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The place of Belsey Mark IV fundoplication in the era of laparoscopic surgery☆

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Abstract

Objectives: Laparoscopic fundoplication to correct or avoid gastroesophageal reflux decreased Belsey Mark IV fundoplication (BMIV) dramatically worldwide. The purpose of this paper was to determine the role of BMIV and its current indications. **Methods**: We reviewed all patients who underwent fundoplication between April 1997 and December 2001. All patients underwent a complete work-up included barium meal, endoscopy, 24-h pH-metry and manometry preoperatively. **Results**: Sixty-two consecutive fundoplications were performed. There were 23 males and 39 females. Forty-six patients were treated by laparoscopic approach (37 patients with total and nine patients with partial fundoplication). BMIV was preferred in 16 patients with the following indications: reoperations for failed oesophageal surgery (5), hiatal hernia fixed in the chest (4), epiphrenic oesophageal diverticula (3), diffuse oesophageal spam (2), hiatal hernia associated with bullous emphysema (1), leiomyoma of the oesophago–gastric junction (1). Excellent to good results were reported in 14 patients and poor in two. Follow-up was completed in all patients. **Conclusions**: BMIV remains a valid fundoplication although the current indications are now limited. The technique is to be considered an additional, but necessary, weapon for thoracic surgeons with interest in oesophageal disease.

Keywords: Failed antireflux surgery; Fundoplication; Laparoscopy

1. Introduction

Fifty years ago, Mr Belsey following 10 years of clinical trials with various surgical techniques to control gastro-esophageal reflux (GER), practised the last modification known as the Mark IV fundoplication [1]. The number IV indicated the proceeding clinical trials of the operation and sequentially abandoned on the basis of unsatisfactory long-term results. The addiction of Mark was adopted from the car industry (Jaguar). Fifteen years later, based on his philosophy that "Prematurity in publication carries a mortality rate proportional to the degree of immaturity demonstrated by the theories and evidence presented" [2], the long term results were published [1] and the technique was therefore known world-wide. Several surgeons accepted the pathophysiological principle of the fundoplication and performed the operation themselves with a success rate of 90% [3–8].

In the 1990s the indication of antireflux surgery was narrowed. This could be explained by better diagnostic tools such as 24-h oesophageal pH monitoring and the advent of more potent drugs. The introduction of laparoscopic surgery to perform gastric fundoplication increased the number of antireflux operations among many institutions internationally. This new approach stimulated thoracic surgeons, historically involved in functional diseases of the oesophagus, trained in minimally invasive surgery and experienced in oesophageal diseases, to undertake laparoscopic antireflux procedures with excellent results comparable to abdominal surgeons [9]. Moreover, the thoracoscopic Belsey Mark IV (BMIV) fundoplication is technically more difficult and reported with poor results, and it should still be considered under investigation [10]. These are the main reasons because the number of BMIV fundoplications decreased dramatically worldwide.

The objective of the study was to review our experience of all patients who underwent fundoplication between April

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1997 and December 2001, and in the light of progress in laparoscopic antireflux surgery to consider whether in future we will be limiting our indications for Belsey operation.

2. Material and methods

Between April 1997 and December 2001, 62 patients (23 males and 39 females with a mean age of 59 years) underwent fundoplication to treat or avoid GER at the University of Catania tertiary care affiliated Hospitals. Sixteen patients (25%) had a BMIV fundoplication, and are the subject of this report. The others 46 patients had a laparoscopic fundoplication.

All patients had a thorough preoperative work up, which included barium swallow, endoscopy, oesophageal manometry and 24-h pH monitoring. Patients were carefully queried about the presence or absence of symptoms such as heartburn, dysphagia, pharyngo-oesophageal dysphagia, chest pain, epigastric pain, weigh loss, gas bloat and regurgitation.

Reports of the preoperative contrast roentgenography studies of the oesophageal and gastric anatomy were reviewed to determine the reducibility of the Hiatal Hernia (HH) below the diaphragm. The HH was considered fixed in the chest in case of irreducible cardia with or without oesophageal shortening, or a para-oesophageal or large mixed hernia.

