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Laparoscopic repeat surgery for gastro-oesophageal reflux disease: results of the analyses of a cohort study of 117 patients from a multicenter experience

Running title: Repeat surgery for GERD

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ABSTRACT

Background: Short and long-term outcomes after repeat anti-reflux surgery (RARS) are still debated and generally not considered as satisfying as after primary anti-reflux surgery (PARS). The aim of this study was to evaluate functional outcomes after RARS and risk factors associated to intra-operative and post-operative complications.

Methods: This is a multicenter retrospective survey from four European laparoscopic centers. Patients who underwent elective RARS from January 2005 to October 2017 for dysphagia or for persistent reflux disease refractory to medical treatment were analyzed. Data on demographic characteristics, including type and timing of previous operations as well as intra-operative details (surgical technique, type of RARS, conversion to open surgery, prosthetic material placement) were collected. Patients who underwent operations in the emergency setting, interventions mixed with bariatric procedures and PARS performed in other surgical departments were not included in this study. Primary endpoint of this study was to evaluate risk factors associated with intraoperative and postoperative complications. Secondary endpoint was to evaluate clinical outcomes and to identify any possible correlation with clinical and surgical parameters.

Results: Among 1662 patients who underwent PARS, failure occurred in 174 (10.5%) patients. Repeat surgery was performed in 117 (7%) patients, after a mean time of 80 months (range 4-315). RARS was carried out laparoscopically in 88% of cases. Prosthetic mesh to reinforce hiato-plasty was used in 22.2% of patients. Intra-operative upper gastro-intestinal tract's injuries occurred in 6 (5.1%) patients. Perioperative mortality was nil and 13 (11.1%) patients experienced postoperative complications. Mean length of hospital stay was 9.6 ± 6.4 days. Based on a multivariable analysis, age >70 years (OR 1.074, C.I.95% 1.018-1.133, $p=0.008$) and body mass index (BMI) <23 (OR 0.172, C.I.95% 0.052-0.568, $p=0.004$) were independently associated to postoperative complications. After a mean follow-up time of 36 months (range 6-107), 24 (20.5%) patients presented recurrent symptoms. Based on a multivariable analysis, early onset of dysphagia (OR 3.539, C.I.95% 1.254-9.990, $p=0.017$), open approach (OR 4.505, C.I.95% 1.314-15.442, $p=0.016$) and the use of prosthetic material (OR 2.790, C.I.95% 0.930 – 8.776, $p=0.047$) were significantly associated to good clinical outcomes.

Conclusions: Repeat anti-reflux surgery is a safe and feasible procedure in high-volume centers, with acceptable perioperative outcomes. Long-term results are favorable with a success rate of almost 80%. Advanced age (> 70 years) and low BMI (<23 kg/m²) were factor predicting perioperative complications. The use of prosthesis for hiatoplasty was associated to better functional outcomes.

Key words: Gastroesophageal reflux disease, recurrence, minimal invasive surgery, repeat surgery

INTRODUCTION

The incidence of reflux disease resistant to proton pumps inhibitors has widely raised, especially in Western Countries and in East Asia, leading to an increased number of patients undergoing anti-reflux surgery¹. Among patients having a primary anti-reflux surgery (PARS), at least 2% to 30% develop a recurrence of symptoms, with an important deterioration of their quality of life^{2,3}.

Hiatal failure, incorrect wrap construction or wrap disruption as well as wrap slippage are considered the most common causes of failure after PARS⁴⁻⁶.

As high as 3 to 10% of patients require a repeat anti-reflux surgery (RARS)⁷.

Actually, long-term outcomes after RARS are not well established. Some series reported less impressive outcomes after RARS than after PARS⁸⁻¹⁰. The rate of success after RARS is 85-90% while stands at 90-95% after PARS^{9,10}. Recurrent symptoms occur in 2 to 30% of patients after redo surgery⁸. Furthermore, intraoperative complications such as upper gastro-intestinal tract's injuries are generally considered to be more frequent in RARS (0-38%), probably in relation to the alteration of the normal anatomy of the hiatus and tissue consistency^{11,12}.

Nevertheless, there are few studies that evaluated both short- and long-term outcomes after RARS in a large multicentre setting¹¹.

