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Transitioning to Robotic-Assisted ParaEsophageal Hernia Repair-Single Centre Experience

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Abstract

Aim: *Paraesophageal hernias (PEH) constitute 5% of hiatal hernias. Surgical repair of symptomatic PEHs is the current standard of care. This study explores our centre's experience with the introduction of Robotic Assisted PEH (RA-PEH) repair in comparison to our longer established technique of laparoscopic repair.*

Methods: *Retrospective review of all laparoscopic and RA-PEH repair using the DaVinci Xi between January 2017 and May 2020 was undertaken. A total of 27 cases were included in our review. An analysis of patient demographics, operative time, approach, morbidity and mortality was performed.*

Results: *Sixteen laparoscopic and 11 robotic repairs were included. Fundoplication was performed in both groups while mesh repair was used in 18% of the laparoscopy group. Type IV hiatal hernia was found in 50% and 37% in the laparoscopy and RA-PEH groups, respectively. The mean operative time was 144 minutes in the laparoscopy group and 153 minutes for RA-PE (P=0.07). The median length of stay was 2 for both groups (P=0.18). Post-operative morbidity was 37% and 9% in the laparoscopy and RA-PEH groups respectively(P=0.18). One case of recurrence and re-intervention in the laparoscopy group during index admission was noted.*

Conclusion: *The robotic technique is a safe and effective approach when compared to the standard laparoscopic repair. It may have an advantage in reducing reliance on experienced assistance in the operating theatre without utilising more theatre time.*

Keywords: *paraesophageal (PEH) hernia, laparoscopic PEH repair, robotic PEH repair.*

Introduction

A hiatal hernia is the protrusion of the stomach and abdominal viscus through the diaphragmatic hiatus into the thoracic cavity. It is a prevalent condition with an incidence of 10-60% within the population [1,2]. Type I hernias (sliding hiatal hernias) represent 95% of all cases while type II-IV paraesophageal hernias (PEH) are less commonly encountered. Incarcerated PEHs are associated with significant morbidity and mortality [2-4]. Operative management, particularly with regard to selection of patients for elective surgical intervention remains somewhat unclear. While low incidence of PEHs presenting as emergencies carries a significant risk of mortality, elective repair also carries a mortality risk of approximately 1.5% [5-8].

The aetiology behind PEHs is multifactorial. Laxity and redundancy of the phreno-oesophageal ligament is a contributing factor to sliding hiatal hernias [2]. Congenital or acquired widening of the hiatus, trauma and surgical dissection of the oesophagus are also recognized risk factors. Type III and IV PEHs are commonly found in the elderly and obese populations and those with conditions associated with increased intrabdominal pressure. Many patients remain asymptomatic during their lifetime or present with vague symptoms such as bloating, chest pain and nausea. Severe complications such as gastric volvulus, gastric and perforation, gastric ulceration, and respiratory compromise may also occur.

Surgical repair involves several cardinal steps like sac excision, diaphragmatic crural repair with or without mesh application and either an anti-reflux procedure or gastropexy. Laparoscopy has superseded open repair as the standard approach and is associated with a shorter length of stay and reduced morbidity [9-11]. Robotic assisted surgery presents new opportunities in managing these complex hernias. Several studies have investigated the advantages of robotic repair as opposed to the open or laparoscopic approaches; however, longer follow up studies are needed. Case series by Tartagila et al published in February 2020 had reported similar perioperative morbidity, with at least equivalent perioperative outcomes [12]. There is a significant learning curve associated with complex robotic

assisted procedures, although this learning curve may be attenuated in surgeons who have significant robotic surgery experience.

The aim of this study was to assess the impact of introducing a programme of RA-PEH repair on perioperative parameters – particularly time of operation, length of hospital stays and post-operative morbidity.

