

Laparoscopic revision of failed antireflux surgery: a systematic review

Nicholas R. A. Symons, M.Sc., M.R.C.S.^a, Sanjay Purkayastha, M.D., M.R.C.S.^a,
Bruno Dillemans, M.D.^b, Thanos Athanasiou, Ph.D., F.E.C.T.S.^a,
George B. Hanna, Ph.D., F.R.C.S.^a, Ara Darzi, K.B.E., M.D., F.A.C.S.^a,
Emmanouil Zacharakis, M.D., Ph.D.^{a,*}

^aDepartment of Surgery and Cancer, Imperial College London, St. Mary's Hospital, Academic Surgical Unit, 10th Floor, QEOM Building, South Wharf Rd., London, W2 1NY UK; ^bDepartment of General, Laparoscopic and Bariatric Surgery, AZ Sint-Jan Hospital, Brugge, Belgium

KEYWORDS:

Laparoscopy;
Fundoplication;
Gastroesophageal
reflux;
Reoperation;
Recurrence;
Systematic review

Abstract

BACKGROUND: Laparoscopic antireflux surgery is an accepted treatment for persistent gastroesophageal reflux but about 4% of patients will eventually require revision surgery.

METHODS: We searched The Cochrane Collaboration, Medline, and EMBASE databases, augmented by Google Scholar and PubMed related articles from January 1, 1990, to November 22, 2010. Twenty studies met the inclusion criteria, reporting on 930 surgeries.

RESULTS: The mean surgical duration was 166 minutes and conversion to open revision fundoplication was required in 7% of cases. Complications were reported in 14% of cases and the mean length of stay varied between 1.2 and 6 days. A good to excellent result was reported for 84% of surgeries and 5% of patients required a further revisional procedure.

CONCLUSIONS: Laparoscopic revision antireflux surgery appears to be feasible and safe, but subject to somewhat greater risk of conversion, higher morbidity, longer hospital stay, and poorer outcomes than primary laparoscopic fundoplication.

© 2011 Elsevier Inc. All rights reserved.

Laparoscopic fundoplication is well accepted as the gold standard treatment for severe gastroesophageal reflux. It appears to be more efficacious¹ and less expensive² than ongoing medical therapy. Unfortunately, between 2.8% and 4.4% of patients undergoing laparoscopic fundoplication at a specialist center will require late reoperation for persistent or recurrent symptoms³⁻⁵ and

there may be an increased revision rate after primary laparoscopic antireflux surgery compared with an initial open approach.⁶ It is estimated that nearly 24,000 antireflux surgeries were performed in the United States in 2003,⁷ which suggests that approximately 1,000 revision surgeries are required annually.

Revision of failed antireflux surgery increasingly is being performed laparoscopically, but data about this approach are limited. This systematic review assessed the available evidence for the feasibility, safety, and efficacy of laparoscopic revision of failed antireflux surgery in adults.

* Corresponding author. Tel.: +44 (0)20-331-21012; fax: +44 (0)20-331-26950.

E-mail address: e.zacharakis@imperial.ac.uk

Manuscript received December 17, 2010; revised manuscript March 30, 2011

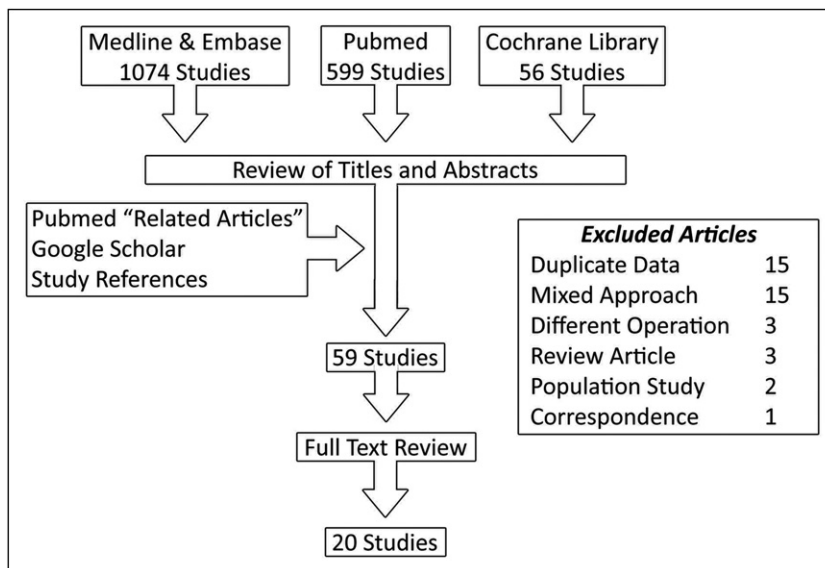


Figure 1 Flowchart of literature search.

