Complications of robotic assisted radical prostatectomy

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Abstract

Objectives Robotic radical prostatectomy claims optimal oncologic results, minimal morbidity and best outcomes of urinary continence and erection function. Potential benefits concerning side effects and complications compared to open radical prostatectomy are analysed.

Methods Out of 450 robotic radical prostatectomies performed, the last 210 patients aged 64 (41–78), PSA of 7.2 ng/ml (0.6–75) and body mass index of 27 (20–37) were assessed in detail using the Clavien’s classification of surgical complications. In addition, a retrospective Medline based meta-analysis of 4,928 patients from eight centres involved was performed and compared to published data of open retropubic radical prostatectomy.

Results In total 55/210 (26%) of the patients had complications, whereof 48/55 (87%) were minor (Clavien’s grade I–IIIa). Complications (IIIb and IVa) with open reoperations occurred in 7/210 (3%) of the patients including three bleedings, two incarcerated small bowels, one perforation of a sigmoid diverticle and one trocar hernia. No IVb or V complication occurred. Overall robotic complication rate is very low and appears to be even less than in open series. Minor and major complications seem to decrease after 200 individual console surgeries.

Conclusions Robotic radical prostatectomy has proven to be a safe and reproducible surgical treatment with low morbidity. We encourage further trials using the same classification of complications to evaluate the morbidity of robotic prostatectomy conclusively in the near future.

Keywords Complications · Prostatectomy · Robotic prostatectomy · da Vinci-Prostatectomy

Introduction

During the past 20 years radical prostatectomy has undergone major technical development [1, 2]. The improved understanding of functional anatomy and impact of early cancer diagnosis operative techniques, has changed the reputation of radical prostatectomy of being an non curative extremely invasive procedure with huge blood loss and high incontinence and impotence rates. Today, radical prostatectomy is performed by open retropubic and perineal access, by conventional laparoscopic and robotic approaches. The development of minimally invasive laparoscopic techniques has had a profound impact on urology in the last decade. Despite numerous patient-related advantages for many minimally invasive procedures, laparoscopic techniques are often more difficult to perform than corresponding tasks in open surgery. Indeed, the technical learning curve for minimally invasive laparoscopic techniques can be very steep. Laparoscopy can impose limitations on instrument manipulation (secondary to trocar positioning), dexterity (secondary to long non-articulated instruments), tissue palpation (lack of haptic interface) and vision (two-dimensional on flat screen). Robotic surgery has been developed to increase operative precision, decrease the learning curve and thereby increase the clinical applicability of minimally invasive laparoscopic techniques. Since the introduction of surgical robots, a rapid technologic evolution has been witnessed in urology. Today, robotic radical prostatectomy is the fastest evolving technique to treat localized prostate cancer. The principally used robotic system, the “da Vinci”-master-slave-telemanipulator, is manufactured by Intuitive Surgical®.
Sunnyvale, CA, USA. In 2007, about 60–70% of all radical prostatectomies in the US were performed by assistance of the “da Vinci” surgical system (personal communication, Intuitive Surgical). Beside reported excellent oncologic and functional results of robotic radical prostatectomy [3–7], the urological community is interested in the complication rate of this new technique. Conclusive and standardized reports of robotic prostatectomy series are rare. This paper reviews the potential complications of robotic radical prostatectomy in our own series as well as including the currently available literature data.

Materials and methods

Intraoperative complications and perioperative morbidity of patients undergoing robotic radical prostatectomy are analysed. We report the complications in our own experience in 210 cases from September 2005 to October 2007 that were classified according the Clavien-system [8]. Two console surgeons performed the surgeries, whereof one had completed 200 previous console surgeries (HJ) and assisted the second, previously laparoscopically trained surgeon (JLF) procedures until he felt comfortable. In addition, Medline-collected published data of 4,928 patients in eight institutions reporting complication-rates after robotic prostatectomy were added [3, 6, 9–11]. An objective complication scoring is difficult and inhomogenously applied in all study protocols. The best classification is probably the one described by Clavien and Collegues [8, 12]. Briefly, the Clavien system is divided into five grades. While grade I deviates from the normal postoperative course without any therapeutic changes, grade II needs pharmacological and/or bedside treatment, grade III endoscopic or open surgical intervention, grade IV is a life-threatening problem and grade V death. Medical complications are divided in vascular injuries and bleeding, bowel complications, urinary tract problems and device associated malfunctioning.

