implications of high intestinal obstruction are due essentially to the loss of electrolytes and fluids by vomiting. The liberal administration of saline and other electrolytes in the obstructed dog will keep it alive for 3 to 4 weeks without disturbance of mineral or nitrogen balance. Similarly a patient with obstruction of the efferent loop of the jejunum, after gastric resection, may with the administration of fluids and electrolytes survive without serious threat to life the loss of these digestive juices for a comparatively long period (14/21 days). Although loss of fluids and electrolytes are most frequently the threat to life in cases of high intestinal obstruction, in cases of closed loop obstruction of the jejunum the pressure in the lumen can rise several times greater than closed loop obstructions of the ileum due to the copious secretions of the bowel wall at this point.

In low obstructions, the loss of fluid and electrolytes is not a prominent feature and the mechanical effects of distention are more manifest.

The factors contributing to distention are 1) gaseus distention mainly as a result of swallowed air, 2) the digestive juices which in the adult man are probably in excess of 7,000 ccs. a day and under the influence of distention and obstruction may increase in amount.

The three possible sources of gaseus distention in obstruction of the gut are 1) formation of gas as a result of digestive processes 2) diffusion of gases into the intestinal lumen and 3) passage of air from the atmosphere into the intestine. Wangensteen (1955) considers that 68% of the gas in obstruction has its origin in swallowed air and that 70% of the remainder passes in by diffusion through the vessel walls. Hubbard and Wangensteen (1934) conducted experiments in animals with a preparation which excluded the possibility of swallowed air by transection of the cervical oesphagus and bringing the cut ends out to the skin. The results of these experiments are quoted above. Although other workers i.e. Anderson and Rungsted (1943) have concluded that swallowed air is exclusively the source of intestinal distention, in cases of closed loop strangulated obstruction the distention can be very rapid due to the contents being heavily infected with bacteria.

As the volume of fluid and gas rises the intra-intestinal pressure rises and at the peak of peristalsis may attain 75 cms of H_2O

Lower measurements have been found by Paire and Wangensteen(1936) of only 12 - 19 cm. of H_2O. The figures referred to above are for small bowel obstruction. In large bowel obstruction higher pressures have been recorded. In 5 cases the sustained pressures varied between 12 and 52 cm. of water, these observations were made at operation. The occurence of grades of pressure of this height after continuous duodenal intubation indicates the futility of suction in the conservative treatment of acute obstruction of the colon. The obstructed colon behaves virtually like a closed loop according to some investigators. Since the original observations by Brinton in 1859 of the competence of the ileo - caecal valve, a further study by Ulin and Ehrlich (1962) shows that in their experience some 40% of valve are incompetent with associated radiographic evidence of small bowel obstruction.

It is apparent that increase in the intraluminal pressure will affect unfavourably the blood supply of the gut wall. Von Zwalenburg (1907) studied the blood supply of the gut and the effects of distention in the dog by means of an electric meter built within the lumen. He observed capillary stasis at 30 mm. Hg, venous stasis at 60 mm. Hg., partial arterial arrest at 90 mm. Hg., and complete arrest at 130 mm. Hg. Dragstedt et al (1929) particularised their investigations and found that the duodenum was the most sensitive to these changes in pressures. Although, it should be noted that strangulation high in the intestine is infrequent compared with strangulation in the ileum. This lower incidence probably caused by the shorter mesentry, the more direct blood supply and its greater vascularity.

The above observations are in excess of the pressures observed clinically i.e. 10 to 50 cms. H_2O. It is the lower sustained pressures which seem to have such a dilaterious effect on the bowel wall. Sperburg and Wangansteen (1935) subjected closed loops of bowel in the dog to sustained increases in pressure maintained for hours at a predetermined level. A range of 10, 20 and 40 cms. of H_2O were used. At a level of 10 cms. H_2O, the mucosa became congested and oedematous, absorption dropping to a standstill . Although death occurred often before the full picture of devitalisation and gangrene occurred, ulcers were observed histologically and areas of devitalised tissue,especially on the anti-mesenderic border at a level where the pressure was particularly high. Although the intestines have the ability to compensate to a certain extent for the effects of distention, the pressure produced by the obstruction eventually devitalises the bowel wall.

Studies of absorption in distention are very pertinent to the consideration of what are the lethal factors in

obstruction. Many workers believe that intestinal absorption decreases with increased intraluminal pressure i.e. Aird (1941), Fisher (1954). Other investigators believe differently. Stone and Firor (1924) showed that increased pressure accelerated the absorption of intestinal contents before producing mucosal damage to the wall of the bowel. Blakenskely (1952) showed that for NaCl in the dog there was a statistically significant maximum in the absorption/pressure curve occurring at 20 - 25 cms. saline. Anderson et al(1962) investigated the rate of absorption for the terminal ileum and caecum of the dog. In an attempt to eliminate as many variables as possible an isolated circular intestinal fistula was utilised. The pressures used were 70 - 80 cms. H_2O, derived from the work of others to eradicate the effects of strangulation. Although the pressure was maintained as long as 24 hours little mucusal change was observed. While, there is no evidence that the iodine 131 used in the experiment was absorbed over the lymphatic chain it must be noted that Wangansteen et al (1955) has shown increased lymphatic flow with increased pressure in the lumen. The flow rate being directly related to the reduction in the venous flow.

