Received: 15 September 2022 | Revised: 1 February 2023 | Accepted: 9 February 2023

DOI: 10.1111/codi.16537

ORIGINAL ARTICLE

"Happy to close?" The relationship between surgical experience and incisional hernia rates following abdominal wall closure in colorectal surgery

Laurie Smith[1,2] | Alexandra Coxon-Meggy[1,2] | Michael Shinkwin[1] | Julie Cornish[1] | Alan Watkins[3] | Greg Fegan[3] | Jared Torkington[1] | on behalf of the HART Trial Collaborators[†]

[1]Department of Colorectal Surgery, University Hospital of Wales, Cardiff, UK

[2]Cardiff University, Cardiff, UK

[3]Swansea Trials Unit, Swansea University Medical School, Swansea, UK

Correspondence
Laurie Smith, Department of Colorectal Surgery, University Hospital of Wales, Cardiff, UK.
Email: laurie.smith@wales.nhs.uk

Abstract

Aim: Incisional hernia (IH) is a common complication of colorectal surgery, affecting up to 30% of patients at 2 years. Given the associated morbidity and high recurrence rates after attempted repair of IH, emphasis should be placed on prevention. There is an association between surgeon volume and outcomes in hernia surgery, yet there is little evidence regarding impact of the seniority of the surgeon performing abdominal wall closure on IH rate. The aim of our study was to assess the rates of IH at 1 year following abdominal wall closure between junior and senior surgeons in patients undergoing elective colorectal surgery.

Methods: This was an exploratory analysis of patients who underwent elective surgery for colorectal cancer between 2014–2018 as part of the Hughes Abdominal Repair Trial (HART), a prospective, multicentre randomised control trial comparing abdominal wall closure methods. Grade of surgeon performing abdominal closure was categorised into "trainee" and "consultant" and compared to IH rate at one year.

Results: A total of 663 patients were included in this retrospective analysis of patients in the HART trial. The rate of IH in patients closed by trainees was 20%, compared to 12% in those closed by consultants (p = <0.001). When comparing closure methods, IH rates were significantly higher in the Hughes closure arm between trainees and consultants (20% vs. 12%, p = 0.032), but not high enough in the mass closure arm to reach statistical significance (21% vs. 13%, p = 0.058). On multivariate analysis, age (p = 0.036, OR: 1.02, 95% CI: 1.00–1.04), Male sex (p = 0.049, OR: 1.61, 95% CI: 1.00–2.59) and closure by a trainee (p = 0.006, OR: 1.85, 95% CI: 1.20–2.85) were identified as risk factors for developing IH.

Conclusion: Patients who undergo abdominal wall closure by a surgeon in training have an increased risk of developing IH when compared to those closed by a consultant. Further work is needed to determine the impact of supervised and unsupervised

[†]See Appendix A for all members HART Trial Collaborators.

trainees on IH rates, but abdominal wall closure should be regarded as a training opportunity in its own right.

KEYWORDS
abdominal wall closure, incisional hernia, surgical training

INTRODUCTION

Incisional hernia (IH) is a common complication of colorectal cancer surgery with rates at 2 years following surgery of 30% [1]. It is a source of significant morbidity to patients which negatively impacts on their quality of life, and is costly to treat [2]. It is in the interests of patients, clinicians, and the healthcare system to find ways of reducing the rate of occurrence of IH.

Risk factors for developing IH are diverse. Patient risk factors include raised body mass index (BMI), diabetes mellitus, increasing age and previous intra-abdominal surgery [3,4]. Surgical risk factors include emergency surgery, location of abdominal incision, abdominal wall closure (AWC) technique and postoperative wound infection [4]. Despite extensive research into surgical risk factors, there has been little change in the rates of IH after abdominal surgery, from Jenkins [5] who reported IH rate of 13% in 1976, to 13% reported in the 2015 Small bite, Small Stitch (STITCH) trial [6]. An understanding of modifiable risk factors is key to reducing patients' overall risk of IH.