Materials and Methods

End points

Surgical duration, conversion rate, and presence of an anatomic cause for failure of the initial surgery were used as primary end points to investigate the feasibility of revision laparoscopic fundoplication. Secondary end points used were complication rate and length of stay to examine safety, and long-term outcomes and re-revision rate to assess efficacy.

Literature search

A literature search was performed using OvidSP to search the MEDLINE and EMBASE databases for all studies involving laparoscopic revision of antireflux surgeries from January 1, 1990, to November 22, 2010. In addition, the Cochrane Library, Google Scholar, and the PubMed related articles feature were used to broaden the search. Medical subject headings search terms used were “laparoscopy,” “fundoplication,” “hiatal hernia,” “gastroesophageal reflux,” “heartburn,” “reoperation,” and “recurrence.” In addition, the words “keyhole,” “redo,” “revision,” “antireflux,” and “antireflux” were used. The references of the articles that the search yielded also were reviewed.

Data extraction

Two authors (N.R.A.S. and E.Z.) assessed studies for inclusion, limited to surgeries on adults who had undergone a previous antireflux surgery and in whom reoperation occurred beyond 30 days. Only studies in English and with direct observation were included. If multiple studies from the same institution were present in the literature the most

informative study was used. Studies that included mixed data on open and laparoscopic revision surgeries were excluded. When disagreement about eligibility occurred it was resolved by consensus opinion. The same authors (N.R.A.S. and E.Z.) extracted data, using a predefined protocol, on feasibility, safety, and efficacy, as well as demographics and baseline data.

Results

Studies included

The literature search (Fig. 1) identified 19^{8–26} case series (level of evidence, 4²⁷) and 1 prospective case-control study²⁸ (level of evidence, 3b²⁷) meeting the inclusion criteria (Table 1). Five case series^{13,15,17,21,25} were studied prospectively, 7^{9,10,16,18–20,23} were retrospective, and for 7^{8,11,12,14,22,24,26} the timing was not explicitly stated. These studies included 922 patients, 8 of whom underwent surgery twice within the study periods, for a total of 930 surgeries.

Patient demographics

Patients ranged in age from 13 to 83 and 57% were female. Eight articles^{8,13,18,20,21,23,24,28} quoted the mean time between initial fundoplication and revision. The overall mean interval was 45.5 months, ranging from 2 to 360 months. Twelve studies^{8,10,12,14,16,17,19–21,24,25,28} noted the number of previous fundoplications each patient had undergone. Forty-seven surgeries included were second reoperations (6.9%) and 9 (1.3%) were third reoperations. In addition, there were 3 surgeries¹¹ in which the patient had undergone “multiple” previous fundoplications.

Table 1 Study demographics

Study	Location	Study duration	Study design	Number of surgeries	Male-female ratio	Median age, y (range)
Alexander and Hendler ⁸	Dallas, TX, USA	1993–1994	—	2	0–2	59 (49–69)
Bataille et al ⁹	Brussels, Belgium	1998–2004	Retrospective	10	7–3	(24–74)
Byrne et al ¹⁰	Brisbane, Australia	1993–2001	Retrospective	118	48–70	—
Coelho et al ¹¹	Curitiba, Brazil	1993–2002	—	56	24–29	(21–72)
Cowgill et al ¹²	Tampa, FL, USA	2000–2006	Prospective, case-controlled	76	32–44	58
Croce et al ¹²	Milan, Italy	1994–1997	—	5	—	—
Curet et al ¹³	Albuquerque, NM, USA	1993–1998	Prospective	27	13–14	(17–72)
DePaula et al ¹⁴	Goiás, Brazil	1991–1994	—	19	11–8	(48–72)
Dutta et al ¹⁵	Ontario, Canada	1992–2001	Prospective	28	5–23	Mean, 48.6
Frantzides et al ¹⁶	Skokie, IL, USA	1992–2006	Retrospective	68	—	(23–78)
Granderath et al ¹⁷	Zell am See, Austria	1994–2002	Prospective	51	34–17	55 (33–78)
Hatch et al ¹⁸	Salt Lake City, UT, USA	1998–2003	Retrospective	39	17–22	(13–75)
Khajanchee et al ¹⁹	Portland, OR, USA	1991–2006	Retrospective	176	69–107	Mean, 55
Luketich et al ²⁰	Pittsburgh, PA, USA	1996–2001	Retrospective	80	28–52	49 (22–80)
Oelschlager et al ²¹	Seattle, WA, USA	1996–2002	Prospective	41	21–20	49 (23–73)
O'Reilly et al ²²	Nashville, TN, USA	1992–1995	—	8	4–4	47 (38–62)
Papasavas et al ²³	Pittsburgh, PA, USA	1996–2002	Retrospective	54	23–31	(24–80)
Richardson ²⁴	Louisiana, USA	1999–2002	—	10	1–9	(26–74)
Safraneck et al ²⁵	Reading, UK	1996–2005	Prospective	35	13–20	56 (23–83)
Watson et al ²⁶	Adelaide, Australia	1992–1997	—	27	14–13	—
Total				930	364–488	(13–83)