Up to 60 - 70 cms. H_2O the peristaltic activity increased as did the absorption, confirming the work of Lawson et al (1941) that peristalsis increases absorption. An elevation in the rate of absorption up to 60 - 70 cms. H_2O was noted only in the colon, little effect being seen in the ileum. In both cases higher pressures led to decreased absorption.

Although, as noted above the absorption in the intestine is reduced with increase in pressure above 70 cms. H_2O and the only factor which increases is the lymphatic flow investigations indicate that together with the compromised blood supply there is devitalisation and an increase in the transperitoneal diffusion and absorption. Laufman et al (1951) found lecthinase, the α toxin of clostridium welchii in the thoraxic duct lymph but not in the periferal blood indicating a possible absorption of these lethal products via the increased lymph supply. Nemir et al (1949) reported the presence of an abnormal hemin, identified spectroscopically in the gut of strangulated loops, later in the peritoneal cavity and finally in the blood stream. This fluid was toxic when injected into normal dogs. Cohn et al (1953) have reported recovering this pigment from a fatal case of strangulated obstruction in man.

The nature of the toxic agent in cases of closed loop obstruction and indeed any cases of late intestinal obstruction is in dispute. Recent work by Barnett et al (1963) on experimentally produced strangulated obstructions of different lengths of intestine in dogs has revealed the following facts.

There is a progressive deterioration in the results of strangulation depending on the length of gut infarcted. In the long loop obstruction the main factor is the loss of fluids, the effects being similar to a rapidly fatal haemorrhage. There is no uuestion of toxaemia. If the affected loop is enclosed in a plastic bag to exclude all avenues of escape of fluid death still occurs within a few hours if the fluid loss is not replaced. With intermediate loop obstruction death occurs after a few days if treatment is witheld. In this case it was found necessary to include blood and antibiotics in the treatment together with saline. The toxaemic factor reached its zenith in these experiments with the short loop strangulation. Exudation occurred through the bowel wall. If the animal was protected from this by enclosing the gut in a plastic bag no signs of shock developed. Treatment of normal loops of gut with the toxic exudate resulted in an increase in weight of the loops due to pooling of blood. Antiendotoxin agents cortisone and dibenzylin prevented this increase in weight of normal gut loops. These results, together with the observed leucopenia and raised haemocrit would tend to implicate endotoxins and from other experiments bacterial cells must be present to maintain toxicity.

Cohn et al have not confirmed Barnett's work and indeed come to the conclusion from work in rabbits, that the toxic factor was the exotoxin of Cl.welchii. Investigations in dogs reveal that no one bacterial group was responsible for the infection at the death of these animals. Further work by Cohn (1962) on germ free rats and dogs serves to underline the importance of bacteria in the role of toxaemia . Germ free rats and dogs had a longer survival time than conventional animals with strangulated obstruction and there were marked differences in the toxicity of the bowel contents. Cell free transudates were shown to contain the lethal factor on injection into normal animals.

The role of antibiotics in the treatment of strangulated obstruction has been intensely investigated. Both histologically and clinically they appear to be of great value.

In summary of the above evidence it would seem that, distention leads to degenerative changes in the bowel wall with compromisation of the blood supply. These conditions of anoxia and necrosis provide ideal conditions for growth of bacteria within the lumen particularly the anaerobic organisms. As these proliferate and produce toxins, they permeate the damagedbowel wall and exert their effects systemically.

The second factor of importance is fluid loss. Under normal conditions some 7 - 8 litres each day pour into the

upper reaches of the bowel from the alimentary glands. Most of this is absorbed so efficiently that only 80 - 160 ml. are lost in the faeces each day. But, with an obstruction located above the main absorbing areas of the gut this fluid cannot be reabsorbed and is lost by vomiting and suction. Simultaneously there is passage of fluid and electrolytes across the bowel wall. The effect of distention on this flow was investigated by Shields (1962). The preobstructive values of electrolyte flux were a net gain of H_2O 4.6 mLs. sodium 0.77 meq and a net loss of potassium of 0.018 meq. During obstruction the fluxes were measured at intervals of 12 hours, 24 hours, 36 hours, 48 hours and 60 hours. In the case of water, absorption was significantly depressed after 12 hours - at the end of 60 hours it was 3.9 mL in 10 mins compared with 10.6 ml in 10 mins. in the unobstructive segment. At 36 hours excretion of water was seen to be increased until at 60 hours 16.7 ml. passed into the gut in 10 mins. This led to a net loss of water from the body at the end of 60 hours of 12.8 ml. / 10 mins.

A similar picture was seen with sodium reaching a net excretion of 1.85 meq/10 mins. but as the excretion never at any point passed the absorption there was no net loss of sodium from the body.

The usual loss of potassium was markedly increased due to a decreased absorption and an increase excretion the net loss rose from 0.0185/10 mins to 0.0871 meq/10 mins at 60 hours. It should be noted that although both water and cation were being lost into the bowel the normal relationship between net water and net cation movement were preserved in obstruction.

Loss of sodium, chloride and potassium from the gastric juice, bicarbonate from the bile and pancreatic juice are roughly parallel and acid-base balance is maintained. The salt loss is compenstated for by retention in the urine, passage from the red blood corpusles to the plasma and partly by bicarbonate replacement. This leads to an increase in the osmotic pressure of the extracellular fluid and withdrawal of water from the cells. Thus the loss of salt is first mainly from the interstitial fluid, the loss of water is from the interstitial and intracellular fluids. The plasma volumne is unaltered, but the intracellular fluid volume is markedly reduced.

