GASTRO-INTESTINAL TUBE WITH INFLATABLE WEIGHT RELEASING MEANS

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ABSTRACT OF THE DISCLOSURE

Gastro-intestinal suction and medication introduction apparatus comprising a bi-lumenal, flexible tube having a smaller lumen within a larger one and inflatable means near the lower end of the smaller lumen adapted to inflate to substantially constrict the passageway of the larger lumen; a weighted object, such as a thin-walled rubber bag of mercury, a flexible element such as a thread secured to the bag and an enlargement secured to the opposite end of the thread from the bag, the enlargement adapted to be releasably retained in the tube larger lumen by inflation of the inflatable means to dispose the weighted bag relatively freely a short distance beyond the lower end of the tube.

A method of assembling, inserting, employing and withdrawing the tube is also described.

The foregoing abstract is not intended to be a comprehensive discussion of all of the principles, possible modes or applications of the invention disclosed in this document and should not be used to interpret the scope of the claims which appear at the end of this specification.

The present invention relates to improved apparatus for draining and medicating the gastro-intestinal region.

Gastro-intestinal tubes of the nasally inserted type are generally flexible, of a diameter sufficiently small to allow introduction of the tube through the patient's nasal passage and of a length sufficient to permit the introduced end of the tube to reach the appropriate location so that gastro-intestinal contents can be removed by suction through the upper end of the tube which projects from the patient's nose, or in some instances, from the patient's mouth.

Although it is usually not difficult to introduce such tubes to the stomach, prior art gastro-intestinal tubes are often found to be unsatisfactory for draining or medicating the small intestine because of the difficulty experienced in attempting to pass the lower end of such tubes through the ring shaped muscle at the lower end of the stomach or in retrieving the tube from the gastro-intestinal tract once the lower end of the tube has been introduced into the small intestine. To aid passage of the tube through the ring-shaped muscle at the lower end of the stomach, prior art devices have employed means such as bulbous weighted attachments on the lower end of the tube usually in the form of a thin-walled rubber bag containing air, water, mercury or the like. Progress of the tube lower end is often observed by fluoroscopy or X-ray techniques.

Besides being cumbersome and time-consuming, these procedures are sometimes unsuccessful since the natural tendency of the bulbous weighted object to descend in the gastro-intestinal tract is hindered by its direct attachment to the end of the tube. The feeding of the tube faster than its rate of descent sometimes causes it to coil in the stomach so that the lower end is not presented at the lower end of the stomach.

In instances where the practitioner is successful in introducing such prior art weighted bulbous lower end tubes into the small intestine, such difficulty is often encountered in attempting to withdraw the tube from the small intestine because of the tortuous passageway thereof and the contraction of the ring-shaped muscles of the stomach about the tube, that the practitioner may be left with no alternative but to cut the tube at the nose of the patient and allow the tube to pass through the esophagus and gastro-intestinal tract in the normal manner. Fortunately, when such tubes are cut they usually pass through the patient in about 24 hours, but instances where such tubes when cut have taken up to three weeks passing through have been reported. Needless to say, such a method causes some consternation to both the patient and his physician.

Recognizing this problem, others have proposed means for detaching the weighted object from the tube within the patient to facilitate withdrawal of the tube. Such constructions are exemplified by the tube shown in the U.S. patent of Barron, 3,155,097.

A prior art device for gastro-intestinal intubation has provided a feeding tube adapted to be inserted through a patient's nose and carried to his stomach by a mercury filled bag disposed closely adjacent the lower, open ended end of the tube by a suture thread which loops through one of the apertures and through an eyelet on the bag.

