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RESEARCH

Dual robotic surgery: Da Vinci SP® and Levita® MARS (magnetic-assisted robotic surgery) platforms

Ashley N. Gonzalez[1] · Benjamin M. Eilender[1] · Jeffrey A. Cadeddu[1]

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Abstract

The applications of robotics in urology has been rapidly expanding since the introduction of the Da Vinci robotic platform in 2000. In recent years, there have been further developments in the robotic surgery space including advancements in Da Vinci's own robotic platform, the introduction of a single-port (SP®) system, as well as new competitors and adjacent technology that has come to the market. One such technology is the magnetic-assisted robotic surgery (MARS™) from Levita (Mountain View, CA). This system consists of a detachable magnetic grasper that can be placed within the body by a specialized laparoscopic instrument and manipulated from outside the body with an external magnet on a robotic arm that is surgeon controlled. Herein we describe the first dual robotic surgery employing MARS™ during an SP® transperitoneal robotic-assisted radical prostatectomy (RARP), demonstrating its feasibility and potential applications for use in single-port surgery in particular.

Keywords Robotics · Da Vinci · Magnet · Single port · Prostatectomy

Introduction

Robotic surgery continues to evolve and transform the field of surgery across specialties. The Da Vinci multiport system (Intuitive Surgical) has become the most ubiquitous robotic surgery platform in the world [1]. Initially launched in 2000, it is now on its fifth generation with significant iterative improvements since its introduction [2]. The Da Vinci SP® (single port) system consists of a single trocar that houses a fully articulating camera and three multijointed arms, offering single incision robotic surgery with potential benefits in limited spaces. In recent years, there has been a surge in development within the robotic surgery space, with both direct competitors as well as adjuncts, and applications to other fields such as ureteroscopy, bronchoscopy, and microsurgery [3–6].

Levita® founded in 2011, developed the first and only Magnetic Surgery® platform for use in minimally invasive surgery to reduce the number of port sites and improve patient recovery post-operatively. The system involves two parts, a detachable magnetic grasper which is deployed via the bedside assistant with a laparoscopic instrument, and the external magnet. The external magnet was first available through use on a post that is mounted to the operating room table and manipulated by the bedside assistant into the appropriate position throughout the case. In 2023 Levita® introduced a new platform, the magnetic-assisted robotic surgery (MARS™) which affixes the external magnet to a specialized robotic arm that can be operated by the surgeon or assistant through use of a foot pedal.

In this publication, we demonstrate the applications and limitations of MARS™ for additional retraction during a single-port robotic radical prostatectomy; to our knowledge, the first simultaneous dual robotic surgery to be performed.

Materials and methods

During a routine transperitoneal robotic-assisted radical prostatectomy (RARP) performed on the Da Vinci SP®, the DaVinci metal trocar was placed after a cutdown incision 3 cm above the umbilicus. A 12 mm assistant trocar was placed 10 cm to the left of the umbilicus. Robotic instruments included a monopolar scissor, Maryland bipolar, and Cadiere forceps. The surgical technique utilizing the Levita

✉ Ashley N. Gonzalez
Ashley.gonzalez2@utsouthwestern.edu

1 Department of Urology, University of Texas Southwestern, Dallas, TX, USA

magnet has been described in more detail by Steinberg et al. [7] In the present case, instead of the manually operated Levita magnet, the MARS™ was utilized throughout the case for retraction.

Results

Use of the MARS™ (Fig. 1) proved to be well suited in combination with the Da Vinci SP® (Fig. 2). The MARS™ was used for several key steps throughout the RARP, allowing for retraction in various orientations within the pelvis (Fig. 3) without the need for an additional assistant trocar. The low profile of the Da Vinci SP® allowed for ample space for the MARS™ to be docked alongside the SP® robotic boom. The MARS™ was used for retraction primarily in the midline pelvis and right pelvis given the placement of the assist trocar in the left lower quadrant; however, the MARS™ could also be used in left pelvis without clashing (Fig. 3D).