Results

In total, we observed in 55/210 (26.1%) of the patients complications according to the Clavien-classification I–IVa (Table 1). They had a median age of 64 years (41–78), a total PSA of 7.2 ng/ml (0.6–75) and a body mass index of 27 (20–37). Minor complications (grade I and II) were observed in 17.6% and major complications (grade III and IVa) in 8.5% of the patients. There was no grade IVb or grade V complication. Grade I complications occurred in 24/210 (11.4%), grade II in 13/210 (6.2%), grade III in 11/210 (5.2%), grade IVb in 4/210 (1.9%) and IVa in 3/210 (1.4%). Out of the 55 complications, 24/55 (44%) were classified as grade I, 13/55 (23.6%) as grade II, 15/55 (27.3%) as grade III and 3/55 (1.4%) as grade IVa complication (Table 1).

Bleeding

Intraoperative bleeding is generally a minor problem in robotic laparoscopic urology due to the elevated intra-abdominal pressure by the CO₂-insufflation. In our series, we observed five symptomatic abdominal wall hematomas that resolved spontaneously (Table 1). Most papers report blood loss between 100 and 300 ml. Blood transfusion rate is between 0 and 1% [3, 6, 9, 10]. In this series, the transfusion rate was 1% (Tables 1, 2). Postoperative hematomas resolve often spontaneously—urinary retention due to retrovesical hematoma is rarely observed in our series once (Fig. 1).

Table 1 Complications of 210 robotic prostatectomies according the Clavien’s classification (adapted from Dindo [8])

<table>
<thead>
<tr>
<th>Clavien</th>
<th>Number</th>
<th>Percentage (%)</th>
<th>Frequency (%)</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>24</td>
<td>43.6</td>
<td>11.4</td>
<td>Thirteen prolonged catheterization, five abdominal wall hematomas, four lymphoceles, two umbilical wound infections</td>
</tr>
<tr>
<td>Grade II</td>
<td>13</td>
<td>23.6</td>
<td>6.2</td>
<td>Five symptomatic urinary infections, two subileus, two blood transfusions, two septic venous catheter infections, one epididymitis, one balanitis</td>
</tr>
<tr>
<td>Grade III</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade IIIa</td>
<td>11</td>
<td>20.0</td>
<td>5.2</td>
<td>Seven lymphoceles with percutaneous drainage, two abdominal wall hematomas with percutaneous drainage, one anastomotic stricture, one mental stenosis</td>
</tr>
<tr>
<td>Grade IIIb</td>
<td>4</td>
<td>7.3</td>
<td>1.9</td>
<td>Two open revision due to bleeding, one trocar hernia, one abdominal wall hematoma with open revision</td>
</tr>
<tr>
<td>Grade IV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade IVa</td>
<td>3</td>
<td>5.5</td>
<td>1.4</td>
<td>Two incarcerated small bowel hernia, whereof one bowel resection (intensive care), one sigmid diverticula perforation (day 7), colon resection (intensive care)</td>
</tr>
<tr>
<td>Grade IVb</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>–</td>
</tr>
<tr>
<td>Grade V</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>–</td>
</tr>
</tbody>
</table>
Lymphoceles

Out of 11 documented lymphoceles, seven had to be percutaneously drained in this series (Table 1). Lymphocele formation is described between 0.1 and 5% and depends on the grade of lymph node dissection and operative approach (Tables 1, 2, Fig. 2). Extraperitoneal access may facilitate lymphatic collections. Extended lymph node dissection has a higher risk to produce larger lymphatic collections than standard lymphadenectomies. Lymphoceles need to be drained, if further vascular (deep vein thrombosis) or inflammatory complications occur.