The ends of the suture thread project from the upper end of the single lumen tube. To release the bag, one end of the suture thread is pulled and the other released. The latter travels down the tube and upon being withdrawn from the bag eyelet, the bag is released. Apparently, when the bag of the prior art device is attached, sufficient tension must be maintained on the suture thread to key the bag to the tube, otherwise descent of the bag would not cause the tube to be drawn along. The tension on the thread undoubtedly increases the tendency of the tube to kink and at the least, decrease its flexibility. The size of the looped lower end of the tube of the prior art device would effectively prevent its use in the intestine, since the loop would probably be too large and rigid to pass through the stomach lower end ring muscle. If it were used as a gastro-intestinal tube the tube of the prior art device would necessarily possess many of the above-noted disadvantages of prior art weighted tubes where the weight is attached closely adjacent the lower end of the tube. For instance, the release mechanism of the bag of the prior art device, while probably performing well in the stomach, would encounter technical difficulties in the intestine were it used there, due to the necessarily longer tube length and the tortuous path which would probably increase suture thread friction against the tube to such an extent that the thread could not be successfully withdrawn.

Accordingly, it is a primary object of the present invention to provide apparatus useful in intestinal intubation including a flexible tube which will readily pass through the muscular contractile ring at the lower end of the stomach, into the upper part of the small intestine, or duodenum, and thence into the remainder of the small intestine if necessary and which can be dependably retrieved from this location by withdrawal through the patient's nose or mouth.

A more particular object of the invention is the provision of a flexible gastro-intestinal tube having a weight releasably attached adjacent its lower end by a cord or the like of appreciable length which allows the bag to freely descend within the gastro-intestinal tract unhampered by the relative rigidity of the flexible tube, resulting in the pulling of the tube by the attached cord along the path traversed by the bag.

A further object of the invention is the provision of improved gastro-intestinal suction and medication introduction apparatus comprising a bi-lumenal, flexible tube having a smaller lumen within a larger one and inflatable means near the lower end of the smaller lumen adapted to inflate to substantially constrict the passageway of the larger lumen; a weighted object, such as a thin-walled
rubber bag of mercury, a flexible element such as a thread secured to the bag and an enlargement secured to the opposite end of the thread from the bag, the enlargement adapted to be releasably retained in the tube larger lumen by inflation of the inflatable means to dispose the weighted bag relatively freely a short distance beyond the lower end of the tube.

Yet another object of the present invention includes the provision of a method for reliably accomplishing intestinal intubation and for equally reliably withdrawing the introduced tube.

These and further objects of the present invention will become more clearly apparent, as will the principles and scope of advantageous applicability of the present invention, during the course of the following detailed discussion which relates to the preferred embodiment of the apparatus of the invention that is illustrated in the accompanying drawings.

In the drawing:

**FIGURE 1** is an enlarged fragmentary perspective view of a tube embodying the present invention, the wall of the larger lumen being partly broken away to expose the smaller lumen, the inflated balloon and the balloon enclosing bag retaining block;

**FIGURE 2** is a transverse cross-sectional view taken substantially along the line 2—2 of **FIGURE 1**;

**FIGURE 3** is a transverse cross-sectional view taken substantially along the line 3—3 of **FIGURE 1**;

**FIGURE 4** is an enlarged fragmentary perspective view similar to **FIGURE 1**, but showing the balloon in a deflated condition and the weighted bag, thread and retaining block escaping from the tube; and

**FIGURE 5** is a fragmentary perspective view of a modification shown in a condition thereof similar to the **FIGURE 1** condition of the preferred embodiment shown therein.

The apparatus 10 includes a tube 12 of soft, flexible material such as rubber or synthetic plastic material preferably having an outside diameter sufficiently small to permit insertion of the tube in the patient's nasal cavity and passage of the inserted end of the tube down the patient's throat, esophagus and into his stomach and small intestine. For the normal human adult, a tube 12 of approximately ten feet in length has been found to be adequate and allow a sufficient amount of the tube 12 upper end 14 to extend from the patient's nose or mouth after the tube 12 lower end 16 has reached the desired point to permit the attachment of suction, pressure, and other apparatus to the tube upper end.

The tube 12 comprises two lumens or channels 18, 20 the former being of smaller diameter and disposed within the latter so as to extend from the upper end of the tube 12 nearly to the lower end thereof.

