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Original Article

Temporal patterns of hiatus hernia recurrence and hiatal failure: quality of life and recurrence after revision surgery

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SUMMARY. **Antireflux and paraesophageal hernia repair surgery is increasingly performed and there is an increased requirement for revision hiatus hernia surgery. There are no reports on the changes in types of failures and/or the variations in location of crural defects over time following primary surgery and limited reports on the outcomes of revision surgery. The aim of this study is to report the changes in types of hernia recurrence and location of crural defects following primary surgery, to test our hypothesis of the temporal events leading to hiatal recurrence and aid prevention. Quality of life scores following revision surgery are also reported, in one of the largest and longest follow-up series in revision hiatus surgery. Review of a single-surgeon database of all revision hiatal surgery between 1992 and 2015. The type of recurrence and the location of crural defect were noted intraoperatively. Recurrence was diagnosed on gastroscopy and/or contrast study. Quality of life outcomes were measured using Visick, dysphagia, atypical reflux symptoms, satisfaction scores, and Gastrointestinal Quality of Life Index (GIQLI). Two-hundred eighty four patients (126 male, 158 female), median age 60.8(48.2–69.1), underwent revision hiatal surgery. Median follow-up following primary surgery was 122.8(75.3–180.3) and 91.6(40.5–152.5) months after revision surgery. The most common type of hernia recurrence in the early period after primary surgery was 'telescope'(42.9%), but overall, fundoplication apparatus transhiatal migration was consistently the predominant type of recurrence at 1–3 years (54.3%), 3–5 years (42.5%), 5–10 years (45.1%), and >10 years (44.1%). The location of crural defects changed over duration following primary surgery as anteroposterior defects was most common in the early period (45.5% in <1 year) but decreased over time (30.3% at 1–3 years) while anterior defects increased in the long term with 35.9%, 40%, and 42.2% at 3–5 years, 5–10 years, and >10 years, respectively. Revision surgery intraoperative morbidity was 19.7%, mainly gastric (9.5%) and esophageal (2.1%) perforation. There was a 75% follow-up rate and recurrence following revision surgery was 15.4%(44/284) in unscreened population and 21%(44/212) in screened population. There was no difference in recurrence rate based on size of hiatus hernia at primary surgery, or at revision surgery. There were significant improvements in the Visick score (3.3 vs. 2.4), the modified Dakkak score (23.2 vs. 15.4), the atypical reflux symptom score (23.7 vs. 15.4), and satisfaction scores (0.9 vs. 2.2), but no difference in the various domains (symptom, physical, social, and medical) of the GIQLI scores following revision surgery. Revision hiatal surgery has higher intraoperative morbidity but may achieve adequate long-term satisfaction and quality of life. The most common type of early recurrence following primary surgery is telescoping, and overall is wrap herniation. Anterior crural defects may be strong contributor to late hiatus hernia recurrence. Symptom-specific components of GIQLI, but not the overall GIQLI score, may be required to detect improvements in QOL.**

KEY WORDS: **antireflux surgery, hiatal hernia, large hiatal hernia, quality of life.**

INTRODUCTION

Hiatal hernia repair and antireflux surgery have excellent long-term outcome but has been reported with large variations in hiatal hernia recurrence of 5%–42%.[1,2] A recent meta-analysis of 13 studies in 965 patients reported mean 14% hernia recurrence in unscreened postsurgical patients, which increased to 25% recurrence in routinely screened patients.[1] This was supported by a systematic review, which also reported 25% hiatus hernia recurrence in patients undergoing routine screening with contrast swallow.[2] The appreciation of the excellent outcomes of primary antireflux surgery[3,4] and the introduction of minimal

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invasive approaches have led to increased number of primary antireflux procedures with subsequent increased numbers of hiatal recurrences and demand for revision hiatal surgery.[5,6] However, there are only a few reports on outcomes of revision hiatal surgery, which have mostly associated revision surgery with higher morbidity, and potentially decreased symptomatic success compared to primary surgery.[7–11] Furthermore, the temporal changes in types of hiatus hernia recurrence and the part of the diaphragm repair that fail after primary surgery have never been investigated. We aimed to report the observed changes in types of hiatal hernia recurrence, and the location of crural failure following primary surgery and to test our hypothesis of temporal events leading to hiatal recurrence (see Methods: Classifications of Failure). We also aimed to report the outcome of revision surgery as defined by further hernia recurrence and quality of life scores.

