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ORIGINAL ARTICLE

Initial experience of Robotic-assisted cholecystectomy at Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences Gambat.

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ABSTRACT… Objective: To evaluate the safety, learning curve and outcomes of Robot assisted cholecystectomy (RAC) using the Versus Surgical System® in a public sector hospital. **Methods:** Retrospective Observational study. **Setting:** Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences Gambat, Pakistan. **Period:** 1st December 2022 to 30th June 2023. **Methods:** Analyzed patients who underwent RAC Key parameters assessed include docking and console times, conversion rates, intraoperative complications, and postoperative outcomes. This study also analyzed the RAC learning curve. **Results:** A total of 50 patients (74% female) underwent RAC. The median docking time was 20 minutes (range: 10–40), improving significantly after the first five cases ($p < 0.00001$). The mean console time decreased from 156.0 min in the initial 25 cases to 105.6 min in subsequent 25 cases ($p < 0.00001$), demonstrating a clear learning curve. Only single conversion to open procedure (2%) occurred due to hemorrhage. No bile duct injuries or any other significant postoperative complications were observed, Similarly, no readmission at 90-day follow-up was recorded. **Conclusion:** RAC using the Versius Surgical System® is a safe technique. Regarding the learning curve, despite initial technical challenges, experience leads to reduced operative times. Further studies are required to compare outcomes and cost-effectiveness in resource-limited hospitals.

Key words: Experience, Cholecystectomy, Pakistan, Robotic, Safety.

INTRODUCTION

Minimally invasive surgery has significantly evolved with the introduction of robotic-assisted techniques, offering enhanced precision, improved dexterity, and better patient outcomes. Robotic-assisted cholecystectomy (RAC) is an advancement over conventional laparoscopic cholecystectomy (LC), addressing several limitations such as instrument rigidity, restricted movement, tremors, and poor depth perception.[1] The incorporation of articulated instruments with seven degrees of freedom, motion scaling, and tremor filtration enhances surgical precision, particularly in delicate dissections.[2,3]

Despite these advantages, the adoption of robotic-assisted surgery in general surgical procedures, including cholecystectomy, remains limited compared to its widespread use in pelvic and urological surgeries.[4] The major barriers include high costs, longer operative times, and the steep learning curve associated with robotic platforms.[5] Additionally, in high-volume surgical centers, the time required for docking and setup can be an obstacle to maintaining surgical efficiency.[6]

The Versius Surgical System®, developed by Cambridge Medical Robotics, UK, represents a next-generation teleoperated robotic system designed to overcome some of these barriers. Unlike the da Vinci® robotic system, Versius features a modular, portable design with independent bedside units, improving operative flexibility and communication between the operating surgeon and the team staff present at operating room. Additionally, its open console design and cost-effectiveness make it a more practical option for public sector hospitals.[3,7]

Recognizing the potential benefits of this newer

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robotic platform, Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences, Gambat recently integrated the Versius Surgical System® into its surgical practice. Given the limited data on robotic-assisted cholecystectomy (RAC) from public sector hospitals, particularly in developing countries, we aimed to share our initial experience with RAC, highlighting the surgical learning curve, operative challenges, and patient outcomes in a resource-limited setting.

METHODS

Study Design and Setting

This was a retrospective observational study conducted at the department of Hepatopancreatobiliary Surgery, Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences Gambat, Pakistan. The study analyzed data from patients who underwent robotic-assisted cholecystectomy (RAC) using the Versius Surgical System® between December 22, 2022, and June 5, 2023. Ethical approval was gained from the Institutional Review Board (IRB No 22/9).

Patient Selection

All patients undergoing robotic-assisted cholecystectomy (RAC) aged ≥18 years with either gender, diagnosed with symptomatic gallstone disease or complicated cholecystitis requiring surgical intervention during the study period were included. Cases that began as robotic-assisted cholecystectomy but required conversion to laparoscopic or open surgery (defined as hybrid cases).

Patients with contraindications to laparoscopic surgery (e.g., severe cardiopulmonary disease or uncorrected coagulopathy). Patients who declined robotic-assisted surgery and opted for conventional laparoscopic or open cholecystectomy were excluded to participate in the study.

