Journal of Robotic Surgery
https://doi.org/10.1007/s11701-022-01451-4

ORIGINAL ARTICLE

Implementation of robotic hernia surgery using the Versius® system

Frances Dixon[1] · Adnan Qureshi[2] · Parveen Vitish-Sharma[1] · Achal Khanna[2] · Barrie D. Keeler[1,3]

Received: 24 March 2022 / Accepted: 29 July 2022

Abstract

This case series aims to demonstrate that hernia surgery is safe and feasible using the Versius® robotic system from CMR Surgical, and to describe the surgical techniques used. It is the first series published using this novel system. Forty-one consecutive hernia repair cases were completed using Versius®, including inguinal and ventral hernias. Data were collected prospectively on a number of pre-, peri-, and postoperative outcomes. Techniques are described for robotic transabdominal preperitoneal repair of inguinal hernia, and intraperitoneal onlay mesh repair of ventral hernia. Thirty-two inguinal and nine ventral hernia repairs were performed over a 12-month period. The population were 88% male with a mean body mass index of 27.4 ± 3.5. There were no conversions to open surgery. Median length of stay was 0 days. Six patients (15%) experienced urinary retention, and there were 2 further minor complications with no major complications, readmissions or reoperations. Use of the Versius® system for robotic hernia surgery is safe, with comparable results to existing robotic systems. Implementation is possible with minimal changes to established surgical techniques.

Keywords Ventral hernia · Inguinal hernia · Robotic surgery · Implementation · Feasibility · Novel systems

Introduction

Use of robotic-assisted minimally invasive surgery is rapidly increasing in a number of surgical specialties, fuelled by perceived advantages of robotic systems including wristed instruments and three-dimensional visualisation of the operative field. One area showing particular expansion is benign general surgery, with Intuitive Surgical describing it as their fastest growth area worldwide and reporting a 34% increase in the number of general surgical procedures performed in the United States between 2018 and 2020 [1].

Hernia repair is one of the most commonly performed operations in the United Kingdom, with 100,000 performed each year [2]. Laparoscopic hernia repair has been shown to reduce postoperative pain and enable earlier return to normal activities [3], and is recommended as an option for inguinal hernia repair by both the UK's National Institute for Health and Care Excellence and the HerniaSurge International Guidelines published in 2018 [4, 5].

Robotic inguinal hernia repair was initially described as a standalone procedure in 2015, although it had been performed concurrently with prostate surgery for some years prior to that [6]. The most commonly used method is the robotic transabdominal preperitoneal repair (rTAPP), although totally extraperitoneal repair can also be performed robotically (rTEP) [7]. Both techniques are equivalent in terms of outcomes, and choice is therefore left up to the individual surgeon's discretion [5]. Complex inguino-scrotal or recurrent hernias are often considered unsuitable for laparoscopic repair, but it has been suggested that the precise dissection facilitated by robotic surgery may make it possible for these patients to also benefit from the advantages of minimally invasive surgery [8].

Rates of robotic ventral hernia repair are also increasing globally and, as reported by Mohan et al. in a recent meta-analysis, this operation has comparable outcomes to laparoscopic repair [9]. Longer operative times are offset by lower rates of conversion to open surgery.

As robotic surgery increases in popularity and utility, there are a number of new robotic systems entering the

