Use of a low-pressure 3cm diameter everting (toposcopic) catheter as an aid to intubating the difficult colon - a feasibility study using a plastic model

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Background

Possible clinical applications of everting (toposcopic) catheters were first suggested by Zeimer and Simkins (1966). Shook et al. (1986) used 1 - 1.7mm (3 – 5 French) everting catheters for arteriography and also described successful ERCP in a dog using this technique. Benjamin and Collins (1986) used a toposcopic through-lumen 4mm (9 French) catheter with everting pressures of up to 40 psi to facilitate dilation of oesophageal strictures.

In 1976 Masuda filed a patent proposing that a flexible fiberscope (36 in Figure 1) could be fed through a conduit by attaching it to the end of an everted tube (i.e. a tube whose end has been turned inwards and pulled back through itself).

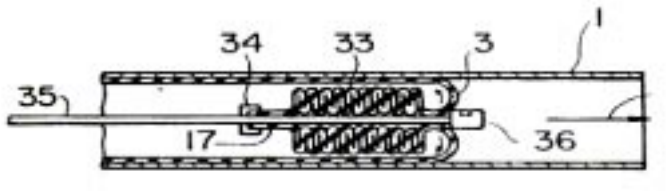

Figure 1 - An everted tube is used to pull a fiberscope through a conduit. From Masuda's 1976 patent

It can be seen in Figure 1 that when the tube is filled with liquid at pressure it will unroll itself and pull the fiberscope forwards and, since the tube is rolling against the conduit wall, there is no sliding friction between it and the wall.

Methods and results

To date studies in plastic models have been encouraging.With suitably folded flexible polyethylene tubing (external diameter 3-4 cm) and an everting hydraulic pressure of less than 10 psi we could get the catheter to "seek" the lumen and pass over 250cm around a tortuous model colon and furthermore drag up its lumen a flexible electrical wire with a small light bulb at its tip.
The everting tip was able to exert a force of similar order of magnitude to that we had previously shown to be applied to the shaft of a colonoscope during colonoscopy (Mosse et al, 1998). This poster is mainly given over to a series of images taken from a video recording of one of our experiments.

Illustrations

The following illustrations were captured from video film taken during one of our experiments. For the everting section we used a length of commercially available polythene lay-flat tubing, suitably folded and wound onto a spool. This assembly was housed in a water-tight casing into which the water could be introduced through a valve. A short length of rigid plastic tubing protrudes through a hole in the casing and the polythene tubing is passed through. Finally, the polythene catheter is everted and clamped around the rigid plastic tube.

Water may be introduced into the system via the valve which progressively everts the polythene catheter, unwinding same from the spool in the process. In the experiment pictured here, the polythene catheter has been adapted so that a small light-bulb attached to flexible wires was 'pulled' through the centre of the everting lumen as it progressed around our model colon. We hope to continue our experiemnts perhaps using fibre-optic material to provide a view from the tip of the catheter after it has been fully everted.

Conclusions

Low pressure wide lumen toposcopic catheters deserve further evaluation as possible aids to intubation of the colon.

Figure 2a - Polythene tubing and spool assembly

Figure 2b - Watertight casing

Figure 2c - Assembling the components

Figure 2d - Sealing the casing

Figure 2e - The model 'colon'

Figure 2f - The model 'colon' with everting catheter introduced

Figure 2g - The Hydraulics!

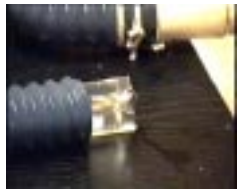

Figure 2h - The catheter tip after fully traversing the model colon

Figure 2i - The catheter tip during eversion

References

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