The aim of our study was to evaluate the risk factors associated to postoperative complications and to poor clinical outcomes after RARS in a large multicentre cohort.

MATERIALS and METHODS

Patient selection

All patients who underwent elective RARS for persistent reflux disease under medical treatment or intolerance to medical therapy from January 2005 to October 2017, were retrospectively reviewed from a prospectively collected database from four European Centers.

The four Surgical Departments concerned were tertiary centers performing more than 50 gastro-esophageal procedures/year. The two surgical divisions of the University Hospital of Montpellier, as well as the CHL of Luxembourg and the Institut Mutualiste Montsouris in Paris provided the data.

Patients who underwent operations in the emergency setting, interventions mixed with bariatric procedures and PARS performed in other surgical departments were excluded from this survey. This study was approved by the Institutional Review Board (IRB, #2018-07-0186) and it was aligned to Helsinki declaration.

Preoperative evaluation and investigations

Poor clinical outcome that justified RARS was defined by the recurrence of reflux symptoms (heartburn, regurgitation and/or chest pain) or by the development of dysphagia with or without recurrent hiatal hernia after PARS.

All patients undergoing RARS underwent a comprehensive history and physical exam. A detailed assess of previous operations was performed. Barium contrast radiography of the upper gastrointestinal tract and oesophago-gastroscopy were systematically conducted. Esophageal manometry and pH testing were performed as (87%) of patients.

Data on demographic features, BMI, ASA, symptoms, type and time of previous operations were collected.

Operative technique

All four centers adopted a roughly standardized surgical technique for both PARS and RARS. The primary surgical approach was generally mini-invasive. The RARS surgery was carried out by a senior surgeon with a minimum experience of 50 procedures annually. In brief, at RARS, the patient was

placed in the standard French position, with a reverse Trendelenburg. A standard five-port technique was routinely used. The first step of the surgical exploration was focused on identifying the potential cause of failure. The second step was about re-performing the anti-reflux surgery. Otherwise, fundoplication and hiatoplasty were generally disassembled, paying attention to avoid either digestive or vagal injury. In patients presenting with severe dysphagia and no wrap herniation, the main target was to reconstruct a floppier fundoplication. In particular, the Toupet valve (270°) was the most frequently type of fundoplication performed.

In case of partial or complete hiatal herniation, the hiatus was reconstructed and a wrap was performed as well. An intraperitoneal non-absorbable prosthetic mesh was placed only in case of important hiatal defects (>5 cm) not suitable for tension-free closure.

When a wrap disruption was intraoperatively detected, an anti-reflux fundoplication was provided.

In cases of conversion to the open technique, a midline incision was performed.

At the end of the operation, an intra-abdominal drainage was placed when dissection was traumatic with significant bleeding and in case of hollow organ injuries detected and immediately repaired.

Surgical approach, surgical technique, conversion to open surgery and its cause, use of prosthetic material and drainage placement were included in this study and referred as intraoperative data.

Follow up and data collection

Postoperative complications were assessed as well and graded according to Clavien-Dindo classification¹⁴. Severe postoperative complications were defined as Clavien-Dindo ≥ 3 .

Patients were then re-evaluated after one, six and twelve months from RARS. Radiologic (CT-scan) and endoscopic exams were systematically planned during surveillance.

WHO quality of life after surgery was assessed. It was defined by scores of six broad domains of quality of life (the physical domain, the psychological one, independence level, social relationships, environment and spirituality/religion/personal beliefs) and was graded on a 1 to 6 scale (1=very poor, 2= poor, 3= neither poor nor good, 4= good, 5= very good, 6= not known)¹³.

Early failure was defined as recurrence of reflux symptoms or the occurrence of grade ≥ 4 dysphagia one month after surgery.

GERD recurrence was defined by the presence of typical reflux symptoms as retrosternal burning, often labeled heartburn, regurgitation, and epigastric pain with or without sleep disturbance¹⁵. Patient presenting early failure underwent CT scan and systematic manometry and pH monitoring.

When detected on imaging, recurrent hiatal herniation included partial or full herniation of the wrap into the mediastinum and partial or complete wrap disruption. Partial wrap disruption was identified when the anterior fundal apposition was attenuated or partly separated, completed wrap break-down was defined when the wrap was no longer visible¹⁶.

