



# Long-Term Outcomes Following Laparoscopic Repair of Large Hiatus Hernias Performed by Trainees Versus Consultant Surgeons

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Received: 1 December 2018 / Accepted: 25 March 2019 / Published online: 22 April 2019  
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## Abstract

**Background** The laparoscopic approach is the preferred method for repair of large hiatus hernias but can be technically challenging. Training surgeons need experience as the primary operator to gain competency in this operation. However, learning the procedure should not compromise the functional long-term outcome for patients. The aim of this study was to determine whether any difference in long-term outcomes exists for patients having a laparoscopic large hiatus hernia repair performed by a trainee versus a consultant surgeon.

**Methods** A total of 648 suitable patients who had undergone laparoscopic repair of a large hiatus hernia were identified from a prospective database. Cases were divided into two groups based on whether the primary operator was a trainee or a consultant surgeon. Demographics, perioperative data, revisions and patient-reported clinical outcomes via standardised questionnaires were compared.

**Results** There were no statistically significant differences in the clinical outcomes for patients undergoing laparoscopic repair of a large hiatus hernia performed by a trainee versus a consultant surgeon, with comparable patient-reported outcomes for heartburn, dysphagia, and overall satisfaction with the outcome following surgery. Median operative time was approximately 20 min longer for trainees ( $p = <0.0001$ ). Revisional surgery rates were similar for the two groups.

**Conclusions** Patients operated on by trainees have equivalent long-term clinical outcomes to patients operated on by consultant surgeons. For these patients, surgery can be safely performed by supervised trainees.

**Keywords** Large hiatus hernia · Laparoscopic repair · Surgical training · Long-term outcomes

## Introduction

Since being described over two decades ago, the laparoscopic approach has become the preferred method for hiatus hernia repair in the majority of patients.<sup>1, 2</sup> The operation is technically challenging and requires considerable expertise in minimally invasive surgery, but offers lasting improvements in patient symptoms.<sup>3–8</sup> As for many complex gastrointestinal laparoscopic procedures, there is a learning curve that progresses towards consistent perioperative and longer-term

outcomes.<sup>9–12</sup> In order to gain proficiency, trainee surgeons need ongoing practice in performing the operation. Conversely, patients should be afforded the best result possible, and perioperative and long-term clinical outcomes should not be compromised by trainee operators.

A difference between perioperative and clinical outcomes for laparoscopic anti-reflux surgery performed by trainees versus consultants has been reported previously by our group, and at 5 years postoperatively, satisfaction with the surgical outcome was reported to be slightly better in patients operated on by a consultant.<sup>13</sup> Patients in the trainee cohort were more likely to require endoscopic dilatation or reoperation.<sup>13</sup> A subgroup analysis of patients with large hiatus hernia repairs in the same study did not find any statistically significant disparity in perioperative results or clinical outcomes at 1 year, although this sub-cohort was small.<sup>13</sup> Another study found that increased experience in laparoscopic Nissen fundoplication led to significantly decreased mean operative time, hospital stay and fewer reoperations, however no difference in patient-reported

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outcomes such as heartburn, regurgitation, dysphagia or overall satisfaction scores at one year.<sup>14</sup> Neo et al. showed that operation time for trainees performing laparoscopic repair of large hiatus hernias was 10 min longer than their consultant counterparts, although frequency of conversion, morbidity, reoperation and short-term clinical outcomes were similar. Outcomes greater than 1 year were not assessed.<sup>10</sup>

The purpose of this study was to determine if there is a significant difference in long-term clinical outcomes following laparoscopic repair of large hiatus hernias performed by experienced consultant surgeons versus relatively inexperienced trainee surgeons under supervision. A secondary aim was to identify any perioperative discrepancy between the two groups.

## Materials and Methods

We identified patients who had laparoscopic repair of a large hiatus hernia, defined as having 50% or more of the stomach within the chest, from a prospective database which included cases predominantly from South Australian public and private hospitals, spanning a timeframe from February 1992 to October 2017. Hernia size was determined intraoperatively, by recording the estimated percentage of the stomach within the hiatus hernia prior to dissection. Patients were categorised as trainee or consultant cases depending on the primary operating surgeon listed.