All but 2 studies^{10,12} documented the approach of the prior surgeries. Sixty-two percent (501 of 812) of initial funduplications were laparoscopic, 35% via laparotomy, 3% via thoracotomy, and .2% (2 cases) via video-assisted thoracoscopic surgery. Nissen fundoplication (82%; 617 of 752) and Toupet partial fundoplication (7%) were the most common initial procedures.^{8–13,15–19,21–26,28}

Feasibility

Indication for reoperation

Indications for laparoscopic reoperation were recorded in all but one study,²⁸ however, many patients were noted to have more than 1 symptom and for some patients no symptoms were recorded. Reflux or heartburn was the most prevalent indication (265 of 851; 61% of patients) and in 31% of patients the indication was dysphagia. A smaller number of patients had revision surgery for gas bloat symptoms (4%), regurgitation or vomiting (3%), or chest pain (2%).

Preoperative investigations

There was almost universal use of endoscopy (486 of 496; 98%) and contrast radiography (562 of 567; 99%) to investigate patients before reoperation. Esophageal manometry (278 of 324; 86%) and 24-hour pH monitoring (265 of 359; 74%)

were used frequently, however, several investigators reported omitting them for patients with clear anatomic abnormalities on contrast radiography.^{10,16,20,26} Gastric emptying studies were performed in 52 of 208 (25%), usually in selected patients, although it was used routinely in 2 studies.^{18,24} It is probable that the overall proportion of patients undergoing gastric emptying studies is lower than 25% because it is likely to be subject to significant reporting bias.

Details of reoperation

All case series documented the procedure performed at laparoscopic reoperation. Nissen fundoplication was the most common revision surgery, performed 650 of 930 times (70%), 87 of these included a hiatal repair and 46 incorporated a Collis gastroplasty. Toupet partial fundoplication made up 160 (17%) of the reoperations. Thirty-six (4%) patients required hiatal repair without fundoplication and 19 (2%) patients solely had the hiatus widened. A variety of other procedures were performed less frequently (Table 2).

Surgical duration

Thirteen case series^{8,10,11,13–19,23,24,28} reported the mean surgical duration and this ranged from 55 to 246 minutes. The overall mean surgical time for 721 patients was 166 minutes (Table 3). Watson et al²⁶ and Granderath et al¹⁷ have both shown a surgical time of 80 minutes

Table 2 Revision surgery performed

Study	Nissen	Nissen + hiatus repair	Nissen + Collis gastroplasty	Toupet	Partial anterior wrap	Hiatal repair only	Widening of hiatus	Removal of wrap	Roux-en-Y bypass	Other
Alexander and Hendler ⁸	1	—	—	1	—	—	—	—	—	—
Bataille et al ⁹	6	—	1	—	—	2	—	—	—	1
Byrne et al ¹⁰	24	41	2	34	15	—	—	—	—	2
Coelho et al ¹¹	16	1	—	—	—	26	12	—	—	1
Cowgill et al ²⁸	58	—	—	13	4	—	—	—	—	1
Croce et al ¹²	—	—	—	3	—	1	—	—	1	—
Curet et al ¹³	14	—	—	13	—	—	—	—	—	—
DePaula et al ¹⁴	11	—	1	4	—	—	—	—	1	2
Dutta et al ¹⁵	28	—	—	—	—	—	—	—	—	—
Frantzides et al ¹⁶	28	35	—	—	—	—	3	—	—	2
Granderath et al ¹⁷	42	—	—	9	—	—	—	—	—	—
Hatch et al ¹⁸	31	—	—	8	—	—	—	—	—	—
Khajanchee et al ¹⁹	131	—	—	26	—	—	—	2	—	17
Luketich et al ²⁰	26	—	42	7	—	2	—	—	2	1
Oelschlager et al ²¹	37	—	—	4	—	—	—	—	—	—
O'Reilly et al ²²	1	—	—	2	—	—	—	—	—	5
Papasavas et al ²³	27	—	—	25	2	—	—	—	—	—
Richardson ²⁴	4	—	—	2	—	2	—	2	—	—
Safranek et al ²⁵	17	10	—	5	1	—	1	1	—	—
Watson et al ²⁶	15	—	—	4	2	3	3	—	—	—
Subtotal	517	87	46	160	24	36	19	5	4	32
Total	930									

when initial surgery was by a laparoscopic approach, compared with 105 or 245 minutes, respectively, for patients who have had a previous laparotomy. The comparative study²⁸ compared surgical duration for primary

and revision laparoscopic fundoplication and found a trend toward longer surgical duration (147 ± 54.6 vs 107 ± 30.9 min; $P =$ not significant) for revision surgery compared with primary surgery.