A total of two cases have been performed utilizing this approach. Total operative time from incision to closure was 3 h and 36 min and 3 h and 41 min in each case. No defaults or technical issues with the SP robot were noted throughout the case due to the magnet. No complications from use of MARS™ were noted including pressure injuries.

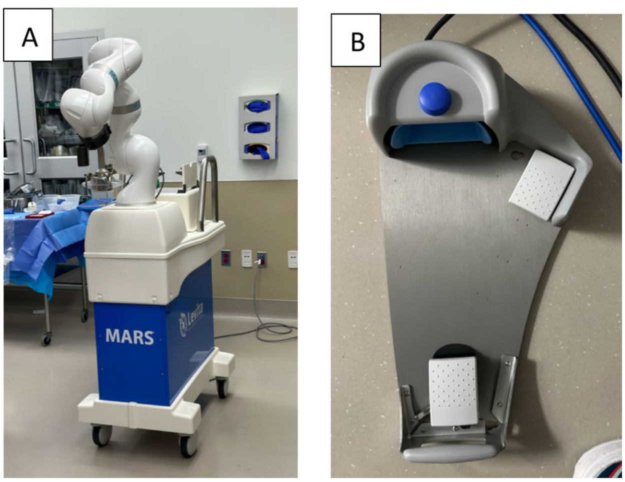

Fig. 1 **A** MARS™ system. **B** Foot pedal

Discussion

Urology has been one of the most rapid adopters of robotic technology, and robotic approaches to radical prostatectomy, renal surgery, and reconstruction have become standard practice, leading to comparable oncologic outcomes with improved recovery and functional outcomes [8]. This transformation happened largely due to the introduction of Intuitive's Da Vinci® robotic platform which has dominated the market since its introduction in 2000. Innovation and competition in recent years has led to numerous new platforms in the market, including Levita's MARS™.

To date, magnetic surgery has primarily been applied within the field of laparoscopic surgery, driven by the motivation to make procedures even less invasive and limit the number of ports required for a safe and successful operation. Such efforts have included percutaneous sutures, internal