The indication for surgery was decided only after the patient's anatomic and functional assessments, which included the review of past medical history, barium meal, endoscopy and functional oesophageal tests (manometry and 24-h pH-metry). Although in our unit all patients referred for antireflux surgery were considered for a laparoscopic fundoplication, the current indications for the BMIV fundoplication as indicated in Table 1.

Patients with hypotonic oesophageal contraction (<30 mmHg) were treated with a laparoscopic partial fundoplication, but the reason for performing transthoracic open fundoplication was independent for GER itself. In three out of five patients with a failed oesophageal surgery, indication for surgery was based on the presence of a tight Nissen fundoplication. One patient had a postoperative diverticulum after the thoracoscopic removal of an oesophageal leiomyoma in the middle third of the oesophagus, and another had a recurrent HH fixed in the chest with absence of pathological GER.

Table 1
Indications for the Belsey Mark IV fundoplication in the study population

	No. patients
Reoperations for failed esophageal surgery	5
Hiatal hernia fixed in the chest	4
Epiphrenic esophageal diverticula	3
Diffuse esophageal spasm	2
Hiatal hernia associated with other intrathoracic pathologies	1
Benign tumour in the oesophago–gastric junction	1

Follow-up information was obtained by direct patient contact every 6 months and then after 1 year. Patients were queried about the presence of any new symptoms that may have developed after surgery. Objective evaluation was proposed at 6 and 1 year postoperatively.

Clinical results were graded as follows: excellent (completely asymptomatic), good (occasionally symptoms), fair (symptomatic requiring medication daily), or poor (symptoms need a reoperation). Only patients with at least 12 months follow-up were included in the study. Data relating to patients demographics were expressed as the mean and range.

3. Results

3.1. Clinical presentation

There were six males and 10 females, with a mean age of 58.7 years ranging from 35 to 75 years. Thirteen patients had dysphagia as the main symptom. Regurgitation was present in four and chest pain in three patients. Two patients with diffuse oesophageal spasm had weight loss and chest pain. Heartburn was present in two patients. Post-prandial dyspnea was also present in two patients. One patient was admitted to the emergency room for recurrent left pneumothorax associated with HH and long lasting grade II oesophagitis. Frank gastrointestinal bleeding was present in one patient.

3.2. Preoperative evaluation

Preoperative evaluation included an upper gastrointestinal tract series, which showed stenosis in the distal oesophagus in five, hiatal hernia fixed in the chest in four, epiphrenic diverticulum in three, corkscrew oesophagus in two, sliding HH in one, and pseudodiverticulum in the mid-oesophagus in one patient. Five patients had a stenosis in the distal oesophagus. The stenosis was due to complication of antireflux surgery (tight Nissen) in three of them, one had a spasm of the LES secondary to a pan-oesophageal motility disorder after the thoracoscopic removal of a leiomyoma of the middle third of the oesophagus, and the last had a benign tumour of the distal third of the oesophagus associated with GER. Patients with HH fixed in the chest were four, of those three were paraoesophageal and one of the mixed type. In these patients pathological GER was present in two. Five patients had functional disorders of the oesophagus. Three had epiphrenic diverticulum and two diffuse oesophageal spasm (DES). Although manometry showed incomplete relaxation of the LES in three patients, we always performed the myotomy of the LES because the barium meal showed a delay in oesophageal emptying through the sphincter, and

the fact that the motility catheter could not be passed beyond the sphincter suggested a spasm of the sphincter itself. One out three patients with diverticulum had a double epiphrenic oesophageal diverticula. Preoperative endoscopic evaluation of the oesophagus, stomach, and duodenum showed grade I oesophagitis in five patients, and grade II in one. Barrett oesophagus was present in one patient who had HH fixed in the chest. This patient had pathological reflux on 24-h pH study. Oesophageal manometry was performed in all patients. Notably, the motility catheter could not be passed beyond the lower oesophageal sphincter in three patients. Specifically, two patients with epiphrenic diverticula and one patient with diffuse oesophageal spasm.

Disordered oesophageal motility characterized by tertiary contraction and inefficient peristalsis (<30 mmHg) was noted in eight patients. Eight patients had either non-specific motility disorders, simultaneous high amplitude contraction or non-propagated waves. The lower oesophageal sphincter was hypotonic in six patients, normal in four and hypertensive with absence of relaxation in three patients. We routinely perform 24-h pH monitoring in our patients with functional diseases of the oesophagus. This study demonstrated abnormal acid exposure to the oesophagus in seven patients.