Table 3 Outcome measures

Study	Mean surgical duration, min (range)	Median length of stay, d (range)	Median follow-up duration, mo (range)	Number satisfactory/excellent result (%)	Number undergoing further surgery (%)
Alexander and Hendler ⁸	144 (135–153)	3.5 (2–5)	10.5 (5–16)	2/2 (100)	—
Bataille et al ⁹	135 (75–270)	6 (4–22)	16 (8–30)	9/10 (90)	—
Byrne et al ¹⁰	115	3 (1–8)	12	88/104 (85)	7/118 (6)
Coelho et al ¹¹	159 (63–480)	Mean, 1.2 (1–8)	35 (6–72)	45/53 (85)	3/53 (6)
Cowgill et al ²⁸	147	3, mean, 6	Mean, 20	59/76 (77)	2/76 (3)
Croce et al ¹²	—	—	(6–20)	5/5 (100)	0/5 (0)
Curet et al ¹³	246 (138–426)	Mean 3.7 (1–22)	22 (1–60)	27/27 (100)	—
DePaula et al ¹⁴	210 (140–320)	(1–22)	13 (1–26)	16/19 (84)	—
Dutta et al ¹⁵	55	Mean, 3.0	Mean, 25.1	—	2/28 (7)
Frantzides et al ¹⁶	156 (42–270)	Mean, 2.5 (1–6)	27 (6–42)	59/68 (87)	0/68 (0)
Granderath et al ¹⁷	145 (45–420)	—	≥ 12	—	—
Hatch et al ¹⁸	138	Mean, 2.1	(1–24)	29/35 (94)	—
Khajanchee et al ¹⁹	225	Mean, 2.5	Mean, 9.2	128/145 (88)	—
Luketich et al ²⁰	—	Mean, 2.5 (1–25)	18 (1–52)	44/54 (82)	7/80 (9)
Oelschlager et al ²¹	—	2 (1–9)	50 (20–95)	28/41 (68)	—
O'Reilly et al ²²	—	(1–6)	(12–42)	7/8 (88)	—
Papasavas et al ²³	180 (60–355)	Mean, 2.3 (1–8)	22.5 (.8–57.2)	44/54 (82)	3/54 (6)
Richardson ²⁴	163 (64–295)	3 (1–8)	16 (1–40)	9/10 (90)	1/10 (10)
Safranek et al ²⁵	121 (65–210)	2 (1–7)	12	24/35 (69)	2/33 (6)
Watson et al ²⁶	—	3 (2–10)	12 (3–48)	25/27 (93)	—
Totals	164 (60–480)	(1–25)	(.8–95)	648/773 (84)	27/525 (5)