All cases were primary repairs, except for two patients operated on by consultants who had previously undergone a transthoracic hiatus hernia repair. Repair entailed dissection of the hiatal rim, complete removal of the sac from the chest, followed by hiatal repair using posteriorly placed sutures, supplemented with anterior sutures as required, and then a fundoplication was added at the responsible surgeon's discretion. Where mesh was used to reinforce the repair (mostly in the context of a randomised controlled trial), this entailed the placement of either TiMesh or Surgisis to reinforce the posterior hiatal sutures.<sup>15</sup>

A consultant was defined as an upper gastrointestinal specialist surgeon who was competent in the procedure and had overcome the learning curve. Of the repairs performed by surgeons that pioneered the laparoscopic technique, cases done earlier than 1997 (first 5 years of experience) were excluded to ensure that personal and institutional learning curves were not included in the analysis. For surgeons who became consultants after that period, the first 20 cases performed (their learning curve) were excluded. Consultant cases were assisted by either a trainee or another consultant.

A trainee was defined as a surgeon who had not yet completed 20 cases and who was supervised by a consultant surgeon when acting as the primary operator. There were no surgeons designated as trainees that performed more than 20 large hiatal hernia repair procedures. Trainee surgeons had

typically completed training in General Surgery and were undertaking a fellowship in upper gastrointestinal surgery. These trainees were already competent in routine laparoscopic procedures such as cholecystectomy and appendectomy, but were not yet considered specialists in upper gastrointestinal surgery. In all cases, trainees operated under the direct supervision of an experienced consultant surgeon who assisted by holding the camera and providing retraction, as well as general direction of the case. Patients who had a follow-up of less than 1 year were excluded as they would not yield longer term follow-up data.

Data collected comprised patient demographics, perioperative details, revisions and patient responses from follow-up questionnaires. Operation time was taken as the time from first incision to the last suture. Significant intraoperative complications and postoperative complications occurring within 30 days of the procedure were recorded. Early return to theatre in the immediate postoperative period was also included in postoperative complications (designated as within 30 days of the index procedure). Revisional operations after 30 days were subcategorised in relation to the reason for revision: dysphagia, recurrent hiatus hernia and reflux.

Patients were sent a yearly standardised questionnaire to determine outcomes after repair of the large hiatus hernia. We looked at three follow-up time-points: 1–2 years, 4–6 years and 9–11 years. If there were multiple questionnaires returned within those periods, the 1 year, 5 year and 10 year questionnaires were taken in preference. Measures of satisfaction relating to the procedure were collected, including a satisfaction score from 0 to 10 (least to most satisfied) and answering yes or no to the question “Having gone through this operation and knowing what is involved, would you have the same operation for the same problem (in other words, do you think you made the correct decision when you agreed to have the operation)?” The severity of any subsequent heartburn was rated on a scale from 0 to 10 (from no heartburn to severe heartburn). No heartburn was defined in this study as a score of 1 or less. Dysphagia was measured using a score from 0 to 45, where patients reported swallowing difficulties (always, occasionally, never) to a panel of nine different food/fluid consistencies; higher scores indicate a greater degree of dysphagia. Additionally, difficulty in swallowing liquids and solids was assessed individually using a 0 to 10 scale, again with a higher score indicating more difficulty.

Statistical analysis was performed with GraphPad Prism version 7.00 for Mac, La Jolla, CA, USA, [www.graphpad.com](http://www.graphpad.com). Specific tests used were Fisher's exact test for dichotomous categorical data, the Mann-Whitney U test for continuous data and the Chi-squared test to determine any difference in the spread of types of fundoplication between groups. *P* values of < 0.05 were considered statistically significant. Follow-up for this study was approved by the Southern Adelaide Human Research Ethics Committee.

## Results

Overall, 857 individual patients were identified as having had laparoscopic repair of a large hiatus hernia (Fig. 1). Thirteen cases were deemed unsuitable for analysis as they were performed by consultant surgeons without sufficient prior supervised experience with laparoscopic hiatus hernia repair. After exclusion of the consultant learning curves, patients operated on prior to 1997 and those with less than 1 year of follow-up; 648 cases were considered appropriate for analysis. There were 433 in the consultant group and 215 in the trainee group. Forty-eight trainees and 11 consultants were the primary operators in these patients.