In addition, in strangulated obstructions particularly, blood loss can be so great as to cause death. A study with radioactive tagged red cells showed that blood loss could range up to 73% of the total blood volume. Cross(1954) showed that inhalation of 92% O_2 under increased pressure would improve survival in this condition. It has been suggested by Fine (1936) that a similar method could be used to decompress the bowel.

With the inhalation of a reduced concentration of nitrogen , the nitrogen in the distended bowel will equalise with the blood and alveolar air and so decompress the bowel.

USE OF SUCTION

The use of suction as a method of treatment was first reported in 1931 by Wangensteen. The patient was a 72 year old lady, admitted to hospital with an obstruction of 72 hours duration. She was badly dehydrated with a systolic pressure of 80 cms. Hg. Suction and saline drip were started. 200 ccs. of fluid and 800 ccs. of gas were aspirated and the patient's condition improved. After 40 hours complete decompression was produced.

Relief of distention is one of the primary objects in the treatment of intestinal obstruction. Suction is indicated in treatment either as a main course of action or as an ancillary or preparative procedure in all cases of intestinal obstruction.

The need to remove air and fluid from the stomach by suction and its subsequent decompression is at its easiest to understand in cases of acute dilation of the stomach. The onset after abdominal operations and the picture of a hollow-eyed patient sitting up with distress, constant eructation, with a dribble of brownish fluid from the corner of the mouth and progressive dehydration can be countered with rapid and complete success by gastric suction. Failure to treat, leads to a high mortality. The upper cervical sphinter acts superficially to produce a closed loop situation in the stomach, but due to the elasticity of the walls, decompression can be effected. The removal of air and fluid from the intestines especially, is more difficult to explain. With the tube in this position in the stomach, the reduction of the distention depends on reflux through the pylorus. The activity of the pylorus sphinter interrupts the continuity of the stomach and the small intestine as a simple tube but not uncommonly, this sphinter fails to act as a physiological block.

In the intestine of the dog excised at necropsy, it can be demonstrated that following introduction of air or water subsequent suction applied to one end is immediately appreciated to some degree at the other. When however a mixture of air and fluid is present, the difficulties of a rigid as opposed to an elastic tube must be considered.

The only reason the gastrointestinal tract can be decompressed is that it can be considered to be an elastic tube. Due to the activity of the sphinters at the oesphagus and the

ileo - caecal regions it is to all intents and purposes a closed loop. When the wall of a cavity refuses to collapse on being aspirated, as in the case of empyema, the force needed is often too great to be tolerated. It should be noted that the pliability of the intestine is to some extent a disadvantage, as it will often block an intestinal suction tube, but due to the multiple perforations, this is seldom appreciated.

In an experiment by Paine (1936) in the dog, a series of manometers were placed at intervals down the intestine with an ileal block. The pressure throughout the system of alternating fluid and air was 38 cms. of H_2O. 75 cms. of H_2O were applied to the duodenal end and the other manometers read from proximal to distal 10, 12, 15, 14 cms. of H_2O. By alteration in the position of the coils of intestine further decompression was produced. In patients the initial pressure would have been in the region of 10 - 20 cms. H_2O.

In paralytic ileus there is cessation of all motor activity and reflux through the pylorus will not occur if the sphinter is competent. The longer intestinal tubes developed by Miller Abbot, Canton and Levin are of use in this condition. Due to the lack of activity in ileus, the tubes must be introduced operatively when the cause of the ileus is treated, i.e. pelvic abcess. In simple obstruction the motility of the gut is very high and although the initial introduction of the tube into the duodenum may be very difficult, once in the duodenum, the end balloon is inflated and peristalsis rapidly passes the tube to the site of the obstruction.

This method of suction overcomes two of the shortcomings of intubation when it was first described. These are, 1) removal of more fluid and gas than is necessary; this is often used as an argument for enterostomy rather than an indwelling nasogastric tube - not only is less fluid and gas removed, but readjustment of the fluid and gas levels is more rapid. 2) Due to the presence of the tube in the stomach, the absorptive area of the intestine cannot be used for feeding and nutrition. With the longer catheters this does not arise to any great extent.

Previously to 1931, surgeons had noted that patients with adhesive or inflammatory obstruction of the small intestine were frequently entirely relieved of the obstruction after the proximal bowel had been decompressed by enterostomy. The fatalaties being due to the subsequent peritonitis or other complications of the enterostomy. With the introduction of suction for this condition, a high degree of success was reported. The series reported were selected to exclude, strangulation, infarction and colonic distention since, as explained above, it is unusual to have an incompetent ileo-caecal valve allowing full colonic decompression with a gastric or intestinal tube.

The suction in the series was performed under the most rigourous hygenic and nursing conditions with much reference to the radiologist in an attempt to exclude the diagnosis of strangulation as far as possible. Both authors (Paine and Wangensteen) stressed that "suction without spillage" is the motto of the technique.

