ORIGINAL ARTICLE

Laparoscopic Instruments Marking Improve Length Measurement Precision

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Abstract

Introduction: Bariatric surgery has increased the demand for accurate laparoscopic bowel length measurement. Measures to achieve such precision are scarce in the medical literature. Our study investigates the effect of instruments marking on measurement precision.

Methods: Eight consultants and fourteen senior trainees with laparoscopic experience were asked to estimate 150 cm on a piece of string fixed within a standard laparoscopic training stack. Each candidate carried out three pairs of measurement using standard laparoscopic instruments without marking, with 10 cm and with 5 cm mark. Each measurement was timed separately. Candidates were result blinded to prevent any self-correction. Data were analyzed using Bland-Altman plots along with ANOVA tests.

Results: Greater accuracy was achieved via marked instrumentation, the differences being statistically significant ($P < 0.01$). The improvement was significant regardless of candidates' level or initial length judgment. Time was almost doubled for the marked measurement. No statistically significance differences were found between the 5 or 10 cm instrument markings for measurement or time.

Conclusions: Marked laparoscopic instrument is a simple and effective way of enhancing length measurement precision regardless of surgeons' experience.

Keywords: Laparoscopy, instrument length measurement, bariatric surgery, laparoscopic instrument design.

INTRODUCTION

Bowel length measurement has always been a part of surgical practice, whether it is performed for Michel's diverticulum[1] or to avoid short bowel syndrome during bowel resection. The introduction and evolution of barbaric surgery has increased the demand for measurement precision. Early bariatric surgical attempts in 1950s adopted the malabsorption approach by creating short bowel syndrome.[2,3] Following the same principle, the Jejunocolic bypass was introduced followed by, the jejunoileal bypass.[4] Along with its side effects of mineral and vitamins loss, purely malabsorption procedures failed to maintain weight loss due to bowel adaptation.[5] The gastric restriction approach followed in the 1960s with gastric pouch and Billroth II gastrectomy.[6] Following the popularity of Roux-en-Y anastomosis in 1970s,[7] Mason started to perform gastric pouches with various lengths of jejunal Roux-en-Y anastomosis. Various gastroplasty and gastric banding approaches were developed under the same gastric restriction umbrella that lacked the malabsorption concept. The current approach in bariatric surgery combines the two principles of malabsorption and gastric restriction. The two dominant operations under this approach are biliopancreatic diversion[8] and the duodenal switch.[9] Both operations use the jejunal Roux-en-Y anastomosis approach.

Joining the laparoscopic era in the 1990s the first laparoscopic procedure was gastric banding.[10] Gastric bypass followed in 1994,[11] and hence the demand for accurate laparoscopic bowel length measurement started. Currently the recommendation for roux limb varies according to the body mass index, namely 75, 150, 200 and 250 cm for patients with body mass indices of less than 40, 40 to 50, greater than 60 and 70 to 80 respectively.[12] Despite the demand for length precision, there is as yet no consensus regarding a standard approach for laparoscopic measurement. The majority of laparoscopic instruments are not length marked; therefore unguided estimation of length is common practice. One study suggested that a 5 cm groove mark be introduced to the Babcock shaft to help standardize bowel length measurements.[12] Two text books hinted at the possibility of using a special bowel grasper with 10 cm marking, premeasured umbilical tap or a ruler for length measurement without ruling out the established length estimation practice.[13,14]

Multiple factors affect the laparoscopic vision including lens magnification, distance from the object, resolution, depth of the field and optical light transmission.[15] Magnification is well known to change length perception as there is an inverse association between magnification and length perception. This effect is well-established even when background landmarks are given.[16] All these effects will impair length estimation under laparoscopic vision.

This study was designed to investigate the difference between estimation and length measurement using marked and unmarked instruments, and to look at other factors that might influence precision.