MATERIALS AND METHODS

Data were collected from a prospectively maintained single-surgeon database of revisional hiatal surgery from 1992 to 2015. All patients underwent endoscopy, contrast radiography, and 24-hour pH and manometry. Standardized novel reflux-aspirate technetium scans were used for patient with atypical or upper respiratory symptoms.[12]

Selection criteria

Revision surgery was only considered when there was a clinical correlation between a recurrent and typical symptom (e.g. heartburn) with objective evidence of recurrence/reflux in at least one of the investigations. Patients reporting a new unexplained symptom after primary surgery were not offered surgery unless it was dysphagia with confirmed manometric evidence of an isolated high-pressure zone in the surgical field. For patients with atypical symptoms (e.g. cough), laryngopharyngeal reflux must be demonstrated on technetium scan regardless of evidence of hernia recurrence/reflux on other investigations. All surgical patients had also failed trial of medical management. Patients with symptoms only (regardless of how convincing) but without objective evidence on any investigations were not offered surgery.

Ethics approval was by RGH Concord Institutional Ethics approval for maintenance reporting (Database, serially approved CH62/6/2011-092). Hiatus hernia at primary surgery was classified as none, small (1–5 cm), and large (>5 cm). Hiatus hernia noted at time of revision surgery was classified as none, small (0–2 cm), moderate (2–5 cm and/or <30% intrathoracic migration), large (>5–10 cm defect and/or 30%–50% intrathoracic migration), or massive (>10 cm and/or >50% intrathoracic migration).

Classifications of Failure

Findings at revision surgery were classified into six groups based on intraoperative examination at time of revision surgery and our hypothesis of sequence of events leading to recurrence (Fig. 1):

1. Intact hiatus (fibrosis/tight hiatus).
2. 'Telescope' (Fig. 1a).
3. Paraesophageal hernia, often a lateral/posterior defect involving fundus with GOJ and wrap in position (Fig. 1b).
4. Crural failure with intact wrap herniation (Fig. 1c).
5. Crural failure with herniation and wrap disruption.
6. Wrap disruption only (intact hiatus and intra-abdominal position maintained).

The location of crural defects following primary surgery were classified into five groups based on intraoperative assessment at revision surgery: (a) intact hiatus, (b) lateral defect, (c) anterior defect only, (d) posterior defect only, or (e) anteroposterior defect (global).

Patients were routinely followed with subjective and objective review. Those who had not followed the routine clinical pathway were contacted for clinical review and examination. Symptoms were measured using the Gastrointestinal Quality of Life Index (GIQLI),[13] the modified Visick score,[14] the Dakkak dysphagia score,[15] the atypical reflux score,[16] and the satisfaction score. These were measured at <1 year, 1–3 years, 3–5 years, 5–10 years, and >10 years. Continuous data are presented as median (IQR). Paired *t*-test was used to calculate pre- and postsurgical scores. Statistical analysis was performed using the IBM SPSS, version 20.

RESULTS

Patient demographics and procedures

Two hundred eighty-four patients (126 male, 158 female) underwent revision surgery between 1992 and 2015. The median age was 57.1(42.5–65.3) years at primary surgery and 60.8 years (48.2–69.1) at revision surgery. The median interval between primary and revision surgery was 46.5 months (19.7–95.1). Primary surgery had been performed at the authors' institution in 121(43%) patients and 163(57%) at other institutions. The primary and revision procedures are shown in Table 1. Median postoperative follow-up was 122.8 months (75.3–180.3) after primary surgery and 91.55 months (40.5–152.5) after revision surgery. Revision surgery was performed open in 113(40%), laparoscopic conversion to open in 20(7%), and laparoscopic in 151(53%). Mesh reinforcement was used in

