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Long-term outcomes following surgical repair of giant paraoesophageal hiatus hernia

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Abstract

Introduction There are limited data regarding long-term outcomes after surgical repair of giant paraoesophageal hiatus hernia (GPHH). The aim of this study was to assess symptomatic recurrence and patient-reported outcomes following GPHH repair.

Methods 178 patients undergoing elective (127) and emergency (51) GPHH repair between 1994 and 2015 were identified from the prospectively collected Lothian Surgical Audit database. Electronic patient records were used to determine rate of clinical recurrence. A postal questionnaire was used to assess modified DeMeester, 'Gastrointestinal Symptom Rating Scale' symptom scores, breathing and exercise tolerance, and patient satisfaction.

Results Median follow-up was 35 months (range 12–238). 15 (8.4%) patients developed a clinical recurrence and 13 (7.3%) underwent a further operation. The clinical recurrence rates were similar in patients followed-up less than 5 years and beyond 5 years [10/128 (7.8%) vs 5/50 (10%)]. Mortality rate was 1.6% for elective compared with 16.7% for emergency procedures ($P < 0.001$). Completed questionnaires were received from 95 (78.5%) of 121 eligible patients. Mean symptom scores were low (Modified DeMeester 2.6). 83.7% of patients reported a good or excellent outcome, and 97.8% believed they had made the correct decision to undergo surgery.

Conclusions Surgical repair of GPHH is associated with high levels of patient satisfaction and good overall symptom outcome. There is a clinical recurrence rate of 8.4%, which does not significantly increase with long-term follow-up.

Keywords Hernia, Hiatal · Hernia, Diaphragmatic · Stomach volvulus · Fundoplication

A number of definitions have been used for 'intrathoracic stomach' (ITS) and giant paraoesophageal hiatus hernia (GPHH), but most require that more than half of the stomach is within the hernial sac [1]. Patients with GPHH often suffer from intermittent mechanical symptoms including post-prandial fullness, pain, vomiting, and dysphagia [2, 3]. When the herniation is sufficient to compromise the function of thoracic organs, patients can suffer from cardiorespiratory symptoms such as dyspnoea [4]. GPHHs can also undergo volvulus around either the long or short axis of the stomach, termed organoaxial and mesenteroaxial volvulus, respectively [1]. This can result in life-threatening acute presentations, including acute gastric obstruction, strangulation, and perforation, necessitating emergency surgery [2, 4].

The Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) guidelines advise that all symptomatic GPHH be considered for surgery, with the intent of reducing intrathoracic abdominal organs, repairing the hiatal defect, and preventing recurrence [1]. This is a major operation, however, and patients are often elderly and frail. High recurrence rates following repair have also been reported,

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and vary from 15% [5] to 66% [6], depending on how recurrence is looked for and defined. Therefore, there is ongoing debate regarding the optimal management and outcome of GPHH [1].

There are limited data on symptomatic recurrence following surgical repair of GPHH or of patient-reported outcomes. This study aims to evaluate the outcomes following surgical repairs of GPHH between 1995 and 2015 in Lothian, with particular respect to rates of symptomatic recurrence, prevalence of gastrointestinal symptoms, and patient-reported outcomes of success.

Methods

Patients

Patients who had undergone surgical repair of a GPHH were identified from the Lothian Surgical Audit (LSA) database, a prospectively maintained record of all surgical admissions and procedures occurring within NHS Lothian. Ethical approval for the study was obtained from the University of Edinburgh. Written consent from patients was not required although patients were aware that completion of the questionnaires was voluntary and they were free not to participate for any reason. Electronic records were accessed via TRAKcare, a prospectively maintained healthcare database containing all written correspondence, discharge and clinic letters, and operation notes. Inclusion criteria were that patients had undergone a surgical procedure to repair a PHH with equal to, or in excess of, half of the stomach above the diaphragm. All GPHHs had the diagnosis confirmed pre-operatively by radiological investigations (barium swallow and/or CT scan). Patients who had undergone previous surgery involving the stomach or GOJ were excluded. Information relating to patient demographic, presentation, operation, and follow-up were extracted from TRAKcare and the LSA. Post-operative morbidity was classified according to the Clavien–Dindo system [7].