An important problem is how long should the suction be continued ? Authors vary in the amount of time they allow between starting suction and starting exploratory laporotomy due to a non-response or mal-response to suction. Depreciation in the clinical condition of the patient being a positive indication for surgery. It should be realised that with suction a false sense of security can be produced by the temporary alleviation of the symptoms. This recognition is especially important in elderly patients who seldom react in a text book fashion and children who are rather more delicately poised as regards reserve of fluids etc. A decompression, although slow, will be an indication to continue suction for another 12 to 24 hours; although experience has shown that an adhesive obstruction often relents in the majority of cases rather quickly, if it does so at all. If an operation must be resorted to, the prolongation of suction beyond a certain time will add to the risks of surgery, both by changes in the bowel wall proximal and distal to the obstruction and the pressure of the adhesive band or some other obstructing mechanism increasing the hazards in the inevitable handling of the bowel.

Gradual preoperative decompression has several advantages. It facilitates intrabdominal manipulation at the subsequent operation, it lessens the dangers of copious vomiting and inhalation of vomitus under anesthetic, it improves the local circulation of the bowel and cancels the dangers of sudden operative decompression of the bowel.

The problem of sudden relief of distention underlines the role of toxicity in intestinal obstruction. In the experimental animal when distention is produced acutely, the blood pressure falls, due to pooling of the blood in the affected bowel. If the bowel is deflated 2 hours later, the blood pressure rises to normal. If the distention is kept on for a longer time, i.e. 5 to 6 hours, the release of distention leads to a further fall in blood pressure. These observations have been repeated on the operating table in man and the experiments of Anderson et al have relevance at this point. The experiments in dogs were on the colon and the ileum, relief of distention after 7 hours and 24 hours were correlated with the increase in absorption. In the colon in 3 dogs, 2 showed substantial increases in absorption after 7 hours and more so, after 24 hours - the other dog failed to react. A similar result was noted in the ileum. Lawson and Chumley (1940) have reported a reactive hyperaemia after distention, but this only lasted 6 mins.

It is difficult to assess whether or not operative deflation of the intestine in man is beneficial or deleterious without first removing the intestinal contents by preoperative suction. Although Lowden (1951) has shown that needle aspiration of the colon operatively is a worth while procedure; both the colon and the small intestine can be decompressed aseptically, only gas can be aspirated, the bore of the needle allowing it to be easily clogged up.

Strangulated obstruction is a surgical condition and suction is employed preoperatively as a preparation. This principle was recognised rather early in the "intubation era". A wave of enthusiasm was tempered by Wangansteen in 1939, warning against the use of suction as a diagnostic tool to see if operation was needed or not. Cooke (1958) has expressed his anxiety at the problem of late operation prolonged by the previous endless suction and saline. An illustration of his anxiety being the Registrar General's report of 1956 in which the pediatric deaths from intersusception had fallen from 350 in 1946 to below 100 in 1956, whereas the deaths from intestinal strangulation had risen to over 400 cases.

The place of suction in colonic obstruction is an ancilliary role. Obstruction of the large bowel presents a dual problem, overdistention and the underlying cause. Distention calls for emergency decompression, while the underlying cause can wait for definative treatment after proper preparation. No matter where the obstruction is located in the bowel, the caecum is the most vulnerable portion leading to perforation. The normal pressure in the caecum varies from 10 - 25 cms. H_2O but may reach 50 cms H_2O in obstruction. Not only is the greatest distention borne by the part with the largest diameter, but also by the part with the thinnest wall. Lowman and Davis (1956) in analysing a series of 19 cases of large bowel obstruction, state that with the caecal shadow in the X-ray of the patient in the prone position of 9 cms. or more, perforation is impending and immediate surgical intervention is reuuired. Distention can be relieved by tube caecostomy and when the immediate emergency is over, a leisurely transverse colostomy can be made to ensure diversion of the faecal stream. All strangulated obstructions need resection followed by colostomy. Nasogastric suction is of use in preventing further distention preoperatively, but the results on the colonic distention are variable. In some cases, atube passed via the rectum will produce decompression in selective cases.

The place of suction in paralytic ileus postoperatively is a region of immense dispute. This condition occurs following abdominal operations, also after operations in adjacent areas, i.e. thorax and frequently major trauma of any sort. It is

It is difficult to assess whether or not operative deflation of the intestine in man is beneficial or deleterious without first removing the intestinal contents by preoperative suction. Although Lowdon (1951) has shown that needle aspiration of the colon operatively is a worth while procedure; both the colon and the small intestine can be decompressed aseptically, only gas can be aspirated, the bore of the needle allowing it to be easily clogged up.

Strangulated obstruction is a surgical condition and suction is employed preoperatively as a preparation. This principle was recognised rather early in the "intubation era". A wave of enthusiasm was tempered by Wangansteen in 1939, warning against the use of suction as a diagnostic tool to see if operation was needed or not. Cooke (1958) has expressed his anxiety at the problem of late operation prolonged by the previous endless suction and saline. An illustration of his anxiety being the Registrar General's report of 1956 in which the pediatric deaths from intersusception had fallen from 350 in 1946 to below 100 in 1956, whereas the deaths from intestinal strangulation had risen to over 400 cases.