METHODS

Twenty-two surgeons with previous laparoscopic surgery exposure were recruited to the study, eight consultants and eleven senior surgical trainees at Sunderland city hospital general surgical department. Three visiting senior trainees from Gateshead Health NHS Foundation Trust were also included. Candidates were asked to estimate 150 cm on a piece of string fixed within a standard laparoscopic training stack. The string length was four meters and was fixed at both ends. The laparoscopic camera was held on a metal fixed holder to eliminate human movement and any depth of field effects on the magnification. The experiment consisted of three phases. During the first phase each candidate carried out the estimation twice, one from each fixed string end, using standard laparoscopic instruments without marking. Candidates judged length via a range of values from 2 to 20 cm incrementally in order to estimate the target length of 150 cm. These increments were classified into three groups as 5 cm or less, 10 cm and 15 cm or more. The estimated 150 cm length on the string was marked with the laparoscopic autoclip applicator. Each measurement was timed independently. The estimated lengths were measured and the clips were removed before the next phase. Candidates were oblivious of their results and string length to prevent any self-correction. The experiment was repeated twice after marking the same instrument at 10 cm and at 5 cm level respectively.

STATISTICAL ANALYSIS

Data were analyzed using Bland-Altman plots along with ANOVA tests.

RESULTS

Using an unmarked instrument, half the candidates initially attempted to estimate length in 10 cm increments in order to achieve the 150 cm target. Seven candidates initially opted for 5 cm increments and two chose 15 cm increments. Only one candidate judged 2 cm and 20 cm respectively (Fig. 1).

Bland-Altman plots were used to analyze and visualize the results by comparing the average of the two attempts for each of the three scenarios against the differences (Figs 2 to 4). By comparing the plots one can see the magnitude of errors obtained via each of the three methods. The distributions are clustered tighter around the target value of 150 cm when using the 5 and 10 cm guide marks. The error between measurements was also considerably reduced when using the 5 cm guide (Figs 2 to 4).

Therefore candidates might have gained a practicing advantage while conducting the other two. In order to investigate this further, ANOVA tests were performed on the measurement and the time data.

The mean of the measurements estimated using the unmarked instrument was 115.4 cm compared to 139.0 cm and

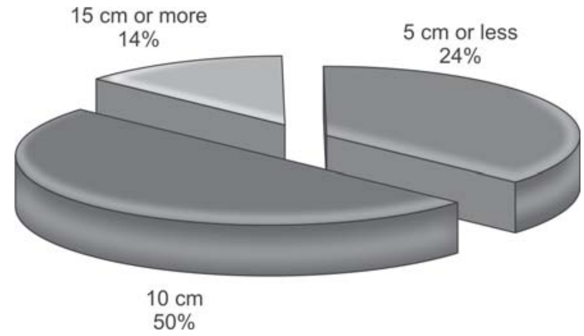

Fig. 1: The percentage of candidates who chose 5 cm or less, 10 cm or 15 cm or more as their repeated measuring unit

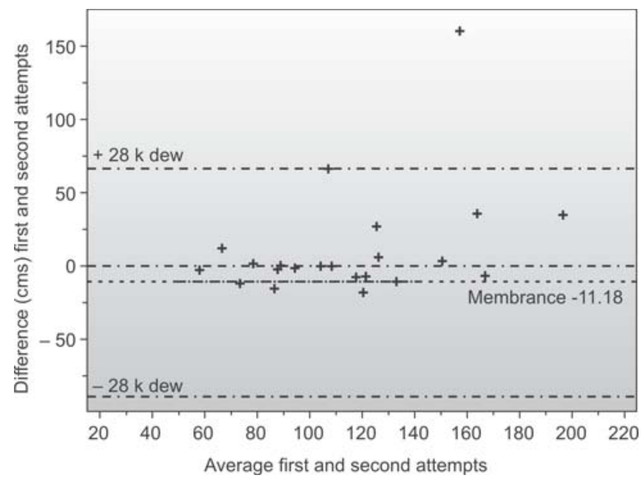

Fig. 2: Bland-Altman plot for attempts without guide marks. The graph represents the mean of the two attempts as the (X-axis) value, and the difference between the two attempts as the (Y-axis) value. Ideally the points should be on 150 cm at the X-axis and on zero on the Y-axis

