Implementation of a new modular robotic platform in anatomic lung resection with a triportal robotic-assisted technique: Technical issues

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The hospital's Institutional Review Board approved the study (approval 516/2022). Informed written consent was obtained from each patient to include their information in this publication.

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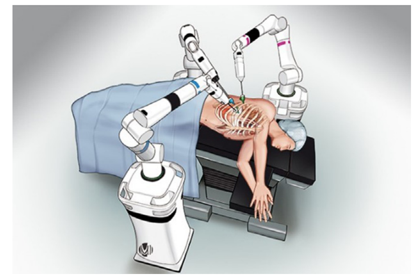


Modular robotic system: personalized arm positioning for anatomic lung resections.

CENTRAL MESSAGE

We describe our monocentric experience with implementation of a new modular robotic platform (Versius) to perform robotic-assisted anatomic lung resections with coded work patterns.

Video clip is available online.

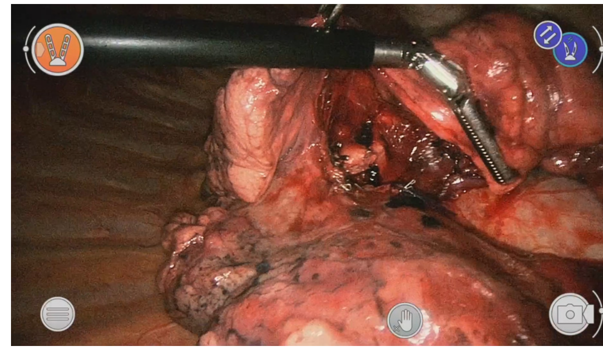
Twenty years after the launch of the Da Vinci surgical system,[1] new companies have entered the market of robotic surgical systems. British MedTech CMR Surgical (CMR Surgical) is emerging as a potential competitor to Intuitive, having developed a new modular robotic surgical system, Versius,[2] based on the needs and feedback of surgeons and surgical teams. The system comprises a surgeon console and up to 4 robotic arms (bedside unit [BSU]) and is characterized by small size and ease of mobilization.[3] The console is open with a 3-dimensional vision support (Figure E1) and is designed to facilitate communication with the operating room, and the wheeled, lightweight BSU is mobile (Figure E2). As energy devices, monopolar hook and bipolar forceps are available, along with grasping instruments (Figure E3). At this time, staplers or clippers have not been integrated into the system. The Cà Granda Foundation was among the first centers worldwide to introduce the Versius platform in thoracic surgery. After performing more than 80 anatomic lung resections, here we describe the Versius surgical technique used in our department to perform robotic-assisted lobectomies and segmentectomies.

METHODS

The hospital's Institutional Review Board approved the study (approval 516/2022), and all patients provided signed consent. Between September 2022 and July 2024, 87 consecutive cases of robotic-assisted anatomic lung resection were performed to treat lung cancer, including 63 lobectomies and 24 segmentectomies. All data were collected prospectively. All the procedures were performed by 3 surgeons experienced in video-assisted thoracic surgery (VATS), robot-naïve, with the triportal robotic-assisted technique described below. All surgeons were trained through a specifically designed training program that included online modules, 3.25 hours of training on the simulator with the completion of 16 tasks, as well as experience in a cadaver lab (on 2 cases). For the first 5 cases, an experienced proctor (a thoracic surgeon from Germany) accompanied the 2 surgeons in the operating room, along with 2 dedicated bioengineers from CMR Surgical who telemetrically monitored the robot arms' function and surgeons' movements in real time.

To minimize the number of thoracoscopic access sites, we tested in the wet laboratory and then applied in the operating room a 3-port anterior approach similar to the classic Copenhagen technique.[4] The port placements in the robotic-assisted thoracic surgery (RATS) technique included a utility anterior mini-thoracotomy (3-4 cm) in the fifth intercostal space, a 11-mm camera port in the eighth intercostal space on the posterior axillary line for lower resections and anteriorly for upper resections, and a

VIDEO 1. Evaluation of spatial interactions of the bedside unit and operating room configuration. Video available at: https://www.jtcvs.org/article/S2666-2507(24)00508-X/fulltext.



VIDEO 3. Inside the operating room, performing a right lower lobectomy. Video available at: https://www.jtcvs.org/article/S2666-2507(24)00508-X/fulltext.