Outcomes

Primary endpoint of this study was to evaluate complication rate and risk factors associated to intraoperative and postoperative complications. Secondary endpoint was to evaluate clinical outcomes and to identify any possible correlation with clinical and surgical parameters.

Statistical analysis

All statistical analyses were conducted by the Department of the Statistical Analysis Unit of the University of Montpellier using GraphPad Prism® and R software®. Descriptive data were expressed as the mean \pm standard deviation. Categorical variables and proportions were compared using the Chi-squared test or the Fisher exact test. Logistic regression modeling was performed to identify significant variables to predict failure. The univariate analysis was performed using a logistic regression model where the predicted variables were the outcomes of the surgery in terms of persistence of symptoms (symptomatic versus asymptomatic) and the presence of complications. The variables which were found to have a p-value <0.15 on univariate analysis were further analyzed using a multivariate logistic model.

RESULTS

Patient characteristics

Among 1662 patients who underwent PARS (laparoscopically performed in 96.6% of cases), surgical failure occurred in 174 (10.5%) patients, after a mean time of 80 months (range 4-315).

However, RARS was performed in only 117 (7%) patients, mainly for GERD symptom recurrence (70 patients, 59.8%), confirmed by pH monitoring. Mean time between diagnosis of failure after PARS and RARS was 22 months.

In this cohort study of 117 patients, the female/male ratio was 1.54 (71/46), the mean age was 60.4 years (range 17-89 years) and the mean body mass index (BMI) was 25.5 (range 17-35). As detailed in **Table 1**, patients were mostly ASA (American Society of Anaesthesiologists classification) II at the time of operation.

Surgical RARS procedures

Laparoscopic RARS was carried out in 103 patients out of 117 (88% of cases). An early conversion to the open technique (midline incision) was performed in 14 patients (12%), due to the presence of strong adhesions in the hiatal region. The most common intra-operative finding was hiatal hernia recurrence, observed in 87 (74.3%) patients.

Fundoplication sequence of reconstruction in RARS followed the principle of anatomical feasibility and preoperative clinical presentation (GERD or dysphagia i.e.). A Nissen fundoplication was re-performed in (16) 13.6% of patients after a previous Nissen fundoplication, a Toupet fundoplication after a Nissen procedure in (61) 52.1%, a Nissen fundoplication after a Toupet procedure in (6) 5.1% and a Toupet fundoplication after a Toupet fundoplication in (23) 19.6% of the cases. In 11 out of 117 patients (9.4%) this data is not available.

The prosthetic mesh for hiatoplasty reinforcement was used in (26 out of 117 patients, 22.2%) of the cases and an intra-abdominal drainage was provided in 61 (52.1%) patients.

No oesophageal lengthening procedures such Collis'one were required as the mobilisation of the intrathoracic oesophagus was systematically obtained.

Intra-operative upper gastro-intestinal tract's injuries (immediately recognized and repaired in our experience) occurred in 6 (5.1%) patients. We accounted for one case of oesophageal perforation, five cases of gastric perforation and one case of partial spleen laceration.

Postoperative complications

Postoperative mortality was nil and 13 (11.1%) patients experienced postoperative complications. Six (5.1%) patients developed postoperative respiratory impairment due to atelectasis, pleural effusion or pneumothorax. One patient experienced postoperative mild cardiac failure but did not require ICU admission. The highest Clavien-Dindo score reported for postoperative complications was graded II. Mean length of hospital stay was 9.6 ± 6.42 days, the longest one lasted 41 days. Length of hospital stay was significantly longer in patients who developed postoperative complications (14 ± 11.2 vs 5.25 ± 1.6 days, $p=0.0001$). Elderly patients (>70 years-old) experienced more frequently postoperative complications compared to their younger counterparts (mean age of 74 years in complicated patients versus 61 years in patients with no complication, $p=0.015$).

Risk factors for postoperative complications are detailed in the analyses reported in **Tables 2 and 3**. Based on a multivariable analysis, age > 70 years (33 patients out of 117, OR: 1.074, C.I.95% 1.018 – 1.133, $p=0.008$) and body mass index (BMI) < 23 (ROC curve) (21 patients out of 117, OR 0.172, C.I.95% 0.052-0.568, $p=0.004$) were independently associated to the occurrence of postoperative complications.

