MDPI

Systematic Review

New Robotic Platforms in General Surgery: What's the Current Clinical Scenario?

Francesco Marchegiani [1], Leandro Siragusa [2], Alizée Zadoroznyj [1], Vito Laterza [1], Orsalia Mangana [1], Carlo Alberto Schena [1], Michele Ammendola [3], Riccardo Memeo [4], Paolo Pietro Bianchi [5], Giuseppe Spinoglio [6], Paschalis Gavriilidis [7] and Nicola de'Angelis [1,*]

[1] Unit of Colorectal and Digestive Surgery, DIGEST Department, Beaujon University Hospital, AP-HP, University of Paris Cité, Clichy, 92110 Paris, France; marchegiani.fra@gmail.com (F.M.)
[2] Department of Surgical Sciences, University of Rome "Tor Vergata", Viale Oxford 81, 00133 Rome, Italy
[3] Science of Health Department, Digestive Surgery Unit, University "Magna Graecia" Medical School, 88100 Catanzaro, Italy
[4] Unit of Hepato-Pancreato-Biliary Surgery, General Regional Hospital "F. Miulli", 70021 Acquaviva delle Fonti, Italy
[5] Division of General and Robotic Surgery, Department of Health Sciences, San Paolo Hospital, University of Milan, 20142 Milan, Italy
[6] Research Institute Against Digestive Cancer (IRCAD), 67000 Strasbourg, France
[7] Department of Surgery, Saint Helena General Hospital, Jamestown, Saint Helena STHL 1ZZ, South Atlantic Ocean, UK
* Correspondence: nicola.deangelis@aphp.fr; Tel.: +33-0140874547

Abstract: *Background and Objectives*: Robotic surgery has been widely adopted in general surgery worldwide but access to this technology is still limited to a few hospitals. With the recent introduction of new robotic platforms, several studies reported the feasibility of different surgical procedures. The aim of this systematic review is to highlight the current clinical practice with the new robotic platforms in general surgery. *Materials and Methods*: A grey literature search was performed on the Internet to identify the available robotic systems. A PRISMA compliant systematic review was conducted for all English articles up to 10 February 2023 searching the following databases: MEDLINE, EMBASE, and Cochrane Library. Clinical outcomes, training process, operating surgeon background, cost-analysis, and specific registries were evaluated. *Results*: A total of 103 studies were included for qualitative synthesis after the full-text screening. Of the fifteen robotic platforms identified, only seven were adopted in a clinical environment. Out of 4053 patients, 2819 were operated on with a new robotic device. Hepatopancreatobiliary surgery specialty performed the majority of procedures, and the most performed procedure was cholecystectomy. Globally, 109 emergency surgeries were reported. Concerning the training process, only 45 papers reported the background of the operating surgeon, and only 28 papers described the training process on the surgical platform. Only one cost-analysis compared a new robot to the existing reference. Two manufacturers promoted a specific registry to collect clinical outcomes. *Conclusions*: This systematic review highlights the feasibility of most surgical procedures in general surgery using the new robotic platforms. Adoption of these new devices in general surgery is constantly growing with the extension of regulatory approvals. Standardization of the training process and the assessment of skills' transferability is still lacking. Further studies are required to better understand the real clinical and economical benefit.

Keywords: robotic surgery; training; new surgical robots; environmental sustainability; colorectal surgery; hepatobiliary surgery; upper gastrointestinal surgery; abdominal wall surgery; endocrine surgery; breast surgery

1. Introduction

Twenty-two years after the clinical introduction of the first Intuitive Surgical Da Vinci system, only a limited percentage of general surgery procedures are performed via robotic

approach in Western countries [1]. In addition, there is a great disparity between developed and low-income countries where robotic surgery remains unsustainable despite its potential technical advantages [1,2].

Historically, AESOP® and ZEUS, both produced by the American Computer Motion, were the first robotic surgical systems adopted in general surgery [3]. In 2003, after long legal action, American Computer Motion merged with its main competitor, Intuitive Surgical, which had been founded eight years prior [3]. The company developed several generations of master-slave multi-arm robots protecting their products thanks to the registration of more than 7000 patents which was the main barrier for the development of contenders [4,5]. After twenty years, the first registered patents are progressively expiring allowing the development of competing products [6]. The twenty years monopoly constituted an enormous advantage for the Intuitive Surgical company, whose products were adopted by most surgical specialties, thanks to the claimed technical advantages over laparoscopy provided by 3D imaging, magnification, dexterity, tremor filtration, motion scaling and a quick learning curve [5]. At the beginning of 2023, more than 11 millions robotic surgeries have been performed worldwide with Intuitive Surgical Da Vinci robots, with over 7500 platforms installed worldwide [7].

Nevertheless, the scenario is changing because new robotic platforms have been recently introduced into the market with several new architectures (e.g., modular platforms). Their use appeared to be feasible, but the associated surgical results and clinical effectiveness still require further investigation [8].

The aim of this systematic review was to evaluate the adoption of these new surgical robotic systems in general surgery in terms of clinical data, technical aspects, costs, and learning curve.

2. Materials and Methods

2.1. Search Strategy and Data Sources

The systematic review was performed according to the Cochrane Collaboration-specific protocol [9] and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [10].

A first search was performed in grey literature and on the internet to identify the newly available robotic platforms, different from the Intuitive Surgical Da Vinci S®/Si®/Xi®/X® (Intuitive Surgical, Sunnyvale, CA, USA). Studies describing the adoption of new robotic platforms in general surgery were searched in the following databases up to 10 February 2023: Medline (through PubMed), Embase, and Cochrane Library.

A specific research query was adopted for each database, using the following keywords: hugo robot; versius robot; da vinci single-port robot; flex robotic system robot; senhance robot; revo-i robot; microhand robot; hinotori robot; avatera robot; distalmotion robot; maestro robot; bitrack system robot; sport surgical system robot; mira robot; mantra robot. Due to the adoption of proper commercial names, multiple spellings for each word were adopted to avoid any missing data related to the improper name typing in the existing publications.

According to the PICOS format, the following items were used to select the retrieved articles:

P, population: patients > 18 years undergoing a robotic intervention with a platform different from Intuitive Surgical multiport Da Vinci S®/Si®/Xi®/X®.

I, intervention: any general surgery intervention with the following exclusions: gynecology, urology, thoracic surgery, othorinolaringoiatry, plastic surgery, pediatric surgery.

C, comparison: any comparison or no comparison.

O, outcomes: all reported outcomes, such as intraoperative, postoperative, short-term, long-term, functional, learning-curve, or cost analysis.

S, study design: due to the expected paucity of studies on the topic, all types of study design were considered, including case reports. Systematic and narrative reviews were

excluded. Redundant studies were included and highlighted in the results. Abstract or congress communications were excluded. Only studies in English language were included.

The literature search and selection were performed by two independent reviewers (FM, LS). According to the PRISMA methodology, all records were first merged into a single database, then duplicates were removed, and the remaining articles were reviewed for relevance using the title and abstract. Disagreement was resolved by discussion and consensus; if no agreement was reached, a third senior author was consulted (NdA) in assessing study inclusion.

Finally, the two reviewers, supported by three supplemental reviewers (AZ, VL, OM) performed an independent full-text analysis to finalize the inclusion of pertinent articles.

The protocol has been registered in the International Prospective Register of Systematic Reviews database (PROSPERO: CRD42023416428).

2.2. Data Extraction and Synthesis

An electronic spreadsheet was filled with data extracted from the selected studies. The following items were collected: first author's name, year of publication, country, type of study design, time frame of the study, pathological state requiring surgical intervention, number of patients/procedures evaluated, type of surgical intervention, adopted robotic platform, number of robotic and assistant arms adopted, number of surgeons involved, surgeon experience, surgical team experience, patient's age, patient's sex, intraoperative surgical outcomes, postoperative surgical outcomes, short-term outcomes, long-term outcomes, functional outcomes, learning-curve, or cost analysis.

2.3. Quality Assessment

The risk of bias of the included studies was assessed according to the MINORS scoring system. The MINORS system attributes a score of 0 if the item is not reported, 1 if the item is reported but inadequate, or 2 if the item is reported and adequate. The global highest score is 16 for non-comparative studies and 24 for comparative studies. Case reports were not evaluated due to the high risk of bias by definition.

3. Results

The initial database search identified a total of 1054 studies, of which 266 were duplicates. After screening the titles and abstracts of the 788 remaining articles, 681 were excluded owing to non-pertinent specialty or intervention. After the full-text reading of the 107 eligible articles, a further 4 were excluded since 1 was a review article and 3 did not have a full-text version available. One-hundred and three studies met the inclusion criteria and were selected for the qualitative synthesis of the literature (Figure 1).

Among the included studies, 36 were case reports [11–46], 52 were noncomparative studies [47–98], and 15 were comparative studies [99–113]. Only one study was a randomized controlled trial [103].

The comparator was the Intuitive Surgical Da Vinci robot in ten cases [99–101,103–107,110,112] and the laparoscopic approach in six cases [102,105,106,108,109,111]. Only one study compared two different techniques with the same platform [113].