Opening and closing the abdomen has traditionally been one of the first operations a trainee surgeon learns to perform, and "mass closure" techniques are taught on basic surgical skills courses to junior doctors and surgical trainees around the world [7]. Recent studies, such as the STITCH trial and the Hughes abdominal repair trial (HART), have moved away from traditional mass closure and place emphasis on meticulous surgical technique [6,8]. This has led to variation in closure techniques between individual surgeons. Abdominal closure, historically in many health care systems, has been left to the trainee to perform often with junior assistance, and at the end of a long operation. Trainees who find themselves working for multiple consultants may be expected to perform several different closure techniques at the same time.

The relationship between surgeon experience and surgical outcomes has been well documented. A systematic review published in 2015 by Maruthappu et al. concluded that increasing surgical volume and years of practice are associated with improved performance and clinical outcomes across surgical specialties [9]. A 2005 study by Langer et al. found that recurrence rates after incisional hernia repair significantly decreased with increasing surgical experience; however, the impact of surgical experience on primary abdominal closure to prevent IH has rarely been reported [10].

There is mounting evidence to suggest that a surgeon's experience plays a role in surgical outcomes and focus is shifting towards risk-reduction in prevention of IH, but the impact of the grade of the surgeon closing the abdomen and rates of IH following abdominal surgery is unknown. Here, we aimed to test our hypothesis that the grade of surgeon performing AWC impacts the incidence of IH.

What does this paper add to the literature?

There is a positive correlation between experience and outcomes in surgery. This study is the first to highlight the difference in incisional hernia rates between trainee and consultant grade surgeons when performing abdominal wall closure. AWC is a training opportunity and independent trainee closure should be competency based.

METHODS

HART data

This was an unplanned retrospective analysis using data obtained from the Hughes Abdominal Repair Trial (HART); a prospective, multicentre randomised control trial of 802 patients, comparing the Hughes abdominal closure method with mass closure technique of the operating surgeon's choice [1]. Patients were recruited between 2014–2018 and had baseline demographics collected at inclusion. All patients underwent surgery for colorectal cancer and were included if they had a midline incision over 5 cm long, regardless of whether their surgery was laparoscopic or open.

Patients were randomised into two methods of AWC. The control arm was mass closure technique of the operating surgeon's choice, compared to the interventional arm; closure using the Hughes abdominal repair method (Hughes technique); a technique combining standard mass closure using two loop 1-PDS sutures with interrupted near-far horizontal and vertical mattress sutures using 1 Nylon.

To assure standardisation of technique, all participating consultant surgeons received training on the Hughes repair and were assessed by the study team before the start of the trial and approved only when closure technique was satisfactory. The study team did not provide formal training to trainees; a cascade training process was followed where site leads could sign off colleagues including trainees in the technique before they could perform closure within the context of the trial. Formal documentation of this training

process was not required, and standardisation of the cascade training was not assessed.

The primary endpoint of the HART study was presence of incisional hernia on clinical examination by a trained physician at 1 year.

Patient identification

Patients participating in the HART trial were included if they had clinical examination for presence of incisional hernia at 1 year and had the grade of surgeon performing AWC recorded.

Baseline demographics, including age, gender, BMI, previous abdominal surgery, smoking history, and type of surgery were collated and can be seen in Table 1. Grade of surgeon closing the abdominal wall was collected and categorised into "trainees" (training grade surgeons on a specialty training programme, equivalent to registrar/resident level) and "consultants" (those who have a qualification of completion of clinical training [CCT], and hold a consultant position at time of surgery).

Statistical analysis

Data was collected using MACRO and analysed using SPSS version 27.0. Continuous numerical variables were assessed using *F*-tests and unpaired sample *t*-tests. Categorical variables were assessed using Pearson's chi-square test and Fisher's exact test, where necessary. The level for significance was set at the conventional $p = <0.05$. A single-predictor binary logistic regression model was developed using a stepwise approach. Univariate analysis was used to identify risk factors for developing IH. Multivariate analysis was then performed using only factors that had reached significance in the univariate model.

RESULTS

A total of 663 patients were identified from the HART trial database and were included in this analysis. The mean age was 68 (27–95). 63% were Male ($n = 421$), and the mean BMI was 28.1 (12.1–49.6).

