Assessment of the Training Program for Versius, a New Innovative Robot-Assisted Surgical Device for use in Minimal Access Surgery

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SUPPLEMENTARY MATERIALS

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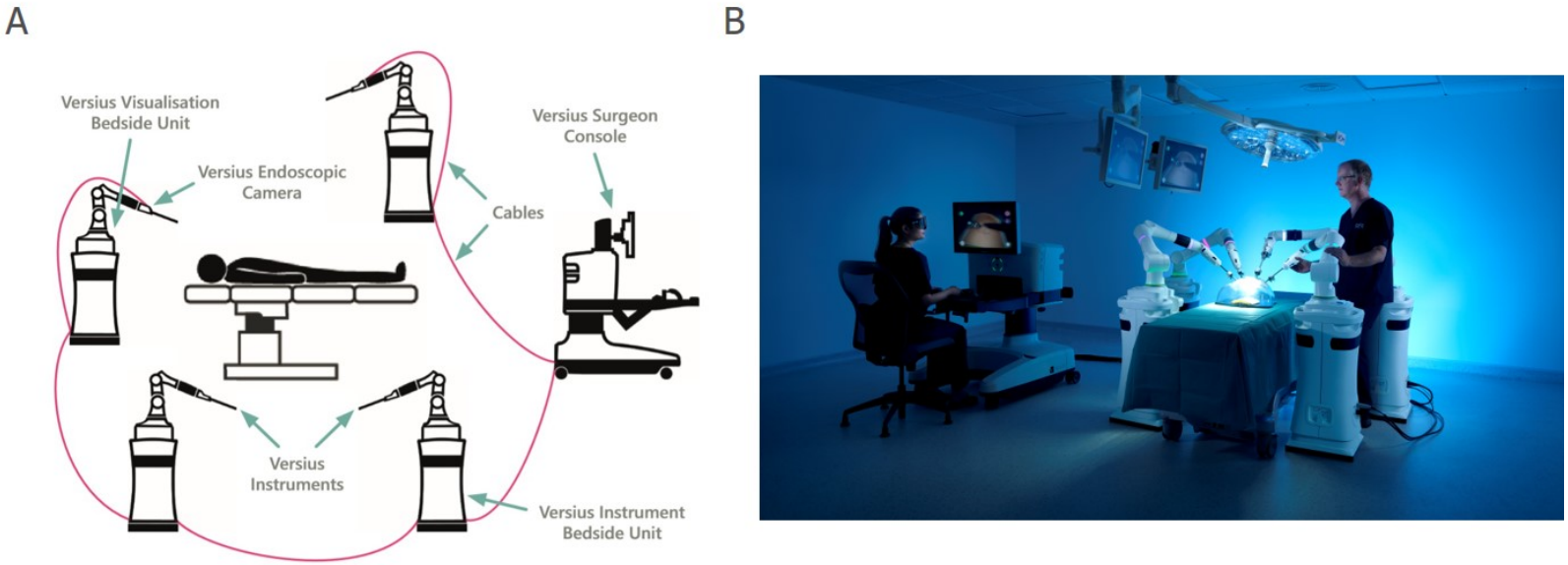
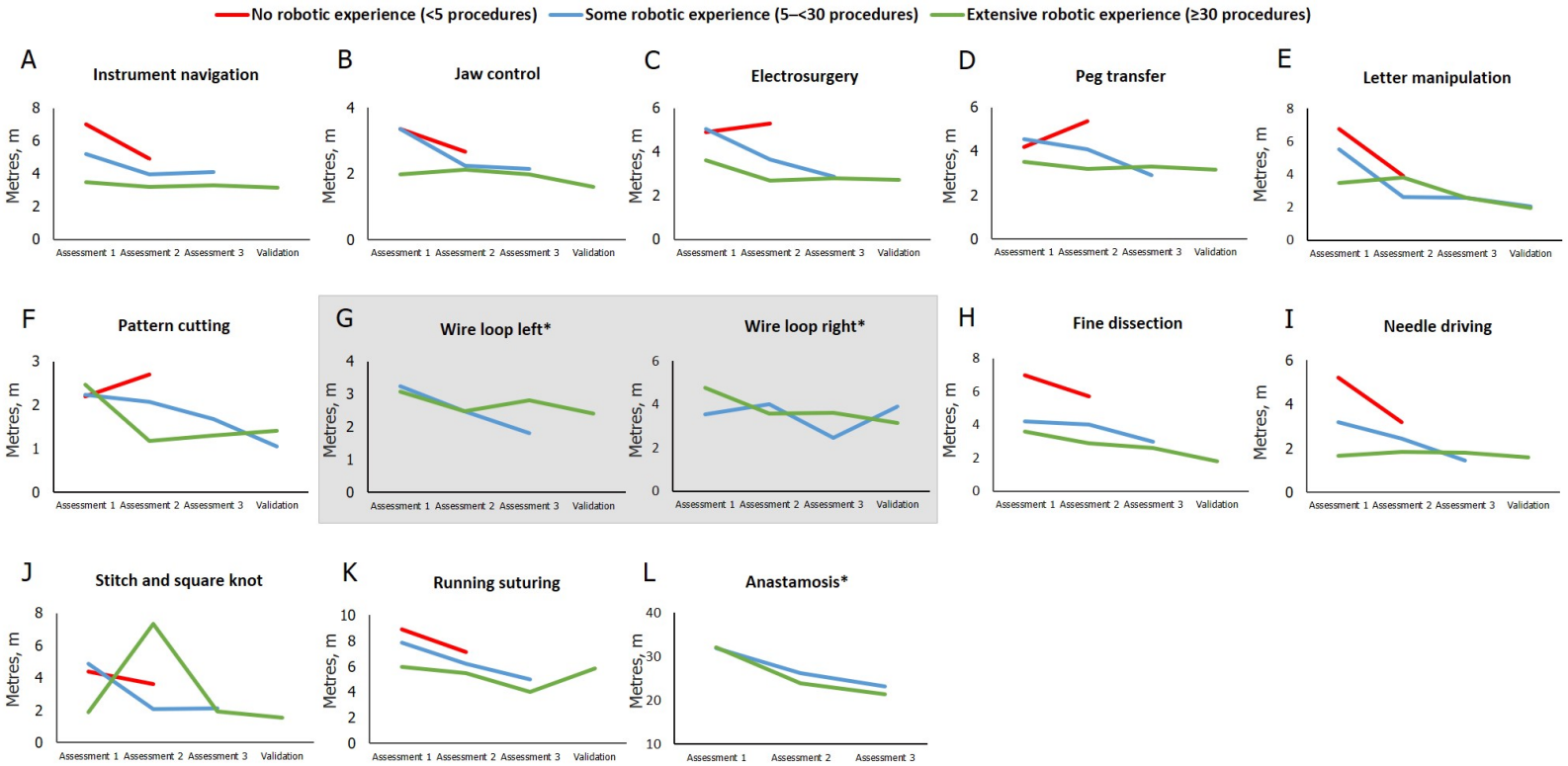
SUPPLEMENTARY FIGURES