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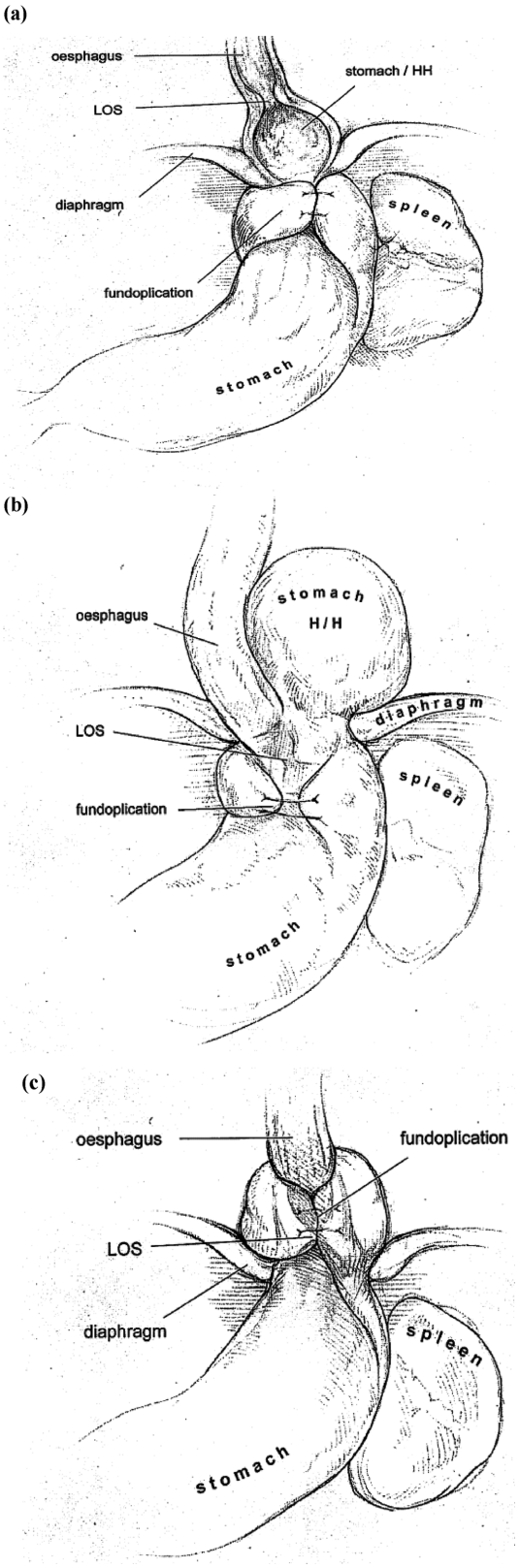

Fig. 1 Classification of types of hernia recurrence following primary. (a) Telescoping; (b) Paraesophageal hernia; (c) Crural failure and intact wrap herniation.

Table 1 Primary and revision procedures

Type of procedure	Primary surgery	Revision surgery
Lap 360	156	116
Open 360	86	94
Lap 270	4	1
Open 270		7
Lap 180	4	4
Open 180	1	14
Lap/open 360–270		3(Lap):3(O)
Lap/open 360–180		5(Lap):5(O)
Lap 270–360		4
Lap Dor		3
Hiatal repair only		2
Other		2
Not available	33	21
Total	284	284

Lap, laparoscopic; O, Open.

14(5%) and cut-Collis gastroplasty was performed in 36(13%) of revision operations. Intraoperative morbidity occurred in 56(19.7%), consisting of 27(9.5%) gastric perforations (11 requiring sutured gastrotomy and 16 required stapled wedge gastrectomy of the tip of the posterior fundoplication), esophageal perforation in 6(2.1%), pleural breach in 15(5.3%), and bleeding in 8(2.8%). 10(3.5%) patients were performed as emergency revision procedures, which was not associated with increase morbidity or recurrence or symptomatic failure.

Further revision surgery (re-revision) was required in 21 patients, 18 were elective and 3 emergencies. There was no change in re-revision rate over time. Esophagectomy was eventually required in two and gastrectomy in two patients. One patient had multiple previous repairs with subsequent recurrent reflux aspiration and severe esophageal dysmotility, which after 10 years culminated in elective esophagectomy and feeding jejunostomy. The second patient also had multiple previous repairs and was found to have at least a third of the esophagus grossly adherent to the diaphragm with mediastinal fibrosis, and had perioperative conversion to two-stage esophagectomy. Original pathology in both patients was a massive hiatus hernia. The two patients who required gastrectomy had multiple previous open repairs with intractable symptoms. There was no operative or 30-day mortality.

Findings at the revision procedure

The median time (years) to each recurrence type, in ascending order, was intact hiatus 1.3, paraesophageal 3.8(2.6–4.1), telescope 4.3(2.4–6.2), primary wrap disruption 4.4(1.2–9.5), crural failure with intact herniated wrap 4.4(4.6–7.9), and crural failure and wrap disruption 6.1(4.1–8.5). The types of recurrence intervals over time after primary surgery are shown (Table 2). The most common type at <1 year was 'telescoping' and wrap herniation in the remaining years.