Intestinal injuries

Subileus and delayed small bowel function may happen more frequently after transperitoneal access, the presence of chemoperitonitis due to urinary extravasation, bleeding or peritoneal CO₂-irritation. Colon injuries include perforations of the cecum or descendent colon and rectal injuries itself and are occasionally reported in <1% of the cases [3, 6, 9, 10]. Rectal injuries may occur with large prostates or in the presence of inflammatory and scarred tissue between the anterior rectal wall and the Denonvillier’sche fascia. If a rectal injury is recognized, the lesion may be sutured in two layers without consequences (Fig. 3). Two out of two hundred and ten (1%) patients had rectal suture in our series without any adverse effect of the injury in the postoperative course. Dangerous complications are unrecognized colon- and small intestinal lesion leading to peritonitis and life-threatening situations. Occasionally, a small bowel sling can incarcerate in patients after extraperitoneal access and peritoneal fenestration (Fig. 4), which happened once in our series. In another patient, small bowel resection and intensive care treatment were necessary after transperitoneal access due to an incarcerated small bowel hernia. Finally, one patient with transperitoneal approach and known chronic diverticulosis had laparotomy 7 days postoperatively due to a sigmoid diverticula perforation, needing colon resection and intensive care treatment (Table 1).

Table 2 Intraoperative and early complications after open and robotic radical prostatectomy

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>N</th>
<th>Blood transfusion (%)</th>
<th>Small bowel (%)</th>
<th>Colon (%)</th>
<th>Ureter (%)</th>
<th>Iliac vessel (%)</th>
<th>Lymphocele (%)</th>
<th>Infection (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open retropubic prostatectomy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dillioglugl et al. [17]</td>
<td>1997</td>
<td>472</td>
<td>NA</td>
<td>3.2</td>
<td>0.6</td>
<td>0.2</td>
<td>1.1</td>
<td>2.2</td>
<td>7.3</td>
</tr>
<tr>
<td>Catalona et al. [1]</td>
<td>1999</td>
<td>1,870</td>
<td>NA</td>
<td>NA</td>
<td>0.05</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Lepor et al. [21]</td>
<td>2001</td>
<td>1,000</td>
<td>NA</td>
<td>0.2</td>
<td>0.5</td>
<td>0.1</td>
<td>NA</td>
<td>0.1</td>
<td>NA</td>
</tr>
<tr>
<td>Augustin et al. [19]</td>
<td>2003</td>
<td>1,243</td>
<td>29</td>
<td>0.1</td>
<td>0.4</td>
<td>0.3</td>
<td>2.9</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Hisasue et al. [18]</td>
<td>2004</td>
<td>123</td>
<td>65</td>
<td>NA</td>
<td>4.6</td>
<td>0.8</td>
<td>NA</td>
<td>5.7</td>
<td>14</td>
</tr>
<tr>
<td>Robotic radical prostatectomy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hu et al. [10]</td>
<td>2006</td>
<td>322</td>
<td>1.6</td>
<td>2.9</td>
<td>0.6</td>
<td>0.3</td>
<td>NA</td>
<td>0.9</td>
<td>1.9</td>
</tr>
<tr>
<td>Ahlering et al. [9]</td>
<td>2006</td>
<td>1,130</td>
<td>0.3</td>
<td>1</td>
<td>0.5</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0.2</td>
</tr>
<tr>
<td>Patel et al. [6]</td>
<td>2007</td>
<td>500</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Badani et al. [3]</td>
<td>2007</td>
<td>2,766</td>
<td>1.5</td>
<td>0.2</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Present series</td>
<td>2008</td>
<td>210</td>
<td>1.0</td>
<td>1.0</td>
<td>0.5</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

\* Small bowel and colon
Urinary complications

Urinary complications are rare but require proper management. Ureteral injuries occur very rarely in lower than 0.5%, however, they need open revision in most cases. Ureteral injuries might happen during extended lymphadenectomy or during bladder neck dissection in large prostates or median lobes. We had no ureteral complications. Prolonged trans-urethral catheterization was observed in 13/210 (6.5%) of our patients. Urinary leakage is reported in up to 8% [10] If a urethral leakage is drained appropriately, it resolves without additional intervention—especially after extraperitoneal approach [13, 14]. Symptomatic anastomotic strictures in 1/210 (0.5%) as a late complication are rare after robotic radical prostatectomy and are described in 0–1.4% in the literature (Table 3).