Materials and Methods

This is a retrospective review of all PEH repair performed by a single consultant surgeon in 2 centres in Dublin, Ireland. Twenty-seven patients underwent repair of a PEH in the study period. All patients had type III and IV para-oesophageal hernias. Fifteen patients underwent a laparoscopic PEH repair while 11 underwent RA-PEH. Patients from both groups underwent similar diagnostic investigations including computed tomography (CT) of the chest, abdomen and pelvis scan, an upper GI endoscopy and barium swallow. Patients who presented to the emergency department with intra-thoracic volvulus only had a CT scan prior to emergency repair. The standard approach was laparoscopic repair prior to the acquisition of the robotic system (da Vinci Xi – Intuitive Medical) in one centre. Laparoscopic repair was accompanied by a 360-degree Nissen type fundoplication, posterior 270-degree Toupet style fundoplication or gastropexy depending on surgeon's choice which was individualised to each patient. Mesh application was used in 3 of our laparoscopic cases.

The DaVinci Xi (*Intuitive Surgical*, Sunnyvale, CA, USA) was introduced in one institution in 2019. Following training and proctoring, both benign and malignant cases were undertaken using the DaVinci Xi system. The criteria for performing the procedure were the patient's preference, availability of robot and complexity of the procedure in the elective setting. Prior to commencing RA-PEH, robotic experience had been established in cholecystectomy, hernia surgery, abdominal wall repairs, Roux-en-Y gastric bypass and sleeve gastrectomy. This study has focussed on perioperative outcomes and did not include long term follow-up data.

In terms of surgical technique, the anatomy was assessed following insufflation. A liver retractor was placed and the laparoscopic or robotic ports were introduced under direct vision. for laparoscopic repair, a 10mm camera port was inserted approximately 15 cm from the xiphisternum just to the left of the midline. Other ports included a 5mm trocar in the right upper quadrant, 10mm trocar in the left upper quadrant and 5mm trocar in the left flank. During a robotic repair an 8mm camera port was placed again approximately 15cm from the xiphisternum just to the left of the midline region, with 3 further 8mm robotic trocars placed in a straight line across the abdomen (right upper quadrant arm 1, left upper quadrant arm 3 and left flank arm 4). An 8mm *AirSeal*® port was placed below and between arms 2 and 3 to allow for assistance. Briefly, where possible, the contents of the hernia were reduced into the abdominal cavity, the hernia sac was completely dissected in the mediastinum with extensive mediastinal mobilisation of the oesophagus. Care was taken to preserve the vagus nerves. Once the sac was dissected free, a crural repair was performed using non-absorbable braided sutures. In selected cases where crural repair was not possible without excessive tension, a non-absorbable mesh was used to reinforce the crural repair and secured with non-absorbable *GORE-TEX*® sutures. Fundoplication or gastropexy was performed on a patient-by-patient basis depending on both findings of oesophageal manometry and on individual assessment at the time of surgery. During RA-PEH, an anterior 270-degree fundoplication was consistently used for all operations. Drains were not used routinely. Oral fluids were permitted on the day of surgery and diet was recommenced on the first post-operative day.

Results

Demographics:

Patient demographics were comparable between both groups (table 1). The majority of patients were females, 75% in the laparoscopic group and 63% in the robotic group. Most patients undergoing elective repair complained of gastroesophageal reflux, heartburn and post-prandial discomfort. Patients' comorbidities and ASA Grades were comparable between the two groups. Half of the laparoscopic cohort had an ASA score of II while 43% were ASA III and one ASA I. In the RA-PEH group, 63% had ASA II and 37% had an ASA score of III. The BMI in the laparoscopic group was 27.7 compared to 28.5 in the robotic group.

Table 1: Patient demographics in the laparoscopic and robotic PEH repair groups.