Functional outcomes

After a mean follow-up time of 36 months (range 6-107), the overall success rate after RARS was 79.5% (93 patients out of 117). Twenty-four (20.5%) patients presented postoperative onset of recurrent symptoms significantly impacting their quality of life. Eleven patients (9.4%) presented recurrent GERD symptoms in the early postoperative period and ten of them still presented GERD beyond the first year after RARS. Moreover, 13 patients (11.1%) presented early post-operative high-grade dysphagia but only two of them presented persisting high-grade dysphagia beyond the first year after RARS.

The analysis of the WHO QoL questionnaire applied after RARS revealed a mean value of 3.65 ± 1.35 . Postoperative complications did not affect QoL.

On univariate analysis, the early onset of high-grade dysphagia, open surgical approach and use of prosthetic material positively influenced clinical outcomes (see results in **Table 4**). Based on a multivariable analysis, early dysphagia onset (OR 3.539, C.I.95% 1.254-9.990, $p=0.017$), open surgical approach (OR 4.505, C.I.95% 1.314-15.442, $p=0.016$) and use of prosthetic material in order to reconstruct the hiatus (OR: 2.790, C.I.95% 1.039-8.776, $p=0.047$) were confirmed as factors significantly associated to better clinical outcomes (**Table 5**).

DISCUSSION

In the present study, surgical failure after PARS occurred in 10.5% of the cases. After a mean follow-up time of almost seven years, RARS was finally performed in 117 (7%) out of 1662 patients, with an acceptable morbidity rate of 11.1% and a success rate of almost 80%.

Repeat surgery for recurrent reflux disease is still a challenging issue. Compared to PARS^{17,18}, which is carried out mostly using the laparoscopic approach with a satisfactory success rate and limited morbidity, postoperative outcomes after RARS may be poor¹⁹. Indeed, conversion rate, morbidity and mortality rates seem to be slightly increased in RARS. Moreover, functional outcomes after repeat surgery are not always as satisfying as after PARS²⁰⁻²². Failure after PARS is mainly due to hiatal hernia recurrence and this situation may be attributed to an incomplete mobilization of the intra-thoracic esophagus, to wrap disruption or even to inadequate repair of the hiatus^{6,20}. In the present series, the most frequent intra-operative finding was hiatal hernia recurrence (75% of cases).

Including more than one hundred RARS, the present series represents a large multicenter reporting of patients undergone repeat surgery for reflux recurrence after failure of a primary procedure.

Digestive perforations occurred in 5.1% of the cases, they were all intraoperatively detected and repaired. Postoperative mortality was nil and morbidity remains limited to less than 15%, in accordance with literature²³.

In the present series, elderly patients (>70 years) and BMI less than 23 were significantly associated to an increased risk of peri-operative complications. Patients' age has been already identified as a risk factor for postoperative complications²⁴.

Interestingly, a BMI higher than 23 was associated to lower rate of post-operative complications, raising questions on the potential protective role of intra-abdominal fat around the hiatus that may reduce local inflammatory response²⁵.

According to the existing data^{6,20-22}, failure after laparoscopic or open PARS occurs in as high as 15% of the patients, even in highly specialized centers. In order to achieve a better knowledge of the evolution of this disease and to assess the real failure rate, the follow-up should be extensively protracted. The mean follow-up time of the present study is 36 months and failure rate accounted for 20.5%.

Notably, early onset of dysphagia gradually regressed over time. Surprisingly, this transient postoperative dysphagia was associated to a positive impact on functional clinical outcomes. Similarly, Granderath *et al.*²⁶ reported a 3-fold (12%) incidence of symptomatic dysphagia at 3 months in patients with prosthetic mesh compared to those who underwent just sutured hiatoplasty. However, the rate of symptomatic dysphagia was 4% in each group one year after surgery. Nevertheless, the herniation rate recurrence was in favor of the use of mesh (26% in the 'no mesh' group versus 5% in the 'mesh' group, $p < 0.001$).

Although the early onset of dysphagia, the present study confirms that placement of prosthetic mesh, positively influenced clinical outcomes after RARS at long-term follow-up. This result suggest that prosthetic materials should be considered intraoperatively in particular in patients with large hiatal defects (>5cm) and when diaphragmatic tissues are inconsistent.