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Table 2 Type of recurrence at each time interval after primary surgery, *n*(%).Data were not available in 56 patients. Bold highlights the most common type of recurrence at each time interval

Type of recurrence	<1 year	1–3 years	3–5 years	5–10 years	>10 years	Total
Intact	0(0)	3(8.6%)	3(7.5%)	4(5.6%)	10(14.8%)	20
Telescope	**6(42.9%)**	6(17.1%)	6(15%)	11(15.5%)	9(13.2%)	38
Paraesophageal hernia	1(7.1%)	1(2.9%)	4(10%)	8(11.5%)	7(10.3%)	21
Crural failure and fundoplication herniation	4(28.6%)	**19(54.3%)**	**17(42.5%)**	**32(45.1%)**	**30(44.1%)**	102
Crural failure and fundoplication disruption	2(14.3%)	2(5.7%)	7(17.5%)	10(14.1%)	6(8.8%)	27
Fundoplication disruption	1(7.1%)	4(11.4%)	3(7.5%)	6(8.5%)	6(8.8%)	20
Total	14(100%)	35(100%)	40(100%)	71(100%)	68(100%)	228

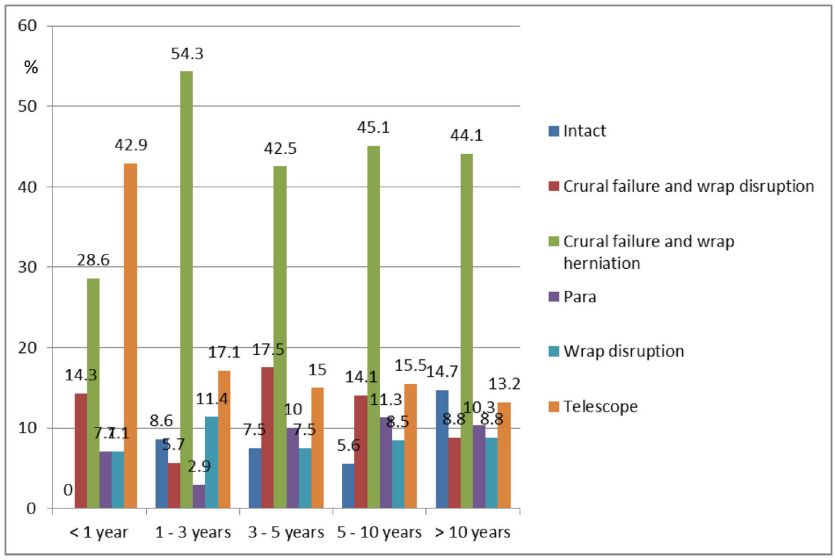

Fig. 2 Proportion (%) of types of recurrence seen at revision surgery (*y*-axis) at each time following primary surgery (*x*-axis).

The distribution of recurrence type at each interval is shown (Fig. 2).

Location of crural defect following primary surgery over time

The median time (in years) for location of crural defect, in ascending order, was intact hiatus 2.6 (1.1–7.3), anteroposterior 3.4(1.6–6.7), anterior only 5.1(2.3–9), and posterior 5.3(2.8–13.7). The distribution over time is shown (p = nonsignificant) (Table 3) (Fig. 3).

Recurrence following revision hiatal surgery

Median follow-up after revision surgery was 91.6 months (40.5–152.5). Seventy-two (25%) patients were lost to follow up (moved/deceased/unwell) and the remaining 212 patients had objective assessments within the last 3 years for recurrence (gastroscopy and/or swallow). Anatomical recurrence occurred in 44 patients giving a 15.4% recurrence rate of the whole series, and probably a 'true' recurrence rate of 20.7% in the 212 patients with objective investigations. Recurrences were subdivided by findings of size of hiatus hernia at primary surgery and size of hiatus hernia at revision surgery (Table 4). The majority of recurrences appeared to be following small hiatus hernia presence at primary surgery, but when individual groups were analyzed, there was no difference in the recurrence rates by size of primary hernia (Table 4, 3rd column]. Reflux symptoms were present in 57%(24/42) of the further recurrence group, compared to 26%(44/170) in those with no further recurrence. Re-revisions were performed in 21 patients and there was no difference in re-revision rate over time.

