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CASE REPORT

How robotic-assisted surgery can decrease the risk of mucosal tear during Heller myotomy procedure?

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Abstract We report the first description of robotic-assisted Heller myotomy in children. The purpose of this study was to improve the safety of Heller myotomy by demonstrating, in two adolescent patients, the contribution of the robot to the different steps of this procedure. Due to the robot's freedom of movement and three-dimensional vision, there was an improvement in the accuracy, a gain in the safety regarding different key-points, decreasing the risk of mucosal perforation associated with this procedure.

Keywords Esophageal achalasia · Heller myotomy · Robotic surgery · Pediatrics

Introduction

Achalasia is a motility disorder of the esophagus characterized by a loss in the receptive relaxation of the lower esophageal sphincter in response to swallowing. Its causes remain unknown. The estimated incidence is approximately of 0.11 cases per 100,000 children; however, symptoms occur in less than 5% of the cases during childhood [1]. The symptoms consist of dysphagia, which can have a major impact on the overall condition of the individual, including significant weight loss. Diagnosis of this disorder is confirmed by barium esophagram, esophageal manometry, and upper endoscopy. The most effective treatment for achalasia in adults and children is laparoscopic Heller myotomy [2–4]. This minimally invasive approach provides durable, long-term outcomes without the disadvantages of classic open Heller myotomy (i.e., postoperative pain, unaesthetic scar, and length of hospital stay) [3]. However, complications can occur during the different steps of this procedure, particularly mucosal perforation [5, 6]. Robotic-assisted Heller myotomy has recently been shown as a safe and effective treatment in the adult population. Unfortunately, only a few pediatric cases (less than 10) were included in the adult series; therefore, the effects of this procedure on young adults and children are still largely unknown [7–11]. We report here the case of two children who were treated with the laparoscopic robotic approach and examine the contribution of the robot during each step of the process. This analysis will help to improve the safety of this procedure for future treatments.

Patient and methods

We report the case of two children referred in our center for symptoms of achalasia. The first one was a 14-year-old boy, without previous medical issues, who presented with a 1-year history of dysphagia, vomiting and the necessity to empty the esophagus 4–5 times during a meal. These symptoms had a major impact on the overall condition of

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the subject, including a 5-kg weight loss and reduction in the BMI from 18 kg/m^2 (thirtieth percentile) to 16.3 kg/m^2 (eighth percentile). Achalasia was diagnosed by a barium swallow. An esophageal manometry demonstrated a lack of lower esophageal sphincter relaxation and disappearance of peristaltic contractions. An upper gastrointestinal endoscopy revealed lower esophagus dilatation without evidence of esophagitis or esophageal tumor.

The second patient was a 11-year-old girl presenting symptomatic of achalasia, since 2 years with the association of vomiting and cough during meal. She suffered from a major weight loss (5 kg) before operation with a reduction of the BMI from 16.3 kg/m^2 (fortieth percentile) to 14.5 kg/m^2 (tenth percentile). Fibroscopy showed esophageal dilatation with food stasis, whereas esophageal manometry confirmed the diagnosis of achalasia diagnostic. It was decided to perform surgical treatment for both of them using the robotic platform as described below.

Results

Heller myotomy was performed using the Da Vinci Surgical Robot manufactured by Intuitive Surgical (Sunnyvale, CA, USA). The patients were placed in a supine, reverse Trendelenburg position with an orogastric tube to decompress the stomach. Four 8-mm robotic ports and one 5-mm accessory port were placed: the first one, for the camera, just above the umbilicus, two 8-mm ports for the robotic arms in the same line on the left- and right-hand side, with a minimum 8-cm distance between each port to allow for full-range motion of the robotic arms and the last 8-mm port in the right hypochondriac region to perform liver retraction. The accessory port was inserted between the left port and the umbilicus. The robot was at the head of the patient and the anesthesia team was on the right-hand side. The surgeon operated while seated at a console and controlled the three arms and three-dimensional camera. The nurse and assistant surgeon were on the left-hand side of the patient (Fig. 1).