Supplementary Figure S1: Overview of the Versius Surgical System



Adapted from Haig et al.[1] A: Schematic overview of the Versius Surgical System; B: Image of the Versius Surgical System.

Supplementary Figure S2: Remaining Versius Trainer outcomes



A–L: Combined path lengths for Versius Trainer outcomes. * Tasks G (wire loop left and wire loop right) and L (anastomosis) were completed by surgeons with some or extensive previous robotic experience only due to time constraints. Decrease in path length indicates an improvement in skill for Versius Trainer outcomes.

SUPPLEMENTARY METHODS

Supplementary Table S1: GEARS assessment tool

Depth perception				
1	**2**	**3**	**4**	**5**
Constantly overshoots target, wide swings, slow to correct		Some overshooting or missing of target, but quick to correct		Accurately directs instruments in correct plane to target
Bimanual dexterity				
1	**2**	**3**	**4**	**5**
Uses only one hand, ignores non-dominant hand, poor coordination		Uses both hands, but does not optimize interactions between hands		Expertly uses both hands in a complementary way to provide best exposure
Efficiency				
1	**2**	**3**	**4**	**5**
Inefficient efforts; many uncertain movements; constantly changing focus or persisting without progress		Slow, but planned movements are reasonably organized		Confident, efficient and safe conduct, maintains focus on task, fluid progression
Force sensitivity				
1	**2**	**3**	**4**	**5**
Rough moves, tears tissue, injures nearby structures, poor control, frequent suture breakage		Handles tissue reasonably well, minor trauma to adjacent tissue, rare suture breakage		Applies appropriate tension, negligible injury to adjacent structures, no suture breakage
Autonomy				
1	**2**	**3**	**4**	**5**
Unable to complete entire task, even with verbal guidance		Able to complete task safely with moderate guidance		Able to complete task without prompting
Robotic control				
1	**2**	**3**	**4**	**5**
Consistently does not optimize view, hand position, or repeated collisions even with guidance		View is sometimes not optimal. Occasionally needs to relocate arms. Occasional collisions and obstruction of assistant		Controls camera and hand position optimally and independently. Minimal collisions or obstruction of assistant

Use of third arm					
N/A	**1**	**2**	**3**	**4**	**5**
Consistently does not use 3rd arm, or does not use it well when required, even with verbal guidance			Mostly uses 3rd arm in a safe and efficient manner with moderate guidance		Consistently uses 3rd arm in a safe and efficient manner without prompting

GEARS: Global Evaluative Assessment of Robotic Skills.