Operative technique

Various techniques, dependent on surgeon preference and clinical condition, were used to repair GPHH. Briefly, repair consisted of complete reduction where possible of the hernial sac from the mediastinum, with subsequent posterior crural repair using non-absorbable sutures. Further anterior crural repair was undertaken if required. More recently the crural repair was selectively reinforced using a Gore™ or Surgisis™ mesh, according to surgeon preference. Permanent mesh was not used in any patients. Biosynthetic meshes were used (Gore™ or Surgisis™) to reinforce the crura if the muscles appeared attenuated. These were not used in a bridging fashion.

Either an anterior (180°) or posterior/Toupet (270°) fundoplication was performed to provide additional crural fixation and as an antireflux procedure. The published literature demonstrates similar results with anterior versus Nissen fundoplication with anterior fundoplication demonstrating a higher incidence of recurrent GORD but less dysphagia. We have always felt GORD is not a major issue for these patients and a posterior recurrence would be surgically difficult to manage; therefore, our practice has moved towards an anterior partial fundoplication. The operation was undertaken laparoscopically where possible. In our unit historically, a laparoscopic gastropexy was performed; however, as laparoscopic skills developed, our surgical approach became a full reduction of the hiatal hernia and sac with crural repair and fundoplication. This procedure involves a gastropexy of the stomach to the crura (so all patients technically receive a proximal gastropexy) but we do not routinely pexy the stomach to the anterior wall. Our current practice is to reserve laparoscopic gastropexy for those patients in whom we cannot completely reduce the hernia sac and who are thought to be unfit to undergo major open surgery.

Determining recurrence

Patient records since discharge were reviewed to determine whether patients had re-presented with symptomatic recurrence. Patients were considered to have a clinical recurrence where the patient was symptomatic and recurrence confirmed either by radiology or endoscopy. Details of subsequent procedures to repair a recurrent hiatus hernia were recorded, as was information relating to the patient's overall health. Length of follow-up was calculated as time from original procedure to either May 2015 or their date of death.

Patient questionnaire

All surviving patients, excluding those with cognitive deficit, were sent a symptom questionnaire. Patients were asked questions relating to frequency and severity of heartburn, regurgitation, and dysphagia. Each was scored from 0 to 3 (0, none; 1, occasional; 2, frequent; 3, every day), from which a 'DeMeester' score was calculated (range 0–9) [8]. A question about painful bloating (0–3) was also added, to give a 'modified DeMeester' (range 0–12). Patients were asked to complete the Gastrointestinal Symptom Rating Scale (GSRS), a series of 15 questions relating to severity, rated from 1 (no discomfort) to 7 (very severe discomfort), of a variety of symptoms experienced in the past week [9]. Mean scores to reflect reflux, diarrhoea, constipation, abdominal pain, and indigestion were then calculated. Further questions were added concerning a patient's ability to belch and

vomit, scored similarly. Patients were also asked whether, since their operation, their breathing and exercise tolerance were worse, the same, slightly, or greatly improved.

Finally, patients were asked to rate how successful they felt their operation had been (poor, fair, good, or excellent), whether they believed they had made the correct decision in agreeing to the procedure, whether they had had any subsequent procedures, and whether they were taking any anti-acid medications.

Patients who had not returned their questionnaire within one month were deemed 'lost to follow-up'.

Analysis

Follow-up times were divided into short-term (< 5 years since operation) and long-term (> 5 years since operation) subgroups for comparison. Statistical analysis was completed using IBM SPSS Statistics for Windows, Version 22.0. IBM Corp.2013. Armonk, NY. Mann–Whitney *U* tests were used to compare continuous variables between short- and long-term outcome groups. Categorical variables were compared using X^2 tests. Correlations were analysed using Spearman's rank correlation.