Demographic information was similar between the groups. The median age at the time of index operation in both cohorts was 67 years ( $p = 0.2932$ ). Thirty percent of the trainee-operated patients were male compared with 36% in the consultant group ( $p = 0.2551$ ).

A summary of the perioperative data is presented in Table 1. The proportion of different types of hiatal hernia was similar for both groups. Although this study was investigating outcomes following laparoscopic repair of a large hiatus hernia, there were two patients in the consultant group in which hiatal repair was abandoned due to oesophageal

perforation; these patients were included on an intention to treat basis thus leading to 99% of patients in that group having hiatal repairs. The median number of sutures used and the frequency of conversion to open operation in both groups were similar. Mesh was used in a minority of both groups without any statistically significant difference. Operative time was significantly shorter in the consultant group (median 90 min, vs 110 min;  $p < 0.0001$ ). Intraoperative complications occurred in 2.33% and 2.54% in the trainee and consultant groups, respectively ( $p > 0.9999$ ). In the trainee group, there was one oesophageal injury (partial thickness), three pneumothoraces requiring intervention and one instance of a broken needle left in situ. In the consultant group, there were two instances of significant bleeding ( $> 500$  mL), four oesophageal injuries (two full thickness perforations related to the bougie and two partial thickness), one pneumothorax requiring intervention, one patient requiring short-term ventilation in the high-dependency unit and three splenic injuries (though none required splenectomy). Postoperative complications occurred in 11.63% in the trainee group and 8.08% in the consultant group ( $p = 0.1515$ ). The types of postoperative complications are listed in Table 2. When early returns to theatre were analysed separately to other complications, 5.12% (11/215) of all trainee-operated patients and 3.23% (14/433) of all