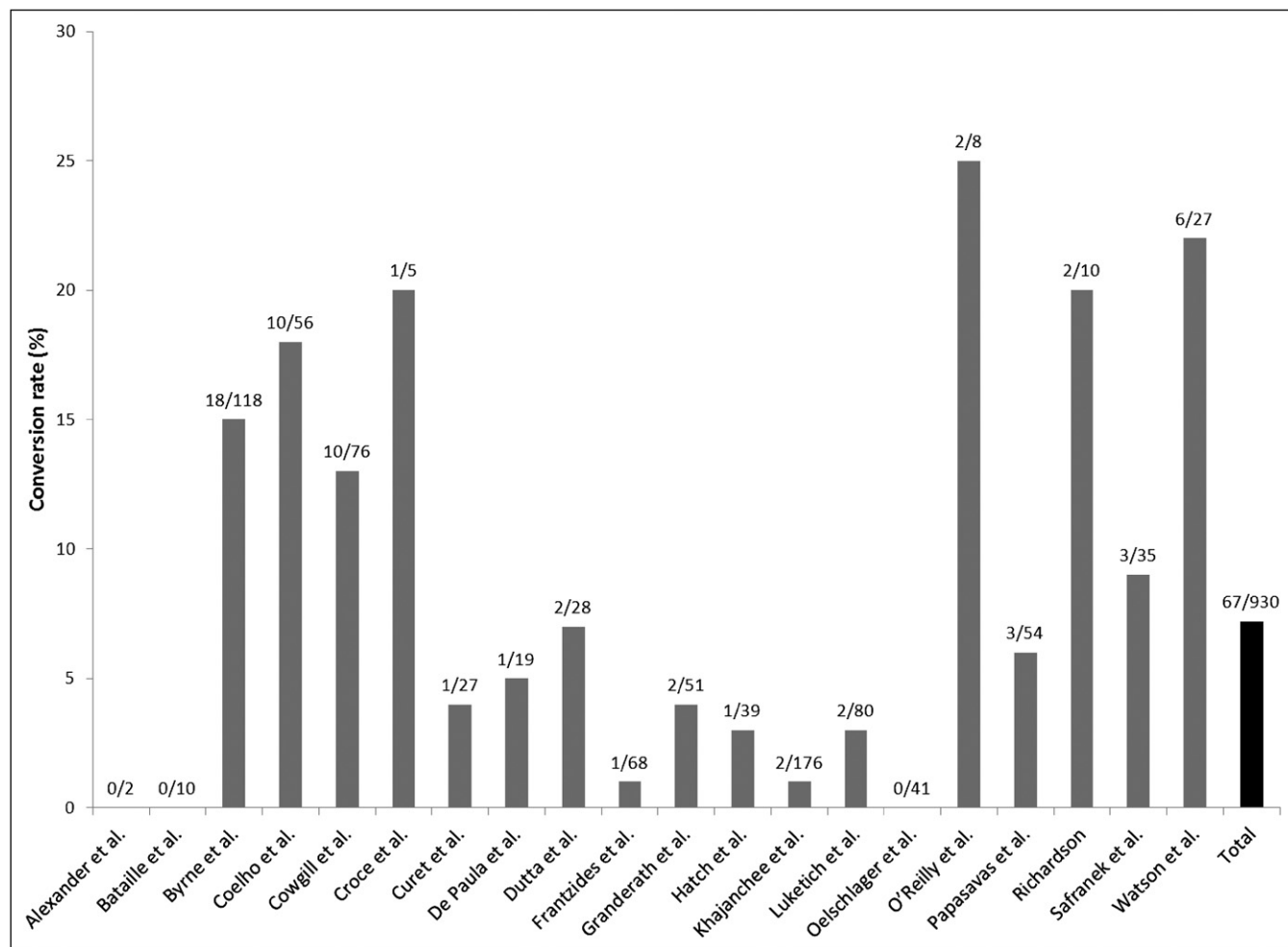


Figure 2 Conversion rate for laparoscopic revision of failed antireflux surgery.

Conversion rate

All investigators reported the rate of conversion from laparoscopic reoperation to open surgery. The overall conversion rate was 7.2% (67 of 930). Within individual studies the conversion rate ranged from 0% to 25% (Fig. 2). For patients who had had more than 1 previous fundoplication the conversion rate was 6 of 31 (19%).^{10,19,21} Sixteen studies^{8,9,12–14,16–26} noted the reason for conversion to open surgery and this usually was owing to adhesions from previous surgery (20 of 27; 74%).

Anatomic causes of failure

Anatomic cause for the failure of the initial fundoplication was studied by 18 investigators,^{8–25} although not all patients were accounted for in each study. Consequently, a total of 764 patients had the cause for the failure of their initial surgery documented. The terms *mediastinal migration of the wrap* and *paraesophageal hernia* were used interchangeably by some investigators and separately by others. For this review they were considered jointly and

comprised the most common anatomic problem found at revision (Table 4).

Safety

Complications

From 18 studies^{8–15,18–26,28} the overall postoperative complication rate was 14%, ranging from 0% to 44% between series (Fig. 3). There were 2 deaths, both in the same study,²⁸ but, unfortunately, no further details were given. There were 33 different complications recorded but all had low frequency. The most common complication was pneumothorax (14 of 810; 2%) (Table 5).

Length of stay

Data on duration of hospital stay was recorded by 18 investigators,^{8–11,13–16,18–26,28} however, there was significant heterogeneity in reporting. Length of stay ranged from

Table 4 Etiology of initial antireflux surgery failure

Etiology of initial surgical failure	Prevalence (%)
Paraesophageal hernia/mediastinal migration*	341 (45)
Disrupted wrap	113 (15)
Slipped wrap	89 (12)
Disrupted cruroplasty	38 (5)
Misplaced wrap	35 (5)
Tight wrap	35 (5)
Loose wrap	21 (3)
Stricture	16 (2)
Motility disorders	10 (1)
Other	34 (4)
Unclear	34 (4)

Analysis based on 18 studies,⁸⁻²⁵ including 766 revision surgeries.

*Paraesophageal hernia and mediastinal migration considered jointly owing to variability in reporting.

1 to 25 days, mean or median length of stay ranged from 1.2 to 6 days (Table 3).

The 1 case-control study²⁸ compared primary laparoscopic antireflux surgery with revision laparoscopic antire-

flux surgery and found a significantly longer hospital stay (3 vs 1 day; $P < .05$) in the revision surgery group.

Efficacy and outcomes

All articles recorded follow-up outcome data although the duration of follow-up evaluation and definition of successful outcome varied widely between studies. A satisfactory to excellent result was reported for 84% of surgeries and 5% of patients went on to have a further antireflux procedure (Table 3). Dysphagia, recurrent hiatal hernia, and persistent reflux with or without the use of medical therapy were noted in small numbers of patients at follow-up evaluation.