The smaller lumen preferably comprises a flexible tube 21 of flexible rubber or synthetic plastic material. It may conveniently be attached to the inner peripheral wall 22 of the larger lumen 20 by solvent welding, heat sealing or any similar technique so as to extend longitudinally along. It is also within the purview of the invention that the tube 12 be extruded as a unitary biliuminal tube utilizing conventional extrusion techniques and a die or extrusion head having a shape corresponding to the cross-sectional shape of the tube 12 as shown in **FIGURE 2**.

Within the larger lumen, near the lower end of the tube 12, an inflatable balloon 24 is provided at the lower terminus of and communicated in the smaller lumen. The balloon 24 may be a separately fabricated, thin-walled element secured as by heat sealing or solvent welding to the smaller lumen, or it may merely comprise a thin area formed in the peripheral wall 26 of the smaller lumen itself, similar to aneurysm of a blood vessel, the lower end of the smaller lumen beyond the thinner section then being closed off by heat sealing, solvent welding or the like.

The balloon 24 is of such elasticity that when inflated it substantially blocks the larger lumen (**FIGURE 3**) and when deflated does not obstruct the larger lumen significantly more than does the smaller lumen (compare **FIGURES 4** and 2).

To the upper end of the tube 12 may be secured a Y connector 26 having a leg 28 which communicates with the smaller lumen and a leg 30 which communicates with the larger lumen. The leg 28 is preferably connected to a source of pressurized fluid such as air or water in order to inflate the balloon 24 and maintain it in an inflated position. The communication to the pressurized fluid is disrupted when deflation of the balloon is desired. The leg 30, communicating with the larger lumen, may be connected to a conventional suction device for removing gastro-intestinal contents and subsequently or alternatively to apparatus for the administration of medication or nutrition through the tube to the appropriate locations in the gastro-intestinal tract. In order to accomplish the gastro-intestinal contents removal and medication or nutrition administration, openings 32 are provided through the tube 12 into the large lumen of the appropriate locations.

An important portion of the present invention involves the discovery that the shortcomings of prior art weighted tubes can be overcome by disposing the weighted means ahead of the lower end of the tube and removably securing it to the tube by an extremely flexible element. In the apparatus 10, this is accomplished by providing a weight 34 shown being a thin walled rubber or plastic bag of heavy, flowable material such as mercury or water.

The bag 34 is secured to one end of an extremely flexible element such as a surgical thread of silk or the like 36. A block of plastic material, rubber metal or the like 38 is secured to the opposite end of the thread 36. The bag 34 is removably attached to the tube 12 by inserting the block 38 in the larger lumen from the lower end of the tube, the balloon 24 being in a deflated condition. When the block 38 is slightly upstream from the balloon 24, the latter is inflated by pressurizing the smaller lumen from the upper end thereof. The balloon 24 in inflating blocks the larger lumen, preventing passage of the block 38 thereby. Preferably the balloon 24 is positioned with respect to the lower end of the tube 12 and the thread 36 of sufficient length that a significant amount of the extremely flexible thread 36, for instance 6-8 inches thereof extends between the bag 34 and the tube 12 lower end (**FIGURE 1**).

The bag 34, thread 36 and tube 12 are progressively inserted in the patient's nasal cavity in the **FIGURE 1** condition thereof and allowed to progress under the weight of the bag 34 through the esophagus, stomach and intestine. It should be apparent that because of the freedom of motion allowed the weighted bag 34 because of its extremely flexible connection to the tube 12, the bag descends in the gastro-intestinal tract under the influence of its fluidity, weight and the peristaltic action of the stomach and intestines, pulling the tube 12 after it more efficiently and with less chance of malfunctioning than is the case with prior art weighted tubes particularly in passing through the stomach lower end ring muscle and progressing along the small intestine.

When the tube 12 lower end has reached the desired position thereof within the gastro-intestinal tract, the weighted bag 34 is released from the tube 12 by deflating the balloon 24. This is accomplished by disconnecting pressurization from the Y connector 26 and the leg 28. Upon collapse of the balloon 24, the block 38 slips downwardly in the large lumen, past the deflated balloon and out of the lower end of the tube 12 (**FIGURE 4**). After this separation, the bag 34, thread 36 and block continue through the intestinal tract and will be eliminated from the body in the usual manner.