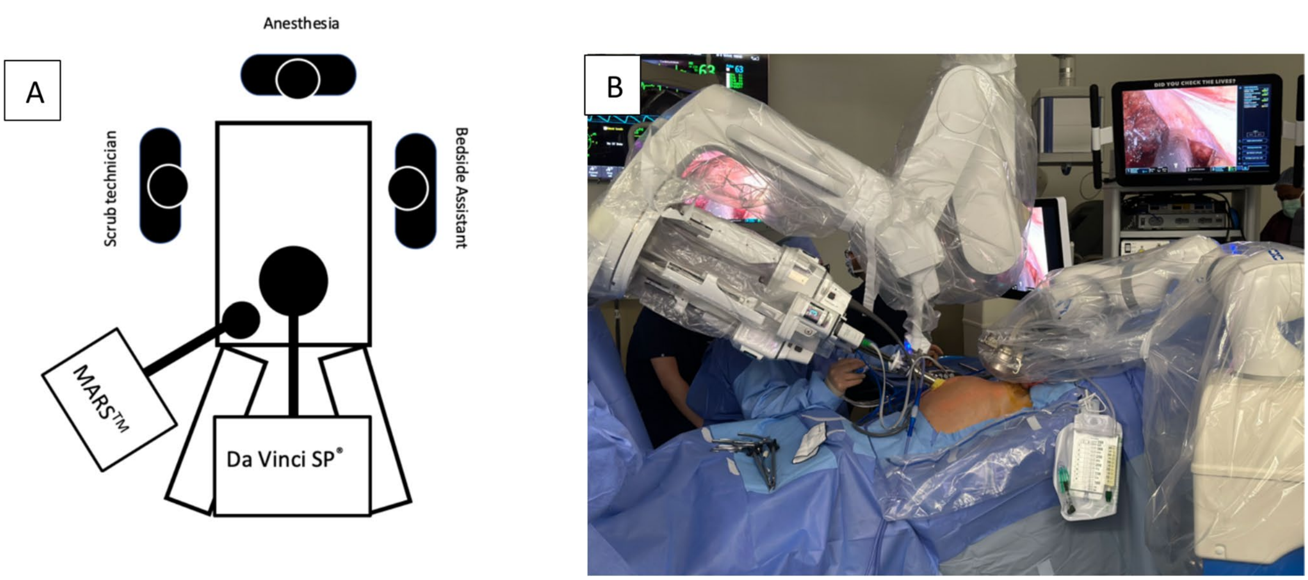

Fig. 2 **A** Operating room configuration with patient in split leg position and Da Vinci SP® docked between the legs. **B** MARS™ draped and docked to the patient's right alongside the docked Da Vinci SP®