A total of 4053 patients were described, of whom 3099 were operated on with a new robotic platform. The population consisted of 1526 women (49.2%) and 1569 men (50.6%) and 4 patients (0.1%) whose sex was not specified. The age of the patients ranged between 15 and 92 years. Several series included the same population reducing the total number to 2819 patients (Table 1).
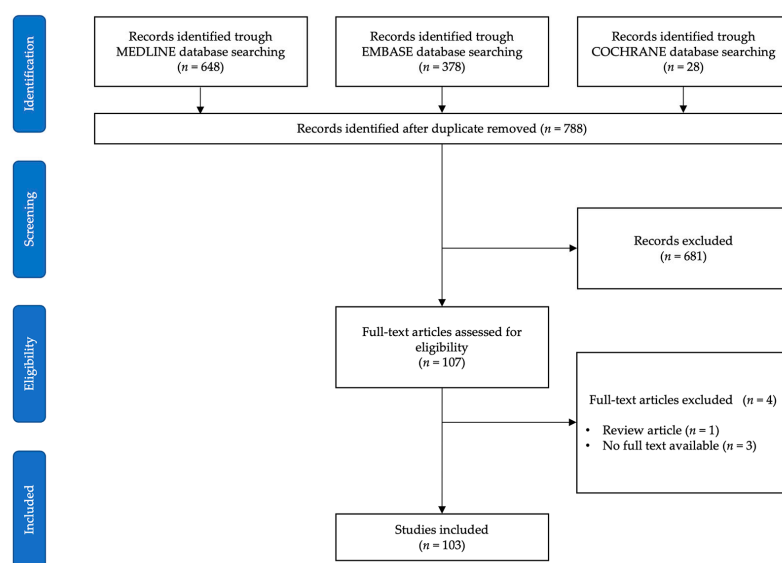
Figure 1. PRISMA flowchart of the literature search and selection.

Table 1. Number of interventions according to the surgical specialties and the type of robotic platforms.

Robotic Platform \ Surgical Specialty	Intuitive Surgical Da Vinci SP®	CMR Versius®	Asensus Senhance®	Wego MicroHand S/SII	Medrobotics Flex®	Meerecompany Revo-i™	Medtronic Hugo™ RAS	Total Cases Per Specialty
Hepatobiliary	386	422	114	96	0	17	0	1035
Colorectal	78	169	251	209	33	0	1	741
Abdominal wall	89	97	345	0	0	0	0	531
Endocrine	298	5	12	0	0	0	0	315
Upper GI	4	69	19	32	0	0	0	124
Breast	73	0	0	0	0	0	0	73
Total cases per platform	928	762	741	337	33	17	1	2819

The authors belonged to institutions located in: South Korea (*n* = 27), China (*n* = 16), North America (*n* = 13), Lithuania (*n* = 11), Japan (*n* = 8), Germany (*n* = 6), Italy (*n* = 6), United Kingdom (*n* = 6), India (*n* = 4), United Arab Emirates (*n* = 2), Taiwan (*n* = 1), France (*n* = 1), Croatia (*n* = 1), Australia (*n* = 1).

The reported cases belonged to several specialties: hepatopancreatobiliary surgery [13, 37–39,50–55,78,79,87–97,100–103] (Tables S1 and S2), colorectal surgery [14–36,56–75,88–91,93–98,104–111] (Tables S1 and S3), abdominal wall surgery [11,12,47–49,87–90,93–95,99] (Tables S1 and S4), endocrine surgery [76,77,81–83,112,113] (Table S5), upper gastrointestinal and bariatric surgery [42–45,71,84,86,88,95–98] (Tables S1 and S6), breast surgery [40,41,80] (Table S7).

The most performed procedure according to the specialty was: cholecystectomy in hepatobiliary surgery, anterior rectal resection in colorectal surgery, transabdominal preperitoneal hernia repair in abdominal wall surgery, transaxillar hemithyroidectomy in endocrine surgery, transthoracic esophagectomy in upper gastrointestinal surgery, and nipple sparing mastectomy in breast surgery.

Perioperative and postoperative outcomes were reported, respectively, in 101 (98.1%) [13–87,89–113] and 99 (96.1%) [13–18,21–113] studies. Five authors assessed the procedural learning curve [49,54,83,108,109]. One article investigated the patients' satisfaction [53]. Functional results were reported in colorectal surgery by five authors only [104–106,108,109].

No major issues related to the robotic system were reported, except for five cases with the same robotic system, reported by three different authors, which did not generate consequent serious clinical events [48–50].

The mean MINORS score was 9 (4–14) and 16 (9–22) for non-comparative and comparative studies, respectively.

3.1. Surgery Setting

Most of the reported cases were elective surgeries (91.2%). Thirteen articles reported on emergency cases performed via a robotic approach. Two incarcerated hernias [12,88], one perforated gastric ulcer [96], seven acute appendicitis [91,96], and 99 acute cholecystitis [50–52,54,87,88,97,100] were described.

3.2. Robotic Platforms

Fifteen different robotic platforms were identified on the internet. Seven robotic platforms were identified as authorized for clinical use in at least one healthcare system (Medtronic Hugo™ RAS; Cambridge Medical Robotics Versius®; Intuitive Surgical Da Vinci SP®; Medrobotics Corp. Flex Robotic System; Asensus Senhance® ALF-X; Meerecompany Inc. Revo-i™; Wego Micro Hand S) and their clinical results were reported. Five robotic systems have been authorized but no clinical data were available in scientific literature (Medicaroid Hinotori™; Avatera Medical Avatera®; Distalmotion Dexter; Moon Surgical Maestro; Virtual Incision MIRA). Three additional surgical platforms were detected but no clinical approval nor application was retrieved (Titan Medical Inc ENOS™; SS Innovation Mantra; Rob Surgical Systems S Bitrack System).

The regulatory approvals and the available information on these platforms are reported in Table 2.

Table 2. Regulatory approvals and available information of the robotic platforms.

Clinically Adopted Platforms				
Company	Product Name	Country	Regulatory Approvals	Marketing Information (n. Procedures/Platform)
Medtronic	Hugo™ RAS	US	FDA: ongoing CE-mark: general surgery; urology; gynecology Australian TGA: urology; gynecology Health Canada: general surgery MHLW PMDA Japan: urology; gynecology	NR
Cambridge Medical Robotics	Versius®	England	CE-mark: general surgery; urology; gynecology; thoracic surgery Australian TGA: general surgery; urology; gynecology Anvisa Brazil: general surgery; urology; gynecology Other countries: India; Pakistan; Egypt	10,000 procedures performed (March 2023) [114] >100 installed platforms (November 2022) [115]
Intuitive Surgical	Da Vinci SP®	US	FDA: urology; transoral procedures MHLW PMDA Japan: urology; gynecology; general surgery; thoracic surgery; transoral MFDS Korea: urology; general surgery; gynecology; thoracic surgery; transoral NMPA China: yes, not specified	121 installed platform (December 2022) [116] A'design award winner 2019
Medrobotics Corp.	Flex® Robotic System	US	FDA: transoral; colorectal; general surgery; gynecology; thoracic surgery CE-mark: colorectal Australian TGA: colorectal	Bankrupt of the producing company

Table 2. *Cont.*

Clinically Adopted Platforms				
Company	Product Name	Country	Regulatory Approvals	Marketing Information (n. Procedures/Platform)
Asensus (formerly TransEnterix)	Senhance® ALF-X	US	FDA: general surgery; gynecology. Pediatric surgery expected in 2023 CE-mark: general surgery; gynecology; pediatric surgery MHLW PMDA Japan: urology; gynecology; general surgery; thoracic surgery Roszdravnadzor—Russia: yes, not specified Taiwan: yes, not specified	>10,000 procedures performed (February 2023) >49 installed platforms between 2016 and 2022 [117]
Meerecompany Inc.	Revo-i™	South Korea	MFDS Korea: urology; gynecology; general surgery	NR
Wego	Micro Hand S	China	NMPA China: general surgery	Reddot award winner 2022
Platforms under Clinical Investigation				
Company	Product Name	Country	Regulatory Approvals	Marketing Information
Medicaroid	Hinotori™	Japan	MHLW PMDA Japan: urology; gastrointestinal; gynecology	840 procedures (December 2022) 28 installed platforms (September 2022) [118]
Avatera Medical	Avatera	Germany	CE-mark: urology; gynecology	Fist clinical procedure in May 2022 [119]
Distalmotion	Dexter	Switzerland	CE-mark: general surgery; gynecology	4 installed platforms [120] iF design award 2020
Moon Surgical	Maestro	US	FDA: laparoscopic procedures CE-mark: laparoscopic procedures	30 procedures performed [121]
Virtual Incision	MIRA	US	FDA: completed IDE for bowel resections. De novo classification pathway ongoing	NR
Titan Medical Inc.	ENOS™ (formerly SPORT)	Canada	FDA: planned in 2023 CE-mark: planned in 2023/24	NR
SS Innovation	Mantra	India	FDA: planned in 2023 CE-mark: planned in 2023 Other countries: India	5 installed platforms 100 procedures performed [122]
Rob Surgical Systems S	Bitrack System	Spain	NR	First clinical trial ongoing [123]

US: United States; FDA: food and drug administration; CE: Conformité Europeenne; TGA: Therapeutic Goods Administration; MHLW PMDA: Ministry of Health, Labour and Welfare Pharmaceuticals and Medical Devices Agency; NR: not reported; MFDS: Ministry of Food and Drug Safety; NMPA: National Medical Products Administration; IDE: Investigational Device Exemption.

3.2.1. Patient Chart Architecture

Five systems (Medtronic Hugo™ RAS; Cambridge Medical Robotics Versius®; Asensus Senhance® ALF-X; Distalmotion Dexter; SS Innovation Mantra) are modular with independent arms ranging from three to four, including the optical arm.