	Laparoscopic (n=16)	Robotic (n=11)	P-value
Age (mean and range)	75.9 (58-94)	67.2 (57-74)	0.003 ‡
Sex (M:F)	4:12	4:7	0.67 *
ASA			
II	8/16 (50%)	7/11 (63%)	
III	7/16 (43%)	4/11 (36%)	
IV	1/16 (6%)		
BMI (kg/m^2) Mean and range	27.7 (22-32.3)	28.5 (24.4 -34.1)	
‡= Mann-Whitney U; *=Fisher's exact test.			

Operative demographics:

Twenty-five percent of the laparoscopy patients (4/16) had an emergency repair while all patients undergoing RA-PEH were elective. The most common complaint amongst patients was an acute episode of chest pain. Other manifestations included postprandial discomfort, vomiting and gastroesophageal reflux. The chief presenting complaints in the emergency cases were severe chest pain and vomiting. No patient had gastric ischaemia

or necrosis at the time of operation. There was an even number of type III and type IV para oesophageal hernias in the laparoscopy group and slightly more patients (63%) undergoing RA-PEH had type III hernias. The operative demographics can be found in Table 2.

Table 2: Operative demographics.

	Laparoscopic (n=16)	Robotic (n=11)	P-value
Pre-operative CT	16/16 (100%)	11/11 (100%)	1.0 *
Pre-operative barium study	9/16 (56%)	7/11 (63%)	1.0 *
Pre-operative pH/manometry	11/16 (69%)	11/11 (100%)	0.06 *
Type III hernia	8/16 (50%)	7/11 (63%)	
Type IV hernia	8/16 (50%)	4/11 (37%)	0.69
Emergency	4/16 (25%)	0/11 (0%)	0.12 *
‡= Mann-Whitney U; *=Fisher's exact test.			

Peri-operative outcomes:

The average operative time was 144 minutes for the laparoscopic repair and 153 minutes for the robotic repair (p=0,07, table 3). Various forms of fundoplication were performed during laparoscopic repair. 25% of the laparoscopic cases had Toupet fundoplication, 50% had Nissen and 25% had a gastropexy without fundoplication. All robotic repairs had an anterior 270-degree fundoplication which was the technique favoured by the robotic proctor who taught and supervised the introduction of the robotic technique. Mesh repair was performed in 3 of the laparoscopic cases and none of the robotic cases. There was one intraoperative complication in the laparoscopy group and none in the robotic group. The complication was bleeding from a short gastric artery during dissection which was controlled using a laparoscopic clip applicator.

The total length of stay was comparable between the two groups. The median length of stay in both groups was 2 days (p=0.18). The rate of postoperative complications in the laparoscopy group was 37.5% (6/16), compared with 9% (1/11) in the laparoscopy group (table 3). The majority of complications were lower respiratory tract infections. One patient in the laparoscopic group had an acute re-herniation and required re-operation on the first post-operative day.

Table 3: Peri-operative outcomes for laparoscopic and robotic assisted groups.

	Laparoscopic (n=16)	Robotic (n=11)	P-value
Length of operation (mins)	144 (110-173)	153 (137-189)	0.07 ‡
Fundoplication performed (Y/N)	12/16 (75%)	11/11 (100%)	0.12 *
Type of fundoplication			
Nissen	4/16 (25%)		
Toupet	8/16 (50%)		
Anterior 270º	0	11/11 (100%)	n/a
Hiatal mesh (Y/N)	3/16 (19%)	0/11 (0%)	0.24 *
Intra-operative complication	1/16 (6%)	0/11 (0%)	1.0 *
Length of stay (median)	2 (1-11)	2 (1-3)	0.18 ‡
Post-operative complication	5/16 (31%)	1/11 (9%)	0.18 *
Re-intervention on index admission	1/16 (6%)	0/11 (0%)	1.0 *
30-day mortality	0/16 (0%)	0/11 (0%)	1.0 *
‡= Mann-Whitney U; *=Fisher's exact test.			