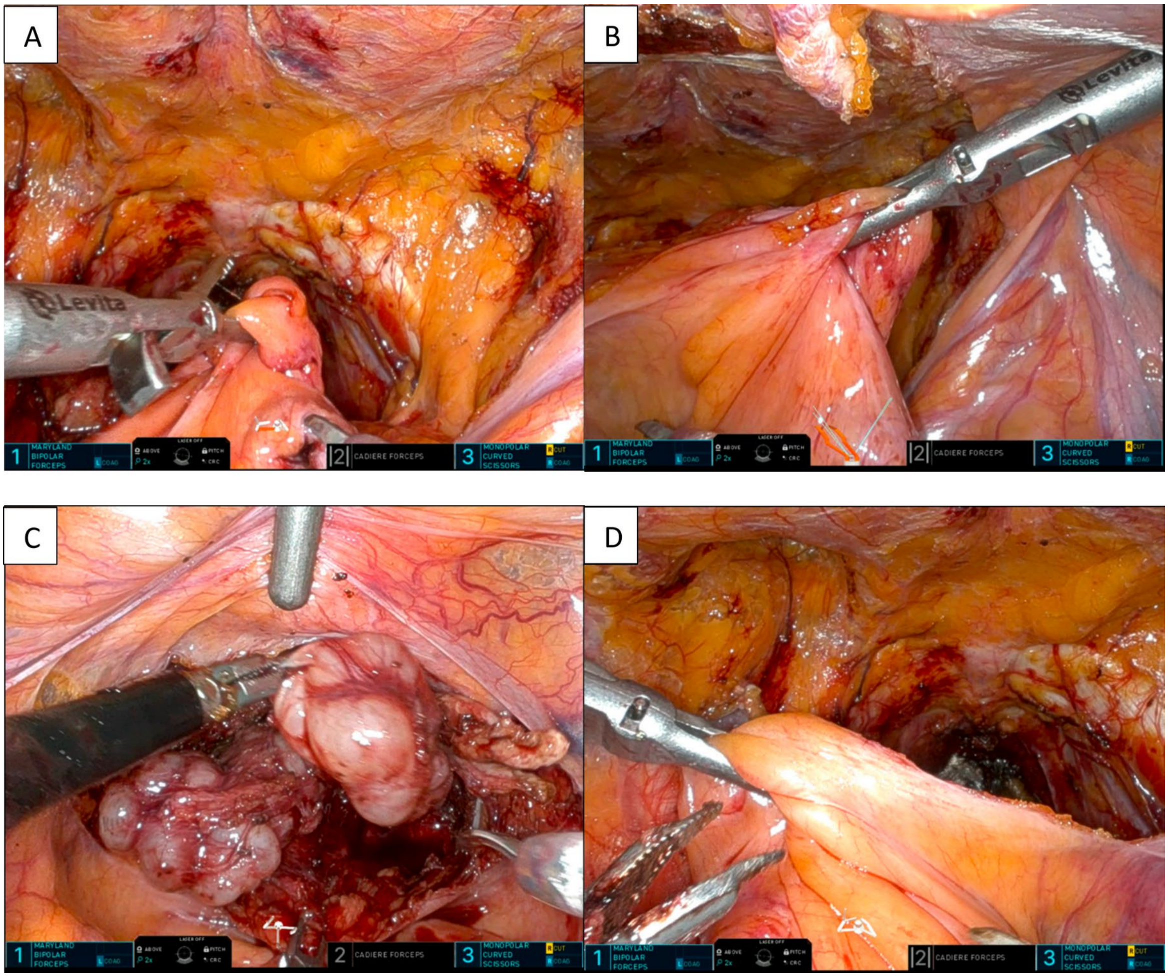

Fig. 3 **A** Magnet being deployed by laparoscopic instrument during a robotic radical prostatectomy. **B** Retracting in the direction of the patient's right hip. **C** Retracting anteriorly in the midline. **D** Retracting in the direction of the patient's left hip

retractors, and needle-sized instruments, each with varying limitations and success [9–11]. Magnetic surgery has been shown to be a feasible option for use in laparoscopic surgery and can lead to decreased post-operative pain scores and shorter length of stays compared to standard retraction measures through a port [12, 13].

With an emphasis on cosmesis, faster recovery times, and use within smaller spaces, the single-port Da Vinci system is finding an increasing number of applications across urology, including prostatectomy (radical and simple), renal surgery, reconstruction, and cystectomy, all of which have shown to be feasible with the SP® robot [14–16]. Further innovations in recent years with transvesical approaches, in which the SP® is docked directly within the bladder to avoid the peritoneal cavity and perform both simple and radical prostatectomy have also been demonstrated [17, 18]. While the design of the SP® robot and adapted tools such as flexible suction systems often obviate the need for an additional laparoscopic port, a surgeon can still expect situations to arise in which an additional assistant port for retraction may prove critical, or allow for a single-port procedure to be performed. Application of the MARS™ in these scenarios could bridge this gap between providing an additional tool for retraction without the need for an additional port site, maintaining the possibility of a truly single incision surgery. Surgeon control of the MARS™ provides further flexibility and adjustments throughout a procedure that does not rely on an assistant. Our utilization of the MARS™ during an SP® RARP is a first of its kind and shows the applicability of this tool for use in the expanding indications of single-port surgery. While we did not quantify the cosmetic outcomes in patients in this feasibility study, cosmesis is a potentially important consideration for patients undergoing single-port surgery, and the omission of an additional trocar site may be attractive.

MARS™ is not without its limitations, including cost of the single use magnetic grasper and the profile of the external magnetic arm which may not be practical for all orientations and is less practical for use in multiport procedures.

The MARS™ foot pedal (Fig. 1B) also introduced limitations as it was too cumbersome for the console surgeon to readily operate, and was ultimately delegated to the bedside assistant. We have not encountered limitations to using the magnetic system due to patient factors such as body habitus, tattoos, or implants; however, patients with pacemakers should be noted and proximity of the magnet taken into consideration peri-operatively and discussed with the anesthesia team. While not a limitation precluding its use, the magnet is notably strong and has magnetized numerous surgical instruments as well as sutures and should be considered. We attempted to use the MARS™ during a da Vinci Xi RARP (to replace the fourth robotic arm); however, the profile of the system clashed with the docked multiport robotic arms and this precluded its use during the case. Use during multiport robotic surgery is likely limited in its current form; however, further iterations with a lower profile robotic arm may overcome these limitations. In additional to a standalone system, this technology could further have applications in the integration and future development of robotic surgery platforms. Current application with single-port surgery, however, remains a feasible application of this technology as demonstrated here.

Conclusion

Magnetic-assisted robotic surgery is a useful adjunct for use in particular with the Da Vinci SP® system to allow for added retraction without the need for additional port sites.

Author contributions J.C. conceived of the work and oversaw the writing process. A.G and B.E wrote the main manuscript and prepared figures. All authors reviewed the manuscript.

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Data availability No datasets were generated or analyzed during the current study.

Declarations

Conflict of interest Jeffrey Cadeddu is a shareholder of Levita and serves on the advisory board. Ashley Gonzalez and Benjamin Eilender have no disclosures.

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