Does the Transition from da Vinci Si to Xi Platform Improve the Short-Term Outcomes for Rectal Cancer Surgery

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Abstract

Background: The newly introduced da Vinci Xi Surgical System was intended to address many of the shortcomings of its predecessor Si, specifically robotic arm restrictions and difficulty working in multiple quadrants. And the aim of this study was to compare the short-term outcomes of robotic rectal cancer resection with the use of da Vinci Si (TME-Si) and new da Vinci Xi (TME-Xi).

Methods: From Jan 2016 to April 2018, 57 patients underwent robotic rectal cancer surgery were included. Patient were classified into 2 groups (TME-Si, n=33 versus TME-Xi, n=24). The TME-Si group was further subdivided into conventional hybrid (TME-Si-hybrid) and total robotic-single docking (TME-Si-robot) approach. Patient characteristics, perioperative clinical outcomes and complications, and pathological assessment were compared between these three groups.

Results: Demographic details were similar between all three groups. TME-Si-robot group had a slight higher proportion of patient receiving neoadjuvant chemo-radiotherapy but it is not statistically significant. The only significant result is the operative time, TME-Si-robot had the longest operative time (208.4 min) followed by TME-Si-hybrid (196 min) and TME-Xi group (189.5 min), however, the results do not reach statistically significance. Other perioperative outcomes including blood loss, conversion rate and length of hospital stay were all comparable. The clinical leakage rate and early complication rates did not differ between TME-Si and TME-Xi and all can be managed conservatively. Postoperative pathological assessment including staging status, lymph nodes harvested and margin involvement were all similar between Si and Xi.

Conclusion: Both da Vinci Si and Xi led to similar short term outcomes for robotic cancer surgery. However, the new generation Xi model did allow surgeon for easier docking and lesser arm collision when performing multi-quadrant surgery.

Introduction

The role of laparoscopic colectomy for colonic cancer had already been well established in many large scale multi-centered randomized controlled trials and meta-analysis [1-3]. However, the status of laparoscopic rectal cancer surgery is not so concrete, still under many intensive discussion. Result from the CLASICC trial raised our concern due to high conversion rate and higher circumferential resection margin positivity rate in the laparoscopic arm [4]. This may be attributed from the inherent limitations of laparoscopic surgery, resulting in technical difficulties in pelvic exposure, precise rectal dissection with total mesorectal excision in the narrow pelvis as well as preservation of pelvic autonomic nerves. One of the major advances in recent decades is the introduction of da Vinci Surgical system, its 3D camera, tremor filter and 7-degree endowrist movement overcomes many of the limitation of laparoscopic surgery, and translated into clinical benefit such as low conversion rate, shorter learning curve and better functional outcomes. Nevertheless, human being should always strive for the best, cannot be easily satisfied with the present status. Da Vinci Si system had several shortcomings, such as robotic arm restrictions and difficulty working in multiple quadrant. The newly introduced da Vinci Xi Surgical System was intended to address many of the shortcomings of its predecessor Si. And the aim of this study was to compare the short-term outcomes of robotic rectal cancer resection with the use of da Vinci Si (TME-Si) and new da Vinci Xi (TME-Xi).

Patients and Methods

From Jan 2016 to April 2018, 57 patients underwent robotic rectal cancer surgery were included.
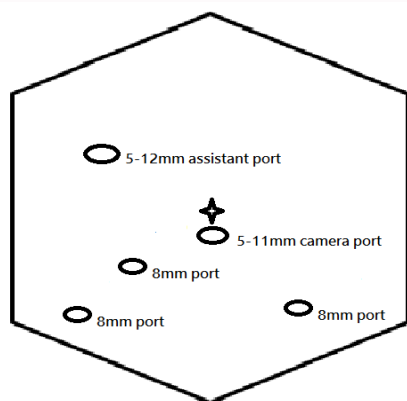
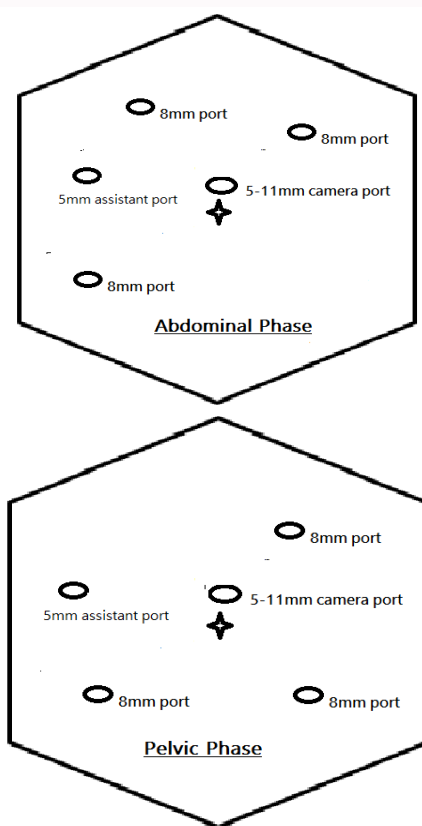**Figure 1**: Ports placement for da Vinci Si hybrid approach.

