An Inexpensive Method of Quality Assessment in Anastomosis Workshops

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SUMMARY: A method of comparing the quality of intestinal anastomoses performed in craft workshops is described. The equipment is readily available in any hospital, inexpensive and requires no technical construction. The apparatus accurately measures the intraluminal pressure at the first sign of anastomotic leak and a method of deriving the wall tension is explained. Calculation of wall tension at the point of failure allows comparison of anastomoses of different size. An instructor can therefore monitor the improvement of an individual trainee or rank a class according to the quality of their anastomoses.

Introduction

Military surgical doctrine still advocates universal exteriorisation or proximal faecal diversion for colonic injury on the battlefield (1). Civilian management of colonic trauma now favours selective primary repair or resection and anastomosis (2, 3). As part of a reappraisal of the colonic injury in war an anastomotic workshop study has been devised to assess a new colonic anastomotic technique using disposable skin staples (4). The study involves introducing surgeons to the new technique and recording the quality of their first attempt at an anastomosis in a portable craft workshop.

The method described is not new (5) and determination of anastomotic bursting pressure has been

widely used as a measure of intestinal wound healing (6, 7).

Craft workshops are becoming an increasingly important part of surgical training (8) but performance is usually determined by subjective assessment which is often left to the trainee. Objective measurement of performance enhances any educational endeavour. This study evaluates a simple, inexpensive method of providing objective performance data in a craft workshop.

Method

Preparation of bowel

Pig colon was harvested from the local abattoir, cleaned with running water, and cut into 30 cm lengths. The mesocolon was carefully removed and the prepared bowel segments immediately stored in normal saline at 4 degrees Celsius. All anastomoses were performed and tested within 24 hours of harvest.

Equipment required

- a) Clear perspex rectangular fish tank
- b) Venous pressure manometer set on simple stand
- c) Extension tubing incorporating a 3 way stopcock
- d) Polyfuser 1 litre infusion bag
- e) Blood administration set
- f) 60ml syringe
- g) 60ml syringe driver to deliver 20ml per min
- h) Indian ink
- i) Doyen bowel clamps — two
- j) Linen ties

Measurement of intraluminal leak pressure

The equipment is assembled as shown in Figure 1. The segment of bowel containing the anastomosis is prepared for immersion in the water bath by inserting the tubing from the manometer into one end and securing it with a linen tie. The other end of the bowel is occluded using a

Fig 1. Photograph of assembled equipment illustrating CVP manometer connected to Polyfuser infusion bag and 60ml syringe via three way tap and the 'venous' end ready for insertion into lumen of anastomosis prior to immersion in water bath. Note opening in top of polyfuser infusion bag and removal of 'Luer' lock connection from venous end of CVP manometer set.

Fig 2. Photograph of anastomosis, immersed in water bath, supported by two Doyen bowel clamps to ensure the whole circumference of the anastomosis can be observed.

Doyen clamp and the second clamp is placed over the linen tie so that the bowel can be suspended in the water bath between these two clamps (Fig 2). Twenty mls of Indian ink are added to each litre of infusion fluid to colour the infusion. The 60ml syringe in the syringe driver can be filled from the infusion bag via the three way tap and the infusion bag is raised to about 90 cms using the manometer. The bowel is filled from the infusion bag by turning the manometer tap, the manometer reading will fall, whilst the empty bowel is filling. Immediately the manometer reading starts to rise, indicating generation of intraluminal pressure, the syringe driver is switched on and the infusion switched off. Controlled inflation at 20 mls per min produces a slow rise in intraluminal pressure whilst the anastomosis is observed for the first sign of leakage. Low pressure ooze of ink is occasionally seen but failure pressure should be recorded when the first gush of ink is observed to exit under pressure (Fig 3).

Fig 3. Failure pressure is recorded when ink is observed to emerge under pressure usually manifest by a fine jet of ink from a readily identifiable spot as demonstrated in this photograph.

Calculation of failure wall load

The point of failure can be marked with babcock forceps and the doyen clamps removed from the bowel. The empty bowel is then removed from the water bath and the anastomosis excised with a 1cm cuff of normal bowel each side. The ring of bowel containing the anastomosis is opened and laid flat allowing inspection of the intraluminal aspect of the anastomosis which may reveal a technical failure at the point of leakage. The circumference of the anastomosis is measured directly using a ruler on the opened specimen which should be gently pulled into a straight line.

The wall load (force/unit length) in a tube of finite wall thickness is calculated by multiplying the intraluminal pressure by the radius of the tube. The radius of a circle is equal to the circumference divided by a constant and is therefore directly proportional to the circumference.

Wall load, in arbitrary units, can be calculated by multiplying intraluminal pressure by circumference. This method of deriving wall tension does not attempt to provide an absolute measurement of circular wall stress/tension; it is designed to give a quick, simple way of comparing the performance of anastomoses of different diameter.