Five platforms (Meerecompany Inc. Revo-i™; Wego Micro Hand S; Medicaroid Hinotori™; Avatera Medical Avatera®; Rob Surgical Systems S Bitrack System) have a multiarm architecture with three to four arms, including the optical arm.

Two systems (Intuitive Surgical Da Vinci SP®; Titan Medical Inc ENOS™) are single port surgery platforms endowed with three to four arms, including the optical arm, characterized by flexible arms.

One robotic platform (Virtual Incision MIRA) shows a new miniaturized architecture allowing the entrance and the deployment of the two sterile arms and the optics directly into the body through a single incision.

One platform (Medrobotics Corp. Flex Robotic System) is a flexible endoscope with two operating arms.

One system (Moon Surgical Maestro) is intended to hold and position laparoscopes and laparoscopic instruments during laparoscopic surgical procedures, like an assisted laparoscopy rather than robotics (Table 3).

Table 3. Summary of the overall characteristics of the robotic platforms.

Robotic Platform	Patient Chart Architecture	Console Architecture	Operative Arms No.	Trocars	Instruments	Instruments' Reusability	Advanced Energy
Medtronic Hugo™ RAS	Modular	Open	3	Commercial	Wristed	Reusables (some disposables)	NA
Cambridge Medical Robotics Versius®	Modular	Open	3	Commercial	Wristed	Reusables	NA
Intuitive Surgical Da Vinci SP®	Single port	Closed	3	Dedicated + commercial	Wristed	Reusables	NA
Medrobotics Corp. Flex® Robotic System	Flexible system	/	2	/	Wristed	Disposables	NA
Asensus Senhance® ALF-X	Modular	Open	3	Commercial	Rigid with a kit of wristed	Reusables	Ultrasonic (rigid)
Meerecompany Inc. Revo-i™	Multiarm	Closed	3	Commercial	Wristed	Reusables	Ultrasonic (rigid)
Wego Micro Hand S	Multiarm	Open	2	Dedicated	Wristed	Reusables	Ultrasonic (rigid)
Medicaroid Hinotori™	Multiarm	Semi-open	3	Dedicated	Wristed	Reusables	NA
Avatera Medical Avatera	Multiarm	Semi-open	3	NR	Wristed	Disposables	NA
Distalmotion Dexter	Modular	Open (with laparoscopic screen)	2	Commercial	Wristed	Disposables	NA
Moon Surgical Maestro	Multiport instrument holder	/	1	Commercial	/	/	NA
Virtual Incision MIRA	Single port	Open	2	NR	Wristed	Reusables	NA
Titan Medical Inc. ENOS™ (formerly SPORT)	Single port	Open	2	NR	Wristed	Reusables	NA
SS Innovation Mantra	Modular	Open	3	Dedicated	Wristed	Reusables	NA
Rob Surgical Systems S Bitrack System	Multiarm	Open	3	Commercial	Wristed	Disposables	NA

NR: not reported; NA: not available.

3.2.2. Surgeon Console Architecture

The majority (64.3%) of the analyzed systems have an open console (Medtronic Hugo™ RAS; Cambridge Medical Robotics Versius®; Asensus Senhance® ALF-X; Wego Micro Hand S; Virtual Incision MIRA; Titan Medical Inc. ENOS™; SS Innovation Mantra; Rob Surgical Systems S Bitrack System; Distalmotion Dexter). One of them (Distalmotion Dexter) does

not have a dedicated viewing system but adopts a laparoscopic screen, considering that the surgeon console is sterile, and the operating surgeon is in the surgical field.

Two robots have a closed console with a Da Vinci-like architecture (Intuitive Surgical Da Vinci SP®; Meerecompany Inc. Revo-i™).

Two systems adopt a semi-open console (Avatera Medical Avatera®; Medicaroid Hinotori™) with an immersive view into a closed viewer but without the bulky system, reducing the physical isolation of the operating surgeon.

One system (Medrobotics Corp. Flex® Robotic System) does not have a real console but an open bidimensional screen to drive the endoscope and two mechanical arms directly controlled by the surgeon with no electromechanical mediation.

One system (Moon Surgical Maestro) is more a holder for laparoscope and instruments so it does not have a dedicated console (Table 3).

3.2.3. Trocars, Instruments, and Reusability

Seven robotic platforms adopt commercial laparoscopic trocars (Cambridge Medical Robotics Versius®; Asensus Senhance® ALF-X; Medtronic Hugo™ RAS; Meerecompany Inc. Revo-i™; Distalmotion Dexter; Moon Surgical Maestro; Rob Surgical Systems S Bitrack System), while three (Wego Micro Hand S; Medicaroid Hinotori™; SS Innovation Mantra) opt for a dedicated trocar. One system adopts a dedicated metallic trocar with a disposable commercial single site access system (Intuitive Surgical Da Vinci SP®)

Medrobotics Corp. Flex® Robotic System is like a coloscope with no need for trocars.

Three platforms (Titan Medical Inc ENOS™; Virtual Incision MIRA; Avatera Medical Avatera®) did not still specify the adopted access system but two of them (Titan Medical Inc ENOS™; Virtual Incision MIRA) will probably opt for a single port commercial system.

All the described systems except for two (Asensus Senhance® ALF-X; Moon Surgical Maestro) have wristed or flexible instruments. As an exception, some papers reported the adoption of wristed instruments (Radia®) for the the Asensus Senhance® ALF-X [23,72,93]. Furthermore, the Wego Micro Hand S system is equipped by some authors with a rigid advanced ultrasonic dissector [69,84,96,103,106,109,110].

Nine platforms adopt reusable instruments (Intuitive Surgical Da Vinci SP®; Asensus Senhance® ALF-X; Cambridge Medical Robotics Versius®; Meerecompany Inc. Revo-i™; Medicaroid Hinotori™; Wego Micro Hand S; Virtual Incision MIRA; Titan Medical Inc ENOS™; SS Innovation Mantra). One of them (Virtual Incision MIRA) is totally sterilizable and portable.

One system is partially sterilizable but adopts disposable instruments (Medrobotics Corp. Flex® Robotic System).

Three robotic platforms use disposable instruments (Avatera Medical Avatera®; Distalmotion Dexter; Rob Surgical Systems S Bitrack System).

One robotic system (Medtronic Hugo™ RAS) uses sterilizable instruments with some disposable tools, as the needle driver and the scissor.

One system (Moon Surgical Maestro) does not have robotic tools so laparoscopic instruments can be adopted (Table 3).

3.2.4. Advanced Energy and Staplers

All the platforms support monopolar and bipolar energy but only three systems (Asensus Senhance® ALF-X; Wego Micro Hand S; Meerecompany Inc. Revo-i™) offer advanced ultrasonic energy.

A complete gamma of staplers or advanced energy is not currently available for any of the investigated platforms (Table 3).

3.3. Training

Forty-five (43.7%) authors reported the surgical background of the operating surgeon and his previous experience [26,31,33,45,47–59,62,64,67,69,76,77,79,83–92,94,96,99,102–106, 108–110]. A structured training process of the surgical team on the adopted system was

reported by 28 (27.2%) authors [26,40,47–49,51–54,56,58–60,64,67,76,77,85,87,88,90–93,95, 99,109,110]. Of these, only five (4.8%) articles clearly stated the involvement of the nurses in the training process [54,64,77,93,99]. Only one (1%) article described the anesthesiologist as part of the team who underwent the surgical training process [93].

Concerning skill transferability, 26 (25.2%) articles reported a previous experience with a Da Vinci robot [26,31,33,45,47,53,54,56,62,67,69,77,79,83,85,87–90,96,99,103–106,110].

No article reported a previous experience with a platform different from Intuitive Surgical Da Vinci.

Three (2.9%) authors declared the existence of a credentialing program for the surgeon or the hospital [55,56,88]. Proctoring was mentioned by only six (5.8%) papers as part of the translational training during the first cases [48,56,87,88,93,99].

3.4. Registries

Two manufacturers (Asensus Surgical; Cambridge Medical Robotics) provided the surgeons with self-established registries whose results were published [94,124].

3.5. Costs

A cost analysis was performed by only one (1%) study [110]. The analysis compared the robotic total mesorectal excision performed with the Wego Micro Hand S or with its comparator benchmark, the Intuitive Surgical Da Vinci Si®. The Micro Hand S group had lower total hospital costs (87,040.1 ± 24,676.9 yuan vs. 125,292.3 ± 17,706.7 yuan, $p < 0.05$) and surgery costs (25,772.3 ± 4117.0 yuan vs. 46,940.9 ± 10,199.7 yuan, $p < 0.05$) when compared to the Da Vinci group.

4. Discussion

Robotic surgery has increasingly been adopted in general surgery since 2001 [125]. For years, the only widely adopted system was the Intuitive Surgical Da Vinci robot but, more recently, several other robotic platforms have been launched and introduced in the current practice after clinical approval in the respective markets. The present systematic review constitutes a state of the art of their clinical application.

The literature reviewed was very recent, published between 2016 and 2023, and reported clinical outcomes of over 2800 patients undergoing a minimally invasive operation with new robotic platforms.

Despite the recent adoption of these newly introduced platforms, the majority of the surgical procedures were performed with no reported adverse outcome and a low rate of technical issues related to the robot malfunction, confirming the reliability of the described systems. The new robots were mostly adopted for hepatopancreatobiliary, colorectal, and abdominal wall surgeries while fewer cases were reported for endocrine, upper gastrointestinal, and breast surgery. While some specialties, such as colorectal surgery, seemed to have extensively benefited from the new devices, others like the hepatopancreatobiliary surgery did not fully exploit their potential as the most performed procedure in such specialty still remains cholecystectomy. One of the reasons for this difference could be the absence of advanced instruments like staplers and powered dissectors, still not available for most of the presented robots. Another explanation could be found in the adoption of the new robotic platforms by hospitals aiming to improve the surgical volume and the attractiveness, even on simple procedures such as hernia surgery and cholecystectomy [126].