Results

Patient demography

In total, 178 patients underwent surgical repair of a GPHH and these are the subjects of this report. Four additional patients, all emergency presentations with gastric necrosis secondary to volvulus and severe comorbidity died without undergoing repair and a further patient underwent a total gastrectomy and survived. Mean age at operation was 69 ± 14 years (range 31–89 years), and 72.5% ($n = 129$) were female. Follow-up ranged from 12 months to 238 months (median 35 months).

Operation details

51 (28.7%) procedures were undertaken during an emergency admission, with the remaining 127 (71.3%) scheduled electively. 136 (76.4%) were completed laparoscopically. Of the 42 open procedures, 45.2% ($n = 19$) were conversions from laparoscopic. Crural repair was performed in 88.2% ($n = 157$) *of* patients. Fundoplication was performed in 149 (83.7%) of patients, with Anterior, Toupet, and Nissen techniques performed in 59.6%, 4.5%, and 19.6%, respectively. 29 (16.3%) patients received a gastropexy only. These patients were operated on early in the series, when it was not possible to reduce the sac in its entirety or when surgery was limited by patient comorbidity. A mesh repair was undertaken in 20.8% ($n = 37$), using either Gore® or Surgisis® absorbable mesh.

The 30-day mortality rate was 5.1% ($n = 9$). 7 deaths followed emergency procedures (16.7% mortality rate). 30-day mortality rate for elective procedures was significantly lower at 1.6% ($n = 2$) ($P = < 0.001$). Both elective deaths were in patients with significant pre-existing comorbidity, one with severe learning difficulties and the other with bilateral hemiplegia.

Post-operative complications and length of stay

Post-operative complications were seen in 35.4% ($n = 63$) (Table 1). Rate of post-operative complications was significantly higher following open procedures than laparoscopic (27/41 (65.9%) versus 36/134 26.9%) ($P < 0.001$), as was mean length of stay (19.8 ± 22.1 vs 4.8 ± 11.6 days, respectively; $P < 0.001$). Median length of stay was 2 days for laparoscopic (range 1–128), and 13 days for open procedures (range 4–101).

Questionnaire details

Completed questionnaires were received from 95 of 121 eligible patients (78.5%). Mean age of questionnaire returners at operation was 65 years (range 38–84), and 67.4% ($n = 64$) were female. Follow-up ranged from 2 months to 165 months (median 29 months). 17.9% of operations ($n = 17$) were undertaken during an emergency admission, and 85.3% of procedures were completed laparoscopically ($n = 81$).

Recurrence

15 (8.4%) patients re-presented with a radiological recurrence causing symptoms. 13 (7.3%) patients underwent re-operation. 5/50 (10%) patients in the long-term follow-up subgroup developed a recurrence. This was not significantly different from the 7.8% recurrence rate (10/128) in the short-term subgroup ($P = 0.692$). There was no significant difference in recurrence rates following elective (10/127) and emergency (5/51) procedures ($P = 0.675$).

Operation success

92 of 95 patients rated the success of their operation. 83.7% ($n = 77$) reported their operation success as good or excellent, 10.9% ($n = 10$) as fair, and 5.4% ($n = 5$) as poor. The five patients reporting poor outcomes were all elective procedures, and all reported that they had made the correct decision to undergo the procedure. There was no correlation between a patient's perspective of operative success and length of follow-up ($n = 92$, $r_s = 0.110$, $P = 0.296$).