Abdominal closure was performed by trainees in 289 cases and by consultants in 374 cases. Patients closed by consultants were more likely to be younger, have a longer duration of operation, and were more likely to undergo Hughes closure. Patients undergoing rectal surgery were more likely to be closed by trainees than those undergoing other types of colonic resection.

Of the patients included in this analysis, 104 patients had IH on clinical examination at 1 year, and a breakdown of this can be seen in Figure 1. IH were present in 59/289 cases closed by trainees and 45/374 cases closed by consultants (20.4% vs. 12%, $p < 0.001$).

In patients closed using the Hughes technique, IH rates were significantly higher in the trainee group (20% vs. 12%, $p = 0.032$). In the mass closure arm, there was a difference in IH rates again between trainees and consultants, however it failed to reach statistical significance (21% vs. 13%, $p = 0.058$; Table 2).

Univariate analysis of risk factors found in Table 1 showed age, male sex, preoperative chemotherapy, rectal surgery, and trainee closure to be associated with increased risk of developing incisional hernia. On multivariate analysis, however, only age ($p = 0.036$, OR: 1.02, 95% CI: 1.00–1.04), male sex ($p = 0.049$, OR: 1.61, 95% CI: 1.00–2.59) and closure by a trainee ($p = 0.006$, OR: 1.85, 95% CI: 1.20–2.85) were identified as risk factors for developing incisional hernia.

TABLE 1 Baseline demographics for patients undergoing abdominal wall closure by trainees versus consultants.

	Trainees, ($n = 289$)	Consultants, ($n = 374$)	*p*-value
Mean age (SD)	70 (11.2)	67 (11.9)	<0.001
Mean BMI (SD)	27.7 (5.18)	28.3 (5.5)	0.083
Male sex	194 (67.1%)	227 (60.7%)	0.088
Previous abdominal surgery	117 (40.4%)	156 (41.7%)	0.348
Steroids	13 (4.5%)	11 (2.9%)	0.287
Preoperative chemotherapy	28 (9.7%)	33 (8.8%)	0.702
Preoperative radiotherapy	28 (9.7%)	32 (8.6%)	0.614
Diabetes	45 (15.5%)	60 (16.0%)	0.869
COPD	45 (15.6%)	43 (11.5%)	0.125
Renal failure	6 (2.1%)	2 (0.53%)	0.071
Smoking history	126 (43.6%)	167 (44.7%)	0.740
Length of operation (min)	183 (SD:76.6)	205 (SD:88.7)	<0.001
Time of abdominal wall closure (min)	17.8 (SD: 8.9)	17.6 (SD: 10.1)	0.749
Laparoscopic surgery	125 (43.3%)	178 (47.6%)	0.266
Rectal surgery	154 (53.2%)	158 (42.2%)	0.005
Hughes closure	119 (41.1%)	217 (58.0%)	<0.001

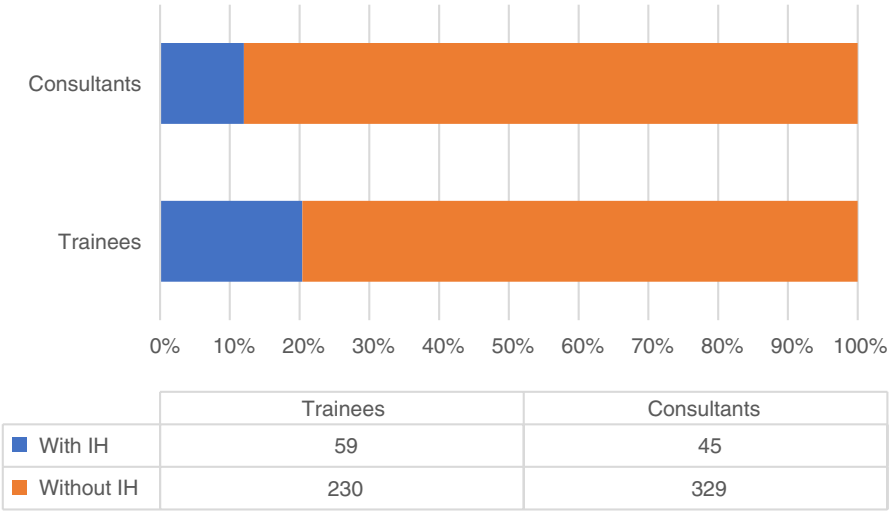

FIGURE 1 Rates of incisional hernia at 1 year when compared to grade of surgeon closing abdominal wall.