3.3. Surgical procedure and outcome

After induction of general anaesthesia a double lumen endotracheal tube was introduced to allow the collapse of the left lung. Patients were positioned semilateral for a left thoracotomy. After division of the inferior pulmonary ligament, the oesophagus was extensively mobilized from its mediastinal bed up to the level of the aortic arch and encircled above the level of the inferior pulmonary vein. This generally requires division of the middle oesophageal artery. During reoperation care must be taken to avoid damage of the vagus nerve. In two patients the diaphragm was incised circumferentially preserving the left phrenic nerve, leaving at least a 2-cm margin adjacent to the chest wall for reconstruction (Fig. 1). The adhesions were divided, any sac hernia excised, the hiatus clearly defined and the possibility of a short oesophagus was evaluated. Once the dissection was completed, the two pillars of the crus were approximated posterior to the oesophagus and the BMIV fundoplication was performed in nine and a modified BMIV in six patients. The operation was performed in association with other procedures in eight patients (50%): myotomy in three, myotomy and diverticulectomy in three, removal of benign oesophageal tumour in one, and wedge resection of the lung in one. A postoperative barium swallow was obtained on the fifth postoperative day before oral intake began. There was no operative mortality and no perioperative complications. Operative morbidity was as follows: one patient required two units of blood for bleeding, three patients had transient dysphagia, two patients had pneumonia, three patients had atrial arrhythmia, pleural effusion and

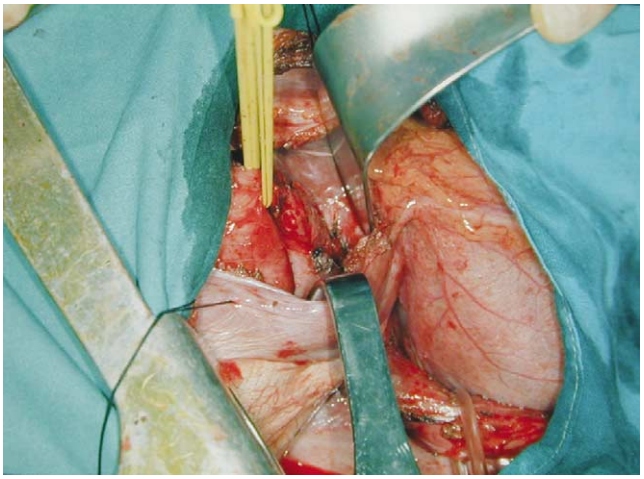

Fig. 1. Intraoperative findings: the oesophagus is encircled above the level of the inferior pulmonary vein. The diaphragm is incised circumferentially preserving the left phrenic nerve. Adhesions with the left lobe of the liver are visualised and dissected. The 360° wrap is encircled with a tape.

persistent thoracic pain, respectively, after 1 year. In the redo cases, histology of the perioesophageal tissue was performed in three patients, and fibrosis was always found. Mean hospital stay was 8.6 days (range 7–14 days). Follow-up information was available in 15 of 16 survivors, ranging from 24 to 60 months with an average of 53.1 months. Eleven (69%) patients were completely asymptomatic. Two patients had heartburn (one was alcohol dependent), and one patient had dysphagia. Undesired gastro-intestinal side effects such as diarrhoea and dysphagia were noted in one patient and chest pain was present in one patient. Subjective follow-up showed excellent to good results in 14 patients and poor in two (12.5%).

Objective postoperative evaluation, i.e. barium meal, endoscopy, manometry and 24-h pH-metry was proposed to all patients, but only two with severe postoperative symptoms accepted complete objective evaluation. Twelve patients underwent postoperative manometry, which showed significant increase in the LES resting pressure in nine patients. Barium meal was performed in 10 patients. An asymptomatic small HH was detected in one patient.