5-mm port positioned posteriorly to the scapula tip in the seventh intercostal space. This port positioning provides the correct distance between the instruments during their movements, avoiding collisions (Figure E4).

Use of the freestanding BSU required an accurate evaluation of spatial interactions with the patient's hip and arms (Video 1). Flexion of the operating table was necessary to open the patient's intercostal spaces and to line up the chest with the iliac crest with the patient in a lateral decubitus position. The ipsilateral side arm needed to be extended cranially and/or anteriorly to gain exposure to the axilla. Reverse Trendelenburg position helped reduce the angle between the instrument and the patient's rib and between the camera and the hip (Figure E4).

The positioning of the BSU was adjusted for upper lung resections and lower lung resections as shown in Figure E5, at a precise distance from the middle line of the operating table. The height of the arms was established for depending on the patient's characteristics. "Port-training" was carried out for each arm, with rotating movements of the instrument around the pivot point (trocar). The initial position of each arm was configured in a "horseshoe" shape, to optimize the range of arm movements from the lung apex to the inferior ligament (Video 2). Video 3 presents an example of the technical preparation and realization of a right lower lobectomy.

RESULTS

The new robotic platform demonstrated excellent versatility and safety; no surgeries had to be interrupted because of the system's technical limitations. No patient sustained injuries (eg, rib fractures) owing to uncontrolled actions of the system. Patient demographics and types of surgery are summarized in Table E1. Conversion to open surgery was necessary in 4 cases due to vascular lesions (3 accidental lesions during periarterial node isolation) or bronchial lesions (1 case of pars membranacea damage during a segmentectomy). Minor bleeding was controlled with conversion to VATS. No patients in this case series required reintervention (Table E2).

VIDEO 2. Correct creation of the bedside unit "U-shape". Video available at: https://www.jtcvs.org/article/S2666-2507(24)00508-X/fulltext.

DISCUSSION AND CONCLUSIONS

Versius is a new robotic modular surgical platform developed through collaboration between engineers and surgeons wishing to overcome the limitation of currently used surgical robots. Its handy size, easy mobilization, and open console make robotic procedures simple,[1] allowing the easy conversion from RATS to VATS in the event of intraoperative complications. This is why the RATS technique adopted at our institution, similar to 3-port VATS, was readily accepted by our surgeons. The majority of work was dedicated to standardizing the technique and placement of robotic arms. Arm placement to ensure that each arm works properly without conflicts and with precise movements is the key factor affecting the performance of the Versius unit for both the surgeon and the patient. Our experience supports the usability, effectiveness, and safety of RATS performed with the Versius platform.

Our initial experience, although limited to a small number of patients, suggests the reliability of Versius surgical system in thoracic surgery, in terms of both safety and efficacy. Further studies are needed to validate these preliminary findings.

Conflict of Interest Statement

The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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FIGURE E1. Positioning and ergonomics of the console.

FIGURE E3. Robotic instruments available for the Versius. *From left to right*: curved scissors, needle holder, grasper forceps, monopolar hook, bipolar Maryland forceps, and monopolar scissors.

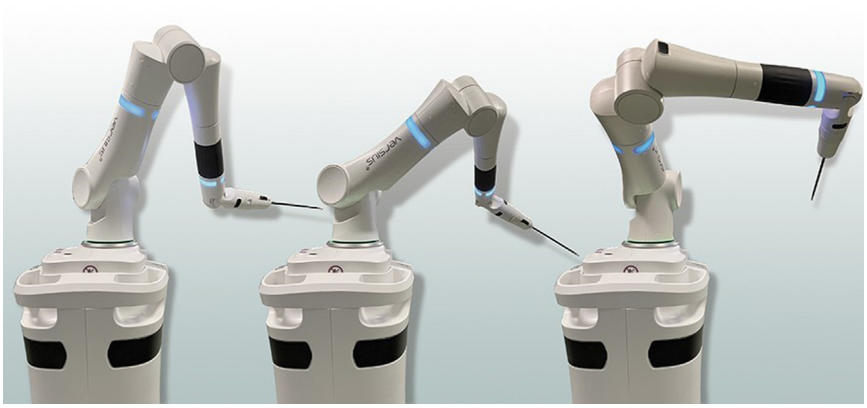

FIGURE E2. Bedside unit (*BSU*) and robotic arms.