Surprisingly, the open approach in the present study was associated to better outcomes after RARS, unlike extensive data available²⁷⁻³⁵. We believe that this result was attributable to the re-operation rate. Indeed, more than half of the patients (6 over 11) in the open group were operated more than two times (mean of 3.8 operation) while in the mini-invasive group only 15.5% of them (16 over 103 patients) had repeated surgeries.

There are several limitations of this study. First, the retrospective design with missing informations and the heterogeneity of the data, including different indications for surgery, different surgical repair techniques and different meshes utilized.

Moreover, the exact technique provided in different surgical Units for the first surgery was not standardised. Repeat anti-reflux surgery is not standardized as well.

Authors also accept that classification of patients into those presenting recurrence of reflux disease and those with dysphagia with or without hiatal hernia recurrence is too simplistic for such a polymorphic and complex pathology. A more detailed classification considering frequency and severity of symptoms and anatomical features as well may be more accurate to explore the issue.

Study included also patients who underwent anti-reflux surgery more than two times.

Furthermore, the preoperative assessment of QoL performed by an appropriate questionnaire for this disease (GERD Health-Related Quality of Life score) was not used.

Heterogeneity of the approach have to be reported as well. Open approach was preferred in multi-operated patients and when strong adhesions were detected.

Control group including patients with GERD recurrence who was not re-operated is lacking.

Finally, despite a long study period, the follow up dropout rate was as high as 19%.

However, despite several limits, herein, we reported results (following STROCCS Guidelines³⁶) of a large cohort of patients who underwent repeat anti-reflux surgery from a multi-centre database. Surgical Units concerned are centres having a high degree of specialization in treating gastro-oesophageal diseases. We share the same guidelines and similar surgical practice.

Conclusion

Repeat anti-reflux surgery is a safe and feasible procedure in high-volume centers, with acceptable perioperative outcome, comparable to those observed after PARS. Long-term outcomes can be considered as satisfying as after primary surgery, since it provides a success rate of almost 80%. Advanced age and BMI <23 kg/m² were factor negatively impacting postoperative complications. The use of prosthetic materials for hiato-plasty was associated to better functional outcomes.

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AUTHOR DISCLOSURE

The authors (Fabrizio Panaro, Piera Leon, Thierry Perniceni, Giorgio Bianchi, Francois-Regis Souche, Jean Michel Fabre, Vito De Blasi, Santiago Azagra, Grégory Marin, Samir Jaber, Brice Gayet, Francis Navarro and David Fuks) have no conflicts of interest or financial ties to disclose.

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Table 1. Features of the cohort population studied.

Features		Number
Gender	F	71 (60.7%)
	M	46 (39.3%)
Age	Mean (range)	60.4 (\pm 13.3)
ASA	1	20 (17.1%)
	2	81 (69.2%)
	3	10 (8.6%)
	Not available	6 (5.1%)
BMI	Mean	25.5 (\pm 3.5)
BMI	<23	21 (17.9%)
Type of access in RARS	Open	11 (9.4%)
	Laparoscopy	103 (88%)
	Robot	3 (2.6%)
Sequence of interventions	Nissen – Nissen	16 (13.7%)
	Nissen – Toupet	61 (52.1%)
	Toupet – Nissen	6 (5.1%)
	Toupet – Toupet	23 (19.7%)
	Not available	11(9.4%)
Prosthetic material in RARS		26 (22.2%)

F: female; M : male ; ASA: American society of anesthesiologists classification; BMI: body mass index; GERD : gastro esophageal reflux disease ; HH : hiatal hernia ; PARS : primary anri reflux surgery ; RARS : repeat anti reflux surgery.

Table 2. Univariate analysis of the risk factors of postoperative complications after RARS.