The place of suction in colonic obstruction is an ancilliary role. Obstruction of the large bowel presents a dual problem, overdistention and the underlying cause. Distention calls for emergency decompression, while the underlying cause can wait for definative treatment after proper preparation. No matter where the obstruction is located in the bowel, the caecum is the most vulnerable portion leading to perforation. The normal pressure in the caecum varies from 10 - 25 cms. H_2O but may reach 50 cms H_2O in obstruction. Not only is the greatest distention borne by the part with the largest diameter, but also by the part with the thinnest wall. Lowman and Davis (1956) in analysing a series of 19 cases of large bowel obstruction, state that with the caecal shadow in the X-ray of the patient in the prone position of 9 cms. or more, perforation is impending and immediate surgical intervention is reuuired. Distention can be relieved by tube caecostomy and when the immediate emergency is over, a leisurely transverse colostomy can be made to ensure diversion of the faecal stream. All strangulated obstructions need resection followed by colostomy. Nasogastric suction is of use in preventing further distention preoperatively, but the results on the colonic distention are variable. In some cases, atube passed via the rectum will produce decompression in selective cases.

The place of suction in paralytic ileus postoperatively is a region of immense dispute. This condition occurs following abdominal operations, also after operations in adjacent areas, i.e. thorax and frequently major trauma of any sort. It is

usually present also in patients with peritonitis, although the degree is variable. Ileus is essentially a loss of intestinal peristalsis with the consequent dilatation of the bowel presenting a picture of abdominal obstruction. The true reflex forms occur by sympathetic nervous overactivity postoperatively, but may be influenced by several factors. For example, the intestine loses its motility in congestion subsequent on distention, so that any from of intestinal obstruction will have an element of ileus. The ileus which complicates peritonitis, is said to be the result of toxic poisoning of Auerbach's plexus directly, plus the condition which exists in the abdominal cavity of oedema and pus. Enforced quietude being one of the beneficial factors which delays spread of the peritonitis and encourages localisation. At one time, it was thought that the relief of distention by suction produced direct cure of the peritonitis, but as Wangansteen (1955) points out, patients died of peritonitis even when the bowel was fully decompressed. With the aid of powerful antibiotics, the fatality of this condition has been greatly reduced. Decompression by suction does however produce the greatest amount of physiological rest for the inflammed bowel. In increasing the flow of blood to the bowel wall, secondly adhesive obstruction is reduced and the comfort of the patient is enhanced. Hypopotassiumaemia will reduce gastric motility as observed experimentally by Henriksen (1951). In rats fed on a diet, low in K the motility of the gastrointestinal tract was much reduced. A failure to appreciate this fact has led to misuse of suction without ade uate replacement of potassium in the diet.

It is impossible to state catagorically exactly which operations produce significant degrees of paralytic ileus to make suction a worth while part of the treatment - the individual response is so variable.

It is true that suction postoperatively has some definite advantages both for the surgeon and for the patient. By combating distention, the patient's recovery is made more comfortable and a reduced incidence of vomiting is noted; in one series of 42 patients with peritonitis - of the patients not treated with suction 62.5% vomited to a greater or lesser degree and of the 43 patients treated with suction, only 19% vomited. Gerber and Smith (1957) disagree with these figures; of a series of 71 patients without suction postoperatively, 21 i.e. 29.5% vomited and of 56 patients without suction, 17 vomited, ie. 30.3%. The possibility of inhalation of vomit leading to pulmonery complications is a very real possibility in a weak or comatose patient. The presence of a suction tube (a nasograstic tube) has definite disadvantages in this respect. Gerber (1958) reports that in cases of intubated patients, 14.3% developed respiratory complications, whereas in the unintubated

patients only 3% developed pulmonary complications. From the point of view of the surgeon, suction provides excellent protection to the healing anastomotic suture lines in the stomach, small bowel and colon, both decreasing the incidence of post-operative obstruction due to adhesions and also by decreasing the frequency and volume of vomiting and general distension. Often preventing disruptive strains on the healing wounds of the abdominal wall.

As noted above, the introduction of a tube to suck out the intestines in ileus is very difficult, except into the stomach, as the pylorus acts as a physiological block. The difficulty of getting a long intestinal tube into the duodenum leads surgeons to adopt the motto "prevention is easier than cure" in this respect.

As pointed out by Smith et al (1965) it is important to recognise two distinct types of paralytic ilues post-operatively. When laporotomy has been performed for some condition which has not been associated with gastric or intestinal obstruction aspiration produces only a few Hundred mls. of fluid and gas per 24 hours. In marked contrast, is the condition following laporotomy for organic or functional obstruction. Here the gut is truly adynamic; it contains both fluid and gas in large quantities, aspiration yields large volumes of both. The problems associated with the treatment of these two conditions obviously should differ.

Gerber and Smith (1957) argue that if normal adults secrete into the intestinal tract approximately 8 litres and in distension this volume is increased c.f. Shield (1962) and that from suction, at the most, 1 litre is produced post-operatively the other 7 litres must be absorbed. If 7 litres can be absorbed, 1 more will surely not make much difference ? On the question of air in the bowel, 70% of which has been shown by Wangansteen to be inspired, Gerber has shown that if patients take nothing by mouth, little or no air is aspirated. This was proved with X-ray examination of a baby before and after sucking on an empty bottle. A 1,000 patients were treated for paralytic ileus without suction, a subgroup of 2 sets of 300 patients were taken out; 36 deaths in the suction group - 23 in the non-suction, no death was directly referrable to the suction tube. Another subgroup of 25 patients with peptic ulcer, treated with vagotomy, but not suction - no complications were noted. No cases of acute dilitation of the stomach resulting from treatment, possibly due to the fact that they were not taking anything orally.