Two patients had poor results. The first was a 54-year-old woman who underwent an uneventful BMIV procedure and had a satisfactory result. She returned 2 weeks later with non-tractable chest pain, which was treated with nerve block. Once again, the symptoms returned but all diagnostic tests failed to demonstrate any oesophageal obstruction or functional disorder. She underwent transcutaneous nerve stimulation. The second patient was a 68-year-old women with Barrett's oesophagus and HH fixed in the chest associated with long lasting GER. She underwent a BMIV fundoplication and intraoperatively extensive perioesophageal fibrosis was found. She was discharged home. Fourteen months later, she returned with severe heartburn and recurrence of HH; the patient refused reoperation. This patient died 3 years later from a stroke.

4. Discussion

Although several studies demonstrated the usefulness of the BMIV fundoplication in controlling GERD, the total number of BMIV fundoplications per year to correct or avoid GERD has decreased worldwide as the introduction of the laparoscopic approach has become more commonplace in the community. Although there are several factors to prefer a laparoscopic fundoplication instead of a transthoracic approach as shown in Table 2, there are indications for the BMIV as shown in Table 1 that are useful for the patient.

In the present experience the most common indication for the BMIV fundoplication is reoperation after failed gastroesophageal surgery. In the general surgical community the most conventional approach to treat failed antireflux surgery is laparoscopic [11]. The transthoracic approach permits full mobilization of the oesophagus and complete visualization of the cardia, upper stomach and fundoplication [3,12]. During reoperation, perioesophageal and hiatal fibrosis and adhesions between the left lobe of the liver and the wrap were found. We therefore performed a 10-cm circumferential diaphragmatic incision to allow a bilateral exposition of the hiatus (Fig. 1). We believe that laparoscopic reoperation for failed antireflux surgery is indicated after an unsuccessful laparoscopic operation only after a short post-operative period, specifically when the perioesophageal fibrosis has not developed yet.

The actual incidence of the short oesophagus is estimated to be approximately 10% of patients undergoing antireflux surgery. Mediastinal mobilization of the oesophagus can be performed in 70% of them, while the remain 30% require a more aggressive surgical approach [13]. The importance of an adequate oesophageal length for the success of an operation for GERD is widely known. We also believe that shortening of the oesophagus is probably underestimated before laparoscopic operation and for this reason all patients with gastroesophageal reflux disease are suitable to the laparoscopic approach.

Long lasting GER and grade IV oesophagitis are often associated with panmural oesophagitis, which in turn causes shortening of the oesophagus. These conditions are contraindications to the BMIV as recommended by different authors with a reported recurrence rate of 40–50%. In such instances a lengthening procedure such as Collis Nissen or Collin Belsey, circular myotomy and Belsey, V-Y gastroplasty and intrathoracic positioned Nissen are recommended [14–18]. In all our patients an adequate mobilization of the oesophagus from the aortic arch permitted an adequate length of the oesophagus, but if a shortening of the oesophagus is recognized intraoperatively, then a lengthening procedure according to the condition of oesophageal peristalsis would have been performed. The fact that there are so many variations of the original gastroplasty described by Collis [19], it means that in case of a short oesophagus the surgical results are not satisfactory. Therefore, in the future further studies are necessary to show a durable success.

Table 2
Reasons to prefer laparoscopic fundoplication to the Belsey Mark IV

Better cosmetic results
Comparable results to open surgery
Less incisional pain
Less incisional hernia
Quicker return to normal life
Less hospital charges

Although Belsey Mark IV fundoplication was the most frequent wrap performed in cases of massive hiatal hernia by Altorki et al. [20], and the open transthoracic approach has been used with excellent results, recently some authors advocated the laparoscopic management of giant paraoesophageal herniation, which has been described as technically challenging and with good intermediate results [21]. Therefore, it seems that even in these difficult and classic thoracic cases the laparoscopic approach substitutes the transthoracic approach, again decreasing the number of BMIV. We still believe that there are different reasons why the transthoracic approach should not be abandoned. First, because giant paraoesophageal hernia is not a common pathology, the experience necessary to overcome laparoscopic surgical problems and a long learning curve due to the small number of cases in many surgical experiences. Second, the presence of a short oesophagus, which is a common finding in such patients, suggests mobilisation of the oesophagus to the aortic arch to release tension, BMIV can therefore be performed avoiding the laparoscopic Collis–Nissen, which increases morbidity. Third, recent studies have shown that Laparoscopic repair of type III hiatal hernias is associated with a disturbingly high (42%) prevalence of recurrent hernia. More than half such recurrences have few, if any, symptoms [22].