Preoperative Protocol

All patients were admitted one day before surgery, and baseline investigations including complete blood count, and liver function tests were performed. An informed consent was obtained for both the surgical procedure and data usage for research purposes.

The robotic-assisted cholecystectomy was performed under general anesthesia using the Versius Surgical System®. Each surgery was conducted by experienced laparoscopic surgeons trained in robotic surgery through a structured Versius training program. A CMR Versius-trained technician was present during all procedures to assist with system setup and troubleshooting.

Docking and Operative Technique

A supraumbilical 12-mm port was placed using the Hasson open technique to create pneumoperitoneum. A robotic camera 10-mm 0°was placed through this port. Two 7-mm robotic ports were introduced both in right and left mid-abdomen for instrument access. A 10-mm port for assistant was placed at subxiphoid region for gallbladder retraction, cystic artery/ duct clipping, and specimen retrieval. The robotic arm docking was standardized, with the camera unit positioned at 4 o'clock, the right bedside unit (BSU) at 2-3 o'clock, and the left BSU at 7 o'clock. The assistant surgeon was positioned at 1 o'clock to facilitate clipping and specimen retrieval.

While using Ligaclips the cystic duct and artery were clipped and transected. The gallbladder was dissected from the liver bed using a monopolar hook and Maryland bipolar forceps. A subhepatic drain was placed in selected cases with severe inflammation or frozen porta hepatis. The 12-mm port site was closed with Prolene/PDS sutures. Patients received single doses of intravenous antibiotics and postoperative analgesia before discharge.

Data Collection, Outcome Measures and Statistical Analysis

Data were retrospectively collected from hospital records and the Versius database. Various variables like patient's demographics (age, gender, BMI, previous abdominal surgeries), surgical Indications, Intraoperative Parameters (Docking time (from induction to BSU port positioning), console time (from

start to undocking), Intraoperative events, postoperative complication, conversions, hospital Stay, and Readmissions were recoded. Follow-ups were conducted at 14, 60, and 90 days postoperatively through outpatient visits or telephonic consultations, and any complications were documented.

Descriptive statistics were used for demographic and clinical characteristics. Continuous variables were presented as mean ± standard deviation (SD) or median (range), while categorical variables were expressed as percentages. Learning curve analysis for docking and console times was performed using linear regression models to assess improvement over time.

RESULTS

A total of 50 patients RAC were performed using the Versius robotic System. Of these, 37 (74%) were female. The mean age was 39 (18–70) years, and the mean BMI was 24.7 (18–37) kg/m^2. Five patients (10%) had undergone previous abdominal surgery, including three appendectomies, one cesarean section, and one total abdominal hysterectomy (Table-I).

Variable	Value
Total Patients (n)	50
Age (mean, range in years)	39 (18–70)
Gender	37 Female (74%) 13 Male (26%)
BMI (mean, range in kg/m^2)	24.7 (18–37)
Previous Abdominal Surgery	5 (10%)

Table-I. Patient demographics

The primary indications for RAC were symptomatic cholelithiasis in 45 patients (90%), calculus cholecystitis in four (8%) and single (2%) patient underwent RAC post ERCP and common bile duct (CBD) stenting for choledocholithiasis (Figure-1)

Regarding the docking time notable learning curve was experienced. The median docking interval was 20(10–40) min. For the first 05 cases, it exceeded more than 25min, but it significantly improved with experience ($p < 0.00001$). Similarly, the median console time was 110 (60–215) min, with an extended console time of over 150 minutes in 11 cases. The prolonged console duration was primarily due to severe inflammation and adhesions secondary to acute calculous cholecystitis in four, and cholangitis following choledocholithiasis in one case. Technical difficulties related to robotic arm and port placement was experienced in six cases.