Quality of life following revision surgery

Prerevision and postrevision GIQLI scores were available in 154 patients giving 72% response rate of the 212 patients available to follow up and 54% response rate of the entire cohort (Table 6).

DISCUSSION

Revision surgery is reported technically difficult and associated with increased morbidity and decreased success compared to primary surgery.[3,7–11] A stringent process of patient selection was used for revision surgery in this series. The proportion of

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Table 3 Proportion (%) location of crural failure at each time interval. Data were not available in 72 patients

Location	<1 year	1–3 years	3–5 years	5–10 years	>10 years	Total
Intact	4(36.3%)	11(33.3%)	8(20.5%)	10(15.4%)	13(20.3%)	46
Anterior	1(9.1%)	10(30.3%)	14(35.9%)	26(40%)	27(42.2%)	78
Posterior	1(9.1%)	2(6.1%)	5(12.8%)	10(15.4%)	8(12.5%)	26
Anteroposterior	5(45.5%)	10(30.3%)	11(28.2%)	15(23.1%)	15(23.4%)	56
Lateral	0(0%)	0(0%)	1(1.6%)	4(6.2%)	1(1.6%)	6

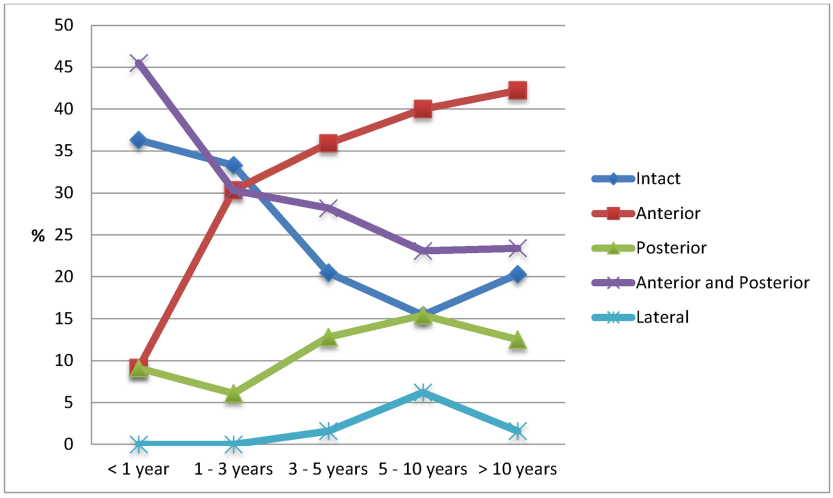

Fig. 3 Incidence of types of crural defects over time.

Table 4 The effect of primary hiatus hernia size on rates of recurrence after revision surgery

Hiatus hernia size at primary surgery	Recurrence following revision Surgery; *n*(% of all recurrences)	Recurrence rate by size of hernia
No hiatus hernia ($n = 25$)	5(11.4%)	5/25(20%)
Small ($n = 79$)	18(40.8%)	18/79(22.8%)
Large ($n = 66$)	12(27.3%)	12/66(18.2%)
Not available ($n = 45$)	9(20.5%)	9/45(20%)
Total recurrences in series	44(100%)	

revision procedures commenced as open surgery was high and reflected the policy of performing open revision surgery if primary surgery had been open. This approach was deliberate, to obtain a better repair and reduce intraoperative complications, especially in the early learning curve. Other studies have indirectly supported our caution, with reports of 30% esophagogastric perforation rate laparoscopic surgery[7,11] and up to 60% perforation rate in laparoscopic converted to open revision procedures,[11] although there is bias in the latter group as perforation is the likely cause of conversion. Surgeons undertaking revision procedures should still be well advised about the intraoperative morbidity, especially during early experience. Our overall conversion rate for revision surgery was 7% and similar to other series.[11] A recent systematic review of laparoscopic revision fundoplication concluded mean conversion rates between 5.6%–7.4% (0%–22%).[10]