Hendry (1962) reported a series of 114 cases after Billroth I and 118 cases of vagatomy and pyleroplasty.

In both groups no saline drips nor suction were used. A post-operative regime of progressive oral feedings giving increased amounts of water for three days is detailed below:-

1st 24 hours	:	1 oz (28 mls/hr) by mouth
2nd "	:	2 oz (57 mls/hr) " "
3rd "	:	3 oz (85 mls/hr) " "
4th "	:	4 oz clear fluids
5th "	:	light diet.

Only 4 failures were reported on this regime.

Disturbance of fluid and electrolyte balance is by far the most fre uent complication of suction drainage. This is particularly so with the use of nasogastric tubes with their excessive removal of fluid; often uoted as an indication for the use of gastrostomy and enterostomy. Taylor (1953) made a study of post-operative nasogastric suction in 46 patients. In a 24 hour period the amount of chloride removed was on average 188 milliEq (11.02 gm NaCl). He found that the procedure of giving fluids orally resulted in an added loss of $\frac{1}{3}$ to $\frac{1}{2}$ more than if no fluid was given orally. Gutierry et al (1962) analysed the electrolyte patterns of gastric drainage post-operatively in 30 pediatric patients. It was found that the average potassium and sodium chloride loss was greater in patients above the age of 6 months than it was in patients below 6 months. In the patient below 6 months, the average loss was Na53.0 meq/l, Cl 80.3 meq/l, and K 10.7 meq/l. In patients older than 6 months the average sodium loss was 88.6 meq/l, chloride 104 meq/l and potassium 14.4 meq/l. The recommendation of these investigators was that there should be a volume for volume replacement of the suction loss at a similar rate.

Pottasium intoxication was at one time blamed for the toxaemia of obstruction. Scudder et al (1938) found that the normal level of 25 mg/100 ml. can be doubled during the course of obstruction. The high levels these observers recorded were probably the result of chloride shift subse uent to sodium loss. A reduction is more often seen in the normal level than an increase. Randell (1952) has studied this problem extensively and his work indicates the prime necessity of the surgeon to understand fluid balance post and preoperatively, especially as regards suction.

The response to operation leads to intracompartmental fluid shifts with a transitory water retention, a larger retention of sodium chloride and an excessive loss of potassium and nitrogen. Potassium is lost in excess of its intracellular ratio to nitrogen. Extracellular fluids increase post-operatively and reach a zenith at 2/3 days. A figure

of 2/3 litres is quoted as the expansion of the extracellular fluid space. Previous suggestions have been that the gastrointestinal secretions are isotonic, and should be therefore replaced with isotonic saline. This is uite reasonable if there is good kidney function; the kidney regulating the electrolytes according to the needs of the body. But so often, kidney function is poor post-operatively. This is especially so following strangulated obstruction with any degree of toxaemia. The hepato-renal syndrome seen following toxaemia from strangulation or other states being a direct result of the endo and exotoxins. If the renal function is poor a more ualitative replacement is necessary. From Randell's analysis of the gastrointestinal drainage, it is seen tha t the secretions are not isotonic but hypotonic with respect to sodium chloride. There are also marked differences in the concentrations produced at different drainage points:-

	Na	K	Cl	Millieq/l.
GASTRIC	59.0	9.3	89.0	
SMALL BOWEL	104.9	5.1	98.9	
ILEUM	116.7	5.0	105.8	
ILEOSTOMY.	129.5	16.2	109.7	
CAECOSTOMY.	79.6	20.6	48.2	

The range of gastric secretions varied widely with the patients, from the elderly who produced equal proportions of sodium and chloride to the patient with the duodenal ulcer where the chloride loss was greater than the sodium by a multiple of 2 or 3. Numerous pitfalls are possible in the replacement of fluid loss from an ileostomy. For example with the loss of a large volume of fluid replaced with an equal volume of saline could lead to a chloride acidosis, similarly the use of sodium chloride (isotonic) to replace a $\frac{1}{3}$ isotonic gastric juice aspirated from a patient with achlorhydra is sufficient to produce gross expansion of the extracellular space.

In high intestinal obstruction the loss of potassium is particularly severe. The vomitus and hence the aspirate contains 5 times as much potassium as saline, Falconer (1939) but the potassium is further depleted by suction - Randell has ascribed the loss of 32.5 millieq/l loss in aspirate - and intravenous saline both dilutes the potassium in the blood stream and washes it out into the urine. The increased protein catabolism of operation is responsible for the freeing and excretion of more potassium. The kidney in an attempt to conserve this mineral secretes an acid urine and with the corresponding release of bicarbonate into the blood the paradox of an acid urine in the presence of an alkalotic blood picture is seen in potassium depleted patients.

As the low level of potassium in the blood potentiaties ilues the ado uate replacement is a prime necessity, especially the excess lost in suction to prevent the need to prolong this form of treatment.

A method suggested by Schroeder and Harris (1964) employs the use of a continuous circuit by suction above the obstruction with replacement of the aspirate below the block - it has had limited clinical success. It should be noted before ending this section on the importance of fluid balance in treatment by suction that Gillesby (1962) has remarked that with a nasogastric tube in position an extra 750 ccs. /24 hours of gastric juice was produced compared to when it was not in position, further complicating the ~~quantitative~~ picture.

