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Accurate assessment of bowel length: the method of measurement matters



Eleanor D. Muise, MD,^a John J. Tackett, MD, MHS,^a
 Kevin A. Callender, MS,^b Neeru Gandotra, PhD,^a
 Michaela C. Bamdad, MD, MHS,^a and Robert A. Cowles, MD^{a,*}

^aSection of Pediatric Surgery, Department of Surgery, Yale University School of Medicine, New Haven, Connecticut

^bDepartment of Psychology, Yale University, New Haven, Connecticut

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ABSTRACT

Purpose: Small intestinal length has prognostic significance for patients with short bowel syndrome, and accurate measurement of Roux-en-Y limbs is considered important. The flexible elasticity of bowel makes its measurement highly subjective, yet a recommended method for intestinal measurement allowing accurate comparisons between surgeons remains undefined. Measurement of intestinal length has been described, but no comparison of the fidelity of measurement technique has been made. We hypothesized that silk suture and umbilical tape would yield the most consistent measurements.

Methods: This institutional review board–approved prospective trial enrolled 12 volunteer surgeons and two Institutional Animal Care and Use Committee–donated rabbits. Participants were asked to measure short, medium, and long segments of small intestine in a euthanized rabbit using common operating room tools: 18-in silk suture, 75-cm umbilical tape, 15-cm straight ruler, laparoscopic Dorsey bowel graspers. Data were analyzed by analysis of variance repeated measures model.

Results: Over short segments, intestinal measurements by grasper were significantly shorter than those by tape ($P = 0.002$) and ruler ($P = 0.039$). Over medium lengths of bowel, measurements by grasper were significantly shorter than those by suture ($P = 0.032$) and tape ($P = 0.046$), and measurements by ruler also were significantly shorter than those by suture ($P = 0.008$). Over the long intestinal segment, measurements by ruler resulted in the greatest variability, and comparison of variance across all possible pairs of groups found significant difference by method of measurement ($P = 0.049$). There was a significant difference in measurements taken along the mesenteric border compared with those taken along the antimesenteric border ($P = 0.001$).

Conclusions: Measurement technique along short segments matters less; however, rigid tools underestimate length, and smaller variances in measurement by silk suture and umbilical tape suggest that these methods are more reliable across longer distances.

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* Corresponding author. Section of Pediatric Surgery, Yale School of Medicine, 333 Cedar St, FMB 131, PO Box 20862, New Haven, CT 06520. Tel.: +1 203 785 2701; fax: +1 203 785 3820.

E-mail address: robert.cowles@yale.edu (R.A. Cowles).

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Introduction

The method used to measure the small bowel, in great part, determines the reported segment length; yet, no standard technique to quantify bowel length has been accepted by surgeons. Sir Frederick Treves is said to have delivered a lecture entitled “The Anatomy of the Intestinal Canal and Peritoneum in Man” at the Royal College of Surgeons in 1923, in which he stated that the last verse on human anatomy had been written and could be learned entirely from a textbook.^{1,2} Treves’ lecture was criticized by Bryant, who identified early variation in intestinal length and suggested the importance of the method of measurement in reducing variability in measurement of intestinal length.² Small intestinal length has functional and prognostic significance for patients with short bowel syndrome, and this makes accurate and consistent measurement important in predicting outcomes for physicians and families.^{3,4} Unfortunately, factors such as the flexibility and elasticity of the bowel make its measurement highly subjective and variable. An optimal method for measurement of intestinal length that minimizes variability and allows for accurate comparison between surgeons and institutions is therefore needed. We hypothesized that techniques using lengths of silk suture and umbilical tape would yield the most consistent measurements when compared with the use of commonly available plastic rulers and laparoscopic bowel graspers.