✉ Barrie D. Keeler
Barrie.Keeler@mkuh.nhs.uk

1 Department of Colorectal Surgery, Milton Keynes University Hospital NHS Foundation Trust, Milton Keynes MK6 5LD, UK

2 Department of General Surgery, Milton Keynes University Hospital NHS Foundation Trust, Milton Keynes MK6 5LD, UK

3 University of Buckingham, Buckingham MK18 1EG, UK

Published online: 11 August 2022

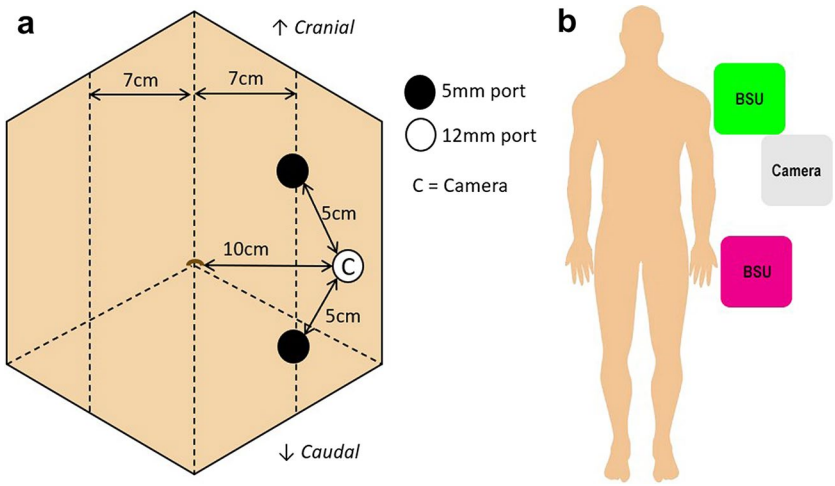

Fig. 2 **a** Port placement for Ventral hernia. **b** Bedside Unit Placement for Ventral Hernia

market. One of the newer commercially available systems is the Versius® system from CMR Surgical (CMR Surgical, 1 Evolution Business Park, Cambridge, UK) which consists of an open console and separate bedside units for each instrument arm. This system has been shown to be safe for use for benign general surgery, both in pre-clinical cadaveric trials and a small mixed-specialty in-human safety analysis [10, 11]. This is the first case series reporting on the feasibility of the use of Versius® for hernia repair surgery, and is in keeping with Stage 2a (Development) of the IDEAL recommendations for safe introduction of new surgical techniques [12].

Methods

On commencement of a robotic general surgery programme in a UK hospital, data were collected prospectively on all consecutive hernia repairs performed with the Versius® system. All patients provided written consent for anonymised data to be held both locally and also securely on a national registry maintained by CMR Surgical. Patients were informed that use of the Versius® system for hernia repair is novel, but that the system itself had already been in use in the hospital for 11 months for colorectal and gynaecology procedures [13]. All surgeons in the programme had extensive experience in minimally invasive general surgery, but only one had previous robotic surgical experience, and all procedures were performed as dual Consultant operations. An in-person CMR Surgical-validated training programme which includes virtual simulation followed by cadaveric training was completed by all surgeons.

Pre-, intra-, and postoperative parameters were collected for each patient, including baseline demographics and comorbidities, as quantified by the Charlson Age Comorbidity Index and the American Society of Anaesthesiologists Physical Status Classification System (ASA).

Intraoperative outcomes collected included set-up/docking time for bedside units (BSUs) and robotic console time. Any unplanned conversions to a different surgical modality (whether open or conventional laparoscopy) were recorded, along with the basis for conversion. Complications were divided into intraoperative, early postoperative (prior to discharge), and delayed postoperative (up to 30 days following discharge). All complications were graded according to the Clavien–Dindo scale, with complications of grade 3 and above being deemed "major". Any unplanned returns to theatre and any readmissions to hospital were also recorded. Overall length of stay was measured in days.

Surgical technique

All inguinal hernias were repaired via the rTAPP method. Port placement is similar to that for a laparoscopic inguinal hernia repair, with a 12 mm supra- or infra-umbilical camera port and one 5 mm working port in both the left and right lumbar regions, as demonstrated in Fig. 1a. Supraumbilical camera ports are favoured in patients with a low-lying umbilicus. A 30-degree endoscope is used. The 5 mm ports are both placed at a distance of 7 cm lateral and 2 cm caudal from the 12 mm port. The patient is positioned in steep Trendelenburg. Figure 1b demonstrates the optimal bedside unit placement. One instrument bedside unit is placed on the patient's left, with the other instrument unit and visualisation unit on the right. The instruments most commonly used for dissection are fenestrated graspers and monopolar curved scissors. Choice of mesh and mesh fixation type was left to individual surgeon discretion.