Nevertheless, the clinical indications for the new platforms are growing thanks to the constant approval of new specialties and new procedures in different countries.

The robotic platforms that are less represented in this review are expanding their market and new reports are available on a daily basis, following the acquisition by hospitals [127,128]. This robotic surgery broadening favored even general emergency surgeries for routine indications, such as appendicitis or cholecystitis, following a current trend in

the literature [129]. Included articles belong to different continents but more than 50% were from Asia, where market is mainly driven by China, Japan, South Korea, India, and Taiwan.

These countries represent a population of more than 3 billion people, and they are pushing towards the development of indigenous platforms with the aim to compete with the existing Da Vinci. Concerning the Chinese market, the import of foreign robots is subject to a very limited quota, which was fully covered by Intuitive Surgical before the arrival of new competitors. The increasing complexity in the regulations will likely cut out expensive imported robots from the local market in favor of newly developed Chinese systems but it is not clear whether other countries will benefit from the commercialization of these platforms [130,131]. Access to the new technologies from China is extremely limited mainly due to the language barrier and the limited sharing of technical information, but currently several devices appear to be under testing and commercialization [132–134]. As for China, even Japan has a long history in robotic surgery, and it recently pushed the development of an indigenous product (Medicaroid Hinotori™). The company's philosophy is tailored to suit the local market, promoting a smaller robot for smaller patients. However, it is also considering global expansion plans, as substantiated by its newly announced partnership with Karl Storz for the vision system [135] and the installation of the robot into a European training center [136]. Likewise, South Korea and India also developed their own systems with the aim of reducing robotic surgery expenses and facilitating the access to their population [137,138].

All the platforms presented in this review differ in nature, history, development, and technology. Only half of the included robots demonstrated their clinical potential while the rest are still under approval or in the investigational stage. The multi-arm robotic architecture invented by the Intuitive Surgical experience was adopted only by five manufacturers, whereas five others developed a modular concept more inspired by laparoscopy. Although the concept of "new robot" refers to small, portable, modular devices equipped with small instruments, this point was not agreed upon by the authors when reviewing the currently available robotic architecture, which is largely inspired by the well-known Da Vinci system. [139]. New concepts are emerging in the existing literature such as the mini-robot by Virtual Incision MIRA or the single port systems by Intuitive Surgical and Titan Medical emerged from the literature, leading to debates regarding indications and results, as it was in the laparoscopic era [140]. Additionally, two mentioned systems introduced the opportunity to robotize two routine practices such as the colonoscopy (Medrobotics Flex®) and the common laparoscopy (Moon Surgical Maestro). These innovations require proper trials to demonstrate their usefulness due to the current lack of clinical evidence.

Furthermore, analysis of instruments and trocars reveal differences across platforms in terms of materials, dimensions, and degree of articulation. Cost reduction, processability of instruments, tools' precision, and CO_2 emission remain top priorities for manufacturers despite the absence of common consensus, moreover regarding the use of reusable or disposable instruments.

These profound differences complicate a direct comparison between available robotic platforms. The only studies that aimed to show differences between manufacturers, were related to the Chinese Wego Micro Hand S system. The authors produced redundant literature demonstrating the equivalence of their new system with the existing Intuitive Surgical Da Vinci. In addition, they reported a decrease in hospital and surgical costs which could represent an advantage [110]. Additional economic studies are necessary to understand the real economic impact of the new platforms in various surgical environments.

The heterogeneous global situation, the variety of robots, and the continuous market growth are expected to revolutionize the clinical scenario in general surgery. Healthcare professionals will probably encounter multiple platforms throughout their career.

Due to the new paradigm of multiple robotic platforms possible co-existing in the same hospital, a proper credentialing system becomes essential.

The training process in surgery has been a topic of debate for decades, both in elective and emergency surgery [141]. Despite more than two decades of robotic surgery adoption as a surgical treatment across multiple specialties, no definitive training and credentialing programs were defined. Recently, Stefanidis et al. [142] and Burke et al. [143] tried to cope with this issue in the United States and United Kingdom, respectively. Currently, the proficiency assessment on the single platform is guaranteed by the manufacturer and hospitals grant permission to utilize the robot according to regulatory policies. This paper highlights that only 43.7% of the studies reported the operating surgeon's previous experience. In addition, only 27.2% of the authors described the training process of the surgical team on the adopted platform. The involvement of the nurses and of the anesthesiologists is even more marginal, despite a growing interest in literature for the topic [144,145]. The proposed structured training from a single manufacturer confirms the technical ability of the surgeon to accomplish prefixed tasks in different settings (usually simulation, dry lab, wet lab on pigs and/or cadavers). Typically, the first clinical procedures performed are proctored, although this is reported by less than 6% of the authors.

These training modalities have been extensively adopted since the introduction of robotic surgery despite limited evidence and some conflict of interest. In fact, proficiency assessment is performed by the same company that has an interest in the robot's clinical adoption. As there is no standardized curriculum in robotic surgery, analyzed papers did not provide information on the transferability of the skills from one platform to another. In a simulation environment, Larkins et al. were able to demonstrate some degree of robotic console skill transferability between two different multiport robotic platforms [146], while Ghazi et al. concluded for a partial transferability when simulating multiport and single-port robotic surgery [147]. In urology, currently the main market for robotic companies, a transition towards new systems were observed with positive clinical results [148], and it is reasonable to expect a similar process of validation for general surgery.

In order to validate the transition to new robotic devices, robotic companies are developing their products in collaboration with clinicians, trying to differentiate their approach and to collect data from the clinical activities. Two recently published registry analyses concerning the adoption of the two mainly diffused new generation robots, namely Asensus Senhance® and CMR Versius®, reported 871 and 2083 cases, respectively [94,124]. The published databases will make the comparison of clinical outcomes simpler and more transparent. Furthermore, the registry promotion distinguished the competitors from Da Vinci.

The next stage of development will focus on the producer partnership to improve and ameliorate the existing products in order to better compete in a market still dominated by a single leader. The vision capabilities will be augmented thanks to the new technological standards, as announced in February 2023 by Asensus with its new Luna Surgical System endowed with a 4K-3D vision without the need to wear glasses.

In terms of clinical data analysis, the next major advancement will entail the adoption of artificial intelligence as proposed by Asensus or Medicaroid, in order to digitalize the surgical practice, opening the door to new opportunities such as the telesurgery [149,150].

The present review presents some limitations mainly related to the low-quality of existing evidence, the design and the small sample of studies included, and the absence of data on several robotic platforms. Nevertheless, this systematic review provides a good snapshot of the real clinical application of the recently introduced platforms in general surgery.

5. Conclusions

Robotic procedures with new robotic devices have been progressively described in hepatobiliary, colorectal, abdominal wall, upper gastrointestinal, endocrine and breast surgery. Despite the low-quality of the current evidence, this review suggests that most surgical interventions are feasible with no technical issues. More platforms are obtaining clinical approvals and their continuous development will be likely stimulated by the Asian

market. However, the absence of an international training curriculum and credentialing program hinders the ability to evaluate surgical proficiency and the transferability of skills across different devices. Thus, the future holds substantial technological innovation whose clinical evidence is yet to be established.