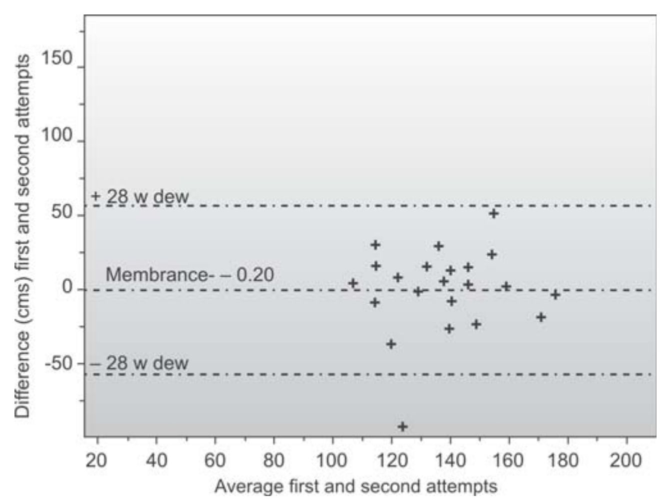

Fig. 3: Bland-Altman plot for attempts using 10 cm guide mark. The graph represents the mean of the two attempts as the (X-axis) value, and the difference between the two attempts as the (Y-axis) value. The distributions are clustered tighter around the target value of 150 cm than the nonguide mark attempts

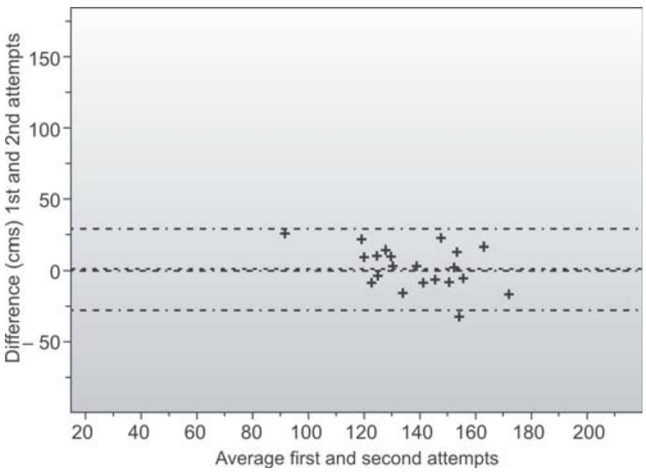

Fig. 4: Bland-Altman plot for attempts using 5 cm guide mark. The graph represents the mean of the two attempts as the (X-axis) value, and the difference between the two attempts as the (Y-axis) value. The distributions are clustered tighter around the target value of 150 cm than the nonguide mark attempts. The error between measurements was also considerably reduced when using the 5 cm guide

137.5 cm when 5 cm and 10 cm marked instruments were used respectively. The improvement was statistically significant between the unmarked and marked measurements, with P values of 0.001 and 0.002 for the 5 cm and 10 cm marking respectively (Table 1 and Fig. 5). The mean distance from target was reduced from 34.6 cm for the unmarked to 12.5 cm and 11.0 cm for the 10 cm and 5 cm marked measurements respectively. Although candidates found the 10 cm marking harder to use due to field vision limitation, no statistical significant difference was found between the two markings. Even when we included the candidates' initial judgment, the difference between 5 cm and 10 cm remained statistically insignificant. Although senior trainees did slightly better than consultants, the experience level of the candidate was not a significant factor.

Interestingly, time was almost doubled from 2.5 minutes for the unmarked instrument to 4.1 and 3.9 minutes for the 5 cm and 10 cm marked measurement respectively (Fig. 6). Although 5 cm marking requires 30 repeated measurements to achieve the 150 cm as opposed to 15 ones in the case of 10 cm marking, the difference in timing between the two markings was not statistically significant.