Discussion

Surgical repair for PEHs is a complex operation. Conventional open surgery was the standard form of PEH repair up until the 1990s when laparoscopic surgery was popularised. Despite the initial technical challenges, laparoscopic repair has been shown to be feasible, safe and effective and rapidly became the standard surgical treatment in most centres [5,8]. Some reports suggested that laparoscopic repair may have a higher risk of recurrence in comparison to an open approach [14,15]. However, most of the data comes from retrospective case series, recurrences are asymptomatic and are only detected radiologically with a 5-6% rate of reoperation [16-19]. RA-PEH repair was introduced in the late 2000s with various upsides in comparison to the laparoscopic approach. The–benefits of the da Vinci robotic system include the dexterity of the instruments, three-dimensional vision for the surgeon and less reliance on surgical assistants to operate both the camera and provide retraction. All of these benefits may be advantageous to the surgeon performing PEH repairs [17-20].

Our data which reported on our initial experience with robotic repair has shown comparable results to our established laparoscopic technique. Length of stay, post-operative

complications and re-intervention rates were similar between both groups. Operative time of RA-PEH was initially longer in the first few cases taking 189 minutes which was then reduced to a best time of 134 minutes. It was our experience that operating times very rapidly became comparable with established surgical time for the established laparoscopic technique. Indeed, our expectation is that the robotic operation will be more time efficient with more experience. Reasons for gains in time efficiency include the fact that the robotic system allows the operating surgeon to control both camera movement and retraction. This avoids repetitive pauses in operation flow to instruct and change assistants' positions. This may be an underestimated advantage of robotic system which warrants further evaluation. Intraoperatively, robotic surgery overcomes the shortcomings of laparoscopy through high instrumental precision, dexterity and wide ranged wrist flexibility. In RA-PEH, such dexterity in the instrumentation offers technical advantages when operating in the mediastinum through the hiatus. It is our experience that this facilitates the posterior mediastinal dissection of the sac, mobilization of the oesophagus and posterior crural repair. The flexibility and dexterity of instruments, lower number of assistants and the 3D visualization intraoperatively are all recognized advantages of the DaVinci platform [20-23]. A full illustration of the mains steps of RA-PEH repair can be found in Figure 1.

