A method for continuous real-time measurement of the pressure exerted by the shaft of a colonoscope upon the bowel wall: an in vitro evaluation

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Background

Two of the problems with the column buckling method to measure colonoscope flexural rigidity are that it is a) an in vitro measurement and b) it can only be applied to straight elements undergoing small deflections.

Future work on the effects of colonoscope stiffness on looping formation need to include looking at what happens when the endoscope is experiencing the tortuous path and non-uniform axial loading associated with full insertion [1].

Techniques such as that described by Moss et al[2] go someway to overcoming this problem but suffer from the disadvantage that they are only measuring an externally delivered force on the shaft of the endoscope. This will at best give only a very indirect indication as to the force actually delivered to different sections of the bowel wall.

Methods

We have designed a method for accurately assessing in real time the exact pressure being exerted by an endoscope on the bowel wall.

A pressure sensing array in the form of a soft silicone conductive rubber oversleeve is attached to the surface of the colonoscope and electrically isolated from the surrounding tissue. The sensor system consists of sixty-four pressure sensitive elements arranged into an 8x8 array. Eight conductive sleeves cross eight conductive tapes at right angles so forming a mesh with each point of intersection being a pressure sensing point (see Figures 1-3).

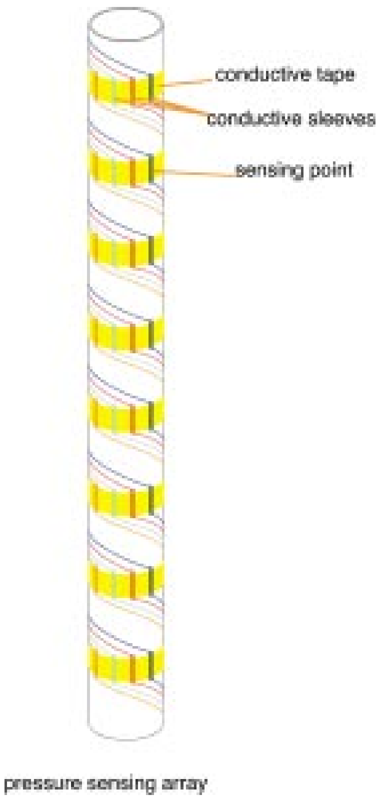

Figure 1 - Schematic view of pressure sensing system to measure pressure exerted by the shaft of the endoscope on the bowel wall. The sensor system consists of 64 pressure sensitive elements arranged into an 8x8 array. Eight conductive sleeves cross 8 conductive tapes at right angles so forming a mesh with each point of intersection being a pressure sensing point

The sixty-four elements are spaced evenly along and around the endoscope shaft as shown in Figure 1. The measured point pressure at the intersections of the conductive elements is proportional to the change of electrical resistance and it is this change which is fed into an embedded electronic circuit.

Values for the sixty-four pressure measurements are continuously displayed in real time in both tabular and graphical format on the computer screen (Figure 4). The data is currently being linked to our magnetic endoscope imaging system [3] so that we will be in a position to be able to determine exactly where along the endoscope shaft any pressure is being applied to the bowel wall.

Figure 2 – Overall view of the pressure sensing system fitted over the shaft of the colonoscope

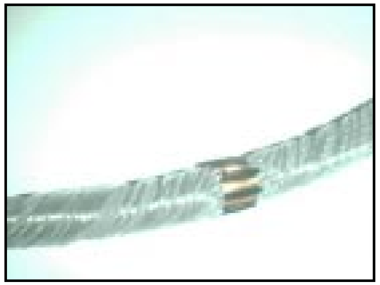

Figure 3 – Close-up view of the pressure sensing system fitted over the shaft of the colonoscope

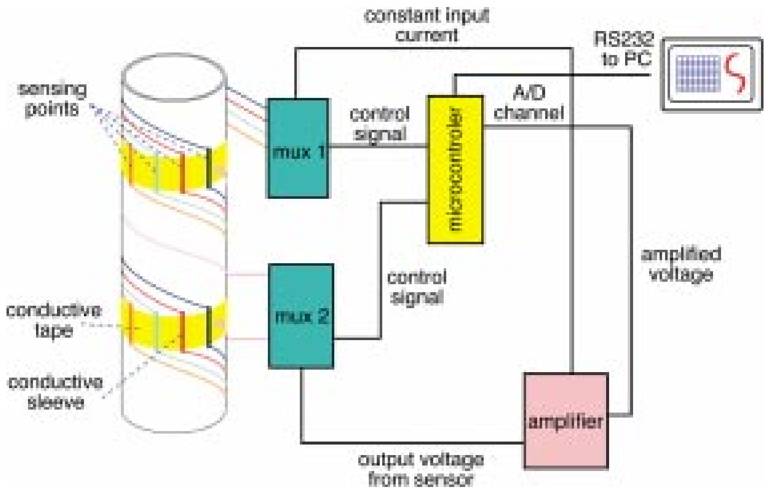

Figure 4 - Schematic diagram of the entire pressure sensing system

Conclusions

This method, which combines pressure measurement with magnetic endoscope imaging, will allow accurate and continuous real time assessment of the pressure that any colonoscope or flexible sigmoidoscope exerts on the bowel wall.

When linked to our "painometer" [4] we will be in an excellent position to study commercially available and prototype endoscopes in the hands of both trainees and experts. The combination of technologies should produce valuable information over the next few years.

References

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