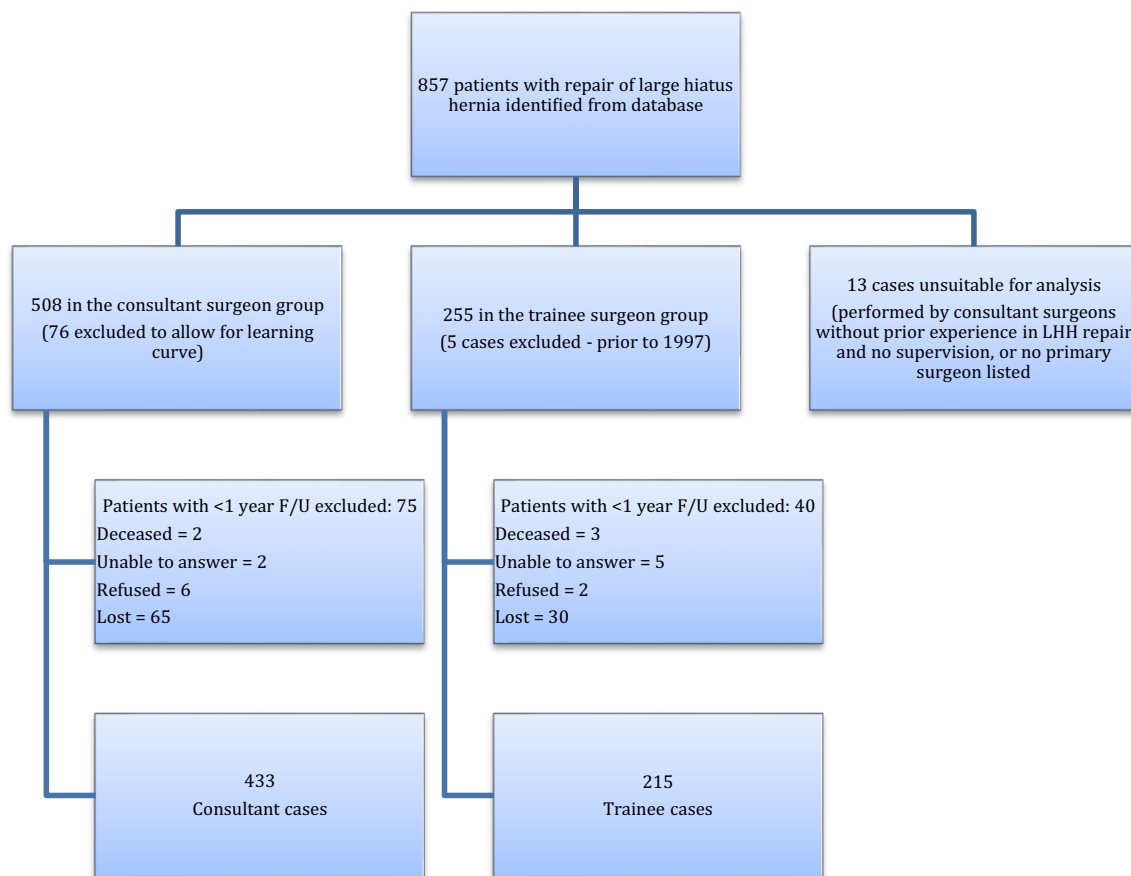


Fig. 1 Flow-chart of division into cohorts and exclusions

**Table 1** Perioperative data

	Trainee group ( <i>n</i> = 215)	Consultant group ( <i>n</i> = 433)	<i>p</i> value
Hiatal repair	214 (100%) ( <i>n</i> = 214)	428 (99%) <sup>a</sup> ( <i>n</i> = 430)	> 0.9999
Number of sutures used, median [95% CI]	4 [3.983–4.421] ( <i>n</i> = 213)	4 [4.267–4.589] ( <i>n</i> = 430)	0.0983
Mesh used	41 (19%)	61 (14%)	0.1093
Operation time in minutes, median (range) [95% CI]	110 (35–253) [106.1–117.8] ( <i>n</i> = 205)	90 (30–242) [91.59–100.6] ( <i>n</i> = 346)	< 0.0001
Conversion to open	5 (2.33%)	14 (3.23%)	0.6264
Intraoperative complications	5 (2.33%)	11 (2.54%)	> 0.9999
Postoperative complications (including early return to theatre)	25 (11.63%)	35 (8.08%)	0.1515
Type of fundoplication	( <i>n</i> = 215)	( <i>n</i> = 432)	0.022 <sup>b</sup>
360 Nissen	36 (16.7%)	95 (22.0%)	
270 posterior	3 (1.4%)	20 (4.6%)	
180 anterior	118 (54.9%)	185 (42.8%)	
90 anterior	54 (25.1%)	125 (28.9%)	
No fundoplication done	4 (1.9%)	7 (1.6%)	

<sup>a</sup> 2 patients did not have a hiatal repair due to intraoperative oesophageal perforation; included on an intention to treat basis

<sup>b</sup> Chi-square test, chi-square statistic 11.44, degrees of freedom 4

**Table 2** Postoperative complications, including early return to theatre

	Trainee group ( <i>n</i> = 215)	Consultant group ( <i>n</i> = 433)
Bleeding		
Bleeding requiring transfusion	0	1
Haematoma	0	1
Cardiovascular		
Atrial fibrillation	0	2
Cardiac arrest (resuscitated)	0	1
Myocardial infarction	1	0
Gastrointestinal		
Chylothorax	1	0
Gas bloating causing readmission	1	0
Postoperative ileus	0	2
Pseudomembranous colitis	1	0
Infection		
Wound infection	1	0
Small leak postop	0	2
Neurological		
Delirium	0	2
Stroke	0	1
Respiratory		
Pleural effusion	0	1
Pneumonia	7	3
Pulmonary embolism	1	3
Respiratory failure	0	1
Return to theatre		
– Acute dysphagia	3	3
– Early hernia recurrence	7	6
– Infection	1	3
– Oesophageal perforation	0	2
Urological		
Urinary retention	1	1

consultant-operated patients required an early reoperation ( $p = 0.2795$ ). There was a statistically significant difference in the choice of fundoplication with more 360° Nissen funduplications in the consultant group and more 180° anterior funduplications performed in the trainee group.