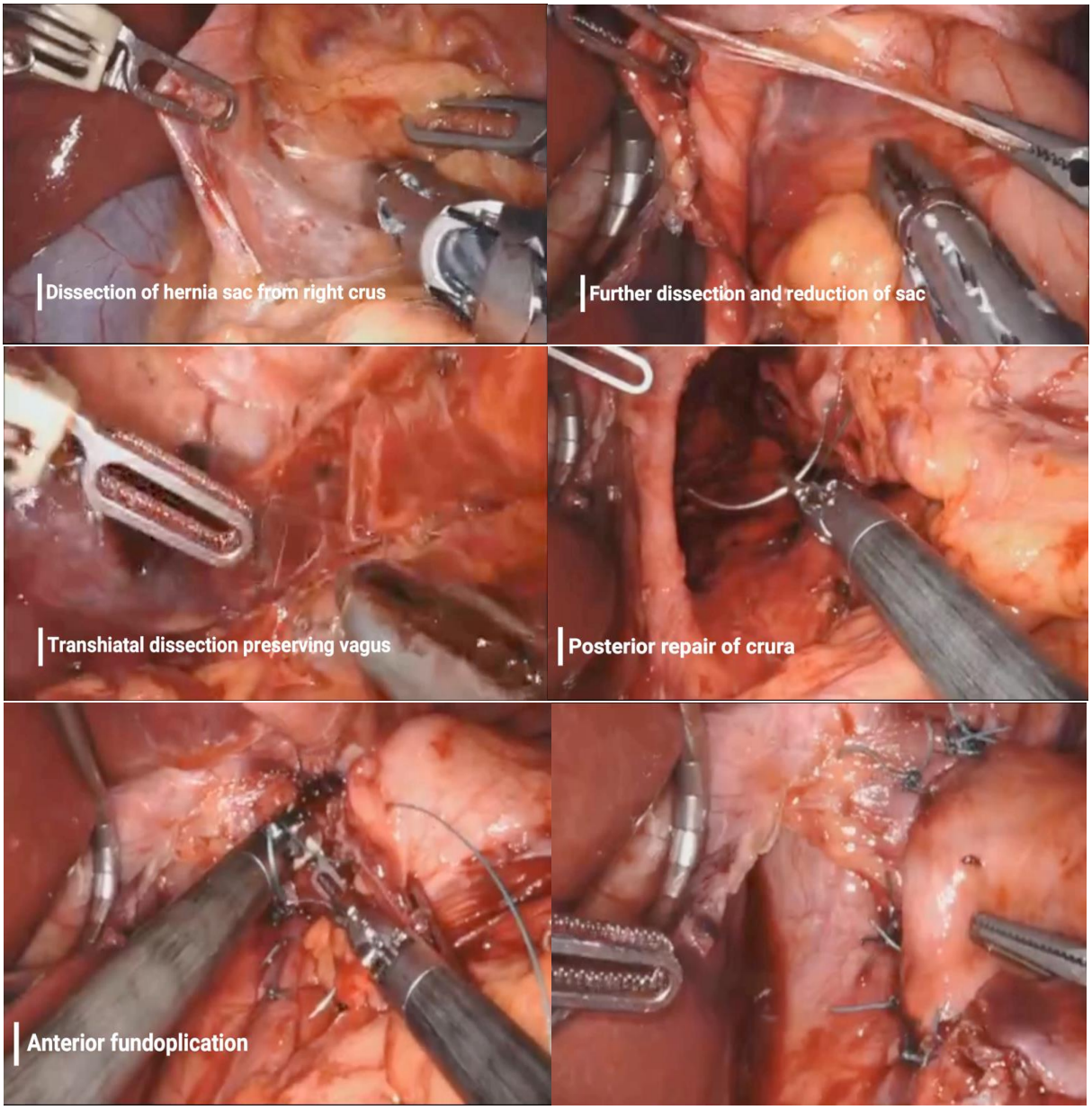

Figure 1: illustration of the cardinal steps of Robotic PEH repair. First image demonstrates the dissection of the sac off both crurae proceeding to reduction of the sac back into the abdominal cavity. Picture 2 demonstrates transhialtal dissection and preservation of the vagus nerve. Fourth picture demonstrates the use of ethibond sutures for posterior repair, a total of three stitches were in place at the end of the repair. The fifth picture demonstrates anterior fundoplication as an anchoring method and is the final step of the procedure. The final and 6th picture demonstrates the stomach situated back into the abdominal cavity.

Single centre experiences have been published with the outcomes for RA-PEH; however, the results still lack long term follow-up data [24-25]. Draaisma et al' experience demonstrated the RA-PEH repair technique to be effective with preliminary results of low recurrence rates in their patients-cohort [24]. Gerull published one of the largest case series of PEH repair over a-five-year period in June 2020 which included 128 patients. The report showed comparable length of stay in both laparoscopic and RA-PEH groups and lower incidence of complications and 30-day reoperation rate in the robotic group [25]. The results from our study are comparable to the outcomes published from various centres worldwide [9,10,25]. The LOS was found to be shorter in the robotic group with reduced postoperative complications and reoperation rate. There is still a paucity of literature in the assessment of the outcomes of RA-PEH repair. This study represents another step in the move towards robotic surgery and despite the learning curve that comes with any novel technique, our results are promising. The main limitations include the small cohort of patients taken from a single surgeon and the current lack of long term follow up and assessment of anatomical and radiological recurrence.

In conclusion, as with any new technique our experience demonstrated an associated learning curve to be overcome. This will vary depending on the extent of each surgeon's prior robotic experience. The precision and dexterity of the robotic instruments offer many advantages over laparoscopy especially in mediastinal dissection and the surgeon becomes more autonomous. RA-PEH is a safe and effective approach when compared to the standard laparoscopic repair.