Table 1 Post-operative complications

Overall complications total				
Clavien–Dindo classification	Number	Elective/emergency	Open/laparoscopic	Details
I	13			
II	27			
IIIa	1	Elective	Open	Mediastinal collection requiring drainage
IIIb	6	Elective	Laparoscopic	Laparoscopy + upper GI endoscopy for suspected leak on CT (none present)
		Elective	Laparoscopic	Oesophageal leak secondary to necrosis. Thoracotomy + repair + insertion of feeding jejunostomy, subsequent CT-guided drainage
		Elective	Lap converted to open	Abdominal dehiscence secondary to post-operative vomiting, mesh closure abdomen + re-do gastropexy
		Elective	Open	Bile leak, laparotomy + T-tube placement (Hernia surgery combined with cholecystectomy + bile duct exploration)
		Emergency	Open	Re-look laparotomy for suspected recurrence on CT (none present)
		Emergency	Open	Deep wound infection requiring drainage
IVa	7	Elective	Laparoscopic	Post-operative bleeding requiring laparotomy for control
		Elective	Laparoscopic	Post-op bleed (treated conservatively), pneumonia, pleural effusion
		Elective	Laparoscopic	Apnoea following extubation requiring reintubation & ventilation
		Elective	Open	Gastric leak requiring re-operation, repair + feeding jejunostomy. Respiratory failure requiring period ventilation
		Emergency	Open	Post-op sepsis, poor oral intake requiring supplemental jejunal feeding
		Emergency	Open	Respiratory failure
		Emergency	Open	Prolonged period mechanical ventilation requiring tracheostomy
IVb	0			
V	9	Elective	Laparoscopic	Aspiration pneumonia
		Elective	Laparoscopic	Aspiration pneumonia
		Emergency	Open	Developed loculated pleural effusion, recurrence, not fit for re-operation
		Emergency	Open	Cardiac arrest, pulseless electrical activity. Unclear cause
		Emergency	Open	Pneumonia + sepsis
		Emergency	Open	Pneumonia + probable colonic perforation, not fit for re-operation
		Emergency	Open	Ongoing respiratory disease taken over by medical team
		Emergency	Open	Multi-organ failure
		Emergency	Open	Multi-organ failure
Total	63			

91 of 95 patients responded when asked if they believed they had made the correct decision in undergoing the procedure. 2.2% of patients ($n=2$) did not believe they had made the correct decision. Whilst both reported a 'good' result from their operation, they had also suffered from Grade IIIb post-operative complications, with post-operative lengths of stay of 16 and 128 days, respectively.

Symptom scores

Mean symptom scores and ranges are presented in Table 2. Post-operative symptoms were significantly worse in patients reporting a poorer outcome—with a significant correlation with poorer patient opinion of operative success (Table 3).

A range of symptom scores displayed significant correlation with length of follow-up. There was weak positive correlation with symptom scores for heartburn, regurgitation, and inability to vomit, as well as cumulative and modified DeMeester scores. Significant negative correlation existed with severity of indigestion (Table 4).

Symptom scores were higher in elective patients than emergency patients. This was significant in DeMeester, modified DeMeester, abdominal pain, diarrhoea, and indigestion domains (Table 5).

Table 2 Mean post-operative symptom scores and ranges

Symptom scores[a]	*n*	Mean (s.e.m.)
Cumulative DeMeester (0–9)	91	2.0 (0.2)
Heartburn (0–3)	91	0.8 (0.1)
Regurgitation (0–3)	92	0.6 (0.1)
Dysphagia (0–3)	92	0.7 (0.1)
Modified DeMeester (0–12)	91	2.6 (0.3)
Bloating (0–3)	93	0.7 (0.1)
GSRS (1–7)		
Abdominal Pain	94	1.8 (0.1)
Reflux	94	1.8 (0.1)
Diarrhoea	92	1.8 (0.1)
Indigestion	93	2.3 (0.1)
Constipation	91	1.9 (0.1)
Inability to vomit (1–7)	93	1.4 (0.1)
Inability to belch (1–7)	95	1.3 (0.1)

s.e.m. standard error of the mean, *GSRS* Gastrointestinal Symptom Rating Scale

[a]Lower scores reflect favourability

Table 3 Correlation between symptoms scores and patient opinion of operative success

