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ORIGINAL ARTICLE

Robotic Oncological Surgery: Our Initial Experience of 164 Cases

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Abstract Minimal access surgery is an accepted modality for benign surgery. Despite the advantages of laparoscopy, its acceptance in oncology is slow. Robotic surgery is an emerging field with rapid acceptance because of the 3—dimensional image, dexterity of instruments and autonomy of camera control. We report here our experience of using the Da Vinci robot for various oncological procedures. We performed 164 oncological surgeries from November 2009 to June 2011. The surgeries performed included thoracic, colorectal, hepatobiliary, gynaecological and urological system. We could complete 163 cases robotically. We share our initial experience of robotic surgery in oncology with comparison with other series.

Keywords Robot · Oncology · Thoracic · Colorectal · Hepatobiliary · Gynaeconcology · Urology

Introduction

Minimally invasive surgery was introduced more than 15 years ago. Laparoscopy changed surgical outlook from “big surgeon, big incision” to the “best surgeon, no incision.”

Despite the advantages of laparoscopic surgery limitations such as learning curve, the lack of propioception, spatio-temporal awareness and haptic feedback, the compromise of hand eye co- ordination, the restricted degree of movement and lack of correct ergonomics for surgeon prevented its widespread adoption in oncology.

In order to maintain the advantages of minimally invasive approach but to avoid the restrictions of laparoscopic surgery, robotic surgery is emerging as a reliable surgical option that can achieve the same results of laparoscopic surgery.

The first robotic surgery was performed in 1988 [1]. Robotic system was used mainly for prostatic surgery and in the field of thoracoscopic beating heart surgery [2]. Robotic surgery facilitates the advantages of open surgery while refining the minimally invasive techniques. Robotic surgery techniques claim to overcome the difficulties encountered in traditional laparoscopic surgery and thus broaden the indications of minimally invasive surgery or atleast make difficult minimally invasive surgical procedures easier [3–7].

Materials and Methods

Three Arm Da Vinci robot system (Intuitive surgical) was introduced in Galaxy Care Laparoscopy Institute in November 2009.

We performed 164 oncological surgeries from November 2009 to June 2011. The surgeries performed included thoracic, colorectal, hepatobiliary, gynaecological and urological system.

The preoperative work up was the same as any laparoscopic oncosurgical procedure. The procedures were performed by a team of surgeons with extensive experience in advanced laparoscopy. Case selection criteria were same as that of laparoscopic procedures.

Informed written consent for conversion to laparoscopy or open surgery was taken in all the cases.

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Three robotic ports along with 2 or 3 accessory ports were used. The accessory ports were used for suction, retraction, laparoscopic energy sources and for applying vascular clips when required.

We compared the total duration of surgery, docking time, blood loss, complications, hospital stay and oncological clearance with published laparoscopic and robotic series.

Results (Table 1)

Transthoracic Esophagectomy

Robotic transthoracic esophagectomy was performed in prone position. 4 ports were used, 3 robotic ports and one assistant port. The mean thoracic operative time was 100 min (80–160 min). 40 patients underwent robotic transthoracic esophagectomy. No patient required conversion either to thoracoscopy or thoracotomy. The average blood loss was 80 ml (range 40–200 ml). The mean mediastinal lymph node yield was 20 nodes (10–28 nodes). The complication rate was 20% (8 out of 40). 3 cases of chyle leak, 3 cases of anastomotic leak, and 2 patients developed recurrent nerve palsy. The patients of recurrent nerve palsy developed respiratory complications. All the complications were managed conservatively. The median hospital stay was 9 days (range 5–20 days).