Figure 2: Ports placement for da Vinci Si total robotic SINGLE docking approach.

Patient were classified into 2 groups (TME-Si, n=33 versus TME-Xi, n=24). The TME-Si group was further subdivided into conventional hybrid (TME-Si-hybrid) and total robotic-single docking (TME-Si-robot) approach. Patient characteristics, perioperative clinical outcomes and complications, and pathological assessment were compared between these three groups.

Preoperative workup and preparation

Pre-operative workup includes colonoscopy with histological confirmation, whole body Computer Tomography scan (CT) and pelvic Magnetic Resonance Imaging (MRI). Multi-disciplinary meeting involving surgeon, radiologist, oncologist and pathologist was carried out every two weeks in our hospital, all newly diagnosed

rectal cancer cases would be discussed and a final management plan would be made. For locally advanced disease (clinically T3 or above, presence of nodal disease and threatened circumferential resection margin) confirmed on MRI, neoadjuvant chemo-irradiation was given. Bowel preparation protocol included low residue diet 3 days before operation, fluid diet and Klean prep one day before operation.

Surgical procedure

All the patients in this study underwent robotic low anterior resection with loop ileostomy covering. The robotic trocar placements of different robotic approach were shown in figure 1-3. Lymph node dissection was started around origin of the inferior mesenteric artery and medial to lateral technique was used in all operations. Splenic flexure was not routinely taken down, because in Chinese population, the sigmoid colon is relatively long and incidence of sigmoid diverticulitis was low as compared to western countries. So tension free anastomosis can usually be created without splenic flexure mobilization. Operations were performed according to the accepted mesorectal excision principles. The specimen was extracted through pfennenstiel incision, and end to end colorectal anastomosis was performed using circular stapler.

Operative technique with da Vinci Si hybrid approach: The hybrid approach combines laparoscopic left sided colonic mobilization and vascular control with robotic technique for rectal dissection. The robot was docked in between the legs.

Operative technique with da Vinci Si total robotic SINGLE docking approach: We used the Korean technique in which the surgery is divided into abdominal and pelvic phase. The robotic cart is docked over the left hip of patient at a 45°. In the abdominal phase, inferior mesenteric vessel ligation and left sided colonic mobilization were performed using robotic system. On completion of abdominal phase, the position of the robotic cart remained unchanged, but two of the robotic arms are repositioned to different position to perform pelvic dissection.

Operative technique with da Vinci Xi total robotic SINGLE docking approach: The operative procedure in the Xi group was totally robotic and single docking. And all the procedures were completed without need for repositioning of the robotic arms.

Outcome measures

The outcomes measured included operative time, blood loss, conversion rate, length of postoperative hospital stay and postoperative morbidity. Operative mortality was defined as postoperative death that occurred within 30 days after surgery. Anastomotic leakage was defined as clinically (presented as peritonitis or faecal content from drains) or radiologically (as confirmed by water soluble contrast enema). Two designated pathologists were specifically requested to evaluate the quality of mesorectum specimen. Pathological data including pathological stages, number of harvested lymph nodes, status of circumferential resection margin and distal margin were analyzed.

Statistic

Statistical analysis was performed using the SPSS program. The student t test was used for continuous variables. The categorical variables were analyzed by the chi test or Fisher's exact test. A two-sided p-value of less than 0.05 was considered significant.