TABLE 2 Multivariate analysis of factors affecting incisional hernia development.

	Odds ratio (95% confidence interval)	*p*-value
Age	1.02 (1.00–1.04)	0.036
Male sex	1.61 (1.00–2.59)	0.049
Chemotherapy	2.31 (0.79–6.69)	0.125
Rectal surgery	1.53 (0.97–2.40)	0.065
Trainee closure	1.85 (1.20–2.85)	0.006

DISCUSSION

This study identified three risk factors for incisional hernia development. Both male sex and age are recognised risk factors for IH development and have been commented on in a number of studies; however, trainee led AWC has not yet been recognised as a risk factor [4,11,12]. This finding has been commented on historically. Jenkins observed a difference in abdominal closure technique between trainees and "experienced surgeons" in his 1976 study describing his eponymous rule for AWC technique. A similar observation was also made by Hughes in his study first detailing the Hughes Abdominal Repair [5,13]. This study, however, is the first to quantify this risk.

Abdominal wall closure is often performed by trainees. In our results, patients with rectal cancer were more likely to be closed by a trainee, as rectal surgeries are technically more challenging. This may be as an opportunity for the trainee to achieve some training from the procedure or due to fatigue of the surgeon. However, given that our results also showed that patients closed by a consultant also had longer operating times, this inference may not be the case.

Mass closure is a commonly performed technique familiar to all grades of surgeon. It is taught to all prospective surgeons at part of the Intercollegiate Basic Surgical Skills course; however, more recent AWC techniques, such as Small Stitch and the Hughes closure are not yet taught as part of the surgical curriculum in the UK, and training in these techniques is dependent on individual trainers at a local level [7]. Currently, there is no requirement for trainees to achieve competence in AWC as part of their professional development in the UK [14,15]. Consultants participating in the HART trial underwent standardised training in the Hughes technique, whereas trainees did not receive this same standard of training. This may well explain the difference in outcomes within the Hughes closure arm when compared to mass closure. The difference in IH rates between trainees and consultants in both arms of the HART trial suggests that focussed training on surgical technique is perhaps more important than case volume in AWC. This highlights the importance of standardised training and providing evidence of competence in common AWC techniques.

It is worth noting some limitations of our study. This was an unplanned, retrospective analysis of a randomised control trial; therefore, data on trainee supervision and grade of assistant were not captured and these are both likely to be important factors. Another limitation is the discrepancy in training provided by the study team between trainees and consultants. Whilst this may well explain the difference in IH rates between trainees and consultants performing Hughes closure, it does not, however, account for the difference in rates in the mass closure group. Future studies using newer techniques such as small stitch should look to implement a standardised teaching programme to all study investigators to avoid bias.

We propose that the difference in IH rates between grade of surgeon should be overcome not by consigning the trainee to the role of the assistant, but by changing attitudes towards training and AWC. Implementation of standardised levels of competence and training in common closure techniques at a national level, alongside consultant-led support in developing meticulous closure technique may reduce the difference in incisional hernia rates between the two groups.

CONCLUSION

Rates of incisional hernia are higher when the abdominal wall is closed by a trainee surgeon compared to consultants, and traineeled

AWC is a risk factor for incisional hernia development. Abdominal wall closure should be seen as a procedure, with standardised training and mandatory competency assessments. Closure time should be treated as training time, not coffee time.

FUNDING INFORMATION

None declared.

CONFLICT OF INTEREST STATEMENT

None disclosed.