Colorectal Malignancies

Out of the 37 patient, 3 patients underwent right hemicolectomy, 33 patients anterior resection and 1 patient abdomino perineal resection robotically. For all pelvic surgeries 5 ports were used 3 robotic and 2 assistant 10 mm ports. Foot end docking was done for abdomino perineal resection and anterior resection. Right lateral docking was done for right hemicolectomy. All the patients had T2-T3 tumors. None of the patients with rectal cancer had preoperative chemotherapy or radiotherapy. Blood loss was 100 ml (50 ml–250 ml). Mean operative time was 160 min (120–240 min) for anterior resection and abdomino perineal resection, 80 min (60–100 min) for right hemicolectomy. There was no conversion to laparoscopy or open surgery. These surgeries were robotic assisted as stapling and anastomosis were done laparoscopically. The median hospital stay was 6 days (5–10 days). Only 2 patients had minor anastomostic leak (5.4%). Both cases were managed conservatively.

Table 1 Over view of robot—assisted oncological procedures

Esophagus	Transthoracic esophagectomy	40
Colorectal	Anterior Resection	33
	Abomino Perineal Resection	01
	Right hemicoloectomy	03
Hepatobiliary	Radical completion Cholecystectomy	02
Urology	Radical prostatectomy	20
	Radical nephrectomy	10
	Radical cystoprostatectomy	10
Gynaecology	Radical hysterectomy	35
	Anterior exenteration	10
Total		164

Hepatobiliary

Two patients of completion radical cholecystectomy were performed robotically. The robot was docked from the right lateral side. 5 ports were used and both cases were completed robotically. Lymph node yield was 20 nodes. Segment IV B was removed along with Gall bladder fossa liver bed.

Urological

We have performed 20 cases of robotic radical prostatectomies (RRP). Robotic radical prostatectomy is rapidly gaining acceptance in the urological community as safe and efficacious treatment option for localized prostatic adenocarcinoma with comparable oncological outcomes as open and laparoscopic counterparts [8–10]. We perform robotic radical prostatectomy by intraabdominal retropubic approach. Mean operative time was 130 min (80–160 min). No intraoperative transfusion was required. No conversion or post operative morbidity was seen. 85% patients have normal erectile function while 90% are continent at 1 year.

10 cases of radical nephrectomy and 10 cases of radical cystoprostatectomy were performed robotically. We had to convert one case of radical nephrectomy from robotic to laparoscopy because of renal vein bleed. Pruthi et al. [11] found that robotic assisted radical cystoprostatectomy had a longer operative time than open radical cystoprostatectomy (4.2 vs 3.5 h) but there was no significant difference in postoperative complication rate and mean hospital stay. The mean operative time in our cases was 160 min (140–180 min). Urinary diversion was performed extracorporeally.

Gynecological

35 patients underwent robotic radical hysterectomy by “pune technique” [12], with no conversion to laparoscopy. The median duration of surgery was 118 min (range 90–300 min). The median number of pelvic lymph nodes removed was 30 (16–38). The average distal vaginal margin was 2.5 cm (2.4–3.8 cm) (Table 2). The average paracervical clearance was 3.5 cm.

Table 2 Results of robotic radical hysterectomy

Time taken	118 min (90–300 min)
Blood loss	50–100 ml
Conversion	Nil
Nodes	30 (16–38)
Vaginal margin	2.5 cm (2.4–3.8)
Paracervical clearence	3.5 cm

Robotic anterior exenteration was performed in 10 patients who had received neo adjuvant treatment but had residual disease. The mean operative time (without urinary diversion) was 180 min (154–240 min). We were able to achieve a clearance of 3 cm and a distal vaginal margin of 2 cm with mean harvested nodes of 24.

Discussion

The three arm Da-Vinci robot was installed in Galaxy Care Laparoscopy Institute, Pune, India in November 2009. Before we embarked on to robotic surgeries we were performing advanced laparoscopic oncological procedures. The benefit of the robot lies in seven degrees of freedom due to the intra abdominal articulated instruments, 3–D vision, better alignment of eye hand instruments, recovery of control of camera by surgeon and downscaling the amplitude of motions and eliminating tremor [13].