Results

Table 1 shows the results obtained from testing anastomoses performed by the author to standardise the equipment. Half the anastomoses were created using Gambee suture technique with 3/0 vicryl sutures and

Table 1
Leak Pressure — Anastomoses Performed by Author

No.	Type of Anastomosis	Leak Pressure (cms of water)	Circumference (Centimetres)	Circular Wall load (Arbitrary units)
1	Sutured	21.5	14.0	301
2	Sutured	34.8	9.1	317
3	Sutured	21.5	16.8	361
4	Sutured	39.8	13.7	545
5	Sutured	38.8	14.7	570
6	Stapled	85.4	11.6	991
7	Stapled	57.2	18.4	1052
8	Stapled	97.0	11.2	1086
9	Stapled	100.0	11.9	1190
10	Stapled	80.9	16.3	1319

Intraluminal leak pressure, Anastomotic circumference and derived circular wall load for 10 anastomoses performed by the first author, on fresh pig colon, to standardise the equipment. Sutured anastomoses performed using Gambee technique with 3/0 vicryl. Autosuture premium 35W disposable skin stapler used for skin staple technique described by Fackler (9).

Table 2
Anastomatic Leak Pressure — Workshop of 8 Students

Student Number	Leak pressure (cms of water)	Circumference (centimetres)	Circular Wall load (Arbitrary units)
7	0	0	0
5	8.3	14.2	118
4	11.0	14.2	157
1	13.5	16.5	223
6	24.2	17.0	411
8	40.5	15.5	628
3	69.5	12.5	869
2	90.5	11.7	1059

Intraluminal leak pressure, anastomotic circumference and derived circular wall load for 8 skin stapled anastomoses on fresh pig colon performed by military operating theatre staff after watching a 20 minute video presentation introducing the technique.

other half were fashioned using Autosuture's premium 35W disposable skin staples according to a technique previously described by Fackler (9).

All anastomoses were observed to fail at stitch or staple insertion holes except numbers 1, 2, 7 and 10. Number 1 failed at a serosal tear caused by over-tightening of a suture. Number 2 failed in between two sutures where a tenia coli crossed the anastomotic line. Number 7 failed in between two staples placed 7mm apart and where inversion of the serosa was incomplete on inspection of the lumen. Number 10 anastomosis remained intact but the bowel wall failed away from the staple line.

Table 2 shows the results from a 'Dress Rehearsal' for the anastomotic workshop study where 8 military operating theatre staff were shown a 20 minute video demonstrating the skin stapled colonic anastomotic technique and immediately invited to perform an anastomosis on fresh pig colon. Student 2 was a surgeon with previous experience of skin stapled anastomosis whose anastomosis was as good as the first author's. Student 7 succeeded in picking up the opposite wall of the bowel with stay sutures and created an anastomosis without a lumen! Student 8 produced a macroscopically sound anastomosis which leaked at multiple staple insertion holes which represented 'heavy handedness' with the staple gun. All other students had technical flaws in their anastomoses, the most common being failure to invert adequately the serosa at some point; although the quality of student 3's anastomosis appears satisfactory despite this flaw.

Discussion

Assessment of anastomotic integrity during surgery can be performed using air insufflation whilst the

anastomosis is immersed thus demonstrating the absence of an air leak. Anastomotic failure pressure is often measured during research on intestinal healing. The clinical method provides a good subjective assessment of integrity whilst the laboratory method involves accurate measurement of an easily reproducible end point. Assessment of anastomotic quality in an educational setting should combine the accurate measurement of a clinically relevant end point with the ability subjectively to observe the performance of the anastomosis to controlled stress.

When comparing anastomoses, simple intraluminal failure pressure does not take into account differences in bowel diameter. The circular wall load produced by a given intraluminal pressure is proportional to the radius of the anastomosis. Calculation of the circular wall load at the point of anastomotic leakage provides a measurement of performance that can be used to compare anastomoses performed on bowel of different diameters.

The method designed for our study produces accurate data without resorting to complex, expensive laboratory equipment and allows critical inspection of the anastomosis after its 'quality' has been determined. The equipment is simple, economic and portable allowing quality assessment to be performed at any anastomotic workshop.

Anastomosis workshops are considered to be good surgical education by trainees who attend them but can be formidable undertakings for the organisers (10, 11). Performance is usually based on subjective assessment by an instructor or not infrequently left to the trainee to make up his own mind. Subjective assessment does not always demonstrate technical flaws as shown in this study. Objective assessment increases the educational benefit and was observed to instil an element of competition which should improve performance. Incorporation of regular craft workshops into a surgical department's postgraduate teaching program would allow surgical tutors to monitor the progress of trainees. This study demonstrates the feasibility of setting up In-house anastomotic workshops and describes a simple effective method of quality assessment.

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