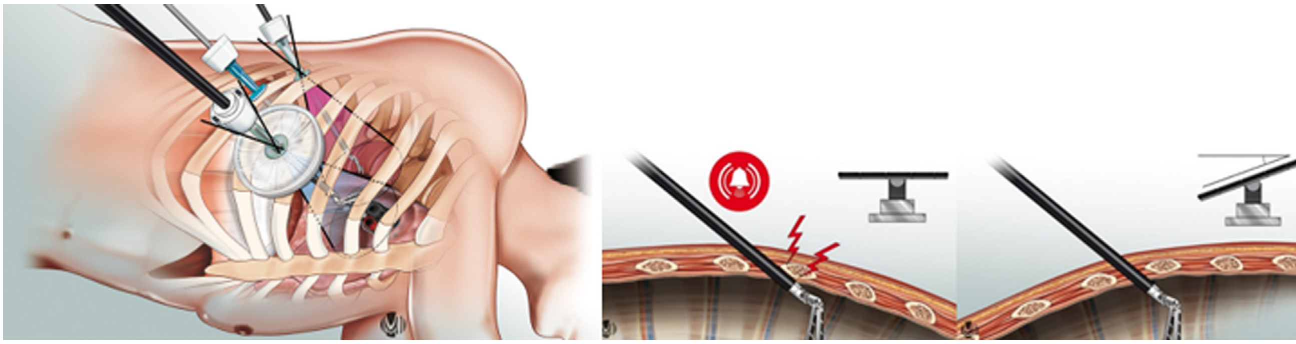

FIGURE E4. *Left*, Port setting in a 3-port anterior approach, with the working area of the instruments. The anterior thoracotomy port can be used by the bedside surgeon for a suction tube, stapler or other instruments when necessary. *Right*, The Versius system alarms when excessive pressure is applied on the chest wall. This could help reduce postoperative pain. To avoid alarms, appropriate tilting of the bed must be maintained.