After retracting the liver with a static robotic instrument, the right crus was dissected, the posterior vagal trunk was identified, and the gastric fundus was mobilized. Once the lower end of the esophagus was identified, it was dissected through the posterior mediastinum. This was facilitated by the use of a traction stitch to surround the esophagus. The esophageal myotomy started a few centimeters above the gastroesophageal junction on the mediastinal esophagus. This allowed us to easily identify the layer between the mucosa and the muscle layers. We used 8-mm robotic scissors and bipolar forceps. The articulation of these devices provided precise control and helped to keep the end of the instrument directly parallel above the esophageal mucosal with a cranial and caudal fashion (Film).

The myotomy was extended proximally 5 cm from the gastroesophageal junction and distally 2 cm onto the stomach. For this latter dissection, the angle of the scissors to the axis of the instrument was 180°. Here again, the scissors remained strictly parallel to the muscle fibers with no inadvertent perforation. The next step consisted of an intraoperative endoscopy to ensure the effectiveness of the myotomy and the absence of any mucosal perforation.

Finally, a Thal fundoplication was performed by suturing the fundus on the right side of the myotomy. The time of surgery was, respectively, 300 and 220 min. No perioperative complication was noted.

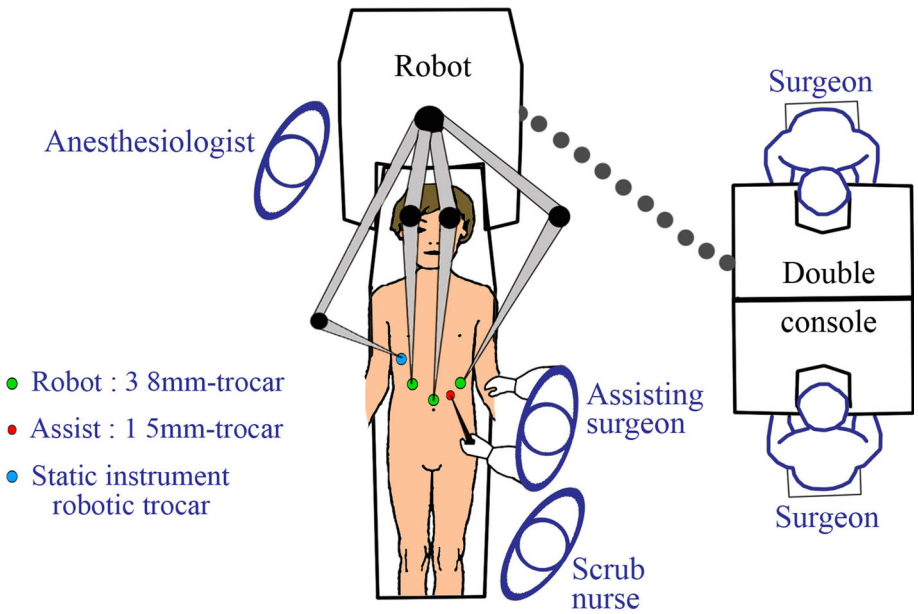

Fig. 1 Schematic diagram of the surgical robotic installation

The immediate postoperative course was simple: food consumption was resumed as early as the first day and patients were discharged on the third postoperative day. The symptoms had completely disappeared and the patients' general condition had improved significantly, with a 5-kg weight regain for the first patient and a 4-kg weight regain for the second one, respectively, after 2- and 1-year of follow-up.

Discussion

We reported here the cases of two children with successful robotic-assisted surgical treatment of symptomatic esophageal achalasia. Over the past 15 years, laparoscopic Heller myotomy has been used as first-line treatment for achalasia in adults and children and has provided durable, long-term outcomes, as indicated by the lack of symptom recurrence or of need for subsequent intervention [12]. Furthermore, this laparoscopic approach improves postoperative results in terms of length of hospital stay and postoperative pain. As an alternative, some authors advocate for a thoracoscopic approach, although meta-analyses and a Best Evidence Topic report showed no difference in long-term results, increased hospital stay and surgical time in comparison with the laparoscopic approach [13]. Hence, laparoscopic approach is the most favored surgical technique and laparoscopic Heller myotomy associated with fundoplication has become the gold standard procedure for achalasia in adults and children [2, 8, 12].

Some complications have been reported even when this minimally invasive approach is performed by experts [5–14]. The most serious one is the mucosal perforation during esophageal dissection. We hypothesize the existence of determining risks and associated preventive attitude for this particular step. Using standard laparoscopic approach, the mediastinum is reached in a caudo-cranial direction. However, esophageal myotomy should be performed in both directions: cranial but also caudal.