Intraoperative robotic malfunction and conversion

In 2/210 (1%) cases robotic arm failure was experienced in this series. The operation were finished by conventional laparoscopic technique. Worldwide device failures so far have been described in 168 cases, whereof 58% underwent open conversion [11]. Only 4.8% of all robotic failures had an associated patient injury. Instrumental control system and monopolar scissors most often were the malfunctioning parts in 80%. Other groups have reported a failure rate between 0.9 and 2.6% [15, 16].

Discussion

Robot assisted radical prostatectomy has gained widespread acceptance in the urological community. Robotic technology provides the surgeon with movements similar to those of the human wrist including tremor elimination and three-dimensional view as main potential technical benefits. Appropriate use in skilled hands provides excellent functional and oncologic results [3, 4, 6]. Robotic radical prostatectomy is quickly becoming the preferred operative way to manage localized cancer. The da Vinci system is estimated to have been used worldwide in more than 100,000 procedures [11]. While best outcomes are well documented in the literature, complications are reported inhomogenously. Complications associated with laparoscopic access, the radical prostatectomy itself and technical robot system failures can have a significant impact on morbidity, hospital length and morbidity. A conclusively widespread used complication reporting system is lacking. Furthermore institutions have an interindividual reality to judge and report minor or major
complications. The Clavien classification [12], a comprehensive complication classification system classifying five grades of severity, has been used so far only by one group [3]. They found in 2,766 patients overall a very low 13% complication rate. Blood transfusion rate was 1.5 and 0.1% of the patients had reoperations for bowel injury, port site hernia and persistent bleeding. The incidence of unscheduled postoperative visits was 5.8% (Tables 2, 3). A pluri-institutional analysis of 1,130 robotic prostatectomies showed an overall complication rate of 11.3% [9]. Only 1 (0.1%) open conversion was observed. Major complications occurred in 1.5% including rectal injuries (0.5%), bleeding (0.3%), pulmonary embolism (0.4%), deep vein thrombosis (0.2%) and myocardial infarction (0.15). Minor complications in 7.2% included acute urinary retention (2.7%), anastomotic leakages (1.9%), transient ileus (1%), blood transfusion (0.3%), wound infections (0.1%), urinoma (0.1%) and others. Late complications in 2.6% included anastomotic strictures (1.8%), hernias (0.6%) and lymphoceles (0.2%). Comparison between different operative techniques and institutions is always problematic, however, overall complication rates appear to be lower in robotic series compared to reported open prostatectomy data [1, 17–21].

Access complications

Access complications include lesions of the epigastric vessels and intra-abdominal injuries. Steep Trendelenburg position may lead to higher intracranial pressure with skin and eye edemas as well as to ischemic complications in the lower extremities—especially in long operative times during the learning curve of a team. The extraperitoneal access [4, 13, 14, 22, 23] may provide some benefits in case of small pelvis hemorrhage, urinary leak or in preventing intra-abdominal organ lacerations. No data is published so far on these known occasional potentially very severe complications, as initial patients series are often not reported by many institutions.
Intraoperative bleeding

Low intraoperative blood loss is mainly due to the intra-abdominal currently used 12 cmH₂O CO₂-pressure that maintains the exposition of the working space. It potentially benefits therefore the quality of the nerve sparing technique, the apical dissection and the anastomosis by improved visualization of the operative field. The robotic surgeon should identify and control smaller bleedings fast. In addition, the pneumo-peritoneum tamponades bleeding vessels. Large bleeders from the Santorini plexus or the prostatic fossa need to be controlled for adequate nerve sparing or suture placements. If a dislodgement of the dorsal vein suture occurs, another stitch with a small needle can clean the operative field efficiently. An increase of intra-abdominal pressure from 12 to 16 cmH₂O during the anastomotic period can be helpful. Urinary retention due to retrovesical hematoma is extremely rare (Fig. 1) and was observed once in this series. Estimated blood loss in robotic prostatectomy is reported between 50 and 500 ml [5, 6, 24] and 0% transfusion rates are published in several series [25–28]. We experienced a 1% transfusion rate. Direct comparisons between robotic (176 cases) and open retropubic prostatectomy (103 cases) at the same institution was performed by Farnham and Smith [29]. The estimated blood loss was significantly lower in the robotic group with 191 ml versus 664 ml (P < 0.001). Other open series reveal similar estimated blood loss between 600 and 1,000 ml [30].