Features		Number	Odds-ratio	95% C.I.	p-value
Gender	female vs male	71/46	1.190	0.372 – 3.805	0.769
Age			1.067	1.013 – 1.125	0.015
BMI			0.842	0.711 – 0.998	0.046
BMI	≥25 vs <25	65/52	0.172	0.052 – 0.568	0.004
ASA*	2 vs 1	81/20	2.357	0.283 - 19.924	0.425
	3 vs 1	10/20	12.667	1.177 – 136.283	0.036
Type of PARS*	Toupet vs Nissen	29/77	0.571	0.149 – 2.190	0.414
Prosthetic material in PARS	Yes vs no	7/110	3.201	0.558 – 18.347	0.191
HH recurrence	Yes vs no	107/10	>999.999	<0.001 - >999.999	0.970
GERD recurrence	Yes vs no	79/38	0.681	0.192 – 2.417	0.552
Type of wrap in RARS	Toupet vs Nissen	84/26	1.709	0.353 – 8.280	0.505
Sequence of interventions*	Nissen – Nissen vs Nissen – Toupet	16/61	0.946	0.180 – 4.966	0.948
	Toupet – Nissen vs Nissen – Toupet	6/61	0.994	<0.001 - >999.999	0.980
	Toupet – Toupet vs Nissen – Toupet	23/61		0.239 – 4.124	0.993
Type of access in RARS	Open vs mini-invasive	14/103	2.281	0.551 – 9.451	0.255

Prosthetic material in	Yes vs no	26/91	0.549	0.115 – 2.624	0.452
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RARS

Early dysphagia	Yes vs no	24/93	1.984	0.622 – 6.325	0.247
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recurrence

C.I. 95%: Confidential Interval considered; ASA: American society of anesthesiologists classification;

BMI: body mass index; GERD: gastro esophageal reflux disease; HH : hiatal hernia ; PARS : primary

anti-reflux surgery ; RARS : repeat anti-reflux surgery. *Complete data not available

Table 3. Multivariate analysis of the risk factors of postoperative complications after RARS.

Features		Number	Odds- ratio	95% C.I.	p-value
BMI	Continuous		0.806	0.663 – 0.979	0.029
	< 23	21	0.172	0.052-0.568	0.004
Age	<70 vs >70	84/33	1.074	1.018 – 1.133	0.008

BMI: body mass index

Table 4. Univariate analysis of the risk factors of RARS failure.

Features		Odds- ratio	95% C.I.	p-value
Gender	F vs M	0.764	0.296 – 1.969	0.577
Age		0.986	0.956 – 1.016	0.351
BMI		0.972	0.853 – 1.107	0.668
ASA*	2 vs 1	0.557	0.147 – 2.110	0.389
	3 vs 1	0.706	0.098 – 5.096	0.729
Type of PARS*	Toupet vs Nissen	0.933	0.342 – 2.548	0.892
Prosthetic material in PARS	Yes vs no	0.618	0.112 – 3.408	0.580
HH recurrence	Yes vs no	<0.001	<0.001 - >999.999	0.970
GERD recurrence	Yes vs no	0.880	0.329 – 2.356	0.799
Type of wrap in RARS*	Toupet vs Nissen	0.812	0.244 – 2.706	0.734
Sequence of interventions*	Nissen – Nissen vs Nissen – Toupet	4.522	0.547 – 37.371	0.161
	Toupet – Nissen vs Nissen –	1.413	0.151 – 13.188	0.761
	Toupet	2.826	0.583 – 13.701	0.197

Toupet – Toupet vs Nissen –

Toupet

Type of access in RARS	Open vs mini-invasive	0.202	0.063 – 0.652	0.007
Prosthetic material in RARS	Yes vs no	0.383	0.144 – 1.020	0.045
Perioperative complication	Yes vs no	0.322	0.067 – 1.548	0.157
Early dysphagia recurrence	Yes vs no	0.309	0.117 – 0.817	0.018

C.I. 95%: Confidential Interval considered; F : female ; M : male ; ASA: American society of anesthesiologists classification; BMI: body mass index;

GERD : gastro esophageal reflux disease ; HH : hiatal hernia ; PARS : primary anti reflux surgery ; RARS : repeat anti reflux surgery; * Complete data not available.

Table 5. Multivariate analysis of the risk factors for RARS failure.

Features		Odds-ratio	95% C.I.	p-value
RARS surgical approach	Mini-invasive vs. Open	4.505	1.314 – 15.442	0.016
Prosthetic material in RARS	No vs. Yes	2.790	1.039 – 8.776	0.047
Post operatory transient dysphagia	No vs. Yes	3.539	1.254 – 9.990	0.017

RARS: repeat anti reflux surgery