Result

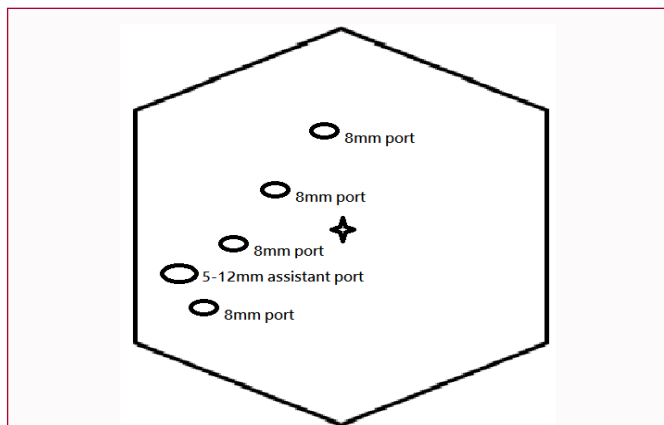From Jan 2016 to April 2018, 57 patients underwent robotic rectal

Figure 3: Ports placement for da Vinci Xi single docking approach.

cancer surgery were included, 33 patients in Si and 24 patients in Xi group. The Si group was further subdivided into conventional hybrid (TME-Si-hybrid) and total robotic-single docking (TME-Si-robot) approach. The patients' demographic characteristics were shown in Table 1. The three groups were similar in terms of age and sex. TME-Si-robot group had a slight higher proportion of patient receiving neoadjuvant chemo-radiotherapy but it is not statistically significant. The perioperative clinical outcomes and complications were shown in Table 2. The only significant result is the operative time, TME-Si-robot had the longest operative time (208.4 min) followed by TME-Si-hybrid (196 min) and TME-Xi group (189.5 min), however, the results do not reach statistically significance. Other perioperative outcomes including blood loss, conversion rate and length of hospital stay were all comparable. The clinical leakage rate and early complication rates did not differ between TME-Si and TME-Xi and all can be managed conservatively. The 30 days mortality rate is 0. Postoperative pathological assessment (Table 3) including staging status, lymph nodes harvested and margin involvement were all similar between Si and Xi.

Discussion

Da Vinci robotic system is one the major surgical advancement in the last decade. Its high resolution 3D camera, 7 degree endowrist movement and stable console, allowing surgeons to perform fine dissection in deep and narrow working space. The safety and feasibility of old Da Vinci Si system for rectal cancer surgery had been well established [5,6], however, several technical difficulties with the Si system did exist. Rectal cancer surgery is a multi-quadrant surgery requires inferior mesenteric vessel control, mobilization of descending and sigmoid colon, sometimes even requires taking down splenic flexure if sigmoid colon is relatively short and unhealthy and pelvic rectal dissection. As a result, dual docking or even multiple docking of robot is necessary and which would lead to increased operative time and increased workload. In order to tackle this problem, different operative approaches have been developed for robotic rectal cancer surgery, including conventional hybrid

Table 2: Perioperative clinical outcomes and complications.

	Si (19) **Hybrid**	Si (14) **Total robotic**	Xi (24)	p-value
OT times (mins)	196	208.4	189.5	0.688
Blood loss (ml)	59	60	55	0.026
Conversion	0	0	1	0
LOS (days)	8	9.5	11.2	0.13
Early complication	3 (3 ileus)	2 (2 ileus)	5 (3 ileus and 2 intra-abd collection)	0.156
Clinical leakage	2	3	2	0.0
30 days mortality	0	0	0	0

Table 3: Postoperative pathological assessment.

	Si **Hybrid**	Si (14) **Total robotic**	Xi (24)	p-value
Stage 1 2 3 4	3 7 9 0	7 2 5 0	5 11 8 0	0.02
LN harvested	9.42	14	14.5	0.4
LN involved	1.01	1.57	1.38	0.12
Distal margin involvement	0	0	0	0
CRM involvement	0	0	0	0

approach and total robotic single docking approach. We practiced the conventional hybrid approach for some time in our unit, it had the benefit of avoiding dual docking of robot so as to shorten the whole operative time and patient can still enjoy the benefit of robot during the most crucial step – rectal dissection. One of the drawback of this approach is that robot cannot be used for lympho-vascular dissection so the lymph nodes harvested was the lowest among the three groups, and the operative cost also increases as need to open a set of laparoscopic instruments . We also performed the total robotic Si single docking surgery, it had the benefit that robot can be used for both lympho-vascular dissection and rectal dissection, and with longer console time per case, the learning curve can be overcome faster. However, we encountered frequent external collisions of Si robotic arms which lead to much longer operative time.