Lymphatic complications

Lymphocele formation depends on the degree of lymphadenectomy and the access technique. As most teams worldwide perform transperitoneal access due to the historical development of laparoscopic prostatectomy, lymphoceles are very rare. The extraperitoneal approach seems to have a higher risk of lymphocele complications (Table 3). Lymphoceles may occur even more often in extendend lymphadenectomy and in well-skilled hands, as numbers of dissected lymphnodes increase in parallel with operative experience [20] (Fig. 2). In case of extended lymph node dissection, a transperitoneal access prevents this potential complication. Alternatively a peritoneal fenestration may be performed [32] in patients undergoing extended lymphadenectomy. Lymphoceles may be drained percutaneously, causing potentially significant protein and fluid loss, local inflammation and septic complications. Very rarely, small bowel herniation and even incarceration through a peritoneal window may occur, causing small bowel ileus (Fig. 4).

Intestinal complications

Small bowel injuries may occure by blind intraperitoneal manipulation of sharp instruments. The console surgeon may not always be able to control the assistant ports and instrument insertion always appropriately. Therefore, the table side surgeon has major responsibility in robotic surgery demonstrating the important team-approach in robotic urology. Colon and rectal injuries are equally dangerous if not recognized. Rectal openings occur occasionally and have to be sutured watertight in two layers (Fig. 3). The closure is controlled either by transrectal applied disinfection solution or by injected air with waterfilled small pelvis (“bubble-test”) to demonstrate a watertight anterior rectal wall suture. Non-observed rectal and colon lesions lead to fecal peritonitis, bowel deviation and possible live-threatening situations. Trocar hernias or incisional hernias, as well as small bowel incarceration are reported in less than 1% after robotic prostatectomy (Table 3, Fig. 4).

Urinary complications

Urinary complications in robotic radical prostatectomy include ureteral injuries and anastomotic problems and are described in less than 1%. Acute painful or septic hydronephrosis may occur in case of clipping/suturing the ureter or the ureteral orifice and requires nephrostomy and revision. Intra-abdominal urinoma should be drained. An extraperitoneal approach is beneficial in such situations as the urinary collection remains isolated from the intraperitoneal cavity. Retrograde or antegrade ureteral stent placement can be successful to readapt a sectioned ureter in rare cases. Vesico-urethral anastomotic leaks are minor problems and generally heal spontaneously under catheterisation. Nowadays, most groups keep the Foley catheter generally in for 6–7 days, as significant urinary retention rate is noted if the urinary catheter is removed within 3 days. Emergency transurethral catheterisation into an unstable anastomotic area may result in a retrovesical catheter placement, bladder neck contractures, urethral stricture and severe urinary incontinence (Tables 2, 3).

Robotic failures

Robotic failure and robot errors are reported between 0.4 and 3% [11, 15, 16]. Andonian et al. [11] analysed the United states Food and Drug Administration—Manufacturer and User facility Device Experience Database (FDA-MAUDE) between 2000 and 2007, assuming 50,000 robotic prostatectomies have been performed within this time. They found 168 malfunctions over this period with the da Vinci system. The rate of open conversions due to device malfunction dropped from 94% in 2003 to 16% in 2007. Mainly,
instrument control system failure occurred in 70% and monopolar curved scissors defects in 10%. General conversion rate to open is reported between 0 and 1.1% [6, 10, 31].

Impact of the learning curve

As in open surgery, robotic prostatectomy complications are influenced directly by the surgeons experience and occur more frequently within the learning curve. Several groups found a statistic reduction of minor and major complications after 200 personal interventions of a console surgeon [6, 9].

Conclusions

Robotic radical prostatectomy has proven to be a safe and reproducible surgical treatment for men with clinically localized prostate cancer with best oncological and functional outcomes in skilled hands. Although the technique is still young compared with the open prostatectomy, the complication rate is very low and appears to be even less than in open series. Further evaluations using comprehensive classifications of complications should be performed.

Conflict of interest statement There is no conflict of interest.

References

radical prostatectomy versus radical retropubic prostatectomy. Urology 67:360–363