Ventral hernia repair is performed using the Intraperitoneal Onlay Mesh (IPOM) technique. The patient is positioned supine with the table angled away from the side of the bedside units. This position has been found to be optimal for minimising robotic arm clashes whilst still allowing for

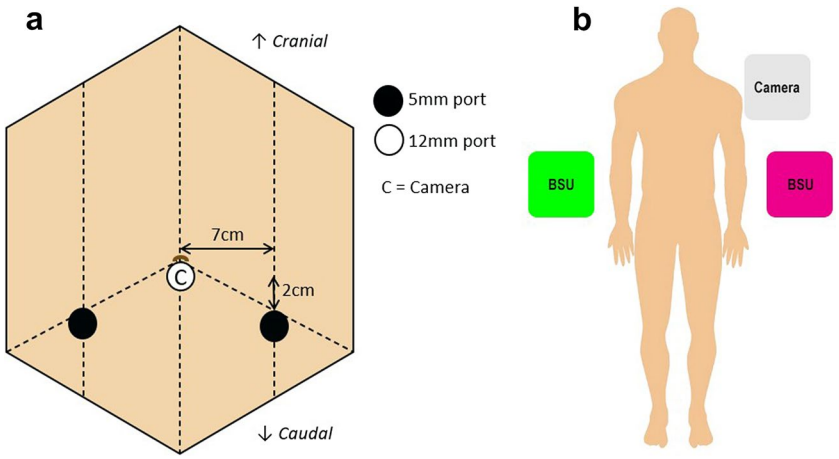

Fig. 1 **a** Port Placement for Inguinal Hernia. **b** Bedside Unit Placement for Inguinal Hernia

good intraoperative views, using a 30 degree endoscope. An optical trochar is used to gain access for the 12 mm robotic camera port, which is placed 10 cm lateral from the umbilicus. Two 5 mm instrument ports are placed, each 5 cm from the 12 mm port, and 7 cm from the umbilicus. This placement can be seen in Fig. 2a. All three bedside units (2 instrument arms and one visualisation unit) are on the patient's left, as demonstrated in Fig. 2b. Reduction of the hernial content is achieved with a combination of traction and sharp dissection using fenestrated graspers and monopolar curved scissors. Composite mesh is used for all repairs, secured in place with an endoscopic tacking device, sutures, or glue as per surgeon preference. All patients had a transversus abdominis plane local anaesthetic block at the end of the operation for postoperative pain control.

Results

A total of forty-one operations were performed over a 12-month period, which included a three-month hiatus due to the COVID-19 pandemic. These operations included thirty-two inguinal hernia repairs (four of which were bilateral), and nine other ventral hernia repairs (including umbilical, epigastric, and incisional). The majority of patients (88%) were male, and their ages ranged from 24 to 80 (mean 56.4 ± 14.8). Twenty-seven percent of the patients were classed as obese (BMI > 30), with an overall mean BMI of 27.4 ± 3.5. Most patients did not have major comorbidities, with a median ASA score of 2 and median Charlson score of 2 (range 0–5). Table 1 gives further details on demographics.

There were no conversions to open surgery. Four cases were converted to conventional laparoscopy (3 inguinal and 1 ventral), the majority of which were early cases converted due to difficulty reducing the hernia sac. This ceased to be an issue as further technical experience was gained. The median length of stay was 0 days (range 0–3) with 71% of cases performed as day case surgery. Most cases were planned as day cases and non-operative factors (such as a late finish in theatre) account for the majority of unplanned overnight stays.

