Mechanical failure rate of da Vinci robotic system

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Introduction: *Robotic-assisted laparoscopic radical prostatectomy (RLRP) is playing an increasing role in the surgical management of prostate cancer. The benefits of minimally invasive surgery, enhanced surgeon familiarity with the instrumentation, and increased patient demand has led to the popularity of this surgical technique. There are, however, shortcomings specifically associated with this technology. Notably, instrumentation failure associated with robotic procedures represents a new and unique problem in urological surgery. We examine the rate of mechanical failure of the da Vinci robotic system and its impact on our prostate cancer program.*

Materials and methods: *We reviewed our prospective, institutional review board-approved database of the first 350 RLRP procedures that were scheduled for surgery at our institution. We identified all cases in which mechanical failure of the da Vinci robotic system resulted in surgery being cancelled, postponed, or converted to a conventional laparoscopic or an open radical prostatectomy.*

Results: *Nine of the 350 (2.6%) scheduled RLRPs were unable to be completed robotically secondary to device malfunction. Six of the malfunctions were detected prior to anesthesia induction and surgery was rescheduled. Three other malfunctions occurred intraoperatively and were converted either to a conventional laparoscopic (1 case) or an open surgical approach (2 cases). The etiology of the malfunctions included the following: set-up joint malfunction (2), arm malfunction (2), power error (1), monocular monitor loss (1), camera malfunction (1), metal fatigue/ break of surgeon's console hand piece (1) and software incompatibility (1).*

Conclusions: *Although uncommon, malfunction of the da Vinci robotic system does occur and may lead to psychological, financial, and logistical burdens for patients, physicians, and hospitals. Patients should be carefully counseled preoperatively regarding the possibility of robotic mechanical failure.*

Key Words: robotic prostatectomy, malfunction, mechanical failure, complication, prostate cancer

Introduction

Radical prostatectomy is an effective treatment for clinically organ-confined prostate cancer providing excellent long-term cancer control and recent evidence demonstrating a survival benefit over watchful waiting for patients with localized disease.[1-6] While traditionally radical prostatectomy is performed through either a retropubic or perineal incision, minimally invasive radical prostatectomy is playing an increased role in the surgical management of prostate cancer. Robotic-assisted laparoscopic radical prostatectomy (RLRP) is an available minimally invasive procedure that has become an accepted approach for radical prostatectomy surgery.

RLRP combines the potential advantages of laparoscopic technique such as shorter convalescence, decreased blood loss, and improved cosmesis with technological advances that may improve surgical outcomes. Technological advantages of robotic-assisted surgery over conventional laparoscopy include three-dimensional viewing with improved magnification, elimination of surgeon tremor through motion-scaling technology, and specialized instrumentation with wristed movements to facilitate fine, precise dissection in the limited confines of the human pelvis. While it is hoped that the advanced technology of RLRP will lead to improved oncologic control as well as improved postoperative erectile and urinary functional outcomes; these advantages have yet to be demonstrated in a controlled trial. Regardless, due to patient demand and evidence that suggests at least equivalent early outcomes

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to open radical prostatectomy, the number of RLRPs performed in the United States has rapidly increased.[7,8]

Despite the potential advantages of RLRP, there are shortcomings specifically associated with this technology. Thus far, increased cost has been the most apparent downside to utilization of the da Vinci robotic system for radical prostatectomy surgery.[9] The lack of haptics has also been criticized as a disadvantage of RLRP. During our initial experience with this technology, we have also found mechanical failure of the robotic system may be problematic. We reviewed our experience with RLRP procedures to determine the mechanical failure rate of the da Vinci robotic system and how mechanical system failure impacted our prostate cancer program from a patient, physician, and hospital perspective.

Materials and methods

We reviewed our prospective, institutional review board-approved database of the first 350 RLRP procedures that were scheduled at our institution. The device utilized in all cases was the original, three-arm da Vinci robotic system. We identified all cases in which mechanical failure of the da Vinci robotic device resulted in surgery being cancelled, postponed, or converted to a conventional laparoscopic or an open radical prostatectomy.

Results

Nine of the 350 (2.6%) scheduled RLRP procedures were unable to be completed robotically secondary to device malfunction. The etiology of malfunction included the following: set-up joint disruption (2), robotic arm malfunction (2), power error (1), monocular monitor loss (1), camera failure (1), metal fatigue/ break of surgeon's console hand piece (1) and software incompatibility (1). Six of the 9 malfunctions were detected prior to anesthesia induction (set-up disruption (2), robotic arm malfunction (2), power error, software incompatibility). In all six instances, patients were offered the choice of proceeding with an alternative radical prostatectomy technique (open or conventional laparoscopic) or postponing surgery and rescheduling the procedure. All six patients elected to reschedule their procedure. Each of the six failures were detected during the routine pre-operative testing of system integrity that occurs through both the system's self testing and by nursing calibration and evaluation prior to the patient entering the operating room.

Three malfunctions occurred intraoperatively and resulted in conversion to either a conventional laparoscopic (1 case) or an open retropubic approach (2 cases). Choice of conversion technique was dependent upon surgeon preference. The etiology for the systems failure in the three cases included: monocular monitor loss, camera failure, metal fatigue/ break of surgeon's console hand piece. There were no intraoperative complications attributable to device failure. Each patient had signed consent for possible open or laparoscopic surgical conversion.

Attempts were made to troubleshoot device difficulties with the aid of manufacturer representatives and engineers in all nine cases. In each case, the robotic system malfunction was expediently repaired and did not delay surgeries scheduled for the following day. Malfunctioning parts were repaired or replaced by the manufacturing company. In comparison to the rate of conversion of robotic cases secondary to instrumentation failure, we have converted 2 of our last 350 LRP cases (<1%) for non-technical reasons (wide spread abdominal adhesions, patient body habitus). In addition six conversions were performed early in our robotic experience (first 100 patients) secondary to failure to surgically progress.

Discussion

While robotic surgical technology offers several potential advantages for the surgical treatment of prostate cancer, this technology is not without drawbacks. Increased cost and loss of tactile feedback have been criticized as disadvantages. In addition, we have found that mechanical failure of the da Vinci robotic system can present new and unique challenges in urological surgery.

The rate of mechanical malfunction of the da Vinci robotic system requiring surgical conversion has not been closely examined. Hu et al encountered device malfunction in 0.6% of robotic cases.[10] Our rate of mechanical failures requiring conversion (2.6%) stands in contrast to typical da Vinci system intraoperative errors which are most commonly treated with fault override designations. Such events occur routinely, and do not impair the ability of the system to function. Mechanical failure of robotic technology is particularly problematic. While duplicate supplies of critical instruments are available for most surgical procedures, most hospitals have only one robotic system due to the high cost of this technology. Without the ability to readily replace the instrumentation, alternative strategies must be developed to cope with the consequences of robotic failure.

Robotic mechanical collapse is problematic for patients. If the system is found to be faulty prior to anesthesia induction, the patient has limited options.

They can choose to proceed with surgery via an open or conventional laparoscopic technique (according the skill set of their surgeon) or surgery may be postponed until the robotic system is operational. In our experience, all patients who have encountered this particular situation have chosen to postpone surgery. Besides the inconveniences of rescheduling surgery and repeating preoperative routines such as bowel preparation, the delay of cancer care could potentially result in significant psychological consequences for the patient.

When mechanical failure of the robotic device occurs intraoperatively, the procedure must be converted to an alternative technique if another robotic system is not available. Surgeons with conventional laparoscopic skills and training can complete the procedure in a minimally invasive fashion. Others will need to convert to an open surgical approach in the event of robotic malfunction. While surgical conversion is an accepted risk of any laparoscopic procedure, conversion secondary to instrumentation failure is a new issue in urological surgery and may result in higher rates of conversion when a backup device is not available.

Surgeons and hospitals also are affected by robotic device failure. Both are faced with financial concerns from non-productivity and idle operating rooms as well as logistical problems associated with rescheduling. This can add to the cost disadvantage of RLRP compared to open radical prostatectomy and should be factored into cost analyses between these two approaches.

A 2.6% mechanical failure rate requires that institutions develop systems to minimize the negative impact of this problem. Options include: obtaining additional da Vinci robotic units or employing surgeons with advanced surgical skills to enable laparoscopic radical prostatectomy to be substituted at will. Furthermore, patients should be carefully counseled preoperatively that malfunction of the robotic system during the course of a procedure is possible and can result in conversion to a conventional laparoscopic procedure or an open radical prostatectomy. Institutions also may wish to institute protocols to address the inconvenience of surgical postponement for patients.

The consequences of robotic mechanical failure are applicable to all robotic-assisted procedures. It should be emphasized that although a new problem, robotic system malfunction is not a common occurrence. Preventive maintenance along with technical support and service is essential to diminish the occurrence of robotic mechanical failure and to minimize its impact on patients, surgeons, and operating room schedules.

The major limitation of our study is that it is a small series from a single institution. However, the rate of mechanical failure is not established and, in fact, has only been reported by one other author. To our knowledge, the potential consequences of mechanical device failure have also not previously been examined. It is important to note that our results are from an experience with the original, three-arm da Vinci system and may not be applicable to newer systems that are now available.

Conclusion

Malfunction of the robotic system occurs and may result in significant psychological, financial, and logistical burdens for patients, physicians, and hospitals. Patients undergoing procedures with the da Vinci robotic system should be carefully counseled preoperatively regarding the possibility of robotic mechanical failure. □

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