Conflict of interest: none.

Disclosure: none of the authors of this paper have anything to disclose.

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References

1. Baiu I, Lau J. What Is a Paraesophageal Hernia? JAMA [Internet]. 2019 [cited 8 July 2020];322(21):2146. Available from: https://jamanetwork.com/journals/jama/fullarticle/2756292
2. Weston A. Hiatal Hernia with Cameron Ulcers and Erosions. Gastrointestinal Endoscopy Clinics of North America [Internet]. 1996;6(4):671-679. Available from: https://pubmed.ncbi.nlm.nih.gov/8899401/
3. Watson T, Moritz T. Sliding Hernia (Paraesophageal) [Internet]. Ncbi.nlm.nih.gov. 2020 [cited 8 July 2020]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK459270/
4. Wright R, Hurwitz A. Relationship of hiatal hernia to endoscopically proved reflux esophagitis. Digestive Diseases and Sciences [Internet]. 1979 [cited 8 July 2020];24(4):311-313. Available from: https://pubmed.ncbi.nlm.nih.gov/456217/
5. Lebenthal A, Waterford S, Fisichella P. Treatment and Controversies in Paraesophageal Hernia Repair. Frontiers in Surgery [Internet]. 2015 [cited 8 July 2020];2. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4403251/
6. Stylopoulos N, Gazelle G, Rattner D. Paraesophageal Hernias: Operation or Observation? Annals of Surgery [Internet]. 2002 [cited 8 July 2020];236(4):492-501. Available from: https://pubmed.ncbi.nlm.nih.gov/12368678/
7. Paul S, Nasar A, Port J, Lee P, Stiles B, Nguyen A et al. Comparative Analysis of Diaphragmatic Hernia Repair Outcomes Using the Nationwide Inpatient Sample Database. Archives of Surgery [Internet]. 2012 [cited 8 July 2020];147(7). Available from: https://pubmed.ncbi.nlm.nih.gov/22430093/
8. Ferri L, Feldman L, Stanbridge D, Mayrand S, Stein L, Fried G. Should laparoscopic paraesophageal hernia repair be abandoned in favor of the open approach? Surgical Endoscopy [Internet]. 2004 [cited 8 July 2020];19(1):4-8. Available from: https://pubmed.ncbi.nlm.nih.gov/15531968/
9. Seetharamaiah R, Romero R, Kosanovic R, Gallas M, Verdeja J, Rabaza J et al. Robotic Repair of Giant Paraesophageal Hernias. JSLS: Journal of the Society of Laparoendoscopic Surgeons [Internet]. 2013 [cited 8 July 2020];17(4):570-577. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3866061/#idm140446544679296aff-info
10. Sarkaria I, Latif M, Bianco V, Bains M, Rusch V, Jones D et al. Early operative outcomes and learning curve of robotic assisted giant paraesophageal hernia repair. The International Journal of Medical Robotics and Computer Assisted Surgery [Internet]. 2016 [cited 8 July 2020];13(1): e1730. Available from: https://pubmed.ncbi.nlm.nih.gov/26928955/
11. Gharagozloo F, Najam F. Robotic surgery. New York: McGraw-Hill Medical; 2009.
12. Tartaglia N, Pavone G, Di Lascia A, Vovola F, Maddalena F, Fersini A et al. Robotic voluminous paraesophageal hernia repair: a case report and review of the literature. Journal of Medical Case Reports [Internet]. 2020;14(1). Available from:
13. Cuschieri A, Shimi S, Nathanson L. Laparoscopic reduction, crural repair, and fundoplication of large hiatal hernia. The American Journal of Surgery [Internet]. 1992;163(4):425-430. Available from: https://www.sciencedirect.com/science/article/abs/pii/000296109290046T
14. Wu J, Dunnegan D, Soper N. Clinical and radiologic assessment of laparoscopic paraesophageal hernia repair. Surgical Endoscopy [Internet]. 1999 [cited 8 July 2020];13(5):497-502. Available from: https://pubmed.ncbi.nlm.nih.gov/10227951/
15. Hashemi M, Peters J, DeMeester T, Huprich J, Quek M, Hagen J et al. Laparoscopic repair of large type III hiatal hernia: objective followup reveals high recurrence rate11No competing interests declared. Journal of the American College of Surgeons [Internet]. 2000 [cited 8 July 2020];190(5):553-560. Available from: https://pubmed.ncbi.nlm.nih.gov/10801022/
16. Andujar J, Papasavas P, Birdas T, Robke J, Raftopoulos Y, Gagn D et al. Laparoscopic repair of large paraesophageal hernia is associated with a low incidence of recurrence and reoperation. Surgical Endoscopy [Internet]. 2004 [cited 8 July 2020];18(3):444-447.

