Anatomical siting of the splenic flexure using computed tomography

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ABSTRACT

INTRODUCTION Often, left-sided colorectal surgery requires splenic flexure mobilisation (SFM) to allow a tension-free anastomosis to be carried out. This step is difficult and not without risk. We investigated a system of anatomical siting of the splenic flexure using computed tomography (CT).

METHODS The Shrewsbury Splenic Flexure Siting (SSFS) system involves siting of the splenic flexure using the vertebral level (VL) as a reference point. We asked three surgical registrars (SRs) to analyse 20 CT scans of patients undergoing colonic resection to ascertain the anatomical site of the splenic flexure using the SSFS system. The distance from the centre of the vertebral body to the lateral edge (CVBL) of the splenic flexure was measured, as was the distance from the centre of the vertebral body to the inner abdominal wall (CVBI) along the same line, on axial images.

RESULTS VL assessment demonstrated substantial inter-observer agreement with a kappa (κ) value of 0.742 (95% confidence interval (CI), 0.463–0.890). CVBL and CVBI demonstrated very strong inter-observer agreement (CVBL: κ = 0.905 (95% CI, 0.785–0.961); CVBI: 0.951 (0.890–0.979) ($p < 0.001$). Overall, there was strong correlation between assessments by all three SRs across the three variables measured.

CONCLUSIONS The SSFS system is an accurate method to site the splenic flexure anatomically using CT. We can use the SSFS system to develop a validated scoring system to help colorectal surgeons assess the difficulty of SFM.

KEYWORDS

Computed tomography – Splenic flexure – Colorectal surgery – Vertebral level

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Often, left-sided colorectal surgery requires splenic flexure mobilisation (SFM) to allow a tension-free anastomosis to be carried out.¹ This step is technically difficult and not without risk. There may be splenic trauma leading to bleeding and, therefore, the possible requirement to proceed to splenectomy,^{2–4} which is associated with reduced 30-day and 5-year survival.⁵ SFM is also associated with longer operative time regardless of surgery type.^{5,6}

We hypothesised that the difficulty of SFM is related to the anatomical height of the splenic flexure (ie difficulty increases with distance from the midline). Studies using computed tomography (CT) for anatomical assessment of the splenic flexure are lacking. Here, we report a system of anatomical siting of the splenic flexure using CT.

Methods

The Shrewsbury Splenic Flexure Siting (SSFS) system involves siting of the splenic flexure using the vertebral level (VL) as a reference point. The splenic flexure was defined as ‘the most superior and lateral aspect of the transverse colon in relation to the splenic hilum on CT’ to allow accurate repeatable siting between observers.

VLs were separated into different levels to allow for accurate siting. Each VL was split into three distinct parts: the intervertebral disc at the lower most aspect of the corresponding vertebra; the lower half of the vertebral body; the upper half of the vertebral body (Fig 1). Coronal and axial CT views were compared in parallel.

The first step was to align the coronal image set on vertebral bodies (Fig 2). Second, axial images were scrolled to the uppermost aspect of the splenic flexure (Fig 3), which corresponded to a level bar on coronal images (Fig 4) and allowed calculation of the VL of the splenic flexure. Third, the distance from the centre of the vertebral body to the lateral edge (CVBL) of the splenic flexure (Fig 5) was measured, as was the distance from the centre of the vertebral body to the inner abdominal wall (CVBI) along the same line (Fig 6), on axial images.

We asked three surgical registrars (SRs) to assess 20 CT scans of patients (10 male and 10 female) undergoing colonic resection to ascertain the anatomical site of the splenic flexure using the SSFS system. The picture archiving and communication system of our hospital was used to view CT scans and undertake the required measurements. All SRs calculated their measurements independently and

were blinded to measurements undertaken by the other SRs to avoid bias.

Then, measurements were collated centrally and analysed using SPSS v22 (IBM, Armonk, NY, USA). Intra-observer variation was calculated using two-way average-measure mixed intraclass correlations.

Results

VL assessment demonstrated substantial inter-observer agreement with a kappa (κ) value of 0.742 (95% confidence interval (CI), 0.463–0.890). CVBL and CVBI demonstrated very strong inter-observer agreement (CVBL: κ = 0.905 (95% CI, 0.785–0.961); CVBI: 0.951 (0.890–0.979) ($p < 0.001$). Overall, there was strong correlation between assessments by all three SRs across the three variables measured.

Discussion

This pilot study was designed to ascertain if the SSFS system could be applied accurately by different observers to site the splenic flexure on CT. Statistical analyses showed

Figure 5 Axial image used for measuring the distance from the centre of the vertebral body to the lateral edge (CVBL)

an acceptable correlation between the three SRs in 20 scans, thus allowing us to use this system with confidence in a much larger sample. It is likely that, had we enrolled more observers with more scans, the correlation coefficient would have been >0.8 .

One difficulty is formal definition of the splenic flexure on CT because it does not exist. Our definition was agreed after discussion by the study designer along with a consultant radiologist in our hospital. It was felt that this section of the splenic flexure would be the most easy to recognise. This definition is crucial for achieving correlation between observers, and must be adhered to rigidly otherwise considerable variation in results can result.

There are two scenarios in which the SSFS could not be used. The first is CT colonography ('virtual colonoscopy'), in which the left side is insufflated with air. Such insufflation produces anatomical distortion by artificial elevation of the colon into the abdomen, thereby showing the splenic flexure at a much higher VL. Second, patients who have had left-sided colonic surgery are not suitable for this method of measurement.

The SSFS was developed so that the surgeon could anticipate if SFM would be difficult and allow him/her to

Figure 6 Axial image used to measure the distance from the centre of the vertebral body to the inner abdominal wall (CVBI)

plan operative strategies to counter this problem. The present study has shown that the measurements required can be made accurately. Hence, the next step is to develop a scoring system and validate the SSFS against subjective reports from surgeons with regard to the difficulty they have encountered during SFM.

Conclusion

The SSFS system is an accurate method to site the splenic flexure anatomically using CT. We can use the SSFS system to develop a validated scoring system to help colorectal surgeons assess the difficulty of SFM.

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