Volume/outcome relationship

By using Spearman rho there was no correlation between the number of cases in a series and the mean surgical duration ($n = 15$; rho, .073; $P = .80$), conversion rate ($n = 20$; rho, .180; $P = .45$), postoperative complication rate ($n = 18$; rho, .019; $P = .94$), or reoperation rate ($n = 10$; rho, .043; $P = .91$).

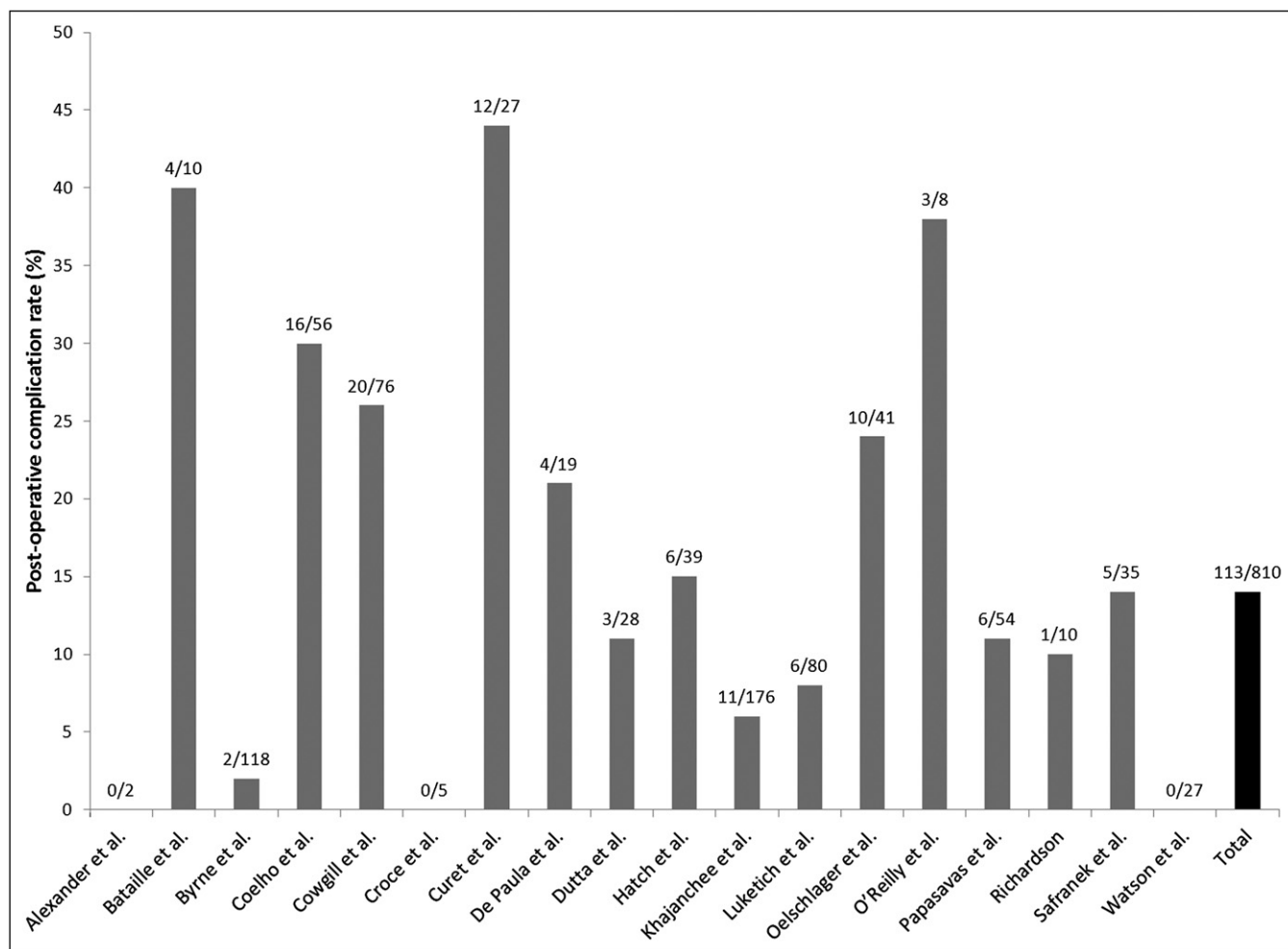


Figure 3 Postoperative complication rate for laparoscopic revision of failed antireflux surgery.

Table 5 Postoperative complications

Complication	Incidence (%)
Pneumothorax	14 (2)
Pneumonia	11 (1)
Esophageal/gastric leak	9 (1)
Gas bloating	9 (1)
Urinary retention	7 (1)
Ileus	6 (1)
Wound infection	6 (1)
Pleural effusion	5 (1)
Port-site hernia	5 (1)
Dysphagia	4 (0)
Other	37 (5)
Total	113/810 (14)

Analysis based on 18 studies^{8-15,18-26,28} including 810 revision surgeries.