Table 1 Patient characteristics

Characteristics	($n = 41$)
Gender, male/female	36/5
Age (years), mean ± SD	56.4 ± 14.8
ASA, *n* (%)	
1	12
2	27
3	2
Charlson comorbidity index, median (range)	2 (0–5)
Body mass index (kg/m^2), mean ± SD	27.4 ± 3.5

Six patients experienced urinary retention, one of whom remained an inpatient for 3 days due to this, and one patient had a rectus sheath haematoma post ventral hernia repair that was managed conservatively. One further patient presented to the Emergency Department several days after his inguinal hernia repair with groin pain, but did not require admission and was discharged home following review. There were no major complications, and no readmissions or reoperations within 30 days. Console operating time and bedside unit set-up (robotic docking) times are reported in Table 2.

Discussion

This is the first paper to examine the use of the Versius® system for hernia repair surgery, and reports the first 41 cases performed in a centre at the beginning of their robotic general surgery programme. Kudsi et al. reported a series of robotic ventral hernia repairs including 197 IPOM repairs, and reported a major complication rate of 6.6%, hence the

Table 2 Perioperative and postoperative outcomes

Outcome	Inguinal ($n=32$)	Ventral ($n=9$)
Perioperative		
Console time (*minutes*), median (range)	41 (13–141)	26 (8–56)
BSU set-up time (*minutes*), median (range)	8 (5–18)	13 (5–25)
Conversion to alternative modality, *n* (%)	3 (9.4%)	1 (11.1%)
Postoperative		
Length of stay (*days*), median (range)	0 (0–3)	0 (0–1)
Complication within 30 days, *n* (%)	6 (18.8%)	2 (22.2%)
Minor, *n* (%)	6 (18.8%)	2 (22.2%)
Major, *n* (%)	0	0
Readmission within 30 days, *n* (%)	0	0
Reoperation within 30 days, *n* (%)	0	0

BSU Bedside unit

low complication rate in the current setting shows promise [14].

The most common complication was urinary retention which occurred more frequently than expected. Six patients (14.6%) in this series experienced urinary retention (5 inguinal hernias and 1 incisional hernia). This is a higher rate than has been described elsewhere, for example Huerta found a rate of just 5.6%, but the overall complication rate in this series was lower (20%) compared to the 38% reported in Huerta's retrospective series [15]. All but one of the patients had their catheter successfully removed prior to discharge, and 2 out of 5 male patients with retention were known to have pre-existing benign prostatic hyperplasia. Edelman suggests that urinary retention rates post hernia repair can be lowered if prior urinary pathology is known and accounted for, for example with the use of alpha-blockers or routine catheterisation in theatre [3]. There was one case of rectus sheath haematoma (2.4%) which compares favourably to previously reported rates of between 3.0% and 4.3% [16, 17]. It is clear from these outcomes that use of Versius® for hernia repairs procedures is safe and feasible.

The surgeons involved in this study stated that although the procedure is the same as for laparoscopic hernia repair, subjectively the robotic system provides better ergonomics and improved fine control for mesh placement and suturing. Being able to use a similar port placement as for conventional laparoscopy was seen as a benefit.

Conclusion

Robotic surgery is now well established for a number of major procedures, particularly in urology and gynaecology. Purchasing a robotic system entails significant financial outlay for a hospital and therefore maximising usage of the system may make this investment more cost efficient. Increased usage of robotic systems for quick, high-volume hernia repairs (often day cases) can be a way for hospitals to take full advantage of their robotic systems, as well as providing an opportunity for surgeons to hone their skills and overcome any learning curve. This paper demonstrates the feasibility and safety of the Versius® system for use with hernia repairs, with few modifications to existing surgical techniques.

Author contributions AK and BK are joint senior authors. All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by FD. The first draft of the manuscript was written by FD and BK and all authors commented on subsequent versions of the manuscript. All authors read and approved the final manuscript.

Funding No funding was received for this work from any funding agencies in the public, commercial or not-for-profit sectors.

Declarations

Conflict of interest BK has acted as preceptor and advisory consultant for CMR Surgical, and BK's institution has received an educational grant from CMR Surgical. FD, AQ, PVS and AK declare that they have no conflicts of interest.