When we began robotic surgery we duplicated patient and port position of laparoscopy. During the course of various robotic surgeries we realized that the robotic ports are unforgiving. This is in contrast to laparoscopic ports which allow one to operate in all quadrants by shifting the screen and surgeon position. In contrast robotic ports allow surgery only in one region. The position of patient and placement of robotic trocars has to be in such a way to prevent collision of robotic working arms and accessory ports. We have devised our own rules. We place the accessory two robotic arm ports at 10 cm lateral and then 5 cm caudal to the camera ports. The accessory ports for the assistants have to be placed cranial to the camera port. This increases the distance to be covered by the assistant's instruments and hence longer laparoscopic instruments are needed. It is impossible to change the ports without undocking the robot. The accessory ports were 11 mm ports which were used for retraction, energy sources (harmonic, ligasure) or for applying clips. The preoperative planning helps in performing a smooth procedure as well as reducing the docking time.

Thoracic

We are proponents of performing thoracoscopic esophagectomy in lateral position [14]. But we realized that lateral position in robotic caused clashing of instruments hence we adopted the prone position. Our results were comparable to Hillegersberg et al. [15] (Table 3). As we had experience with both thoracoscopic esophagectomy and robotic esophagectomy ergonomically better reducing the surgeon's stress. Supra azygous dissection, azygous preservation and nodal clearance were better robotically. The magnification, three dimensional view and seven degree of movement lead to better dissection and less blood loss. Randomized trials are needed to compare thoracoscopic and robotic esophagectomy.

Colorectal

Laparoscopic colectomy was described in 1991, but it has still not become mainstream [16]. TME, the gold standard procedure for rectal cancer was popularized by Heald [17], requires meticulous dissection. The complex anatomy of pelvis, restricted space and visibility, diminished dexterity of laparoscopic instruments makes laparoscopic TME challenging. In robotics three dimensional stereoscopic view, stable camera, 7° of motion facilitates dissection of inferior mesenteric vessels, autonomic nerve preservation, rectal mobilization, dissection in narrow pelvis and suturing. But robotics are difficult to apply in surgeries involving more than 2 discrete quadrants as repeated

Table 3 Comparison of robotic transthoracic esophagectomy

	Hillegersberg et al. robotic TE	Puntambekar et al. robotic TE	Puntambekar et al. thoracoscopy TE
No of patients	47	37	112
Conversion	07	00	00
Recurrent palsy	19%	5.4%	3.5%
Respiratory complications	45%	5.4%	7.14%
Anastomotic leak	21%	8.1%	2.67%
Lymph nodes (mediastinal)	29(8–68)	20(9–28)	20(7–30)
Median blood loss	250 ml(000–800)	80 ml(40–200)	200 ml(30–1000)
Thoracoscopic time	180 min(120–240)	100(80–160)	85(40–120)

docking and changing of ports is not only cumbersome but also time consuming. Thus making applicability of robot to procedures like extended right hemicolectomy, total proctocolectomy is not possible.

Hepatobiliary

Our experience of use of robot in hepatobiliary is limited. During radical completion cholecysystectomy the robot achieved precise dissection and safety of working close to the major vessels in porta. The nodal retrieval was the same as that we achieved by laparoscopy. We have not performed Whipple's procedure robotically though we have done 50 laparoscopic Whipple's.

Urological

The Da-Vinci robot is helpful for reserving bladder neck and neurovascular bundles and the Endowrist allows simplification of performing urethral anastomosis.

Patel et al. [1] compared results in laparoscopic radical prostatectomy and robot- assisted radical prostatectomy (RARP) and concluded that functional and oncological results were similar in both groups but blood loss was less in RARP group. They reported that at 1 year of follow up 71% patients had normal erectile function while 97% were continent. Our results are comparable to these series.