Methods

This institutional review board–approved prospective trial enrolled 12 volunteer surgeons and two Institutional Animal Care and Use Committee–donated 6-kg rabbits. The study was conducted in two phases. The initial phase consisted of measurement of a fixed curvilinear distance of paper 10 times using common operating room tools: 18-in silk suture, 75-cm umbilical tape, standard 15-cm straight ruler, and laparoscopic Dorsey bowel graspers. Baseline data determined that five measurements by each method would be sufficient for the second phase of the study because with five measurements, the average lengths were within one standard deviation of the mean across all methods. During the second phase, short, medium, and long segments of small intestine in a euthanized rabbit were suture ligated and kept intracorporeal for measurement (Fig. 1). Twelve volunteer surgeons (attending surgeons and senior general surgery residents) completed measurements and answered a series of questions to determine the perceived accuracy, efficiency, and familiarity with each method. An observer recorded whether measurements were taken on the mesenteric or antimesenteric aspect of the bowel. Laparoscopic Dorsey bowel graspers were omitted from long segment measurement as the clear inaccuracy of this method became evident after measurement of shorter lengths of bowel. Data were analyzed by analysis of variance repeated measures model, with variance compared using Mauchly’s test for sphericity and Levene’s test.

Results

Over short segments (grand mean across all methods for this segment length, $M = 20.88 \pm \text{SEM}1.83$ cm), intestinal measurements by laparoscopic grasper (18.58 ± 1.96 cm) yielded significantly shorter lengths than those by tape (23.52 ± 2.23 cm, $P = 0.002$) or ruler (20.95 ± 1.83 cm, $P = 0.039$) and not significantly different lengths from what were measured by suture (20.50 ± 1.82 cm, $P = 0.105$). Over medium lengths of bowel ($M = 37.33 \pm 1.29$ cm), measurements by laparoscopic grasper (34.63 ± 1.87 cm) yielded significantly shorter measurements than those obtained by suture (39.09 ± 1.19 cm, $P = 0.032$) and tape (39.63 ± 1.88 cm, $P = 0.046$), and measurements by ruler were also significantly smaller than those by suture (35.96 ± 1.17 cm, $P = 0.008$). Over long segments of small intestine ($M = 104.04 \pm 3.83$ cm), no significant differences were found between measurements by suture (103.40 ± 5.45 cm), tape (109.85 ± 3.79 cm), or ruler (98.88 ± 8.34 cm), although measurements by ruler underestimated length and resulted in the greatest variability. Interestingly, there was a significant difference in measurements taken along the mesenteric border when compared with those taken along the antimesenteric border of the small bowel (85.33 ± 6.64 cm versus 122.75 ± 3.83 cm, $P = 0.001$; Fig. 2).

Mauchly’s test for sphericity, a test of homogeneity of variance, tests the assumption that the differences between variances comparing all possible pairs of groups are equal. Mauchly’s test for sphericity revealed no significant differences in variance in measurement of short or medium length segments ($P = 0.733$ and $P = 0.069$, respectively) and found a significant difference in measurement of the long segment by method of measurement ($P = 0.049$, Mauchly’s $W = 0.511$, $df = 2$). Based on Levene’s test, a second test of homogeneity of variance, there was a marginally significant difference in the variation between measurement locations, such that mesenteric measurements had less variation than antimesenteric measurements (13.33 versus 21.12 , $P = 0.057$).

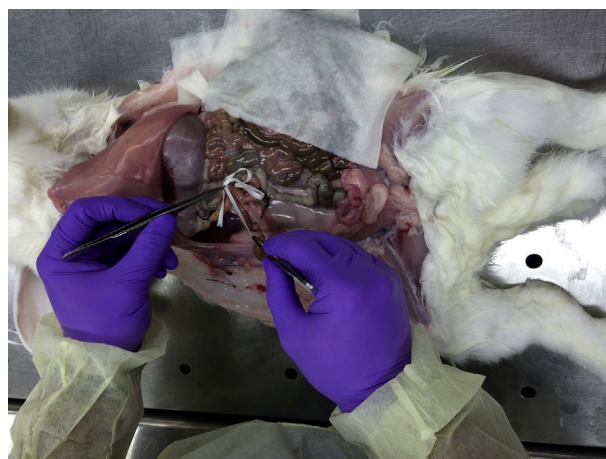


Fig. 1 – Measurement of small intestinal length with umbilical tape in a 6-kg rabbit. (Color version of figure is available online.)

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