References

1. Sheetz, K.H.; Claflin, J.; Dimick, J.B. Trends in the Adoption of Robotic Surgery for Common Surgical Procedures. *JAMA Netw. Open* **2020**, *3*, e1918911. [CrossRef] [PubMed]
2. Mehta, A.; Cheng Ng, J.; Andrew Awuah, W.; Huang, H.; Kalmanovich, J.; Agrawal, A.; Abdul-Rahman, T.; Hasan, M.M.; Sikora, V.; Isik, A. Embracing robotic surgery in low- and middle-income countries: Potential benefits, challenges, and scope in the future. *Ann. Med. Surg.* **2022**, *84*, 104803. [CrossRef] [PubMed]
3. Pugin, F.; Bucher, P.; Morel, P. History of robotic surgery: From AESOP® and ZEUS® to da Vinci®. *J. Visc. Surg.* **2011**, *148*, e3–e8. [CrossRef] [PubMed]
4. World Intellectual Property Organization (WIPO). Global Forum for Intellectual Property Policy, Services, Information and Cooperation. Available online: https://patentscope.wipo.int (accessed on 23 May 2023).
5. Brodie, A.; Vasdev, N. The future of robotic surgery. *Ann. R. Coll. Surg. Engl.* **2018**, *100*, 4–13. [CrossRef]
6. Hughes, T.; Rai, B.; Madaan, S.; Chedgy, E.; Somani, B. The Availability, Cost, Limitations, Learning Curve and Future of Robotic Systems in Urology and Prostate Cancer Surgery. *J. Clin. Med.* **2023**, *12*, 2268. [CrossRef]
7. Intuitive Surgical. J.P. Morgan Healthcare Conference 2023. Available online: https://isrg.intuitive.com/static-files/6683d2bb-75e2-4fa0-b0cd-463ead7c30a4 (accessed on 23 May 2023).
8. Zhang, W.; Li, H.; Cui, L.; Li, H.; Zhang, X.; Fang, S.; Zhang, Q. Research progress and development trend of surgical robot and surgical instrument arm. *Int. J. Med. Robot.* **2021**, *17*, e2309. [CrossRef]
9. Higgins, J.P.T.; Thomas, J.; Chandler, J.; Cumpston, M.; Li, T.; Page, M.J.; Welch, V.A. (Eds.) *Cochrane Handbook for Systematic Reviews of Interventions Version 6.3 (Updated February 2022)*; Cochrane: London, UK, 2022.
10. Moher, D.; Liberati, A.; Tetzlaff, J.; Altman, D.G.; Group, P. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ* **2009**, *339*, b2535. [CrossRef]
11. Kim, C.H.; Al-Sawat, A.; Lee, C.S. Single-port robot-assisted extended totally extraperitoneal repair for ventral hernia using the da Vinci single-port platform: A video vignette. *Asian J. Surg.* **2022**, *45*, 1751–1752. [CrossRef]
12. Kim, D.; Lee, C.S. Single-port robotic totally extraperitoneal(TEP) inguinal hernia repair using the da Vinci SP platform: A video vignette. *Asian J. Surg.* **2022**, *45*, 2062–2063. [CrossRef]
13. Cruz, C.J.; Yang, H.Y.; Kang, I.; Kang, C.M.; Lee, W.J. Technical feasibility of da Vinci SP single-port robotic cholecystectomy: A case report. *Ann. Surg. Treat. Res.* **2019**, *97*, 217–221. [CrossRef]
14. Alshalawi, W.; Lee, C.S.; Lee, Y.S. Single-port robotic intersphincteric resection for very low rectal cancer with the da Vinci SP platform. *Asian J. Surg.* **2022**, *46*, 1056–1057. [CrossRef] [PubMed]
15. Bak, M.R.; Lee, I.K.; Lee, Y.S.; Lee, C.S. Single-port robotic ventral mesh rectopexy for recurrent rectal prolapse with the da Vinci SP platform: A video vignette. *Asian J. Surg.* **2022**, *46*, 1317–1318. [CrossRef] [PubMed]

16. Minagawa, Y.; Hirano, Y.; Kataoka, A.; Shimamura, S.; Kataoka, M.; Asari, M.; Fujii, T.; Ishikawa, S.; Ishii, T.; Sato, H.; et al. The first single-incision plus one-port transverse colon resection using Senhance Digital Laparoscopy System: A case report. *Surg. Case Rep.* **2021**, *7*, 89. [CrossRef] [PubMed]

17. Samalavicius, N.E.; Klimasauskiene, V.; Janusonis, V.; Samalavicius, A.; Dulskas, A. Robotic total mesorectal excision for mid-rectal cancer using the Senhance® robotic platform—A video vignette. *Color. Dis.* **2020**, *22*, 592–593. [CrossRef]

18. Hirano, Y.; Kondo, H.; Miyawaki, Y.; Sugita, H.; Sakuramoto, S.; Yamaguchi, S. Single-incision plus two-port robotic surgery for sigmoid colon cancer using the Senhance robotic system. *Asian J. Endosc. Surg.* **2021**, *14*, 94–96. [CrossRef] [PubMed]

19. Samalavicius, N.E.; Smolskas, E.; Deduchovas, O.; Janusonis, V.; Dulskas, A. Robotic abdominoperineal resection for pT2N0M0 low rectal cancer using the Senhance TransEnterix robotic platform—A video vignette. *Color. Dis.* **2019**, *21*, 847–848. [CrossRef]

20. Samalavicius, N.E.; Smolskas, E.; Deduchovas, O.; Janusonis, V.; Dulskas, A. Robotic right colectomy using the new Senhance® robotic platform: A three-trocar technique—A video vignette. *Color. Dis.* **2019**, *21*, 1092–1093. [CrossRef]

21. Samalavicius, N.E.; Smolskas, E.; Janusonis, V.; Deduchovas, O.; Dulskas, A. Robotic sigmoid resection for locally advanced cancer using the Senhance Transenterix robotic platform—A video vignette. *Color. Dis.* **2019**, *21*, 1216. [CrossRef]

22. Samalavicius, N.E.; Janusonis, V.; Smolskas, E.; Dulskas, A. Transanal and robotic total mesorectal excision (robotic-assisted TaTME) using the Senhance® robotic system—A video vignette. *Color. Dis.* **2020**, *22*, 114–115. [CrossRef]

23. Samalavicius, N.E.; Klimasauskiene, V.; Janusonis, V.; Samalavicius, R.S.; Janusonis, T.; Dulskas, A. Abdominoperineal resection for low rectal neuroendocrine carcinoma after neoadjuvant chemotherapy using the Senhance robotic system with articulating Radia instrument—A Video Vignette. *Color. Dis.* **2022**, *24*, 798–799. [CrossRef]

24. Samalavicius, N.E.; Klimasauskiene, V.; Nausediene, V.; Janusonyte-Mongirdiene, H.; Liekis, A.; Dulskas, A. Sigmoid colon resection for sigmoid cancer using a Senhance robotic system and indocyanine green fluorescent angiography-a video correspondence. *Color. Dis.* **2023**, *25*, 1062–1063. [CrossRef] [PubMed]

25. Kataoka, A.; Hirano, Y.; Kondo, H.; Shimamura, S.; Kataoka, M.; Asari, M.; Fujii, T.; Ishikawa, S.; Ishii, T.; Yamaguchi, S. Right hemicolectomy with D3 lymph node dissection for right-sided transverse colon cancer using the Senhance robotic system: A case report. *Surg. Case Rep.* **2020**, *6*, 263. [CrossRef] [PubMed]

26. Kondo, H.; Yamaguchi, S.; Hirano, Y.; Ishii, T.; Obara, N.; Wang, L.; Asari, M.; Kato, T.; Takayama, T.; Sugita, H.; et al. A first case of ileocecal resection using a Senhance Surgical System in Japan. *Surg. Case Rep.* **2020**, *6*, 95. [CrossRef] [PubMed]

27. Campagna, G.; Panico, G.; Vacca, L.; Caramazza, D.; Mastrovito, S.; Lombisani, A.; Ercoli, A.; Scambia, G. Robotic sacrocolpopexy plus ventral rectopexy as combined treatment for multicompartment pelvic organ prolapse using the new Hugo RAS system. *Tech. Coloproctol.* **2023**, *27*, 499–500. [CrossRef] [PubMed]

28. Piozzi, G.N.; Lee, D.Y.; Kim, J.S.; Kim, S.H. Da Vinci Single-Port (SP) robotic transverse colectomy for mid-transverse colon cancer. *Tech. Coloproctol.* **2022**, *26*, 681–682. [CrossRef] [PubMed]

29. Choo, J.M.; Kim, J.S.; Cheong, J.Y.; Rusli, S.M.; Park, H.; Kim, S.H. Application of a Single-Port Robotic System for Right Colectomy: A Novel Suprapubic Approach. *Dis. Colon. Rectum* **2022**, *65*, e1029. [CrossRef]

30. Cheong, J.Y.; Choo, J.M.; Kim, J.S.; Rusli, S.M.; Kim, J.; Kim, S.H. Da Vinci SP System Optimized for Intersphincteric Resection of Very Low Rectal Cancer. *Dis. Colon. Rectum* **2022**, *65*, e174. [CrossRef]

31. Marks, J.H.; Salem, J.F.; Anderson, B.K.; Josse, J.M.; Schoonyoung, H.P. Single-port robotic left colectomy: First clinical experience using the SP robot (rSILS). *Tech. Coloproctol.* **2020**, *24*, 57–63. [CrossRef]

32. Arezzo, A.; Forcignanò, E.; Morino, M. Robotic endoscopic submucosal dissection and full-thickness excision for laterally spreading tumors of the rectum. *Minim. Invasive Ther. Allied Technol.* **2022**, *31*, 377–379. [CrossRef]

33. Marks, J.H.; Kunkel, E.; Salem, J.; Martin, C.; Schoonyoung, H.P.; Agarwal, S. rSILS: Initial clinical experience with single-port robotic (SPr) right colectomy. *Tech. Coloproctol.* **2020**, *24*, 817–822. [CrossRef]

34. Marks, J.H.; Kunkel, E.; Salem, J.F.; Martin, C.; Anderson, B.; Agarwal, S. First clinical experience with single-port robotic transanal minimally invasive surgery (SP rTAMIS) for benign rectal neoplasms. *Tech. Coloproctol.* **2021**, *25*, 117–124. [CrossRef] [PubMed]

35. Marks, J.H.; Agarwal, S.; Kunkel, E.; Schoonyoung, H.; Salem, J.F. Video Demonstration of an Initial Single-Port Robotic Transanal Total Mesorectal Excision. *Dis. Colon. Rectum* **2021**, *64*, e472–e473. [CrossRef] [PubMed]

36. Marks, J.H.; Salem, J.F.; Adams, P.; Sun, T.; Kunkel, E.; Schoonyoung, H.; Agarwal, S. SP rTaTME: Initial clinical experience with single-port robotic transanal total mesorectal excision (SP rTaTME). *Tech. Coloproctol.* **2021**, *25*, 721–726. [CrossRef] [PubMed]

37. Kim, W.J.; Park, P.J.; Choi, S.B.; Kim, W.B. Case report of pure single-port robotic left lateral sectionectomy using the da Vinci SP system. *Medicine* **2021**, *100*, e28248. [CrossRef]