Conventional laparoscopic instruments are rigid, without any degree of freedom. It prevents the dissection being performed from the esophagus to the stomach in a retrograde manner. This impossibility of bending of the devices causes excessive traction on the tissues and possible mucosal injuries [11, 14].

At this point, and during the whole gastric dissection, the muscle fibers are very close to the mucosal wall without accurate and well-defined partition. In such narrow spaces,

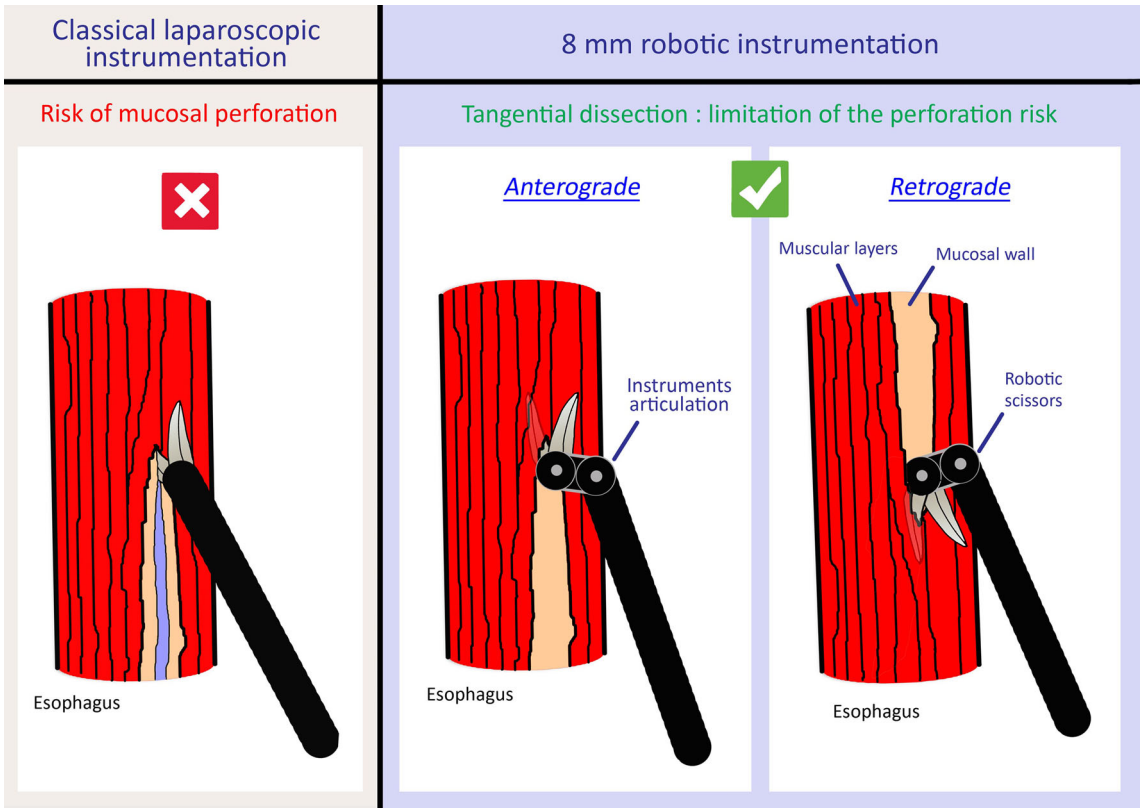

Fig. 2 Technical point: risk of mucosal perforation and different approach of dissection. The *left side* of the *image* shows a traditional laparoscopic dissection with high perforation risk. In *the right side* robotic-assisted instrument allows a tangential dissection attenuating the risk of mucosal perforation

8-mm robotic instruments with 7 degrees of freedom allow the dissection to be performed (Fig. 2) in a tangential manner in order to reduce the risk of mucosal tear in such narrow spaces. Thus, robotic platform is admitted as a modern and safe technique for this indication [7]. To our knowledge, one case (adult) of esophageal perforation has been reported with the robotic series, while the rate varies from 1 to 15% in large cohorts of patients who underwent standard laparoscopic Heller myotomy [8–11].

The main limit of this technique remains the cost efficiency [7]. Long-term results are expected given potential alternative approach consisting in peroral endoscopic myotomy including recent pediatric series [15] with encouraging results.