There have been initial series in application of robot for radical nephrectomy [18, 19]. We had to convert one case of robotic radical nephrectomy to laparoscopy due to renal vein bleeding. The undocking of the robot in such emergency situations can be disconnected and procedure completed laparoscopically hence passing the advantage of minimal invasive surgery to the patient. This is where experience of laparoscopy is a must.

Radical cystoprostatectomy is the gold standard surgical treatment of invasive bladder cancer but is associated with significant co morbidity. Initial results with robotic radical cystectomy have demonstrated that it is feasible and associated with low co morbidity due to reduced blood loss. The biggest advantage in performing Robotic radical cystoprostatectomy, is the preservation of good length and membranous urethra. This is essential if one is planning to do neobladders. In all the 10 patients, our choice of diversion was struder neobladder. This was performed extracorporeally and then anastomosed to the urethra robotically. There was no leak in all these patients and all have excellent day time continence.

Gyneconcology

We have reported our experience of laparoscopy gynaecologic oncology procedures including radical hysterectomy, anterior exenteration and total pelvic exenteration [20–22]. We described laparoscopic radical hysterectomy in six steps and termed "Pune technique" [20]. The docking time was initially 30 min which later reduced to 10 min because of standardization of ports, team gaining experience and becoming acquainted with the system. We operated the first few cases using monopolar and bipolar energy sources which were available with the robotic technology. We had two ureteric fistulae due to lateral spread of current. Both cases were managed by cystoscopic double J stenting. We realized that combing laparoscopic energy sources would lead to a safer and faster procedure. This is the "Hybrid technique". The immediate oncological outcomes were comparable to our laparoscopic series. (Table 4)

The role of anterior exenteration for advanced and recurrent pelvic cancers has changed from palliative to curative modality. We have reported the feasibility and oncological safety of laparoscopic anterior exenteration [21]. We realized that laparoscopy has limitations due to surgeon and patient factors. The patient factors include high BMI, narrow pelvis and bulky tumors. The main limiting surgeon factors are individual skills and team. A few robotic exenteration have been reported in literature but have shown long operative hours [23]. In our series the mean operative time was 180 min. this reduction in operative time was because of extensive open and laparoscopic experience, hybrid technique, standardization of steps and team effort. The main goal in these procedures is to achieve a negative pathological margin of resection. We were able to achieve a comparable parametrial, distal vaginal margin and adequate nodal clearance. The blood loss was less due to 3-d vision resulting in lower morbidity. Thus robotic anterior exenteration is feasible with adequate oncological clearance.

Conclusion

The purpose of introduction of robotics is to broaden the indications of minimal invasive surgery and to make difficult

Table 4 Comparison with our series of laparoscopic radical hysterectomy

Method	Blood loss (ml)	Time (min)	Lymph nodes	Vaginal margin	Paracervical clearance	Hospital stay
Laparoscopic	150–500	65–120	18(14–30)	3.5+	3.5+	3–6
Robotic	50–100	95–300	30(18–38)	2.5–3.8	3.0–3.5	1–3

procedures easier to perform. In oncology the most important factor is oncological clearance which translates into survival benefits. The initial experience of use of robotics in various oncological procedures, have shown comparable results with laparoscopy. Randomized control trials will help to decide gold surgical standard of various solid tumors.