ORCID

Laurie Smith https://orcid.org/0000-0003-0201-9373
Alexandra Coxon-Meggy https://orcid.org/0000-0001-5637-8457
Michael Shinkwin https://orcid.org/0000-0003-0101-9400
Julie Cornish https://orcid.org/0000-0003-4360-4472
Jared Torkington https://orcid.org/0000-0002-3218-0574

REFERENCES

1. Torkington J, Harries R, O'Connell S, Knight L, Islam S, Bashir N, et al. Incisional hernia following colorectal cancer surgery according to suture technique: Hughes abdominal repair randomized trial (HART). Br J Surg. 2022;109(10):943–50.
2. Gignoux B, Bayon Y, Martin D, Phan R, Augusto V, Darnis B, et al. Incidence and risk factors for incisional hernia and recurrence: retrospective analysis of the French national database. Colorectal Dis. 2021;23(6):1515–23.
3. van Silfhout L, Leenders LAM, Heisterkamp J, Ibelings MS. Recurrent incisional hernia repair: surgical outcomes in correlation with body-mass index. Hernia. 2021;25(1):77–83.
4. Bosanquet DC, Ansell J, Abdelrahman T, Cornish J, Harries R, Stimpson A, et al. Systematic review and meta-regression of factors affecting midline incisional hernia rates: analysis of 14 618 patients. PLoS One. 2015;10(9):e0138745.
5. Jenkins TP. The burst abdominal wound: a mechanical approach. Br J Surg. 1976;63(11):873–6.
6. Deerenberg EB, Harlaar JJ, Steyerberg EW, Lont HE, van Doorn HC, Heisterkamp J, et al. Small bites versus large bites for closure of abdominal midline incisions (STITCH): a double-blind, multicentre, randomised controlled trial. Lancet. 2015;386(10000):1254–60.
7. The Royal College of Surgeons. Basic Surgical Skills [Internet]. 2022 [cited 2022 Apr 7], Basic Surgical Skills (Intercollegiate BSS) — Royal College of Surgeons. Available from: rcseng.ac.uk
8. Cornish J, Harries RL, Bosanquet D, Rees B, Ansell J, Frewer N, et al. Hughes abdominal repair trial (HART) – abdominal wall closure techniques to reduce the incidence of incisional hernias: study protocol for a randomised controlled trial. Trials. 2016;17(1):454.
9. Maruthappu M, Gilbert BJ, El-Harasis MA, Nagendran M, McCulloch P, Duclos A, et al. The influence of volume and experience on individual surgical performance: a systematic review. Ann Surg. 2015;261(4):642–7.
10. Langer C, Schaper A, Liersch T, Kulle B, Flosman M, Füzesi L, et al. Prognosis factors in incisional hernia surgery: 25 years of experience. Hernia. 2005;9(1):16–21.
11. Sørensen LT. Smoking is a risk factor for incisional hernia. Arch Surg. 2005;140(2):119.
12. Höer J, Lawong G, Klinge U, Schumpelick V. Einflussfaktoren der Narbenhernienentstehung Retrospektive Untersuchung an 2.983 laparotomierten Patienten über einen Zeitraum von 10 Jahren. Chirurg. 2002;73(5):474–80.
13. Mudge M, Hughes LE. Incisional hernia: a 10 year prospective study of incidence and attitudes. Br I Surg. 1985; 72(1):70–1.
14. Brecknell J, Lintott P. core surgical training curriculum the intercollegiate surgical curriculum programme [Internet]. 2021 [cited 2023 Mar 18]. Available from: https://www.iscp.ac.uk/media/1111/core-surgical-training-curriculum-aug-/2021-approved-oct-20.pdf
15. Cook T, Lund J. General surgery curriculum the intercollegiate surgical curriculum programme [Internet]. 2016 [cited 2023 Mar 18]. Available from: https://www.gmc-uk.org/-/media/documents/General_Surgery_Updated_2016.pdf_68161262.pdf

How to cite this article: Smith L, Coxon-Meggy A, Shinkwin M, Cornish J, Watkins A, Fegan G, et al. "Happy to close?" The relationship between surgical experience and incisional hernia rates following abdominal wall closure in colorectal surgery. Colorectal Dis. 2023;00:1–6. https://doi.org/10.1111/codi.16537