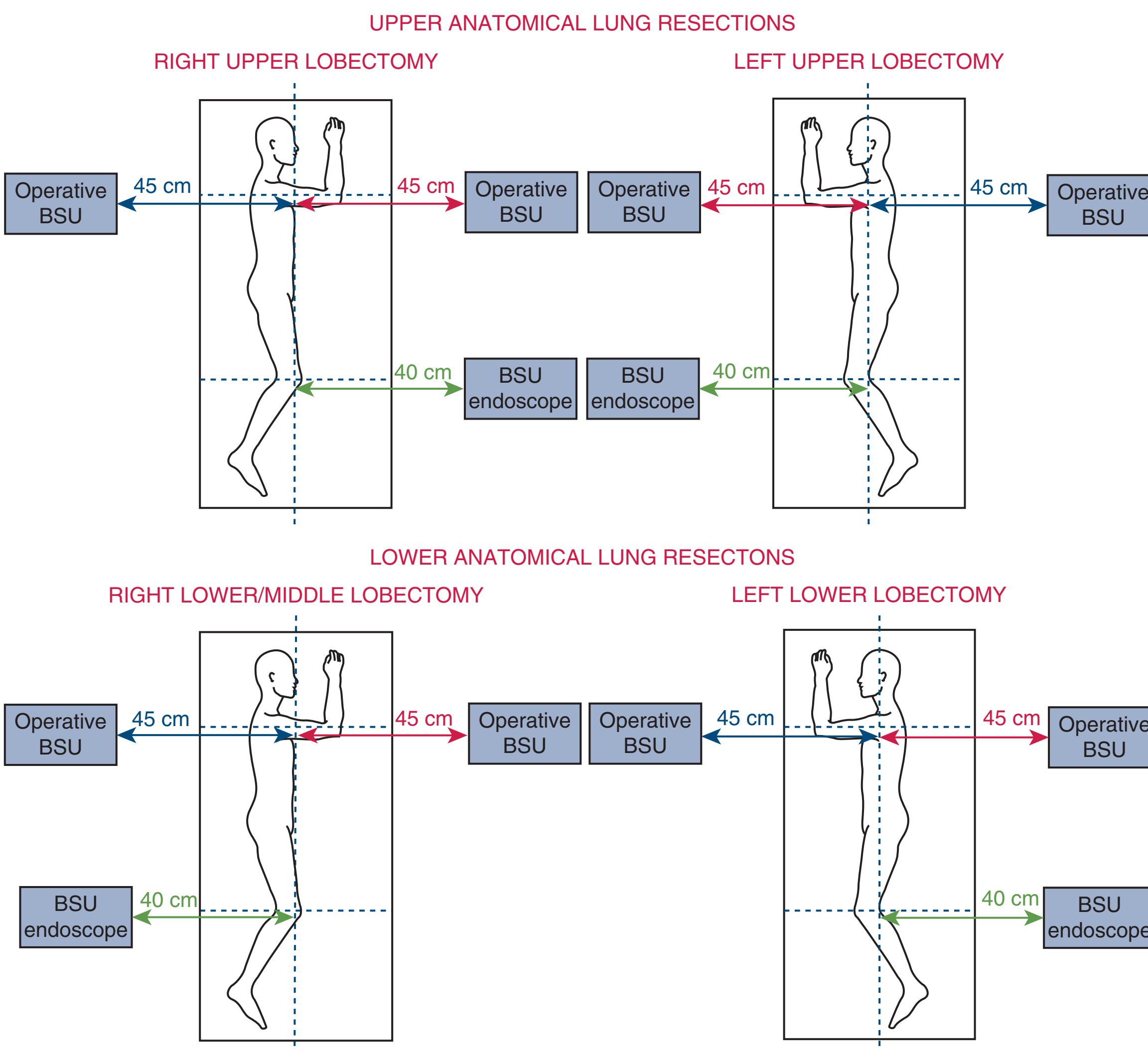

FIGURE E5. *Upper*, Versius robotic arm positioning for upper lung resections. The use of standardized arm settings is crucial to avoid clash alarms. The measurements (in cm) are from the middle line of the operating table. *Lower*, Versius robotic arm positioning for lower lung resection.

TABLE E1. Patient demographics and interventions

Parameter	Value
Male sex, n (%)	36 (41)
Age, y, mean ± SD	67 ± 9.3
BMI, mean ± SD	25.2 ± 2.4
ASA score, n (%)	
1	1 (1)
2	55 (63)
3	31 (36)
Type of surgery, n (%)	
Lobectomy	63 (72)
Left lower lobe	8 (9)
Left upper lobe	14 (16)
Right upper lobe	24 (28)
Right middle lobe	4 (5)
Right lower lobe	13 (15)
Segmentectomy	24 (28)
Left (S1 + S2) + S3	10 (12)
Right S1+ S2	1 (1)
Left S6	2 (2)
Right S6	3 (3)
Left (S7 + S8) + S9 + S10	4 (5)
Right S7 + S8 + S9 + S10	2 (2)
Left S4 + S5	2 (2)
Histology, n (%)	
Adenocarcinoma	64 (73)
Squamous cell carcinoma	19 (22)
Typical carcinoid	4 (5)

BMI, Body mass index; *ASA*, American Society of Anesthesiologists.

TABLE E2. Intraoperative and postoperative outcomes

Outcome	Value
Operative time, min, mean ± SD	257.2 ± 69.7
Conversion to open surgery, n (%)	4 (5)
Conversion to VATS surgery, n (%)	4 (5)
Operative blood loss, mL, mean ± SD	79.6 ± 124.8
Lymph node stations, n, mean ± SD	5.9 ± 1.5
Total lymph nodes, n, mean ± SD	16.1 ± 6.0
Postoperative complications, n (%)	
Clavien-Dindo grade 1	8 (9)
Clavien-Dindo grade 2	12 (14)
Clavien-Dindo grade 3a*	1 (1)
Reoperation, n (%)	0 (0)
Chest tube removal, d, mean ± SD	4.4 ± 2.8
Length of stay, d, mean ± SD	5.6 ± 2.9
30-d mortality, n (%)	0 (0)

VATS, Video-assisted thoracic surgery. *Clavien-Dindo classification[5]: The grade IIIa complication (requiring surgical, endoscopic or radiologic intervention not under general anesthesia) was a case of persistent air leak necessitating chest drainage tube positioning.