38. Kang, I.; Hwang, H.K.; Lee, W.J.; Kang, C.M. First experience of pancreaticoduodenectomy using Revo-i in a patient with insulinoma. *Ann. Hepatobiliary Pancreat. Surg.* **2020**, *24*, 104–108. [CrossRef] [PubMed]

39. Ku, G.; Kang, I.; Lee, W.J.; Kang, C.M. Revo-i assisted robotic central pancreatectomy. *Ann. Hepatobiliary Pancreat. Surg.* **2020**, *24*, 547–550. [CrossRef]

40. Park, H.S.; Lee, J.; Lee, H.; Lee, K.; Song, S.Y.; Toesca, A. Development of Robotic Mastectomy Using a Single-Port Surgical Robot System. *J. Breast Cancer* **2020**, *23*, 107–112. [CrossRef]

41. Joo, O.Y.; Song, S.Y.; Park, H.S.; Roh, T.S. Single-port robot-assisted prosthetic breast reconstruction with the da Vinci SP Surgical System: First clinical report. *Arch. Plast. Surg.* **2021**, *48*, 194–198. [CrossRef]

42. Dreifuss, N.H.; Schlottmann, F.; Cubisino, A.; Bianco, F.M. Novel surgical approach for gastric gastrointestinal stromal tumor (GIST): Robotic single port partial gastrectomy. *Surg. Oncol.* **2022**, *40*, 101704. [CrossRef]

43. Sugita, H.; Sakuramoto, S.; Aoyama, J.; Ito, S.; Oya, S.; Watanabe, K.; Fujiwara, N.; Kondo, H.; Miyawaki, Y.; Hirano, Y.; et al. First experience using the Senhance surgical system in laparoscopic local gastrectomy for gastrointestinal stromal tumor. *Asian J. Endosc. Surg.* **2021**, *14*, 790–793. [CrossRef]

44. Cui, H.; Cui, J.X.; Zhang, K.C.; Liang, W.Q.; Li, S.Y.; Huang, J.; Chen, L.; Wei, B. Can a single-port robot be safely used for robotic total gastrectomy for advanced gastric cancer? First experience using the da Vinci SP platform. *Gastroenterol. Rep.* **2022**, *10*, goac023. [CrossRef] [PubMed]

45. Cubisino, A.; Dreifuss, N.H.; Schlottmann, F.; Baz, C.; Mangano, A.; Masrur, M.A.; Bianco, F.M. Robotic single port anti-reflux surgery: Initial worldwide experience of two cases with a novel surgical approach to treat gastroesophageal reflux disease. *Int. J. Med. Robot.* **2022**, *18*, e2437. [CrossRef] [PubMed]

46. Halabi, M.; Abid, G.; Zenilman, M.E.; Moussa, H. Treatment of an unusual case of Meckel's diverticulum with a new robotic platform. *Int. J. Surg. Case Rep.* **2022**, *99*, 107613. [CrossRef]

47. Dixon, F.; Qureshi, A.; Vitish-Sharma, P.; Khanna, A.; Keeler, B.D. Implementation of robotic hernia surgery using the Versius® system. *J. Robot. Surg.* **2022**, *17*, 565–569. [CrossRef] [PubMed]

48. Samalavicius, N.E.; Dulskas, A.; Sirvys, A.; Klimasauskiene, V.; Janusonis, V.; Janusonis, T.; Eismontas, V.; Deduchovas, O.; Stephan, D.; Darwich, I.; et al. Inguinal hernia TAPP repair using Senhance® robotic platform: First multicenter report from the TRUST registry. *Hernia* **2022**, *26*, 1041–1046. [CrossRef] [PubMed]

49. Schmitz, R.; Willeke, F.; Barr, J.; Scheidt, M.; Saelzer, H.; Darwich, I.; Zani, S.; Stephan, D. Robotic Inguinal Hernia Repair (TAPP) First Experience with the New Senhance Robotic System. *Surg. Technol. Int.* **2019**, *34*, 243–249.

50. Aggarwal, R.; Winter Beatty, J.; Kinross, J.; von Roon, A.; Darzi, A.; Purkayastha, S. Initial Experience With a New Robotic Surgical System for Cholecystectomy. *Surg. Innov.* **2020**, *27*, 136–142. [CrossRef]

51. Kelkar, D.S.; Kurlekar, U.; Stevens, L.; Wagholikar, G.D.; Slack, M. An Early Prospective Clinical Study to Evaluate the Safety and Performance of the Versius Surgical System in Robot-Assisted Cholecystectomy. *Ann. Surg.* **2022**, *277*, 9–17. [CrossRef]

52. Khanna, S.; Barua, A. Robotic assisted cholecystectomy—A retrospective cohort study of experience of 106 first robotic cholecystectomies in versius robotic platform. *Int. J. Surg. Open* **2022**, *47*, 100554. [CrossRef]

53. Lim, J.H.; Lee, W.J.; Choi, S.H.; Kang, C.M. Cholecystectomy using the Revo-i robotic surgical system from Korea: The first clinical study. *Updates Surg.* **2021**, *73*, 1029–1035. [CrossRef]

54. Melling, N.; Barr, J.; Schmitz, R.; Polonski, A.; Miro, J.; Ghadban, T.; Wodack, K.; Izbicki, J.; Zani, S.; Perez, D. Robotic cholecystectomy: First experience with the new Senhance robotic system. *J. Robot. Surg.* **2019**, *13*, 495–500. [CrossRef] [PubMed]

55. Sasaki, T.; Tomohisa, F.; Nishimura, M.; Arifuku, H.; Ono, T.; Noda, A.; Otsubo, T. Initial 30 cholecystectomy procedures performed with the Senhance digital laparoscopy system. *Asian J. Endosc. Surg.* **2022**, *16*, 225–232. [CrossRef] [PubMed]

56. Collins, D.; Paterson, H.M.; Skipworth, R.J.E.; Speake, D. Implementation of the Versius robotic surgical system for colorectal cancer surgery: First clinical experience. *Color. Dis.* **2021**, *23*, 1233–1238. [CrossRef] [PubMed]

57. Dixon, F.; O'Hara, R.; Ghuman, N.; Strachan, J.; Khanna, A.; Keeler, B.D. Major colorectal resection is feasible using a new robotic surgical platform: The first report of a case series. *Tech. Coloproctol.* **2021**, *25*, 285–289. [CrossRef] [PubMed]

58. Fok, K.Y.; Arabaci, F.; Barto, W. Flexible robotic transanal resection of rectal polyps—A case series. *Int. J. Med. Robot.* **2022**, *18*, e2413. [CrossRef]

59. Lin, C.C.; Huang, S.C.; Lin, H.H.; Chang, S.C.; Chen, W.S.; Jiang, J.K. An early experience with the Senhance surgical robotic system in colorectal surgery: A single-institute study. *Int. J. Med. Robot. Comput. Assist. Surg.* **2021**, *17*, e2206. [CrossRef]

60. Morino, M.; Forcignanò, E.; Arezzo, A. Initial clinical experience with a novel flexible endoscopic robot for transanal surgery. *Tech. Coloproctol.* **2022**, *26*, 301–308. [CrossRef]

61. Noh, G.T.; Oh, B.Y.; Han, M.; Chung, S.S.; Lee, R.A.; Kim, K.H. Initial clinical experience of single-incision robotic colorectal surgery with da Vinci SP platform. *Int. J. Med. Robot.* **2020**, *16*, e2091. [CrossRef]

62. Salem, J.F.; Agarwal, S.; Schoonyoung, H.; Martin, C.; Marks, J.H. Initial clinical experience with Single-Port robotic (SP r) left colectomy using the SP surgical system: Description of the technique. *Surg. Endosc.* **2021**, *35*, 4022–4027. [CrossRef]

63. Sasaki, M.; Hirano, Y.; Yonezawa, H.; Shimamura, S.; Kataoka, A.; Fujii, T.; Okazaki, N.; Ishikawa, S.; Ishii, T.; Deguchi, K.; et al. Short-term results of robot-assisted colorectal cancer surgery using Senhance Digital Laparoscopy System. *Asian J. Endosc. Surg.* **2022**, *15*, 613–618. [CrossRef]

64. Spinelli, A.; David, G.; Gidaro, S.; Carvello, M.; Sacchi, M.; Montorsi, M.; Montroni, I. First experience in colorectal surgery with a new robotic platform with haptic feedback. *Color. Dis.* **2017**, *20*, 228–235. [CrossRef]

65. Darwich, I.; Stephan, D.; Klöckner-Lang, M.; Scheidt, M.; Friedberg, R.; Willeke, F. A roadmap for robotic-assisted sigmoid resection in diverticular disease using a Senhance™ Surgical Robotic System: Results and technical aspects. *J. Robot. Surg.* **2020**, *14*, 297–304. [CrossRef]

66. Hirano, Y.; Kondo, H.; Yamaguchi, S. Robot-assisted surgery with Senhance robotic system for colon cancer: Our original single-incision plus 2-port procedure and a review of the literature. *Tech. Coloproctol.* **2021**, *25*, 467–471. [CrossRef]

67. Huscher, C.; Marchegiani, F.; Cobellis, F.; Tejedor, P.; Pastor, C.; Lazzarin, G.; Wheeler, J.; Di Saverio, S. Robotic oncologic colorectal surgery with a new robotic platform (CMR Versius): Hope or hype? A preliminary experience from a full-robotic case-series. *Tech. Coloproctol.* **2022**, *26*, 745–753. [CrossRef]