Symptom scores[a]	*n*	r_s	$P^{\dagger}$
Cumulative DeMeester (0–9)	88	0.509**	< 0.001
Heartburn (0–3)	88	0.395*	< 0.001
Regurgitation (0–3)	89	0.430**	< 0.001
Dysphagia (0–3)	89	0.406**	< 0.001
Modified DeMeester (0–12)	88	0.476**	< 0.001
Bloating (0–3)	90	0.1256	0.242
GSRS (1–7)			
Abdominal pain	91	0.475**	< 0.001
Reflux	91	0.405**	< 0.001
Diarrhoea	89	0.241*	0.023
Indigestion	91	0.481**	< 0.001
Constipation	88	0.276**	0.009
Inability to vomit (1–7)	90	0.266*	0.011
Inability to belch (1–7)	92	0.236	0.024

GSRS Gastrointestinal Symptom Rating Scale, r_s Spearman's rank correlation coefficient

[a]Lower scores reflect favourability

[†]Spearman's rank test

*Correlation significant at 0.05 level (two-tailed)

**Correlation significant at 0.01 level (two-tailed)

Post-operative acid suppression

69.5% of patients ($n = 66$) admitted to currently taking acid-suppressing medication, of which 62 were taking a proton-pump inhibitor (PPI). Patients on acid suppression had a mean age of 71, and 70% were female. There was no significant difference between acid suppression rates in those whose repair did, and did not, include gastropexy (69.5% vs 69.2%; $P = 0.984$) and mesh (73.0% vs 67.7%; $P = 0.579$), or between those whose procedures occurred on elective or emergency bases (70.5% vs 64.7%; $P = 0.638$). Rates of acid suppression were not significantly different between those in the < 5 years and > 5 years follow-up groups (71% and 63%, respectively; $P = 0.412$), nor was there any significant correlation between rates of post-operative acid suppression and whether patients deemed the success of their operation to be poor/fair or good/excellent (73% and 68%, respectively; $P = 0.658$), although those taking acid suppression did report significantly higher levels of heartburn, regurgitation, and reflux symptoms (Table 5). 68.2% of patients (45/66) reported they were taking these medications because of reflux symptoms, whilst 7.6% (5/66) reported other symptoms. The remaining 24.2% of patients either had Barrett's oesophagus (5/66), concomitant NSAID use (1/66), or were not sure why they remained on these medications (10/66).

Table 4 Correlation between length of post-operative follow-up and symptom score

Symptom scores[a]	*n*	r_s	$P^{\dagger}$
Cumulative DeMeester (0–9)	91	0.284**	0.006
Heartburn (0–3)	91	0.209*	0.046
Regurgitation (0–3)	92	0.338**	0.001
Dysphagia (0–3)	92	0.204	0.051
Modified DeMeester (0–12)	91	0.280**	0.007
Bloating (0–3)	93	0.126	0.229
GSRS (1–7)			
Abdominal pain	94	−0.27	0.793
Reflux	94	0.125	0.229
Diarrhoea	92	−0.003	0.975
Indigestion	93	−0.217**	0.037
Constipation	91	−0.139	0.188
Inability to vomit (1–7)	93	0.221**	0.034
Inability to belch (1–7)	95	0.111	0.285

GSRS Gastrointestinal Symptom Rating Scale, r_s Spearman's rank correlation coefficient

[†]Spearman's rank test

*Correlation significant at 0.05 level (two-tailed)

**Correlation significant at 0.01 level (two-tailed)

[a]Lower scores reflect favourability

Breathing and exercise tolerance

89 patients responded to questions about breathing and exercise tolerance. 47.2% ($n = 42$) reported that their breathing was improved following the operation, whilst 4.5% ($n = 4$) reported that it was worse. 46.1% ($n = 41$) reported that

Table 5 Mean post-operative symptom scores in emergency and elective patients, and in those taking acid suppressing medications