Conclusions

Even in the absence of statistical evidence particularly for children, we believe that the use of the robot during Heller myotomy decreases the risk of esophageal mucosal perforation, thanks to an improved three-dimensional visualization and an increased degree of instrument freedom. Larger series are expected to confirm its efficiency and safety in children.

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Compliance with ethical standards

Conflict of interest Q Ballouhey, N. Dib, A. Binet, J. Cros, V. Carcauzon Couvrat, P. Clermidi, H. Lardy, J. Languepin, B. longis and L. Fourcade declare that they have no conflict of interest.

Informed consent Written informed consent was obtained from the patient for publication of this Case Report/any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Ethics All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). Informed consent was obtained from all patients for being included in the study.

References

1. Hussain SZ, Thomas R, Tolia V (2002) A review of achalasia in 33 children. Dig Dis Sci 47:2538–2543
2. Askegard-Giesmann JR, Grams JM, Hanna AM, Iqbal CW, Teh S, Moir CR (2009) Minimally invasive Heller's myotomy in children: safe and effective. J Pediatr Surg 44:909–911
3. Campos GM, Vittinghoff E, Rabl C, Takata M, Gadenstatter M, Lin F et al (2009) Endoscopic and surgical treatments for achalasia: a systematic review and meta-analysis. Ann Surg 249:45–57
4. Pastor AC, Mills J, Marcon MA, Himidan S, Kim PC (2009) A single center 26-year experience with treatment of esophageal achalasia: is there an optimal method? J Pediatr Surg 44:1349–1354
5. Esposito C, Mendoza-Sagaon M, Roblot-Maigret B, Amici G, Desruelle P, Montupet P (2000) Complications of laparoscopic treatment of esophageal achalasia in children. J Pediatr Surg 35:680–683
6. Zhang LP, Chang R, Matthews BD, Awad M, Meyers B, Eagon JC et al (2014) Incidence, mechanisms, and outcomes of esophageal and gastric perforation during laparoscopic foregut surgery: a retrospective review of 1223 foregut cases. Surg Endosc 28:85–90
7. Afaneh C, Finnerty B, Abelson JS, Zarnegar R (2015) Robotic-assisted Heller myotomy: a modern technique and review of outcomes. J Robot Surg 9:101–108
8. Galvani C, Gorodner MV, Moser F, Baptista M, Donahue P, Horgan S (2006) Laparoscopic Heller myotomy for achalasia facilitated by robotic assistance. Surg Endosc 20:1105–1112
9. Horgan S, Galvani C, Gorodner MV, Omelanczuck P, Elli F, Moser F et al (2005) Robotic-assisted Heller myotomy versus laparoscopic Heller myotomy for the treatment of esophageal achalasia: multicenter study. J Gastrointest Surg 9:1020–1029 **(discussion 1029–1030)**
10. Huffmanm LC, Pandalai PK, Boulton BJ, James L, Starnes SL, Reed MF, Howington JA, Nussbaum MS (2007) Robotic Heller myotomy: a safe operation with higher postoperative quality-of-life indices. Surgery 142:613–618 **(discussion 618–620)**
11. Shaligram A, Unnirevi J, Simorov A, Kothari VM, Oleynikov D (2012) How does the robot affect outcomes? A retrospective review of open, laparoscopic, and robotic Heller myotomy for achalasia. Surg Endosc 26:1047–1050
12. Paidas C, Cowgill SM, Boyle R, Al-Saadi S, Villadolid D, Rosemurgy AS (2007) Laparoscopic Heller myotomy with anterior fundoplication ameliorates symptoms of achalasia in pediatric patients. J Am Coll Surg 204:977–983 **(discussion 983–976)**
13. Hughes MJ, Chowdhry MF, Walker WS (2011) Can thoracoscopic Heller's myotomy give equivalent results to the more usual laparoscopic Heller's myotomy in the treatment of achalasia? Interact CardioVasc Thorac Surg 13:77–81
14. Zhang LP, Chang R, Matthews BD, Awad M, Meyers B, Eagon JC, Brunt LM (2014) Incidence, mechanisms, and outcomes of esophageal and gastric perforation during laparoscopic foregut surgery: a retrospective review of 1223 foregut cases. Surg Endosc 28:85–90
15. Li C, Tan Y, Wang X, Liu D (2015) Peroral endoscopic myotomy for treatment of achalasia in children and adolescents. J Pediatr Surg 50:201–205