68. Kim, H.J.; Choi, G.S.; Song, S.H.; Park, J.S.; Park, S.Y.; Lee, S.M.; Choi, J.A. An initial experience with a novel technique of single-port robotic resection for rectal cancer. *Tech. Coloproctol.* **2021**, *25*, 857–864. [CrossRef] [PubMed]

69. Li, J.; Zhu, S.; Juan, J.; Yi, B. Preliminary exploration of robotic complete mesocolic excision for colon cancer with the domestically produced Chinese minimally invasive Micro Hand S surgical robot system. *Int. J. Med. Robot.* **2020**, *16*, e2148. [CrossRef] [PubMed]

70. Piozzi, G.N.; Kim, J.S.; Choo, J.M.; Shin, S.H.; Kim, J.S.; Lee, T.H.; Baek, S.J.; Kwak, J.M.; Kim, J.; Kim, S.H. Da Vinci SP robotic approach to colorectal surgery: Two specific indications and short-term results. *Tech. Coloproctol.* **2022**, *26*, 461–470. [CrossRef] [PubMed]

71. Puntambekar, S.P.; Rajesh, K.N.; Goel, A.; Hivre, M.; Bharambe, S.; Chitale, M.; Panse, M. Colorectal cancer surgery: By Cambridge Medical Robotics Versius Surgical Robot System-a single-institution study. Our experience. *J. Robot. Surg.* **2022**, *16*, 587–596. [CrossRef]

72. Samalavicius, N.E.; Dulskas, A.; Janusonis, V.; Klimasauskiene, V.; Eismontas, V.; Deduchovas, O.; Janusonis, T.; Markelis, R.; Smolskas, E. Robotic colorectal surgery using the Senhance® robotic system: A single center experience. *Tech. Coloproctol.* **2022**, *26*, 437–442. [CrossRef]

73. Song, S.H.; Kim, H.J.; Choi, G.S.; Park, J.S.; Park, S.Y.; Lee, S.M.; Choi, J.A. Initial experience with a suprapubic single-port robotic right hemicolectomy in patients with colon cancer. *Tech. Coloproctol.* **2021**, *25*, 1065–1071. [CrossRef]

74. Liu, S.; Kelley, S.R.; Behm, K.T. Single-port robotic transanal minimally invasive surgery (SPR-TAMIS) approach to local excision of rectal tumors. *Tech. Coloproctol.* **2021**, *25*, 229–234. [CrossRef] [PubMed]

75. Marks, J.H.; Kunkel, E.; Salem, J.F.; Martin, C.T.; Anderson, B.; Agarwal, S. First Clinical Experience With Single-Port Robotic Transanal Minimally Invasive Surgery: Phase II Trial of the Initial 26 Cases. *Dis. Colon. Rectum* **2021**, *64*, 1003–1013. [CrossRef] [PubMed]

76. Knezevic, N.; Penezic, L.; Kulis, T.; Zekulic, T.; Saic, H.; Hudolin, T.; Kastelan, Z. Senhance robot-assisted adrenalectomy: A case series. *Croat. Med. J.* **2022**, *63*, 197–201. [CrossRef] [PubMed]

77. Raffaelli, M.; Gallucci, P.; Voloudakis, N.; Pennestrì, F.; De Cicco, R.; Arcuri, G.; De Crea, C.; Bellantone, R. The new robotic platform Hugo™ RAS for lateral transabdominal adrenalectomy: A first world report of a series of five cases. *Updates Surg.* **2023**, *75*, 217–225. [CrossRef] [PubMed]

78. Choi, Y.J.; Jo, H.S.; Kim, D.S.; Yu, Y.D. Single-port robot plus one port (SP + 1) distal pancreatectomy using the new da Vinci SP system. *Langenbecks Arch. Surg.* **2022**, *407*, 1271–1276. [CrossRef] [PubMed]

79. Liu, R.; Liu, Q.; Zhao, G.; Zhao, Z.; Li, M.; Gao, Y. Single-port (SP) robotic pancreatic surgery using the da Vinci SP system: A retrospective study on prospectively collected data in a consecutive patient cohort. *Int. J. Surg.* **2022**, *104*, 106782. [CrossRef]

80. Go, J.; Ahn, J.H.; Park, J.M.; Choi, S.B.; Lee, J.; Kim, J.Y.; Park, H.S. Analysis of robot-assisted nipple-sparing mastectomy using the da Vinci SP system. *J. Surg. Oncol.* **2022**, *126*, 417–424. [CrossRef]

81. Ho, J.; Kim, D.; Lee, J.E.; Kim, J.K.; Lee, C.R.; Kang, S.W.; Jeong, J.J.; Nam, K.H.; Chung, W.Y. Single-Port Transaxillary Robotic Modified Radical Neck Dissection (STAR-RND): Initial Experiences. *Laryngoscope* **2022**, *133*, 709–714. [CrossRef]

82. Kim, K.; Kang, S.W.; Kim, J.K.; Lee, C.R.; Lee, J.; Jeong, J.J.; Nam, K.H.; Chung, W.Y. Robotic Transaxillary Hemithyroidectomy Using the da Vinci SP Robotic System: Initial Experience With 10 Consecutive Cases. *Surg. Innov.* **2020**, *27*, 256–264. [CrossRef]

83. Park, J.; Kang, L.K.; Kim, K.; Bae, J.S.; Kim, J.S. The learning curve for single-port transaxillary robotic thyroidectomy (SP-TART): Experience through initial 50 cases of lobectomy. *Updates Surg.* **2022**, *75*, 691–700. [CrossRef]

84. Li, W.; Kong, K.; Li, P.; Wang, G.; Cui, B.; Zhu, L.; Zhu, S. Robot-assisted sleeve gastrectomy in patients with obesity with a novel Chinese domestic MicroHand SII surgical system. *BMC Surg.* **2021**, *21*, 260. [CrossRef]

85. Puntambekar, S.; Bharambe, S.; Pawar, S.; Chitale, M.; Panse, M. Feasibility of transthoracic esophagectomy with a next-generation surgical robot. *Sci. Rep.* **2022**, *12*, 17925. [CrossRef]

86. Schmitz, R.; Willeke, F.; Darwich, I.; Kloeckner-Lang, S.M.; Saelzer, H.; Labenz, J.; Borkenstein, D.P.; Zani, S. Robotic-Assisted Nissen Fundoplication with the Senhance® Surgical System: Technical Aspects and Early Results. *Surg. Technol. Int.* **2019**, *35*, 113–119.

87. Bianco, F.M.; Dreifuss, N.H.; Chang, B.; Schlottmann, F.; Cubisino, A.; Mangano, A.; Pavelko, Y.; Masrur, M.A.; Giulianotti, P.C. Robotic single-port surgery: Preliminary experience in general surgery. *Int. J. Med. Robot.* **2022**, *18*, e2453. [CrossRef]

88. deBeche-Adams, T.; Eubanks, W.S.; de la Fuente, S.G. Early experience with the Senhance®-laparoscopic/robotic platform in the US. *J. Robot. Surg.* **2019**, *13*, 357–359. [CrossRef]

89. Dixon, F.; Khanna, A.; Vitish-Sharma, P.; Singh, N.S.; Nakade, K.; Singh, A.; Qureshi, A.; O'Hara, R.; Keeler, B.D. Initiation and feasibility of a multi-specialty minimally invasive surgical programme using a novel robotic system: A case series. *Int. J. Surg.* **2021**, *96*, 106182. [CrossRef] [PubMed]

90. El Dahdah, J.; Halabi, M.; Kamal, J.; Zenilman, M.E.; Moussa, H. Initial experience with a novel robotic surgical system in abdominal surgery. *J. Robot. Surg.* **2022**, *17*, 841–846. [CrossRef] [PubMed]

91. Kelkar, D.; Borse, M.A.; Godbole, G.P.; Kurlekar, U.; Slack, M. 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.* **2021**, *35*, 5193–5202. [CrossRef] [PubMed]

92. Montlouis-Calixte, J.; Ripamonti, B.; Barabino, G.; Corsini, T.; Chauleur, C. Senhance 3-mm robot-assisted surgery: Experience on first 14 patients in France. *J. Robot. Surg.* **2019**, *13*, 643–647. [CrossRef]

93. Samalavicius, N.E.; Janusonis, V.; Siaulys, R.; Jasėnas, M.; Deduchovas, O.; Venckus, R.; Ezerskiene, V.; Paskeviciute, R.; Klimaviciute, G. Robotic surgery using Senhance® robotic platform: Single center experience with first 100 cases. *J. Robot. Surg.* **2020**, *14*, 371–376. [CrossRef]

94. Stephan, D.; Darwich, I.; Willeke, F. The TransEnterix European Patient Registry for Robotic-Assisted Laparoscopic Procedures in Urology, Abdominal, Thoracic, and Gynecologic Surgery ("TRUST"). *Surg. Technol. Int.* **2021**, *38*, 103–107. [PubMed]

95. Wehrmann, S.; Tischendorf, K.; Mehlhorn, T.; Lorenz, A.; Gündel, M.; Rudolph, H.; Mirow, L. Clinical implementation of the Versius robotic surgical system in visceral surgery-A single centre experience and review of the first 175 patients. *Surg. Endosc.* **2023**, *37*, 528–534. [CrossRef] [PubMed]

96. Yao, Y.; Liu, Y.; Li, Z.; Yi, B.; Wang, G.; Zhu, S. Chinese surgical robot micro hand S: A consecutive case series in general surgery. *Int. J. Surg.* **2020**, *75*, 55–59. [CrossRef] [PubMed]