Comments

The current evidence base for laparoscopic revision antireflux surgery is limited to case series and 1 comparative study. Outcomes often were variably reported. There are reasonable data for the feasibility of laparoscopic revision, especially when the primary fundoplication also was laparoscopic. In most cases an anatomic cause for symptoms was found and conversion rates generally were acceptable.

Revision laparoscopic fundoplication does not have excessive morbidity, given its complexity, and there were just 2 deaths in the series studied. Evidence for efficacy is far less convincing, mainly owing to the mixture of reporting time points, inconsistency of end point definitions, and methods of assessment between studies. There appears to be a larger proportion of patients undergoing a re-revision surgery than after primary fundoplication.

Preoperative investigations were similar throughout with endoscopy and contrast radiography routine. Manometry and pH studies generally were performed unless a clear indication for surgery already had been found. Further investigations, most notably gastric emptying studies, were reserved for selected patients.

Nissen fundoplication was slightly less popular for revision surgeries than primary ones and the reverse was true for Toupet and other partial fundoplications. This is probably a reflection of the greater proportion of patients with dysphagia as a primary symptom at the time of revision than is usual for primary surgery. The overall conversion rate of 7.2% is higher than that noted for primary surgery (3.7%³), but is not excessive given the increased complexity of revision surgery. Dense adhesions were cited as the reason for the majority of conversions and this also may explain the shorter duration of surgeries for patients whose initial procedure was laparoscopic. The mean surgical time of 166 minutes was 20% longer than that reported for primary procedures.³

Surgery-specific (gas bloat, perforation) and respiratory (pneumothorax, pneumonia) complications were most com-

mon. Complications were similar to those found during primary surgeries but they occurred more frequently (14% vs 6%).³ Data regarding outcomes for patients with complications were not reported in sufficient detail to include in this review. Length of stay for revision surgery was longer than for primary surgery based on the 1 comparative study found.²⁸ It is likely that laparoscopic revision surgery has fewer complications and a shorter length of stay than open revision surgery because the results for laparoscopic revision in this review are superior to those of primary open surgery in these domains,⁶ however, there is no comparative, single-study data to back up this assertion. In addition, there are insufficient data to assess outcomes dependent on the number or approach of prior surgeries, nor the presenting symptom or anatomic abnormality found. Both the quality of outcome (84% vs 90% satisfactory to excellent)³ and rate of reoperation (5% vs 3%)³ in revision laparoscopic fundoplication are slightly worse than that of primary laparoscopic antireflux surgery.

A review of case series is inevitably subject to publication bias because poor results seldom appear in the literature. Few series documented whether they followed up consecutive patients, only a minority were studied prospectively, and selective reporting of outcomes within studies may alter results. It was necessary to exclude several articles that mixed open and laparoscopic revision surgery data, which reduced the number of studies included. The lack of comparative studies between open and laparoscopic revision antireflux surgery and the lack of recent series of open reoperations makes it difficult to undertake a meaningful comparison of open and laparoscopic revision surgery. A recent systematic review of open and laparoscopic revision antireflux surgery²⁹ produced similar results for laparoscopic reoperation to those described here, however, the authors²⁹ did not exclude multiple publications from the same center and excluded a number of suitable studies from the laparoscopic group.^{14,15,18,20,28} In addition, 1 further suitable study has since been published.¹⁶

This review is based on data from highly specialized units and, for these results to be reproduced, revision laparoscopic antireflux surgery should be performed by surgeons with experience and special interest in both laparoscopic and esophagogastric surgery.

From this systematic review we can conclude that laparoscopic revision antireflux surgery, when performed in units with an interest in this type of surgery, is feasible and safe but subject to somewhat greater risk of conversion, higher morbidity, longer hospital stay, and poorer outcomes than primary laparoscopic fundoplication.

References

1. Grant AM, Wileman SM, Ramsay CR, et al. Minimal access surgery compared with medical management for chronic gastro-oesophageal reflux disease: UK collaborative randomised trial. *BMJ* 2008;337:2664.