The fourth generation robot, da Vinci Xi system was launched with the aim to overcome many of the limitations of its ancestor. The laser targeting system allows easier docking, boom-mounted system with the flexible and mobile platform allow better anatomic access in multi-quadrant surgeries, the thin arms and instruments offer greater range of motion. It is a pity that our unit had not recorded the docking times for all these included cases, but subjectively, our surgical team including surgeon and nurses feel that Xi model had much easier and faster docking as compared to Si model. Morelli and his group had reported a mean difference of 6 minutes in docking time between Si-TME (23.5 +/- 2.7 min) and Xi-TME (17.5 +/- 3.4 min) [7]. As for the overall operative time, both Morelli and Ozben had reported significantly shorter operative time in the Xi-TME group

Table 1: Patient characteristics.

	Si (19) **Hybrid** (lap mobilization, robot pelvis dissection)	Si (14) **Total robotic, Single docking**	Xi (24) Total robotic, single docking	p-value
Age	68.5	68	67.2	0.308
Sex (M:F)	12:7	13:1	12:12	0.273
Neoadjuvant treatment (%)	7 (36.8%)	6 (42.8%)	8 (33%)	0.046

from their comparative studies, around 40 minutes shorter in Xi-TME group in both studies [7,8]. Our data reported that Xi-TME had the shortest operative time among the three groups but the result did not reach statistically significance. We believed the reason was that in Cantonese population, the sigmoid colon is relatively redundant and incidence of sigmoid diverticulitis is low, so a tension-free anastomosis can usually be performed without splenic flexure take down, and all our included cases, in fact none of them required taking down the splenic flexure. As for Western population, splenic flexure taking down rate is much higher; giving the advantage of model Xi in performing multi-quadrant surgery, the benefit of Xi over Si would become more obvious. Our study has several limitations. First, it is a retrospective study with limited sample size. Second, the cases were operated by a wide range of different surgeons during different phase of their learning curve. Third, the Xi cases are the initial case series immediately after Xi installed in our unit, so surgeon and operating staff may not get used to the new trocar position, robotic cart position and new function so affecting the performance of Xi system.

Conclusion

Both da Vinci Si and Xi led to similar short term outcomes for robotic cancer surgery. However, the new generation Xi model did allow surgeon for easier docking and lesser arm collision when performing multi-quadrant surgery and also reducing the operative cost as no more hybrid approach was required in performing rectal cancer surgery.

References

1. Lacy AM, García-Valdecasas JC, Delgado S, Castells A, Taurá P, Piqué JM, et al. Laparoscopy-assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: a randomized trial. Lancet. 2002;359(9325):2224-9.

2. Veldkamp R, Kuhry E, Hop WCJ, Jeekel J, Kazemier G, Bonjer HJ, et al. Laparoscopic surgery versus open surgery for colon cancer: short term outcomes of a randomized trial. Lancet Oncol. 2005;6(7):477-84.

3. Aly EH. Laparoscopic colorectal surgery: summary of the current evidence. Ann R Coll Surg Engl. 2009;91(7):541-4.

4. Guillou P, Quirke P, Thorpe H, Walker J. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASSIC trial): multicenter, randomized controlled trial. The Lancet. 2005;365:1718-26.

5. Trastulli S, Farinella E, Cirocchi R, Cavaliere D, Avenia N. Robotic resection compared with laparoscopic rectal resection for cancer: Systematic review and meta-analysis of short-term outcomes. Colorectal Dis. 2012;14:e134-56.

6. Xiong B, Ma L, Zhang C, Cheng Y. Robotic versus laparoscopic total mesorectal excision for rectal cancer: A meta-analysis. J Surg Res. 2014;188:404-14.

7. Luca M, Gregorio DF, Simone G. Robotic-assisted total mesorectal excision for rectal cancer: case-matched comparison of short-term surgical and functional outcomes between the da Vinci Xi and Si. Surg Endosc. 2018;32:589-600.

8. Volkan O, Turgut B, Deniz A. Is da Vinci Xi better than da Vinci Si in robotic rectal cancer surgery? Comparison of the 3 generations of da Vinci systems. Surg Laparosc Endosc Percutan Tech. 2016;26:417-23.