If after placement of the tube has been effected and the weighted bag, thread and block released, it is desired to discontinue suction or medication or nutrition applica-
tion through the large lumen lower end, but continue such operations through the large lumen openings which are upstream from the large lumen lower end, this can be easily accomplished by reinflation of the balloon 24 to completely block the lower end of the large lumen.

When use of the tube 12 is completed, it may easily be withdrawn from its point of entry since it no longer has the weight attached thereto. It is contemplated that in some instances, especially where the tube is intended to descend no further than into the stomach or a short distance into the small intestine, it may be possible to withdraw the tube after use without releasing the bag, thread and block.

A modification of the apparatus is shown in FIGURE 5. The apparatus of FIGURE 5 is similar in all respects to and similarly numbered as that shown in FIGURES 1-4 but for the inclusion of an electro-magnet 40 in the smaller lumen at the lower end thereof in addition to or in place of the balloon 24. Wires 42 from the electro-magnet proceed upwardly in the small lumen and project from the upper end of the tube 12, being connected to a source of electric potential such as a battery 44. Preferably, switch means 46 are provided in the circuit just described. In the embodiment of FIGURE 5, the block 38 is composed of ferro-magnetic material being removably retained in the large lumen of the tube adjacent the electro-magnet by magnetic force when the current is flowing through the magnet, i.e. when the switch 46 is closed. The tube of FIGURE 5 is inserted in the patient's nasal cavity or mouth in a substantially identical manner to that described in regard to the tube shown in FIGURES 1-4. Release of the bag 34 when the lower end of the tube 12 has reached its desired position in the gastro-intestinal tract is accomplished by opening the switch 46, whereupon the ferro-magnetic block 38 slips out of the lower end of the large lumen. The ferro-magnetic block 38, suture thread 36 and weighted bag 34 are eliminated as usual, and the tube 12 withdrawn through the patient's nose or mouth when the mission it was inserted to facilitate has been completed.

It should now be apparent that the apparatus and method just described efficiently and reliably accomplish each of the objects of the invention as set forth at the outset of this specification and clearly outline the principles of the present invention. Because the specific embodiments depicted in the drawing can be considerably modified without departing from these principles the invention should be understood as encompassing all such modifications as are within the spirit and scope of the following claims.

We claim:
1. Apparatus for applying material to and removing material from the gastro-intestinal tract and especially the small intestine comprising: an elongated flexible tube having a large lumen, a lower end and an upper end; a weight; an elongated extremely flexible element secured by one end thereof to said weight; a block secured to the opposite end of said elongated extremely flexible element; said block having a lateral dimension sufficiently small that said block is slidable receivable in said large lumen; said block being removably received in said large lumen near the lower end of said tube, said elongated extremely flexible element extending outwardly of said tube lower end and said weight depending therefrom; and means in said tube adjacent said block for releasably retaining said block in said large lumen.
2. Apparatus as set forth in claim 1 wherein the portion of said elongated flexible element which extends between the weight and the tube lower end is about 6-8 inches in length.
3. Apparatus as set forth in claim 2 wherein the elongated extremely flexible element is a thread.
4. Apparatus as set forth in claim 1 wherein said means for releasably retaining said block in said large lumen comprises a balloon inflatable to retain said block and deflatable to release said block.
5. Apparatus as set forth in claim 4 wherein said balloon substantially blocks said large lumen when inflated.
6. Apparatus as set forth in claim 4 further including means defining a smaller lumen in said tube than said large lumen, said small lumen extending from said tube upper end to and communicating with said balloon whereby said balloon is inflatable and deflatable from said tube upper end.
7. Apparatus as set forth in claim 6 wherein said smaller lumen comprises a flexible tube secured to the inner peripheral wall of the first-mentioned tube and extending longitudinally therealong.
8. Apparatus as set forth in claim 1 wherein said block is composed of ferro-magnetic material and said means for releasably retaining said block in said large lumen comprises an electro-magnet.

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