The advantage of treating simultaneous pathologies of the chest such as left side pneumothorax, bollous emphysema or lung cancer remains undoubted. In our experience one patient with recurrent left pneumothorax associated with bollous emphysema, sliding HH and pathologic GER have been successfully treated by a transthoracic approach. In case of epiphrenic diverticulum a modified BMIV fundoplication is added after a diverticulectomy and myotomy in few centres [23]. We always add the modified BMIV and although we are not against the new proposed laparoscopic technique to treat epiphrenic diverticula in principle [24], we still believe that the standard thoracic approach is better because in our experience we always found the wall of the diverticulum inflamed with firm adhesions between the sac and the visceral pleura or the lung.

Regarding the modified BMIV as a fundoplication to add after a myotomy, we used the BMIV after a long myotomy for diffuse oesophageal spasm, but to treat achalasia there is no doubt that laparoscopic myotomy with Dor fundoplication is today the treatment of choice.

A small benign tumour located in the gastro–oesophageal junction can be treated via laparoscopy, but in the case of a large tumour of the distal third of the oesophagus involving the gastro–oesophageal junction we prefer the transthoracic approach. One of our patients with an intramural oesophageal tumour located in the distal third of the oesophagus involving the gastro–oesophageal junction associated with GER underwent enucleating of the tumour, closure of the oesophageal muscles and BMIV fundoplication with excellent results.

Although in humans the thoracoscopic approach has been used to perform the Belsey Mark IV fundoplication, the results are poor, and this approach should still be considered under investigation. Some authors initiated the experience with a complete thoracoscopic BMIV, showing minimal morbidity, however, preliminary results suggest that standard thoracotomy remains a better approach for the BMIV [10].

Although laparoscopic fundoplication is the standard approach for GERD in the majority of general and thoracic units, the effectiveness of the procedure still needs to be validated with prospective randomised trials as shown in recent publications that failed to demonstrate the advantage of the laparoscopic fundoplication versus the standard open approach [25].

The BMIV is definitively related to treat complications after laparoscopic fundoplications, leading it to have a paramount surgical role in the treatment of gastroesophageal reflux disease.

In summary, this study did not evaluate intermediate and long term results of the BMIV, which have been clearly shown in the past, but it clarified the current role for the BMIV fundoplication. Laparoscopic fundoplication is in our experience the standard approach for sliding HH and gastro–oesophageal reflux whilst the BMIV fundoplication is indicated for more complicated cases such as reoperations for failed antireflux surgery and massive long lasting hiatal hernia. Finally we strongly believe that to obtain optimal results, fundoplication should be tailored to the patient's anatomic and functional assessments.

This concept should influence not only the type of fundoplication (360°, 270°, 180°) but also the type of approach (laparoscopic, open or transthoracic). In conclusion, the BMIV procedure remains a valid fundoplication although the current indications are limited. The technique is to be considered an additional, but necessary, weapon of the thoracic surgeon with interest in oesophageal diseases.