Table 1: Using ANOVA tests the improvement was statistically significant between the unmarked and marked measurements, with P values of 0.001 and 0.002 for the 5 cm and 10 cm marking respectively

Guide line comparisons	*Mean difference*	*Std. error*	*P value*	*95% confidence interval Lower bound*	*Upper bound*
None *vs* 5 cm	–23.6	6.2	0.001	–38.7	–8.5
None *vs* 10 cm	–22.1	6.2	0.002	–37.5	–7.0
5 cm *vs* 10 cm	1.43	6.2	1.00	–13.7	16.6

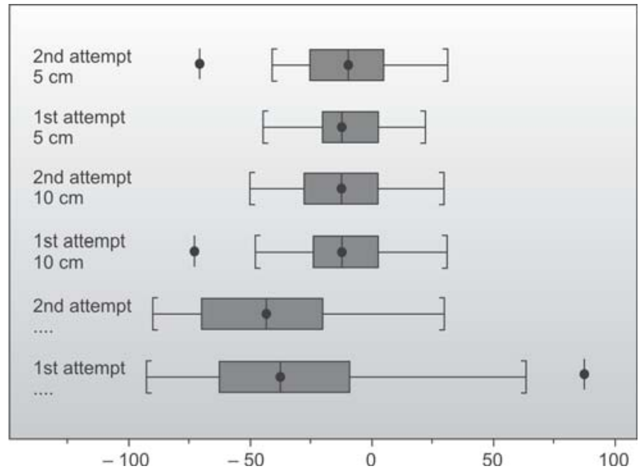

Fig. 5: Boxplots showing distributions of distance from target by guide mark. The mean distance from target was reduced between unmarked and marked measurements

CONCLUSION

Multiple factors affect laparoscopic length estimation. Amongst them, magnification plays a major impact on surgeon's length judgment. Such estimation cannot be trusted to give accurate measurements. Marking the laparoscopic instruments on 5 cm and/or 10 cm levels improved length measurement accuracy considerably. This improvement is not related to surgeon's initial experience or length judgment. Although measurement time was almost doubled, there was a considerable increase in the measurement accuracy. This extra time is well justified under these circumstances. Bowel stretch was not counted for in our experiment since it was carried out on a piece of string. Despite this difference between live bowel measurements and our experience, our results are still valid since bowel stretch will have a minute impact on length precision.

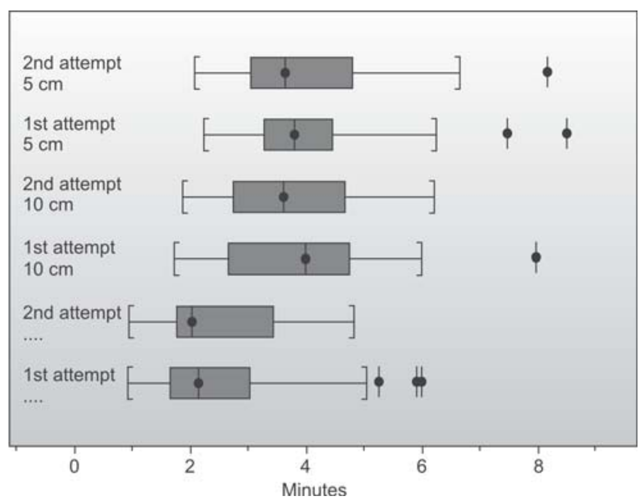

Fig. 6: Boxplots showing distributions of 'time to complete' by guide mark. Time was almost doubled between the unmarked instruments and the marked measurements

However gauging the impact of this requires a standardized method of measurement to be in place before such an effect could be investigated. As a result, we suspect that bowel grasper marking will provide the ideal standard measurement method as it will eliminate the bias in the current estimation practice.

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