Mean symptom scores[a] (s.e.m.)	Elective	Emergency	*P* value	No acid suppression	Acid suppression	*P* value
Cumulative DeMeester (0–9)	2.2 (0.3)	0.7 (0.2)	0.012*	0.7 (0.3)	2.5 (0.2)	0.000*
Heartburn (0–3)	0.9 (0.1)	0.4 (0.2)	0.110	0.3 (0.1)	1.0 (0.1)	0.002*
Regurgitation (0–3)	0.7 (0.1)	0.1 (0.1)	0.050	0.1 (0.1)	0.8 (0.1)	0.004*
Dysphagia (0–3)	0.6 (0.1)	0.2 (0.1)	0.070	0.3 (0.1)	0.6 (0.1)	0.085
Modified DeMeester (0–12)	2.9 (0.3)	1.1 (0.3)	0.012*	1.1 (0.4)	3.2 (0.3)	0.000*
Bloating (0–3)	0.7 (0.1)	0.4 (0.1)	0.418	0.5 (0.1)	0.7 (0.1)	0.407
GSRS (1–7)						
Abdominal pain	1.9 (0.2)	1.4 (0.2)	0.017*	1.9 (0.1)	1.4 (0.1)	0.144
Reflux	1.9 (0.2)	1.2 (0.1)	0.190	2.0 (0.1)	1.1 (0.2)	0.003*
Diarrhoea	1.8 (0.1)	1.5 (0.3)	0.034*	1.9 (0.1)	1.7 (0.2)	0.246
Indigestion	2.5 (0.2)	1.6 (0.2)	0.036*	2.5 (0.2)	1.9 (0.2)	0.056
Constipation	2.0 (0.1)	1.6 (0.2)	0.126	2.1 (0.2)	1.6 (0.1)	0.082
Inability to vomit (1–7)	1.5 (0.2)	1.0 (0)	0.401	1.5 (0.0)	1.0 (0.2)	0.242
Inability to belch (1–7)	1.4 (0.1)	1.1 (0.1)	0.749	1.4 (0.1)	1.1 (0.1)	0.575

s.e.m. standard error of the mean, *GSRS* Gastrointestinal Symptom Rating Scale

*Correlation significant at 0.05 level

[a]Lower scores reflect favourability

exercise tolerance was improved, whilst 7.9% ($n=7$) said it was worse. Neither breathing ability nor exercise tolerance correlated significantly with patients opinion of operative success ($n=87$, $r_s=-0.113$, $P=0.297$, and $n=88$, $r_s=-0.184$, $P=0.086$, respectively).

Results of mesh patients

37 patients underwent insertion of mesh at the hiatus (20.8%). There were no direct mesh-related complications. There was no significant difference in radiological recurrence (3/37 (8.1%) vs 12/141 (8.5%) $P=0.937$) nor re-operation rates (2/37 (5.4%) vs 11/141 (7.8%) $P=0.618$) in the mesh versus no mesh groups. 2/37 were re-operated for recurrent hiatal herniae. No resections were carried out.

Discussion

Giant paraoesophageal hiatus hernia (GPHH) repair was associated with high levels of patient satisfaction, with 83.7% of patients reporting 'Good' or 'Excellent' operative success and 97.8% believing they had made the correct decision to undergo surgery. This is comparable to the 88% success rate and 95% correct decision rate observed after 12-month follow-up in a recent randomised trial [10]. Severity of symptoms on follow-up correlated with how successfully patients viewed their operations. The fact that all patients reporting poor outcomes believed they had made the correct decision in undergoing surgery likely reflects pre-operative symptom severity and its impact on quality of life.