Patient-reported outcomes at all time-points measured were similar between the trainee and consultant groups and there were no statistically significant differences (Table 3). Satisfaction scores remained equivalent throughout the study, and the mean scores all exceeded 8 out of 10. A high proportion (over 89%) of patients in both groups stated they would have the same operation under the same circumstances. Mean heartburn scores were between 1 and 2 out of 10 in all groups and all time-points, and there was no significant disparity between the proportion of patients with no heartburn (score  $\leq 1$ ). All of the dysphagia scores remained low, and again there was no significant difference between trainee versus consultant scores.

Rates of revisional surgery after 30 days were comparable. There were no significant differences in the proportion of patients who had revisional operations by 1 year, by 5 years or after 5 years (Table 4). By 1 year, 0.93% of the trainee group versus 0.46% of the consultant group had a revision ( $p = 0.6031$ ). By 5 years, 4.19% of the trainee group versus 3.70% of the consultant group had a revision ( $p = 0.8291$ ). After 5 years (and in total), 5.58% of the trainee group and 4.39% of the consultant group had revisions ( $p = 0.5585$ ). The reasons for revisional surgery are summarised in Table 4.

## Discussion

The predominant finding from this study was that there was no difference in the long-term clinical outcome for patients

**Table 3** Outcomes after laparoscopic hiatus hernia repair at three time-points

	At 1–2 years			At 4–6 years			At 9–11 years		
	Trainee group (n = 214)	Consultant group (n = 417)	Trainee group (n = 153)	Consultant group (n = 288)	Trainee group (n = 62)	Consultant group (n = 137)			
Follow-up timeframe in years <sup>a</sup>	1.037 [1.012–1.063]	1.036 [1.018–1.054]	4.974 [4.908–5.04]	4.924 [4.877–4.97]	9.79 [9.676–9.904]	9.774 [9.687–9.861]			
Satisfaction score (0–10) <sup>a</sup>	8.839 [8.538–9.139] (n = 211)	8.704 [8.492–8.916] (n = 409)	8.715 [8.405–9.025] (n = 151)	8.363 [8.065–8.661] (n = 278)	8.823 [8.281–9.364] (n = 62)	8.507 [8.086–8.929] (n = 136)			
Satisfied with operation (score > 7) <sup>b</sup>	184 (87%) (n = 211)	341 (83%) (n = 409)	124 (82%) (n = 151)	220 (79%) (n = 278)	51 (82%) (n = 62)	112 (82%) (n = 136)			
Would repeat operation <sup>b</sup>	200 (94%) (n = 213)	378 (93%) (n = 408)	145 (97%) (n = 149)	258 (93%) (n = 277)	51 (96%) (n = 53)	101 (89%) (n = 113)			
Heartburn score (0–10) <sup>a</sup>	1.278 [0.9578–1.599] (n = 212)	1.134 [0.9231–1.346] (n = 409)	1.601 [1.197–2.006] (n = 153)	1.535 [1.255–1.814] (n = 275)	1.685 [0.9527–2.418] (n = 54)	1.554 [1.122–1.985] (n = 112)			
No heartburn (score ≤ 1) <sup>b</sup>	159 (75%) (n = 212)	310 (76%) (n = 409)	108 (71%) (n = 153)	184 (67%) (n = 275)	36 (67%) (n = 54)	72 (64%) (n = 112)			
Dysphagia score (0–45) <sup>a</sup>	5.274 [4.175–6.372] (n = 212)	6.073 [5.3–6.846] (n = 411)	5.447 [4.133–6.762] (n = 152)	5.893 [4.9–6.886] (n = 280)	5.231 [2.968–7.494] (n = 52)	7.149 [5.435–8.863] (n = 114)			
Dysphagia to liquids (0–10) <sup>a</sup>	0.4953 [0.2956–0.695] (n = 212)	0.6277 [0.476–0.7795] (n = 411)	0.6275 [0.3601–0.8948] (n = 153)	0.755 [0.5732–0.9768] (n = 280)	0.8704 [0.3244–1.416] (n = 54)	0.9211 [0.5981–1.244] (n = 114)			
Dysphagia to solids (0–10) <sup>a</sup>	1.175 [0.88–1.469] (n = 212)	1.384 [1.172–1.595] (n = 409)	1.399 [1.021–1.776] (n = 153)	1.575 [1.283–1.867] (n = 280)	1.352 [0.7021–2.002] (n = 54)	1.816 [1.359–2.273] (n = 114)			