The complications of tube suction appear to be legion on first sight. Hanselman and Meyer (1962) in an extensive review of 530 cases of all degrees of severity, remarked however, that they were impressed by the relative small number of deaths even when extensive complications were evidenced. This review involved only the use of the nasogastric tube and 43 deaths were recorded. The review splits into two parts, one is the report by Farris and Smith (1956) of 260 cases of laryngeal and oesphageal complications with 7 deaths. The other 270 of which, there are 202 acceptable reports had 36 deaths. Most due to treatment with the Sangstakner tube for oesphageal varicies. Conn reported the cases of 50 patients with this condition in which there were 31 complications due to pressure, 1. traumatic rupture of the oesphagus and 13 serious respiratory obstructions. In this series there were 41 deaths, 9 probably due to the tube.

In the series of Farris and Smith, a questionaire was sent to 200 members of the American Larg. & Osph. Soc. 115 reported;59 had observed major complications - 238 laryngeal complications 79 requiring tracheostomy and there were 22 cases of oesphageal stricture. McCredie and McDowell (1958) reported 30 cases of oesphageal stricture. This review lead Farris and Smith to recommend gastrostomy in favour of nasogastric tube suction. Farris has recently modified his views on gastrostomy and now advocates its use only in the elderly and the very young. In retrospect 90% of the gastrectomies for post-operative ileus were not necessary.

A review by Jabezenski (1963) on the advantages of gastrostomy versus nasogastric tube reveals the following facts. The patients in this series, were in for operation between 1956/60. 123 patients developed gastrostomy complications eg. persistent drainage after removal of the tube etc. Due to these complications the patients treated by this method had longer hospitalisation, more discomfort,

more wound infection and a higher incidence of thrombophlebitis, possibly due to their longer hospitalisation. There were less respiratory complications with the nasogastric tubes and although the patients varied in their response to the presence of the tube, most tolerated it well. This last observation is not a common one.

Grant in 1,246 patients used gastrostomy and found that there were reduced wound and respiratory complications in the patients over 60 years of age. Mahafferty (1965) had a similar experience with this technique and makes a plea for meticulous attention to detail for success.

Gastrostomy would, therefore, appear to be indicated in cases where there was severe respiratory disease, or in the case of children ear disease (as shown by Peyer the eustation tube in the infant is almost horizontal and therefore predisposes to the complication of ortitis media from the use of a nasogastric tube) or in patients over 60 if there is no evidence of peritonitis.

CONCLUSION

An attempt has been made to investigate the rational behind the use of suction in cases of intestinal obstruction. It would appear that the effect of distension with, or without a compromisation of the blood supply, is the initial condition. The effect of this distension leads to devitalisation and circulatory embarrassment, resulting in conditions which are conducive for the proliferation of bacteria and the production of the clinical picture of toxaemia. The effect on the colon is additionally complicated by the presence of the caecum which has a distinct tendency to perforate under pressure and lead to peritonitis.

The importance of differentiating strangulated from non-strangulated obstruction is stressed and the negative finding of no clear points on which to base this distinction is noted. One view to be taken is that of Barker (1963) who describes operating on all cases of obstruction past a certain time limit; whereas Waldrom and Hampton (1961) report an overall mortality of 14%, Baker in 126 cases of early obstruction had 3.2% mortality and in 49 late cases 10.6% mortality - an average of 5.2%. He argues that complete surgical decompression has the advantages of 1) the site of obstruction is visualised and freed 2) respiratory embarrassment is relieved 3) the wound is more easily closed 4) there is less trauma to the viscera and 5) the opportunity of recurrent obstruction is reduced.

With the safety factor increased by modern surgical techniques, anasthetics an powerful antibiotics some indications for suction, or the extensive use of suction had been eliminated.

The greatest difference of opinion would appear to revolve around the choice of the proper moment for operative correction. All agree that strangulated obstruction and obstruction of the colon are indications for surgery, but the role of suction in simple obstruction is in doubt. Some, like Barker, consider the diagnosis of obstruction whatever the type, to be an indication for surgery. Others, advocate operative techniques after a trial by suction although even Wangansteen admits that surgery is the mainstay of treatment in this condition.

Deaths occurring in any series are important to analyse. Miller (1929) reported a mortality rate of 65% at the Charity Hospital in New Orleans. Tendler and Cartwright reported mortality rates of 51% from 1923/1932 , then 26% from 1933/46 and 8% from 1947/1953. Turner reported 100 consecutive cases from each of three decades and found a mortality of 27% in 1929, 21% in 1939 and 4% in 1949. Missed strangulated obstruction always led to death for although suction will remove the toxic products from a strangulated segment of gut, it will not do so in a closed loop situation. Even in the simple strangulated case, suction only acts to delay the inevitable operation. The uestion of time is also of importance as regards the production of complications from the mechanical effects of the suction tube. It should be noted however, that there is one report of a patient with an indwelling nasogastric tube for 47 days without complication. This is exceptional and many complications arise in the first 48 hours of use.

Post-operatively the picture is even more confused but with observations of the stomach after vagotomy the position is being resolved. Some consider that suction is absolutely necessary after operation involving vagotomy, believing that the stomach is flaccid and distends to a considerable size. It is true that a reduction in the contractile force does occur, but intragastric pressure and mural tone is increased. Numerous reports have been read about the advantages of tubeless post-operative management and the remarkable degree of success it enjoys.