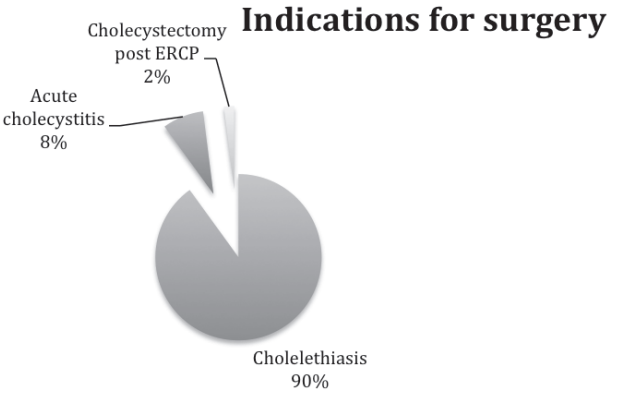

Figure-1. Indication of Surgery

Conversion to open surgery was required in one case (2%) due to hemorrhage from an aberrant cystic artery. A laparoscopic approach was initially attempted but was abandoned due to poor vision, making an open conversion the safer option. No postoperative complications were reported, and the mean hospital stay was two days. Similarly, no readmissions observed during the follow-up period at 14, 60, and 90 days. (Table-II).

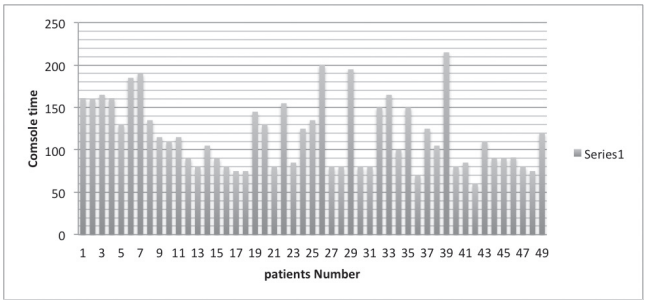

Figure-2. Shows console time for every patient.

The comparison of console time between the initial and last 25 cases of robotic-assisted cholecystectomy reveals a notable improvement in surgical efficiency. The mean console time decreased significantly from 156.0 minutes (SD: 13.84) in the initial 25 cases to 105.6 minutes (SD: 11.21) in the last 25 cases. (Figure-3) Statistical

analysis using an independent t-test yielded a p-value of 0.00001, confirming the difference as highly significant ($p < 0.05$). (Table-III) This substantial reduction demonstrates a clear learning curve, with surgeons becoming more efficient over time.

Parameter	Value
Median Docking Time (min)	20 (10–40)
Docking Time in Initial 5 Cases	>25 min
Median Console Time (min)	110 (60–215)
Extended Console Time (>150 min)	11 cases
Reasons for Prolonged Console Time	Severe Inflammation (Acute Cholecystitis): 4 Dense Adhesions (Cholangitis): 1 Technical Issues: 6
Case Converted to Open	1 (2%) due to hemorrhage
Incidence of CBD injury	None
Postoperative event	None
Hospital Stay (mean)	2 days
Readmission within 90 Days	None

Table-II. Intraoperative parameters and outcomes

Group	Mean Console Time (min)	Standard Deviation (SD)	P-Value
Initial 25 Cases	156.0	13.84	0.00001
Last 25 Cases	105.6	11.21	

Table-III. Comparison of console time between initial and last 25 cases

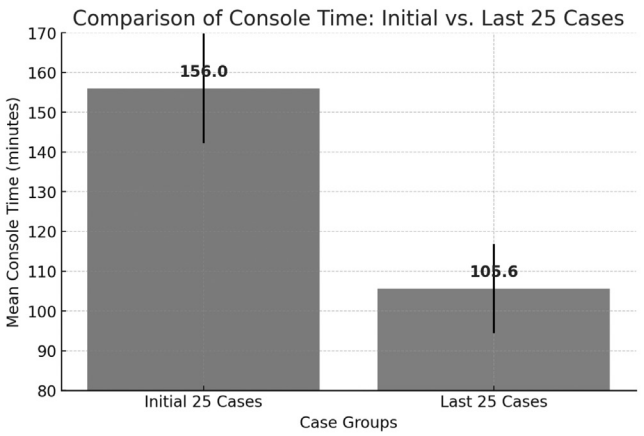

Figure-3. Comparison of Console Time: Initial vs. Last 25 Cases

The p-value (0.00001) indicates a highly significant difference, confirming that experience with the Versius robotic system led to a substantial improvement in console time.

DISCUSSION

Robotic surgery is currently widely accepted in urological and other confined-space procedures, its application in general surgery particularly cholecystectomies remain limited.