In this study, there was a clinical recurrence rate of 8.4%, with 7.3% undergoing re-operation. Recurrence rates following GPHH repair in the literature have varied from 15% [5] to 66% [6], with marked discrepancies in how recurrence is assessed and defined, and at what time point [5, 11, 12]. Most studies have defined recurrence anatomically based on barium oesophagram, some including only recurrences measuring greater than 2 cm above the diaphragm [10, 13], whilst others included all radiologically demonstrable [6, 14]. Many studies also included only elective and/or laparoscopic procedures [5, 6, 12]. As such, it is not surprising that rates of barium oesophagram defined anatomical recurrence have varied so much. Whilst relatively high anatomical recurrence rates were observed across the literature, these have not necessarily been associated with decreased quality of life or return of symptoms [5, 6, 11, 12]. It has also been postulated that rates of potentially dangerous organo-axial rotation in PHH are reduced in recurrences, due to the presence of post-operative adhesions [15]. As such, many anatomical recurrences can be considered subclinical, with only a proportion re-presenting with recurrent symptoms. Rates of re-operation are more definitive, and thus comparable with other literature. A recent study with a comparable duration of follow-up and patient demographic reported similar re-operative rates of 4.8% [11]. There is no doubt that the overall recurrence rate in our study will be higher, but as there was no policy to assess asymptomatic patients, this figure is not relevant to the management algorithm.

In this study with a high patient response rate, mean symptom scores were universally low, reflecting little symptom burden post-operatively. Symptom scores were

comparable to a study of patients who had undergone laparoscopic fundoplication for reflux without GPHH in our centre between 1994 and 2010 [16]. The weak relationship observed between length of follow-up and both the DeMeester scores, and inability to vomit, may reflect a gradual recurrence of minor symptoms that could, if investigated, be associated with small anatomical recurrences. It may also reflect a procedural learning curve or an improvement in durability of operative techniques over the long study period. Higher post-operative symptom scores in elective patients may reflect a difference in sensitivity to symptoms experienced between those who presented electively and those who presented as an emergency.

Patient demography was similar to other studies, which also found an average age close to 69 years and a preponderance of females [10, 11]. The 1.6% 30-day mortality rate following all elective procedures was similar to the 1.4% rate expected in elective laparoscopic repairs of PHH based on analytical modelling of 20 published studies [17]. This likely reflects the frail and ageing nature of the study population. Mean length of stay was also comparable to the literature [10]. 30-day mortality rate following emergency procedures was significantly higher, at 6.7%. The relatively low mortality and length of stay observed following elective procedures, coupled with the high rates of patient satisfaction with the procedure and a significantly increased mortality rate in emergency procedures, add to the body of evidence advocating elective repair of symptomatic GPHH, particularly in lower risk patient groups [1].

A subjective improvement in breathing was observed in almost half of patients following surgical fixation of GPHH. Exercise tolerance improved similarly. Previous work has also demonstrated significant improvements in respiratory symptoms post-operatively—one recent study in 30 patients found that severity of dyspnoea was subjectively improved or resolved in all patients suffering from it pre-operatively [18]. Our study did not record detailed symptoms pre-operatively, and thus we were unable to determine the proportion of patients with respiratory symptoms seeing improvements, but dyspnoea is believed to be present in approximately half of patients with GPHH [19].

Despite high perception of operative success, 69.5% of patients remained on acid-suppressing medications post-operatively, although this did not correlate with a decreased perception of operative success, and a quarter of patients were either unsure of the indication or were taking these medications for other reasons. High use of post-operative PPI therapy has previously been observed following laparoscopic fundoplication procedures for gastro-oesophageal reflux disease despite comparable outcomes [16].

Questionnaire response rate was high at 78.5%; however, there still exist a number of patients lost to follow-up, which may have resulted in non-response bias. In addition, the questionnaire sample may not have been representative of the whole population due to potential attrition bias. Mesh was incorporated into 37 patient's procedures. The sample size is currently not sufficient to identify any differences between mesh and non-mesh subgroups.

In conclusion, surgical repair of GPHH is associated with high levels of patient satisfaction that persist long-term. Mean symptom scores are low, comparable to those of patients who undergo fundoplication for reflux without GPHH, and approximately half of patients reported improvement in respiratory symptoms. Re-operative rates were consistent with the literature and did not significantly increase long-term. Post-operative mortality was significantly increased in the emergency population.

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