References

1. Patel HRH, Amodeo A, Joseph JV (2009) Robotic oncological suregry: technology that's here to stay? Int J Adv Robotic Syst 6 (3):161–168
2. Falk V, Moll FH, Rosa DJ et al (1999) Transabdominal endoscopic computer—enhanced coronary artery bypass grafting. Ann Thorac Surg 68:1555–1557
3. Cadiere GB, Himpens J, Germany O et al (2001) Feasibility of robotic laparoscopic surgery: 146 cases. World J Surg 25:1467–1477
4. Marescaux J, Smith MK, Folscher D et al (2001) Telerobotic laparoscopic cholecystectomy: initial clinical experience with 25 patients. Ann Surg 243:1–7
5. Guillanotti PC, Coratti A, Angelini M et al (2003) Robotics in general surgery: personal experience in a large community hospital. Arch Surg 138(7):777–784
6. Talamini MA, Chapman S, Horgan S, Melvin WS (2003) A prospective analysis of 211 robotic assisted surgical procedures. Surg Endosc 17:1521–1524
7. Ballantyne GH (2002) Robotic surgery, telerobotic surgery, telepresence and telemonitoring. Review of early clinical results. Surg endosc 16(10):1389–1402
8. Colho RF, Rocco B, Patel MB, Orvieto MA et al (2010) Retroubic, laparoscopic, and robot assisted radical prostatectomy: A critical review of outcomes reported by high volume centers. J Endourol 24:2003–15
9. Menon M, Hemal AK (2004) Vattikuti Institute prostatectomy: a technique of radical prostatectomy: experience in more than 1000 cases. J Endourol 18:611–9
10. Menon M, Bhandari M, Gupta N, Lane Z et al (2010) Biochemical recurrence following robot- assisted radical prostatectomy: analysis of 1384 patients with a median 5 year follow up. Eur Urol 58:838–46
11. Pruthi RS, Nielsen ME, Nix J et al (2010) Robotic cystectomy for bladder cancer: surgical and pathological outcomes in 100 consecutive cases. J Urol 183:510–4
12. Puntambekar SP, Agarwal GA, Joshi SN, Rayate NV, Puntambekar SS, Sathe RM (2010) Robotic radical hysterectomy: applying principles of the laparoscopic Pune technique. J Robotic Surg 4:259–264
13. Hubens G, Ruppert M, Balliu L, Vaneerdeweg W (2004) What have we learnt after two years working with Da Vinci robot system in digestive surgery? Acta Chir belg 104:609–614
14. Puntambekar SP, Agarwal GA, Joshi SN, Rayate NV, Sathe RM, Patil AM (2010) Thoracolaparoscopy in the lateral position for esophageal cancer: the experience of a single institution with 112 consecutive patients. Surg Endosc 24(10):2407–14, Epub 2010 Mar 5
15. van Hillegersberg R et al (2006) First experience with robot-assisted thoracoscopic esophagolymphadenectomy for esophageal cancer. Surg Endosc 20:1435–9
16. DE Stein (2006) Minimally invasive surgery for colorectal cancer —an update. Surg Oncol 73–75
17. Heald RJ, Husband EM, Ryall RD et al (1986) Recurrence and survival after total mesorectal excision for*rectal cancer*. Lancet 1 (8496):1479–1482
18. Permpongkosol S, Chan DY, Link RE, Jarrett TW, Kavoussi LR (2005) Laparoscopic radical nephrectomy: long-term outcomes. J Endourol 19(6):628–33
19. Klingler DW, Hemstreet GP, Balaji KC (2005) Feasibility of robotic radical nephrectomy—initial results of single-institution pilot study. Urology 65(6):1086–9
20. Puntambekar SP, Palep RJ, Puntambekar SS, Wagh GN, Patil AM, Rayate NV, Agarwal GA (2007) Laparoscopic total radical hysterectomy by the Pune technique: our experience of 248 cases. J Minim Invasive Gynecol 14(6):682–9
21. Puntambekar SP, Palep RJ, Puntambekar SS, Wagh GN, Patil AM, Rayate NV, Agarwal GA (2006) Laparoscopic pelvic exenteration for advanced pelvic cancers: a review of 16 cases. Gynecol Oncol 102:513–516
22. Puntambekar SP, Agarwal GA, Puntambekar SS, Sathe RM, Patil AM (2009) Stretching the limits of laparoscopy in gynecological oncology: technical feasibility of doing a laparoscopic total pelvic exenteration for palliation in advanced cervical cancer. Int J Biomed Sci 5(1):17–22
23. Magrina JF, Zaagnolo VL (2008) Robotic surgery for cervical cancer. Yonsei Med J 49(6):879–885