97. Yi, B.; Wang, G.; Li, J.; Jiang, J.; Son, Z.; Su, H.; Zhu, S.; Wang, S. Domestically produced Chinese minimally invasive surgical robot system "Micro Hand S" is applied to clinical surgery preliminarily in China. *Surg. Endosc.* **2017**, *31*, 487–493. [CrossRef]

98. Yi, B.; Wang, G.; Li, J.; Jiang, J.; Son, Z.; Su, H.; Zhu, S. The first clinical use of domestically produced Chinese minimally invasive surgical robot system "Micro Hand S". *Surg. Endosc.* **2016**, *30*, 2649–2655. [CrossRef]

99. Dreifuss, N.H.; Chang, B.; Schlottmann, F.; Cubisino, A.; Mangano, A.; Masrur, M.A.; Bianco, F.M. Robotic inguinal hernia repair: Is the new Da Vinci single port platform providing any benefit? *Surg. Endosc.* **2022**, *37*, 2003–2013. [CrossRef]

100. Kang, Y.H.; Kang, J.S.; Cho, Y.S.; Kim, H.S.; Lee, M.; Han, Y.; Sohn, H.J.; Kim, H.; Kwon, W.; Jang, J.Y.; et al. A retrospective multicentre study on the evaluation of perioperative outcomes of single-port robotic cholecystectomy comparing the Xi and SP versions of the da Vinci robotic surgical system. *Int. J. Med. Robot.* **2022**, *18*, e2345. [CrossRef]

101. Kim, W.J.; Choi, S.B.; Kim, W.B. Feasibility and Efficacy of Single-Port Robotic Cholecystectomy Using the da Vinci SP® Platform. *JSLS J. Soc. Laparosc. Robot. Surg.* **2022**, *26*, e2021.00091. [CrossRef]

102. Samalavicius, N.E.; Kaminskas, T.; Zidonis, Z.; Janusonis, V.; Deduchovas, O.; Eismontas, V.; Nausediene, V.; Dulskas, A. Robotic cholecystectomy using Senhance robotic platform versus laparoscopic conventional cholecystectomy: A propensity score analysis. *Acta Chir. Belg.* **2022**, *122*, 160–163. [CrossRef]

103. Wang, G.; Yi, B.; Li, Z.; Zhu, L.; Hao, L.; Zeng, Y.; Zhu, S. Micro-Hand Robot-Assisted Versus da Vinci Robot-Assisted Cholecystectomy: A Multi-centre, Randomized Controlled Trial. *World J. Surg.* **2022**, *46*, 2632–2641. [CrossRef]

104. Jiang, J.; Zhu, S.; Yi, B.; Li, J. Comparison of the short-term operative, Oncological, and Functional Outcomes between two types of robot-assisted total mesorectal excision for rectal cancer: Da Vinci versus Micro Hand S surgical robot. *Int. J. Med. Robot.* **2021**, *17*, e2260. [CrossRef] [PubMed]

105. Lei, Y.; Jiang, J.; Zhu, S.; Yi, B.; Li, J. Comparison of the short-term efficacy of two types of robotic total mesorectal excision for rectal cancer. *Tech. Coloproctol.* **2022**, *26*, 19–28. [CrossRef] [PubMed]

106. Liu, Y.; Liu, M.; Lei, Y.; Zhang, H.; Xie, J.; Zhu, S.; Jiang, J.; Li, J.; Yi, B. Evaluation of effect of robotic versus laparoscopic surgical technology on genitourinary function after total mesorectal excision for rectal cancer. *Int. J. Surg.* **2022**, *104*, 106800. [CrossRef] [PubMed]

107. Luo, D.; Liu, Y.; Zhu, H.; Li, X.; Gao, W.; Li, X.; Zhu, S.; Yu, X. The MicroHand S robotic-assisted versus Da Vinci robotic-assisted radical resection for patients with sigmoid colon cancer: A single-center retrospective study. *Surg. Endosc.* **2020**, *34*, 3368–3374. [CrossRef] [PubMed]

108. Wang, Y.; Li, Z.; Yi, B.; Zhu, S. Initial experience of Chinese surgical robot "Micro Hand S"-assisted versus open and laparoscopic total mesorectal excision for rectal cancer: Short-term outcomes in a single center. *Asian J. Surg.* **2022**, *45*, 299–306. [CrossRef]

109. Wang, Y.; Wang, G.; Li, Z.; Ling, H.; Yi, B.; Zhu, S. Comparison of the operative outcomes and learning curves between laparoscopic and "Micro Hand S" robot-assisted total mesorectal excision for rectal cancer: A retrospective study. *BMC Gastroenterol.* **2021**, *21*, 251. [CrossRef]

110. Zeng, Y.; Wang, G.; Li, Z.; Lin, H.; Zhu, S.; Yi, B. The Micro Hand S vs. da Vinci Surgical Robot-Assisted Surgery on Total Mesorectal Excision: Short-Term Outcomes Using Propensity Score Matching Analysis. *Front. Surg.* **2021**, *8*, 656270. [CrossRef]

111. Zeng, Y.; Wang, G.; Liu, Y.; Li, Z.; Yi, B.; Zhu, S. The "Micro Hand S" Robot-Assisted Versus Conventional Laparoscopic Right Colectomy: Short-Term Outcomes at a Single Center. *J. Laparoendosc. Adv. Surg. Tech. A* **2020**, *30*, 363–368. [CrossRef]

112. Lee, I.A.; Kim, J.K.; Kim, K.; Kang, S.W.; Lee, J.; Jeong, J.J.; Nam, K.H.; Chung, W.Y. Robotic Adrenalectomy Using the da Vinci SP Robotic System: Technical Feasibility Comparison with Single-Port Access Using the da Vinci Multi-arm Robotic System. *Ann. Surg. Oncol.* **2022**, *29*, 3085–3092. [CrossRef]

113. Kim, J.K.; Choi, S.H.; Choi, S.M.; Choi, H.R.; Lee, C.R.; Kang, S.W.; Jeong, J.J.; Nam, K.H.; Chung, W.Y. Single-port transaxillary robotic thyroidectomy (START): 200-cases with two-step retraction method. *Surg. Endosc.* **2022**, *36*, 2688–2696. [CrossRef]

114. Cambridge Medical Robotics. 10,000 Cases—Making Every Procedure Count. Available online: https://cmrsurgical.com/features/making-every-procedure-count (accessed on 23 May 2023).

115. Cambridge Medical Robotics. CMR Surgical Announces More Than 100 Versius Systems Installed Globally. Available online: https://cmrsurgical.com/news/cmr-announces-more-than-100-systems-installed (accessed on 23 May 2023).

116. Intuitive Surgical. Annual Report Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934—Form 10-K. Available online: https://isrg.intuitive.com/static-files/f9d16f73-dcea-419e-ac73-7ae13b86c207 (accessed on 23 May 2023).

117. Asensus. Asensus Surgical Provides Corporate Update. Available online: https://ir.asensus.com/news-releases/news-release-details/asensus-surgical-provides-corporate-update (accessed on 23 May 2023).

118. Japan 2 Earth. Japan's First Surgical Robot: Technological Innovation in the World of Medicine. Available online: https://featured.japan-forward.com/japan2earth/2023/01/2034/ (accessed on 23 May 2023).
119. Avateramedical. Avateramedical Robot-Assisted Surgery System Progresses to Clinical Use. Available online: https://www.avatera.eu/en/company/news/detail?tx_news_pi1%5Bnews%5D=42&cHash=84ba505a890ba27dcf6bec17706087cf (accessed on 23 May 2023).
120. Distalmotion. Available online: https://www.distalmotion.com/news (accessed on 23 May 2023).
121. SAGES. Moon Surgical Maestro Surgical Robotics System. Available online: https://www.sages.org/publications/tavac/moon-surgical-maestro-surgical-robotics-system/ (accessed on 23 May 2023).
122. Madanapalle, A. 'Made in India' Surgical Robot SSI Mantra Completes 100 Successful Surgeries. Available online: https://www.news9live.com/health/medicine/made-in-india-surgical-robot-ssi-mantra-completes-100-successful-surgeries-au941-2068412 (accessed on 23 May 2023).
123. RobSurgical. Rob Surgical Receives Authorisation to Conduct Fih Clinical Trials. Available online: https://www.robsurgical.com/rob-surgical-receives-fih-authorisation/ (accessed on 23 May 2023).
124. Soumpasis, I.; Nashef, S.; Dunning, J.; Moran, P.; Slack, M. Safe Implementation of a Next-Generation Surgical Robot: First Analysis of 2,083 Cases in the Versius Surgical Registry. *Ann. Surg.* **2023**. [CrossRef]
125. Race, A.; Horgan, S. Overview of Current Robotic Technology. In *Innovative Endoscopic and Surgical Technology in the GI Tract*; Horgan, S., Fuchs, K.-H., Eds.; Springer International Publishing: Cham, Switzerland, 2021; pp. 1–17. [CrossRef]
126. Grimsley, E.A.; Barry, T.M.; Janjua, H.; Eguia, E.; DuCoin, C.; Kuo, P.C. Exploring the paradigm of robotic surgery and its contribution to the growth of surgical volume. *Surg. Open Sci.* **2022**, *10*, 36–42. [CrossRef]
127. Bianchi, P.P.; Salaj, A.; Rocco, B.; Formisano, G. First worldwide report on Hugo RAS surgical platform in right and left colectomy. *Updates Surg.* **2023**, *75*, 775–780. [CrossRef] [PubMed]
128. Quijano, Y.; