Can robotic surgery conquer partial nephrectomy?

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Robot-Assisted Partial Nephrectomy (RAPN) is fast emerging as a viable alternative to its open and laparoscopic counterparts. When compared to open and laparoscopic approaches, research indicates that RAPN achieves superior outcomes in all three components of the partial nephrectomy trifecta. However, RAPN is associated with several risks and safety concerns that are exclusive to this procedure. This case report presents a seventy-year-old gentleman with unilateral Renal Cell Carcinoma (RCC) for whom a RAPN was planned but who instead underwent an open radical nephrectomy due to significant intraoperative and robotic challenges. This report encourages the critical evaluation of RAPN and emphases the importance of clinical context when deciding on an appropriate surgical modality. This case also illustrates the significance of adequate risk-assessment and mitigation with regards to RAPN and that when applied to inappropriate clinical situations, robot surgery has the potential to be detrimental to patient outcomes.

Key Words: *Partial nephrectomy; Renal cell carcinoma; Robotic assisted surgery; Robotic assisted partial nephrectomy*

INTRODUCTION

Robotic Assisted Surgery (RAS) is rapidly expanding across all surgical specialties but is most commonly being used in gynaecological and urological theatres [1,2]. RAS is associated with a range of operative and perioperative advantages but also with a unique number of risks and safety concerns [1].

With regards to RAS, the da Vinci surgical system, by Intuitive Surgical, Inc., is the world leading robotic operative system (Figure 1 and Figure 2)[3]. Due to this technology, RAPN has emerged as a viable alternative to open and Laparoscopic Partial Nephrectomy (LPN)[2]. However, there is a distinct lack of high-quality evidence comparing these surgical modalities and therefore one is not currently recommend over the other [4]. This case report uses the example of a RAPN converted to an open radical nephrectomy to critically evaluate the benefits and short-comings of RAS in a urological context.

CASE REPORT

A seventy-year-old gentleman with no urinary symptoms was seen in colorectal clinic for persistent diarrhoea. The patient was referred for abdominal CT which revelled an incidental finding of a 3.2 cm isolated renal mass in the lower pole of the left kidney. Findings were consistent with that of Renal Cell Carcinoma (RCC).

On surgical admission, the patient's blood pressure was 133/92 and blood sugar levels were 11.9 mmol/L. Full blood count, urea and electrolytes, urine microscopy and culture were unremarkable. Glomerular Filtration Rate (GFR) was normal.

During patient preparation, a 10 cm firm ballotable mass was identified in the patient's left iliac fossa. The mass was considered to be a previously unidentified rapidly growing malignancy however ultrasound confirmed that the mass was the patient's left kidney that had shifted anteriorly-inferiorly.

The patient had well controlled type two diabetes, longstanding hypertension and a family history of thromboembolic disease but was otherwise well. The joint decision to undergo a RAPN was made.

Following four hours of surgery, adequate resection of the tumour could not be achieved. This was primarily due to an inability to guarantee a positive tumour margin using the da Vinci robot.

The oncological margin concern was followed by significant intra-operative and robotic challenges including substantial perinephric scaring, poor robotic ergonomics, robotic arm failure and renal vein injury. The decision to undertake a radical open nephrectomy was subsequently made.

Figure 1) The da Vinci surgical system, by Intuitive Surgical, Inc [5].

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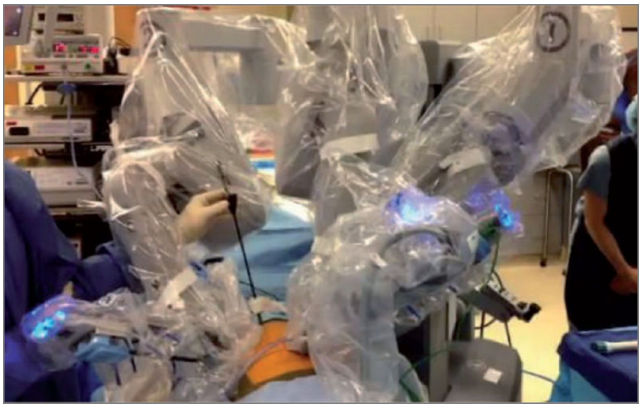

Figure 2) The da Vinci surgical system surgeon's console [5].

DISCUSSION

Robotic Assisted Partial Nephrectomy is a well-established modality for small renal mass resection [2]. When compared to open and laparoscopic partial nephrectomies, research indicates that RAPN achieves superior outcomes in all three components of the partial nephrectomy trifecta (surgical margin status, complication rate and intraoperative ischemia time) [4,5]. These factors can be considered a proxy for surgical quality [4] and therefore indicate that RAPN may be a superior surgical approach.

In contrast, the present operation should have taken less than four hours but rather it occurred over a seven-hour period and resulted in significantly worse post-operative patient outcomes as well as the complete removal of the patient's kidney and the cancelation of three other surgeries.

Warm Ischaemia Time (WIT) is generally reported as lower in RAPN[4, 5]. However, we must consider that if complications arise in robotic surgery, as they did in this case, then there is a considerably greater time delay between identification of the complication and resolution. This patient sustained a significantly greater WIT due to the time required for the surgeon to de-dock the robot, remove the ports and convert to an open radical nephrectomy. Other studies have previously reported that RAPN can be associated with greater WIT when compared to open or laparoscopy surgery (OR: 3.33; 95% CI 2.44–4.54) [4].

A further limitation of RAPN illustrated by this case is that there is little evidence of increased positive oncological margin rates [2]. In the present case, the primary reason for conversion to an open radical nephrectomy was due to an inability to adequately resect the tumour. It is possible that this could have been addressed by margin marking and identification using intraoperative ultrasound which has shown to be safe and effective in such instances [6,7]. Regardless, this brings into question whether the costs associated with robotic surgery can be justified if operative and oncological outcomes are not improved. This emphasises the importance of robotic application only with adequate imaging modalities. However, other measures such as ergonomics and patient recovery also need to be considered.

Robotic surgery not only carries the risk of human error but also introduces the possibility of mechanical error or failure. Both of which were partially responsible for the complete removal of this patient's kidney. On reflection, following the identification of the patient's anatomically shifted kidney, it would have been advisable to repeat the CT scan preoperatively as this may have indicated that a robotic approach was no longer suitable and therefore prevented the operative complications encountered.

Overall RAPN may improve surgical precision and reduce post-operative urological complications. However, these benefits are associated with significant disadvantages which raise the question as to whether RAPN is truly superior to its non-robotic counterparts. Furthermore, how sure are we of these robotic benefits? High quality comparative evidence of these surgical techniques is limited and therefore any comparative conclusions drawn cannot be considered as definite [4].

Greater consideration must also now be given to the outcomes used to compare these surgical modalities. We must contemplate whether the outcomes used to evidence RAPN's alleged superiority carry significant patient impact or not. If so, do these outweigh the increased cost, movement latency and reduced haptic feedback associated with robotic surgery? This case report does not intend to invalidate the many benefits that RAS offers urological practice but rather encourages the reader to evaluate robotic assisted urological surgery from a more critical view point.

A final point for consideration is that there is an emerging argument to suggest that urological surgeons may becoming de-skilled in laparoscopic (and open) surgery due to more time spent operating robotically [8]. This may present a problem as robotic surgery cannot always be offered due to financial, resource related, and operation-specific limitations. Therefore, as we look to the future and to the rise of robotic surgery, we must keep a watchful eye on the past to ensure that the quality of traditional urological surgery does not dwindle.

CONCLUSION

RAPN is rapidly emerging as the standard of care, not only for small renal masses, but also for complex lesions and reports several well evidenced advantages. However, these benefits are only observed when applied to appropriate clinical presentations. This case illustrates the significance of adequate risk-assessment and mitigation and that when applied to inappropriate clinical situations, robot surgery has the potential to be detrimental to patient outcomes. The urological community must now strive to identify which clinical scenarios may benefit from robotic intervention.

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