As a development of heart pacing methods, Bilgutay et al (1962) describes a method of intestinal pacing to restore motility in ileus. He reports that these patients so treated have a lower incidence of complications and a shorter hospitalisation. The gut regaining its motility in 6/20 hours as compared with patients treated by suction in which the gut returns to normal in some 55 hours or more. This is extremely interesting, especially as Smith's (1965) work makes a plea for the treatment of paralytic ileus to be directed at the inhibition produced by trauma, rather than direct muscle stimulation.

REFERENCES.

AIRD (1941)	Ann. Surg. 114 : 385.
ANDERSON et al (1943)	Acta. Chir. Scand. 88 : 475
ANDERSON et al (1962)	Ann. Surg. 156 : 276
BARKER (1963)	Ann. Surg. 157 : 759.
BENNETT et al (1963)	Ann. Surg. 157 : 747.
BERRY (1961)	Ann. Surg. 154 (6) Supp. 1. : 102.
BILGUTAY (1962)	Ann. Surg. 158 : 338.
COHN et al (1953).	Arch. Surg. 66 : 126
COHN (1962).	Ann. Surg. 156 : 692.
CONNER (1956).	Ann. Surg. 144:
CROSS. (1958).	Surg. 36 : 1001.
DIXON et al (1964).	Arch. Surg. 88 : 527.
DRAGSTEDT et al (1929)	Arch. Surg. 18 : 2257.
FALCONER (1939).	Arch. Surg. 38 : 869.
FARRIS et al (1956).	Ann. Surg. 114 : 475.
FINE (1936).	Ann. Surg. 103 : 375.
FISHER (1954).	J. Physiol. 124 : 21.
GERBER (1958).	Surg. Gyn. & Obst. 107 : 247.
GILLESLY (1962).	Surg. Cli. of N. Amer. 42 : 231.
GUTIERRY et al (1962).	Surg. 48 : 611.
HENDRY. (1962).	B. M. J. 1 : 1736.
HENRICKSON (1951).	Amer. J. of Physiol. 164 : 263.
HENSELMAN et al (1962).	Int. Abs. Surg. 114 : No.3. : 207.
HERRINGTON (1965).	Ann. Surg. 159: No. 5. : 807.
HILL et al (1942).	Surg. Gyn. & Obst. 74 : 121.
HUBBARD et al (1934).	Proc. Soc. Exp. Biol & Med. 31 : 1063.
JABCZENSKI (1962).	Amer. Surg. 28 : 335.
LAUFMAN et al (1951)	Surg. Gyn. & Obst. 93 : 292.
LAWSON et al (1940).	Amer. J. of Physiol. 131 : 368.
LAWSON et al (1941).	Ann. Surg. 114 : 415.
LEONARD (1965).	Surg. 57 : No. 3 : 491.
LOWDON (1951).	Lancet 1 : 1103.
MACKENZIE (1962).	Pract. 189 : 296.
MACREDIE (1958).	B. J. Surg. 46 : 260.

MAHAFFERTY. (1965).	Kentucky. Med. Ass. 63 : 171.
MATHERSON (1963).	Lancet. 1 : 695.
MEHNER (1958).	Surg. Gyn. & Obst. 109 : 607.
MILLER. (1929).	Ann. Surg. 89 : 91.
NEMIR et al (1949).	Ann. Surg. 130 : 857.
OSTRUM (1962).	Amer. J. of Rad. 553.
PAINE (1933).	J.A.M.A. 100 : 1910.
PAINE (1936)	Arch. Surg. 33 : 995.
PAINE (1954).	Surg. 36 : 350.
RANDELL (1952).	Surg. Cli. of N. Amer. 445.
RICHARDSON (1920).	Boston Med. & Surg. J. 183 : 288.
SCHROEDER et al (1964).	Surg. Gyn. & Obst. 119 : 851.
SCUDDER et al (1938).	Ann. Surg. 107 : 161.
SHIELDS (1963)	Sympossium of Gastroenterology Ed. J. BRUCE.
SIEBEN et al (1963).	Surg. 53 : 357.
SMITH et al (1957).	Surg. Gyn. & Obst. 107 : 247.
SMITH (1965).	B. J. of Surg.
SPERBURG et al. (1935).	Proc. Soc. Exp. Biol. & Med. 32: 1183 1219, 1385 (3 papers).
SPRONG. (1957).	Amer. J. Surg. 94 : 257.
STROHL. (1958).	Amer. Surg. 24 : 721.
STONE et al. (1924).	Trans. Southern Surg. Ass. 37 : 173.
STRONG (1964).	Arch. Surg. 38 : 527.
TAYLOR (1953).	Arch. Surg. 66 : 538.
ULIN et al. (1962).	Amer. J. of Surg. 104 : 465.
VEST (1962).	Surg. Gyn. & Obst. 115 : 561.
VON ZWALENBURG (1907).	Ann. Surg. 46 : 780.
WANGANSTEEN	Intestinal Obstruction 1955.
WALDER (1962).	Surg. 51 : 407.
WALDRON et al. (1961)	Ann. Surg. 153 : 839.
WILLIAMS (1962).	Amer. J. Surg. 104.
WILLIAMS (1962).	Ann. Surg. 156 : 648.