Supplementary Table S2: GEARS scores based on surgeon experience

Source	Outcome	Novice	Intermediate	Expert
Aghazadeg et al (2015)	Median (range)	19.0 (11.0–27.0)	20.8 (16.5–27.0)	30 (29.0–30.0)
Sanchez et al (2016)	Average (NR)	16.0 (±3.0) 15.8 (±2.9)	24.0 (±2.8) 23.6 (±3.3)	29.8 (±0.4) 29.8 (±0.4)
Goh et al (2012)	Mean (SD)	20.3 (±2.4)	22.9 (±2.8)	28.7 (±1.8)
Mean Scores		**17.8**	**22.8**	**29.6**

NR: not reported; SD: standard deviation.
Aghazadeg et al (2015):[2] Novice: <5 procedures; Intermediate: ≥5 but ≤30 procedures; Experts: >30 robotic procedures completed as primary surgeon.
Sanchez et al (2016):[3] Novice: Laparoscopic surgeon, no robotic procedures no training; Intermediate: Undergone formal Da Vinci training but no in vivo procedures; Expert: >15 procedures of robotic surgery.
Goh et al (2012):[4] Novice: Laparoscopic surgeon, no robotic procedures but in training; Intermediate: Undergone formal Da Vinci training but no in vivo procedures; Expert: Routinely performing robotic surgery (>30 procedures).

Supplementary Table S3: Versius Trainer tasks

No.	Task	Aim
1	Instrument navigation	To familiarize the surgeon with the head-up display and how to assign instruments To familiarize the surgeon with using the clutch button to improve his or her dexterity and ergonomics when using the Versius system
2	Jaw control	To introduce the concept of controlling the instrument jaws
3	Endoscope control	To introduce control of the endoscope using the thumbsticks
4	Multitarget	To combine working with the head-up display, clutch and endoscope control
5	Four arms	To control multiple arms in the same session
6	Electrosurgery	To introduce electrosurgery activation
7	Peg transfer	To familiarize the surgeon with the functionality of the wristed instruments
8	Letter manipulation	To introduce the use of a third instrument to help in completing complex tasks
9	Pattern cutting	To introduce the scissors and to develop wrist articulation
10	Wire loop	To improve the surgeon's use of wristed instruments to deliver intricate control
11	Fine dissection	To familiarize the surgeon with the electrosurgery instruments
12	Needle driving	To introduce needle control with the wristed instruments
13	Stitch and square knots	To introduce knot tying with the instruments
14	Running suturing	To improve the surgeon's use of wristed instruments when needle driving and knot tying
15	Anastomosis	To bring together all the skills learned from previous tasks

Supplementary Table S4: Prior robotic experience across each surgical specialty

	Prior Robotic Experience		
Surgical Specialty (n)	**None (< 5 procedures)**	**Some (5–< 30 procedures)**	**Extensive (≥30 procedures)**
OB/ GYN (4)	1	3	0
General (5)	1	2	2
Colorectal (4)	1	3	0
Urology (4)	1	0	3

OB/GYN: Obstetrics/Gynecology.

1. Haig F, Medeiros ACB, Chitty K, et al. Usability assessment of Versius, a new robot-assisted surgical device for use in minimal access surgery. BMJ Surgery, Interventions, & Health Technologies 2020;2:e000028.
2. Aghazadeh MA, Jayaratna IS, Hung AJ, et al. External validation of Global Evaluative Assessment of Robotic Skills (GEARS). Surg Endosc 2015;29:3261-6.
3. Sanchez R, Rodriguez O, Rosciano J, et al. Robotic surgery training: construct validity of Global Evaluative Assessment of Robotic Skills (GEARS). J Robot Surg 2016;10:227-31.
4. Goh AC, Goldfarb DW, Sander JC, et al. Global evaluative assessment of robotic skills: validation of a clinical assessment tool to measure robotic surgical skills. J Urol 2012;187:247-52.