17. Latzko M, Borao F, Squillaro A, Mansson J, Barker W, Baker T. Laparoscopic Repair of Paraesophageal Hernias. JSLS: Journal of the Society of Laparoendoscopic Surgeons [Internet]. 2014 [cited 8 July 2020];18(3): e2014.00009. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4208886/
18. Mehta S, Boddy A, Rhodes M. Review of Outcome After Laparoscopic Paraesophageal Hiatal Hernia Repair. Surgical Laparoscopy, Endoscopy & Percutaneous Techniques [Internet]. 2006 [cited 8 July 2020];16(5):301-306. Available from: https://journals.lww.com/surgical-laparoscopy/Abstract/2006/10000/Review_of_Outcome_After_Laparoscopic.1.aspx
19. Andujar J, Papasavas P, Birdas T, Robke J, Raftopoulos Y, Gagn&#xF; D et al. Laparoscopic repair of large paraesophageal hernia is associated with a low incidence of recurrence and reoperation. Surgical Endoscopy [Internet]. 2004;18(3):444-447. Available from: https://link.springer.com/article/10.1007/s00464-003-8823-4.
20. Maziak DE, Todd TR, Pearson FG. Massive hiatus hernia: evaluation and surgical management. *J Thorac Cardiovasc Surg*. 1998;115(1):53-62. doi:10.1016/s0022-5223(98)70442-8, https://pubmed.ncbi.nlm.nih.gov/9451045/
21. Konstantinidis, Konstantinos & Konstantinidis, Michael & Hirides, Savvas & Hirides, Petros. (2018). Robotic Hiatal Hernia Repair. 10.5772/intechopen.71164.
22. Lanfranco A, Castellanos A, Desai J, Meyers W. Robotic Surgery. Annals of Surgery [Internet]. 2004 [cited 8 July 2020];239(1):14-21. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1356187/
23. Abitbol J, Munir A, How J, Lau S, Salvador S, Kogan L et al. The shifting trends towards a robotically-assisted surgical interface: Clinical and financial implications. Health Policy and Technology [Internet]. 2020 [cited 8 July 2020];9(2):157-165. Available from: https://www.sciencedirect.com/science/article/abs/pii/S2211883720300307
24. Draaisma WA, Gooszen HG, Consten EC, Broeders IA. Mid-term results of robot-assisted laparoscopic repair of large hiatal hernia: a symptomatic and radiological prospective cohort study. *Surg Technol Int*. 2008; 17:165-170. https://pubmed.ncbi.nlm.nih.gov/18802897/
25. Gerull W, Cho D, Arefanian S, Kushner B, Awad M. Favorable peri-operative outcomes observed in paraesophageal hernia repair with robotic approach. Surgical Endoscopy [Internet]. 2020 [cited 8 July 2020]; Available from: https://pubmed.ncbi.nlm.nih.gov/32556775/.