Revision hiatal surgery is associated with substantial morbidity.[7,8] Our overall intraoperative morbidity was 20%, the most common event being gastric perforation (10%) and esophageal perforation (2%) with a lower incidence of pneumothorax and bleeding (1%–3% each), which is consistent with other reports of 13%–14% perforation and up to 6% pneumothorax.[7,8,10] A prospective record of postoperative complications was not available. There was no mortality. Two recent series on revision massive hiatus hernia surgery (using open abdominal, laparoscopic and open transthoracic approaches) have reported 33%(7/21) visceral perforation and 9.5%(2/21) leak rate;[7] and the other reported 37% operative morbidity and 1.9%(1/52) mortality from respiratory causes.[8] A systematic review summarized 18.6% intraoperative morbidity although individual studies have reported up to 50% complications, and mean postoperative complication rate of 16.9%.[10] Mortality, however, is low (0.3%) and mainly from respiratory causes.[10,11] Re-operation following revision surgery in our series was required in 21/284 (7.5%) and similar to that reported by Haider *et al.* (9.6%, 5/52)[8] and Juhasz *et al.* (10%, 2/21).[7] Two patients (0.7%) required esophagectomy and two required gastrectomy. It is also worth noting that two other authors report

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proceeding directly to resection surgery in patients with previous multiple repairs in 10%.[7,9] The requirement for radical resection either as a result of complication or as a definitive procedure for functional outcome cannot be underestimated.

Temporal changes in type of recurrent hiatus hernia following primary surgery

This is the first study to investigate the changes in types of hiatus hernia recurrences over time. We used a classification which we hypothesized reflected the temporal sequence of events leading to recurrence. Telescoping of the cardioesophageal junction through the intact hiatus and fundoplication is an early event, possibly as a result of mechanical forces on an otherwise robust, and still intact antireflux apparatus. Paraesophageal hernia type recurrence, is also seen to be an early event, and may be caused by a small posterior-lateral defect from inadequate crural closure, or loose redundant left-sided fundoplication. Crural weakening with a widening hiatus may occur later, possibly due to prolonged exposure to mechanical stressors and intraabdominal pressures.[17] Theoretically, once the hiatus is weakened, the same pressures may push the entire fundoplication assembly progressively caudally leading to intrathoracic migration, or a sudden increase in intraabdominal pressure may lead to more sudden migration of the whole apparatus. Finally, the wrap itself may become disrupted, leading to disassembly of the entire apparatus. This hypothesis was partly borne out in our results where the most common recurrence type in the first year was 'telescoping', which accounted for 40% of all recurrences and then decreased over the subsequent years, with the shortest median time to recurrence (4.3 years). Surgical strategy may be devised to counter this tendency. The early telescoping phenomenon emphasizes the need to stabilize the esophagus within the wrap, and the entire apparatus below the diaphragm, if possible. We perform this using a modified cardiopexy, securing the cardioesophageal junction and posterior wrap to the median arcuate ligament.[21]

Fundoplication wrap herniation was the most common overall type of failure. It was also the second most common type of early failure. The many early migrations occurring at the start of the laparoscopic learning curve probably reflects inadequate crural closure. Wrap migration was also the most common type of recurrence in the later part of the study, especially at 5–10 years and >10 years, probably reflects true physiological weakening of the crus. Several other studies, while not succinctly describing the 'types' of failures, similarly report intrathoracic 'migration' as the most common type of recurrence ranging from 44% to 75%, followed by telescoping 12%–16%, paraesophageal hernia 15% and wrap disruption 6%–16%[7,10,11,18–20] although none of these studies have demonstrated variation in types and frequency over time.

Table 5 The effect of size of initial recurrence on revision failure

Recurrent hiatus hernia size seen at revision surgery	Recurrence following revision surgery; *n*(% of all recurrences)	Recurrence rate by size of hernia
No hiatus hernia ($n = 28$)	7/44(15.9%)	7/28(25%)
Small or moderate ($n = 91$)	18/44(40.9%)	18/91(19.8%)
Large/massive ($n = 79$)	15/44(34.1%)	15/79(19.0%)
Not available ($n = 17$)	4/44(9.1%)	4/17(23.5%)
Total recurrences in series	44(100%)	

Temporal changes in location of crural failure following primary surgery

This is the first study to investigate temporal changes in the location of crural defects after primary surgery. The assessment was performed intraoperatively by senior author (GLF). The intact crura noted in 33%–36% of revisions performed within the first 3 years after primary surgery reflects early revision surgery for dysphagia rather than true crural failure. True crural failure in this period was usually a global anteroposterior defect, caused by early technical failure or postoperative vomiting, which occurred less frequently over time. This type of failure decreased over time while isolated anterior defects increased and became the predominant cause of failure beyond 5 years. This anterior failure, rather than the traditional view of posterior failure where sutures are traditionally placed, could be caused by deterioration of the central tendon of the diaphragm leading to loss of integrity of anterior fibrous tissue over time. A recent large experience of large hiatus hernia has made obvious the development of the central tendon defect, which occurs in patients developing giant hiatus hernia over many years.[21,22] The clinical implication of delayed anterior failure suggests emphasis be placed on a concurrent anterior repair, in addition to the traditionally held posterior repair, with a view to reduction in late recurrence.