<sup>a</sup> Reported as mean [95% confidence interval]

<sup>b</sup> Reported as number from cohort (% of entire cohort)

All *p* values > 0.05 at all time-points. There were no statistically significant differences between consultant and trainee outcomes

**Table 4** Reasons for revisional surgery (> 30 days)

	Trainee group	Consultant group	
Total	12 (5.58% of cohort)	19 (4.39% of cohort)	$p = 0.5585$
Dysphagia	3	2	
Recurrent hiatus hernia	4	11	
Reflux	5	6	

undergoing laparoscopic repair of a large hiatus hernia performed by trainees versus consultants. The only significant differences were the type of fundoplication performed and operation time.

Hiatal repair, the number of sutures used and the utilisation of mesh were all similar and it is likely the supervising consultant would have determined these aspects of technique. As has been demonstrated previously, the median operative time was longer for trainee surgeons.<sup>10, 13, 16</sup> This is an understandable and expected finding, and the technical aspects specific to this procedure such as dissection of the hernia sac, hiatal repair with laparoscopic suturing and fundoplication are unlikely to have been encountered by trainees previously. An increased operative time contributes to a longer period of anaesthesia, reduced efficiency in the operating room and will undoubtedly have a cumulative impact on costs.<sup>17</sup> However, in the context of teaching the next generation of specialists, most disciplines should find this acceptable.

Over the last two decades, our unit has progressively shifted from initially routinely performing a Nissen fundoplication towards various partial fundoplications (270° posterior toupet, 180° anterior or 90° anterior) in an effort to reduce postoperative issues such as dysphagia or gas bloating.<sup>18, 19</sup> The majority of Nissen fundoplications in our series would have been done in the earlier stages of the laparoscopic technique and operations in that period were more likely to have been undertaken by a consultant, which would account for the difference in types of fundoplication observed. Over half of the trainee cases (54.9%) had a 180° anterior fundoplication, compared with 42.8% in the consultant group. The distribution also likely demonstrates the preferences of surgeons within the involved institutions in the study, mainly South Australian teaching hospitals.

The majority of patients were greatly satisfied with their outcome following the procedure, which is in keeping with other studies.<sup>4, 5, 7, 20</sup> Whether the primary operator was a trainee or a consultant did not seem to have a profound impact on the long-term satisfaction, willingness to repeat the same operation under the same conditions, heartburn or dysphagia. This could suggest that the main factor dictating the long-term outcome is not solely the primary operator, but rather the level of direct supervision in the operating theatre. Adequate supervision is important in any surgical training experience, and in particular in a procedure such as this with functional outcomes. There did not appear to be any particular difference

in the rates of revisional surgery, again supporting the impression that the longer-term outcomes are similar. These findings should give reassurance to both patients and surgeons that the learning experience for trainees does not lead to poorer outcomes following this procedure.

Our study had several limitations. Symptom scores and in particular satisfaction scores are subjective and might be influenced by a number of confounders. Selection bias is another possible weakness, and possibly the less comorbid or lower BMI patients could have been identified by the attending surgeon as good training cases. Information regarding preoperative status was unfortunately limited; therefore, we have not been able to compare median/mean BMI or baseline comorbidities between cohorts.

## Conclusion

Our study found that the long-term outcomes up to a median follow-up of 10 years were equivalent in patients having laparoscopic large hiatus hernia repairs performed by both consultants and trainees. There appears to be no significant adverse impact associated with training inexperienced surgeons in this technique.

**Author Contributions** All authors meet the stated criteria under “Definition of Authorship” listed in the *Journal of Gastrointestinal Surgery* Instructions for Authors.

## Compliance with Ethical Standards

Follow-up for this study was approved by the Southern Adelaide Human Research Ethics Committee.

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Author names in bold designate shared co-first authorship

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