But now the paradigm is shifting, and Robotic-assisted cholecystectomy (RAC) is emerging as an advancement over conventional laparoscopic cholecystectomy, offering enhanced surgical precision, improved ergonomics, and greater dexterity. But the procedure cost remains a big challenge.[4,8] However, With the emergence of advanced, more mobile, and modular robotic systems, costs are expected to decline while surgical expertise continues to grow, ultimately improving accessibility for both patients and surgeons.[9]

Our study provides an initial evaluation of the Versius Surgical System® in a public sector hospital setting, contributing to the limited data on RAC, particularly in resource-constrained environments. Our findings demonstrate the feasibility and safety of RAC, with a significant learning curve leading to improved efficiency over time.

Our results align with findings from a previous study by Chowbey et al.[10], which reviewed 100 robotic cholecystectomies using the Versius system at a high-volume tertiary care center. Their study highlighted a progressive reduction in operative time, decreasing from 28.53 minutes in the first 50 cases to 22.06 minutes in the last 50 cases. Similarly, our study revealed a substantial improvement in console time, with a mean reduction from 156.0 minutes in the initial 25 cases to 105.6 minutes in the last 25 cases ($p < 0.00001$). Both studies indicate a steep but manageable learning curve, where increased experience with robotic systems leads to greater operative efficiency and reduced setup times.

Unlike Chowbey et al.[10], who observed three conversions to laparoscopic surgery in their first

50 cases, our study reported only one conversion (2%) to open surgery due to hemorrhage from an aberrant cystic artery. This suggests that while robotic cholecystectomy is feasible, intraoperative challenges such as vascular variations and adhesions still require careful consideration. Furthermore, in contrast to their study, where machine errors and alarms were subjectively reported, our study documented specific technical difficulties, such as robotic arm and port placement issues, which contributed to prolonged operative times in six cases.

Both studies underscore the learning curve associated with robotic surgery. Our findings support the notion that docking and console times significantly improve with experience, similar to previous reports. Chowbey et al.[10] reported that operative time improvements were noticeable after 30 cases, which is comparable to our observation that docking time improved substantially after the first five cases. These findings highlight the importance of structured training programs and continued exposure to robotic systems to enhance surgical proficiency.

The prevention of bile duct injuries is crucial for a successful cholecystectomy. In our study, no bile duct injuries were observed. However, a recent analysis of 10 years by Kalata et al.[11], claimed higher bile duct injury risk in the robotic patients compared to the laparoscopic cholecystectomy patients. In contrast, multiple other studies have reported a lower risk in the RC group.[12,13]

Our study found no postoperative complications and a mean hospital stay of two days, consistent with previous literature on robotic cholecystectomy . Similarly, Chowbey et al.[10] reported no major postoperative complications, reinforcing the safety profile of robotic cholecystectomy. Additionally, neither study reported readmissions within the follow-up period, suggesting that RAC is an effective and well-tolerated procedure when performed by trained surgeons.

Despite the advantages of robotic surgery, cost and accessibility remain major barriers, particularly in public sector hospitals. While the Versius system's modular design offers cost-saving potential compared to traditional da Vinci® platforms, further studies are needed to assess long-term cost-effectiveness in different healthcare settings. Additionally, robotic platforms should continue to optimize instrument design and reduce technical difficulties, as identified in our study.

Future research should focus on comparative studies between robotic and laparoscopic cholecystectomy, evaluating cost, operative efficiency, and patient outcomes in various hospital settings. Additionally, expanding the range of robotic instrumentation and energy devices could further enhance the safety and applicability of RAC for complex cases.

CONCLUSION

Robotic-assisted cholecystectomy using the Versius Surgical System is safe. It can have a steep but manageable learning curve. Clear efficiency improvements over time can be achieved with Versius Surgical System. Our findings align with previous research. Robotic surgery remains a promising advancement in minimally invasive surgery, particularly as technology evolves and accessibility increases.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Azam Shoaib:** Original manuscript writing, data analysis, supervision, methodology.
2	**Kaleem Ullah:** Conceptualization, data analysis.
3	**Abdul Wahab Dogar:** Formatting, methodology, writing.
4	**Muhammad Umar:** Referencing, data collection.
5	**Bilal Ahmed:** Data collection, methodology, formatting.
6	**Ajmal Khan Ghwas:** Writing.