2. Epstein D, Bojke L, Sculpher MJ. Laparoscopic fundoplication compared with medical management for gastro-oesophageal reflux disease: cost effectiveness study. *BMJ* 2009;339:2576.
3. Carlson MA, Frantzides CT. Complications and results of primary minimally invasive antireflux procedures: a review of 10,735 reported cases. *J Am Coll Surg* 2001;193:428–39.
4. Oelschlager BK, Quiroga E, Parra JD, et al. Long-term outcomes after laparoscopic antireflux surgery. *Am J Gastroenterol* 2008;103:280–7.
5. Pessaux P, Arnaud JP, Delattre JF, et al. Laparoscopic antireflux surgery: five-year results and beyond in 1340 patients. *Arch Surg* 2005;140:946–51.
6. Peters MJ, Mukhtar A, Yunus RM, et al. Meta-analysis of randomized clinical trials comparing open and laparoscopic anti-reflux surgery. *Am J Gastroenterol* 2009;104:1548–61.
7. Finks JF, Wei Y, Birkmeyer JD. The rise and fall of antireflux surgery in the United States. *Surg Endosc* 2006;20:1698–701.
8. Alexander HC, Hendler RS. Laparoscopic reoperation on failed antireflux procedures: report of two patients. *Surg Laparosc Endosc* 1996;6:147–9.
9. Bataille D, Simoens C, Mendes da Costa P. Laparoscopic revision for failed anti-reflux surgery. Preliminary results. *Hepatogastroenterology* 2006;53:86–8.
10. Byrne JP, Smithers BM, Nathanson LK, et al. Symptomatic and functional outcome after laparoscopic reoperation for failed antireflux surgery. *Br J Surg* 2005;92:996–1001.
11. Coelho JCU, Goncalves CG, Claus CMP, et al. Late laparoscopic reoperation of failed antireflux procedures. *Surg Laparosc Endosc Percutan Tech* 2004;14:113–7.
12. Croce E, Azzola M, Russo R, et al. Laparoscopic re-operation from gastro-oesophageal reflux. *Hepatogastroenterology* 1997;44:912–7.
13. Curet MJ, Josloff RK, Schoeb O, et al. Laparoscopic reoperation for failed antireflux procedures. *Arch Surg* 1999;134:559–63.
14. DePaula AL, Hashiba K, Bafutto M, et al. Laparoscopic reoperations after failed and complicated antireflux operations. *Surg Endosc* 1995;9:681–6.
15. Dutta S, Bamehriz F, Boghossian T, et al. Outcome of laparoscopic redo fundoplication. *Surg Endosc* 2004;18:440–3.
16. Frantzides CT, Madan AK, Carlson MA, et al. Laparoscopic revision of failed fundoplication and hiatal herniorrhaphy. *J Laparoendosc Adv Surg Tech A* 2009;19:135–9.
17. Granderath FA, Kamolz T, Schweiger UM, et al. Failed antireflux surgery: quality of life and surgical outcome after laparoscopic refundoplication. *Int J Colorectal Dis* 2003;18:248–53.
18. Hatch KF, Daily MF, Christensen BJ, et al. Failed fundoplications. *Am J Surg* 2004;188:786–91.
19. Khajanchee YS, O'Rourke R, Cassera MA, et al. Laparoscopic re-intervention for failed antireflux surgery: subjective and objective outcomes in 176 consecutive patients. *Arch Surg* 2007;142:785–92.
20. Luketich JD, Fernando HC, Christie NA, et al. Outcomes after minimally invasive reoperation for gastroesophageal reflux disease. *Ann Thorac Surg* 2002;74:328–32.
21. Oelschlager BK, Lal DR, Jensen E, et al. Medium- and long-term outcome of laparoscopic redo fundoplication. *Surg Endosc* 2006;20:1817–23.
22. O'Reilly MJ, Mullins S, Reddick EJ. Laparoscopic management of failed antireflux surgery. *Surg Laparosc Endosc* 1997;7:90–3.
23. Papisavas PK, Yeane WW, Landreneau RJ, et al. Reoperative laparoscopic fundoplication for the treatment of failed fundoplication. *J Thorac Cardiovasc Surg* 2004;128:509–16.
24. Richardson WS. Laparoscopic reoperative surgery after laparoscopic fundoplication: an initial experience. *Curr Surg* 2004;61:583–6.
25. Safranek PM, Gifford CJ, Booth MI, et al. Results of laparoscopic reoperation for failed antireflux surgery: does the indication for redo surgery affect the outcome? *Dis Esophagus* 2007;20:341–5.
26. Watson DI, Jamieson GG, Game PA, et al. Laparoscopic reoperation following failed antireflux surgery. *Br J Surg* 1999;86:98–101.
27. Atkins D, Eccles M, Flottorp S, et al. Systems for grading the quality of evidence and the strength of recommendations I: critical appraisal of existing approaches The GRADE Working Group. *BMC Health Serv Res* 2004;4:38.
28. Cowgill SM, Arnaoutakis D, Villadolid D, et al. "Redo" fundoplications: satisfactory symptomatic outcomes with higher cost of care. *J Surg Res* 2007;143:183–8.
29. Furnee EJ, Draaisma WA, Broeders IA, et al. Surgical reintervention after failed antireflux surgery: a systematic review of the literature. *J Gastrointest Surg* 2009;13:1539–49.