APPENDIX A

Members of HART Trial Collaborators

J. Torkington, R. Harries, S. O'Connell, L. Knight, S. Islam, N. Bashir, A. Watkins, G. Fegan, J. Cornish, B. Rees, H. Cole, H. Jarvis, S. Jones, I. Russell, D. Bosanquet, A. Cleves, B. Sewell, A. Farr, N. Zbrzyzna, N. Fiera, R. Ellis-Owen, Z. Hilton, C. Parry, A. Bradbury, P. Wall, J. Hill, D. Winter, K. Cocks, D. Harris, J. Hilton, S. Vakis, D. Hanratty, R. Rajagopal, F. Akbar, A. Ben-Sassi, N. Francis, L. Jones, M. Williamson, I. Lindsey, R. West, C. Smart, P. Ziprin, T. Agarwal, G. Faulkner, T. Pinkney, D. Vimalachandran, D. Lawes, O. Faiz, P. Nisar, N. Smart, T. Wilson, A. Myers, J. Lund, S. Smolarek, A. Acheson, J. Horwood, J Ansell, S. Phillips, M. Davies, L. Davies, S. Bird, N. Palmer, M. Williams, G. Galanopoulos, P. Dhruva Rao, D. Jones, R. Barnett, S. Tate, J. Wheat, N. Patel, S. Rahmani, E. Toynton, L. Smith, N. Reeves, E. Kealaher, G. Williams, C. Sekaran, M. Evans, J. Beynon, R. Egan, E. Qasem, U. Khot, S. Ather, P. Mummigati, G. Taylor, J. Williamson, J. Lim, A. Powell, H. Nageswaran, A. Williams, J. Padmanabhan, K. Phillips, T. Ford, J. Edwards, N. Varney, L. Hicks, C. Greenway, K. Chesters, H. Jones, P. Blake, C. Brown, L. Roche, D. Jones, M. Feeney, P. Shah, C. Rutter, C. McGrath, N. Curtis, L. Pippard, J. Perry, J. Allison, J. Ockrim, R. Dalton, A. Allison, J. Rendell, L. Howard, K. Beesley, G. Dennison, J. Burton, G. Bowen, S. Duberley, L. Richards, J. Giles, J. Katebe, S. Dalton, J. Wood, E. Courtney, R. Hompes, A. Poole, S. Ward, L. Wilkinson, L. Hardstaff, M. Bogden, M. Al-Rashedy, C. Fensom, N. Lunt, M. McCurrie, R. Peacock, K. Malik, H. Burns, B. Townley, P. Hill, M. Sadat, U. Khan, C. Wignall, D. Murati, M. Dhanaratne, S. Quaid, S. Gurram, D. Smith, P. Harris, J. Pollard, G. DiBenedetto, J. Chadwick, R. Hull, S. Bach, D. Morton, K. Hollier, V. Hardy, M. Ghods, D. Tyrrell, S. Ashraf, J. Glasbey, M. Ashraf, S. Garner, A. Whitehouse, D. Yeung, S. Noor Mohamed, R. Wilkin, N.

Suggett, C. Lee, A. Bagul, C. McNeill, N. Eardley, R. Mahapatra, C. Gabriel, P. Datt, S. Mahmud, I. Daniels, F. McDermott, M. Nodolsk, L. Park, H. Scott, J. Trickett, P. Bearn, P. Trivedi, V. Frost, C. Gray, M. Croft, D. Beral, J. Osborne, R. Pugh, G. Herdman, R. George, A.-M. Howell, S. Al-Shahaby, B. Narendrakumar, Y. Mohsen, S. Ijaz, M. Nasseri, P. Herrod, T. Brear, J.-J. Reilly, A. Sohal, C. Otieno, W. Lai, M. Coleman, E. Platt, A. Patrick, C. Pitman, S. Balasubramanya, E. Dickson, R. Warman, C. Newton, S. Tani, J. Simpson, A. Banerjee, A. Siddika, D. Campion, D. Humes, N. Randhawa, J. Saunders, B. Bharathan, O. Hay