Further recurrence after revision surgery

There was good follow-up of 212/284, considering the age at revision surgery and subsequent median follow-up of 7.6 years[9,11] but outcomes/responses can be influenced by follow-up duration.[23] We attempted objective testing on all patients as there is increased hernia recurrence rate in screened population compared to unscreened populations.[1,2] The recurrence rate was lower in unscreened population(15%) and

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Table 6 Prerevision versus postrevision surgery scores. Visick, Dysphagia, and Components of GIQLI scores (paired t-test)

Outcome	Mean pre (SD)	Mean post (SD)	*P*-value
Visick score	3.27 (0.83)	2.37 (1.17)	**0.000012**
Dysphagia score	23.15 (9.90)	32.81 (10.54)	**0.000004**
Atypical reflux symptom score	23.69 (11.36)	15.35 (11.24)	**0.000001**
Satisfaction	0.88 (1.05)	2.16 (0.79)	**0.000001**
Symptom (GIQLI)	47.32 (11.45)	51.37 (12.98)	0.837161
Emotional(GIQLI)	10.6 (4.44)	13.10 (4.44)	**0.000001**
Physical (GIQLI)	11.58 (6.74)	14.64 (7.21)	0.143187
Social (GIQLI)	10.51 (3.70)	11.91 (4.34)	0.110152
Medical treatment (GIQLI)	2.65 (1.29)	3.01 (1.41)	0.653474
Question 27 (regurgitation)	2.04	2.61	**0.022**
Question 35 (heartburn)	2.39	2.69	0.154

GIQLI, Gastrointestinal Quality of Life Index.

higher in our screened population(20%) and lower when compared to other studies.[7,8,9,18] This is not strictly comparable as these studies have a select population of large recurrent hiatus hernias but with shorter follow-up. Despite expectation of a higher recurrence rate in patients with initially large hernia, neither hiatal hernia size at primary surgery nor size at revision surgery predicted recurrence after revision surgery (Tables 4 and 5). Patients with anatomical recurrence had double the symptom rate compared with those without recurrence, but it also worth noting than half of those with recurrence were asymptomatic and few required surgery. Those with symptomatic recurrences were manageable with the majority of 'symptoms' being dyspeptic. Hence, many recurrences and symptoms can be managed nonsurgically, with studies including ours, reporting less than half of recurrences requiring surgery.[4,24]

Quality of life

QOL questionnaires were posted to patients who had not followed our follow-up schedule leading to a high response rate of 72% compared with other studies.[11] There was significant improvement in Visick score, dysphagia score, atypical reflux symptom score, and satisfaction score following revision surgery but no change in the components of the GIQLI (Table 6). This is probably because the GIQLI 'symptom' domain incorporates many abdominal symptoms (e.g. diarrhea) resulting in less specificity for reflux symptoms alone, in contrast to specific Visick and Dysphagia scores. When symptom-specific questions of the GIQLI were analyzed, there was significant improvement in Question 27(for regurgitation) and a nonsignificant improvement in Question 35 (for heartburn) following revision surgery. This suggests only certain components of the GIQLI, but not the overall GIQLI score, are sensitive for hiatus symptomology. Different studies have used various outcome measures and all have reported 'success' especially in satisfaction. Revision surgery appears to achieve good satisfaction (although not as good as primary surgery).[3,4]

CONCLUSION

Hiatus hernia recurrence and crural defects, especially anterior crural defects, increase variably over time, raising speculation about the mechanism of hiatus hernia recurrence being deficiency of the central tendon in later time periods. This raises the possibility of alteration in surgical repair strategy. Telescoping occurs early and may be reduced by utilizing a composite cardiopexy repair and fundoplication where cardioesphageal junction is fixed to median arcuate ligament. Anterior repair of the central tendon in the larger hiatus hernia may be beneficial in preventing late recurrence. Revision hiatus hernia surgery is associated with significant intraoperative morbidity, but with adequate preoperative counseling and patient selection, can achieve improved quality of life and reasonable recurrence rates.

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