Ethics approval Ethical approval was waived as this is an observational study.

Consent All patients provided written informed consent for the use and publication of their data. Data used within this article have been anonymised and remains confidential. This series has not been presented at any conference or regional meeting.

References

1. Intuitive Surgical (2020) Annual Report 2020
2. Pawlak M, Tulloh B, Beaux A (2020) Current trends in hernia surgery in NHS England. Annals 102:25–27. https://doi.org/10.1308/rcsann.2019.0118

3. Edelman D (2020) Robotic inguinal hernia repair. Surg Technol Int 36:99–104
4. National Institute for Health and Care Excellence (2004) Laparoscopic surgery for inguinal hernia repair
5. The HerniaSurge Group (2018) International guidelines for groin hernia management. Hernia 22:1–165. https://doi.org/10.1007/s10029-017-1668-x
6. Escobar Dominguez JE, Gonzalez A, Donkor C (2015) Robotic inguinal hernia repair. J Surg Oncol 112:310–314. https://doi.org/10.1002/jso.23905
7. Podolsky D, Novitsky Y (2020) Robotic Inguinal Hernia Repair. Surg Clin North Am 100:409–415. https://doi.org/10.1016/j.suc.2019.12.010
8. Malcher F, Lima DL, Lima RNCL, Sreeramoju P (2021) Robotic-assisted approach for complex inguinal hernias. MIS. https://doi.org/10.20517/2574-1225.2021.48
9. Mohan R, Yeow M, Wong JYS et al (2021) Robotic versus laparoscopic ventral hernia repair: a systematic review and meta-analysis of randomised controlled trials and propensity score matched studies. Hernia 25:1565–1572. https://doi.org/10.1007/s10029-021-02501-w
10. Morton J, Hardwick RH, Tilney HS et al (2020) Preclinical evaluation of the versius surgical system, a new robot-assisted surgical device for use in minimal access general and colorectal procedures. Surg Endosc Publ Online. https://doi.org/10.1007/s00464-020-07622-4
11. Kelkar D, Borse MA, Godbole GP et al (2020) Interim safety analysis of the first-in-human clinical trial of the Versius surgical system, a new robot-assisted device for use in minimal access surgery. Surg Endosc. https://doi.org/10.1007/s00464-020-08014-4
12. McCulloch P, Altman DG, Campbell WB et al (2009) No surgical innovation without evaluation: the IDEAL recommendations. The Lancet 374:1105–1112. https://doi.org/10.1016/S0140-6736(09)61116-8
13. Dixon F, O'Hara R, Ghuman N et al (2021) Major colorectal resection is feasible using a new robotic surgical platform: the first report of a case series. Tech Coloproctol 25:285–289. https://doi.org/10.1007/s10151-020-02366-8
14. Kudsi OY, Gokcal F, Bou-Ayash N et al (2022) Robotic ventral hernia repair: lessons learned from a 7-year experience. Ann Surg 275:9–16. https://doi.org/10.1097/SLA.0000000000004964
15. Huerta S, Timmerman C, Argo M et al (2019) Open, laparoscopic, and robotic inguinal hernia repair: outcomes and predictors of complications. J Surg Res 241:119–127. https://doi.org/10.1016/j.jss.2019.03.046
16. Aiolfi A, Cavalli M, Micheletto G et al (2019) Primary inguinal hernia: systematic review and Bayesian network meta-analysis comparing open, laparoscopic transabdominal preperitoneal, totally extraperitoneal, and robotic preperitoneal repair. Hernia 23:473–484. https://doi.org/10.1007/s10029-019-01964-2
17. Broderick RC, Li JZ, Blitzer RR et al (2022) A steady stream of knowledge: decreased urinary retention after implementation of ERAS protocols in ambulatory minimally invasive inguinal hernia repair. Surg Endosc. https://doi.org/10.1007/s00464-021-08950-9