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References

[1] Skinner DB, Belsey RH. Surgical management of esophageal reflux and hiatus hernia. J Thorac Cardiovasc Surg 1967;53:33–54.
[2] Belsey RH. Surgical treatment of hiatus hernia and reflux esophagitis. World J Surg 1997;1:421–3.
[3] Lerut T. Esophageal surgery at the end of the millennium. J Thorac Cardiovasc Surg 1998;116:1–20.
[4] Stipa S, Fegiz G, Iascone C, Paolini A, Moraldi A, De Marchi G, Chieco PA. Belsey and Nissen operations for gastresophageal reflux. Ann Surg 1989;210:583–9.
[5] Alexiou C, Beggs D, Salama FD, Beggs L, Knowles KR. A tailored surgical approach for gastro-esophageal reflux disease: The Nottingham experience. Eur J Cardiothorac Surg 2000;17:389–95.
[6] Little AG, Naunheim KS, Ferguson MK, Skinner DB. Surgical management of esophageal strictures. Ann Thorac Surg 1988;45:144–7.
[7] Horbach JMLM, Masclee AAM, Lamers CBHW, Gooszen HG. A prospective study on the effect of the Belsey Mark IV 270-degree fundoplication on lower esophageal sphincter characteristics and esophageal body motility. J Thorac Cardiovasc Surg 1995;109:636–41.
[8] Fenton KN, Miller JI, Lee RB, Mansour KA. Belsey Mark IV antireflux procedure for complicated gastresophageal reflux disease. Ann Thorac Surg 1997;64:790–4.
[9] Coosemans W, De Leyn P, Deneffe G, Van Raemdonck D, Lerut T. Laparoscopic antireflux surgery and the thoracic surgeon: What now? Eur J Cardiothorac Surg 1997;12:683–8.
[10] Nguyen NT, Schauer PR, Hutson W, Landreneau R, Weigel T, Ferson PF, Keenan RJ, Luketich JD. Preliminary results of thoracoscopic Belsey Mark IV antireflux procedure. Surg Laparosc Endosc 1998;8:185–8.
[11] Watson DI, Jamieson GG, Game PA, Williams RS, Devitt PG. Laparoscopic reoperation following failed antireflux surgery. Br J Surg 1999;96:98–101.
[12] Skinner DB. Surgical management after failed antireflux operations. World J Surg 1992;16:359–63.
[13] Horvath KD, Swanstrom LL, Jobe BA. The short esophagus: pathophysiology, incidence, presentation, and the treatment in the era of laparoscopic antireflux surgery. Ann Surg 2000;232:630–40.
[14] Pearson FG, Cooper JD, Patterson GA, Ramirez J, Todd TR. Gastroplasty and fundoplication for complex reflux problems. Ann Surg 1987;208:473–81.
[15] Ritter MP, Peters JH, DeMeester TR, Gadenstatter M, Oberg S, Fein M, Hagen JA, Crookes PF, Bremner CG. Treatment of advanced gastresophageal reflux diseases with Collis gastroplasty and Belsey partial fundoplication. Arch Surg 1998;133:523–9.
[16] Allen SM, Matthews HR. Circular myotomy and Belsey repair for acquired shortening of the esophagus. Eur J Cardiothorac Surg 1993;7:645–7.
[17] Reilly KM, Yeasingham K. A modified Pearson gastroplasty. Thorax 1984;39:67–9.
[18] Moghissi K. Intrathoracic fundoplication for reflux associated with short esophagus. Thorax 1983;38:36.
[19] Collis LJ. Gastroplasty. Thorax 1961;16:197–206.
[20] Altorki N, Yankelevitz D, Skinner DB. Massive hiatal hernias: The anatomic basis of repair. J Thorac Cardiovasc Surg 1998;115:828–35.
[21] Wiechmann RJ, Ferguson MK, Naunheim KS, McKesey P, Hazelrigg SJ, Santucci TS, Machrey RS, Landreneau RJ. Laparoscopic

management of giant paraesophageal herniation. Ann Thorac Surg 2001;71:1080–7.

[22] Hashemi M, Peters JH, DeMeester TR, Huprich JE, Quek M, Hagen JA, Crookes PF, Theisen J, DeMeester SR, Sillin LF, Bremner CG. Laparoscopic repair of large type III hiatal hernia: objective follow-up reveals high recurrence rate. J Am Coll Surg 2000;190:553–60.

[23] Altorki NK, Sunagawa M, Skinner DB. Thoracic esophageal diverticula. Why is operation necessary? J Thorac Cardiovasc Surg 1993;105:260–4.

[24] Rosati R, Fumagalli U, Bona S, Bonavina L, Peracchia A. Diverticulectomy, myotomy, and fundoplication through laparoscopy: a new option to treat epiphrenic esophageal diverticula? Ann Surg 1998;227:174–8.

[25] Bais JE, Bartelsman JFWM, Bonjer HJ, Cuesta MA, Go PM, Klinkenberg-Knol EC, van Lanschot JJ, Nadorp JH, Smout AJ, van der Graaf Y, Gooszen HG. Laparoscopic or conventional Nissen fundoplication for gastro-esophageal reflux disease: randomized clinical trial. Lancet 2000;355:170–4.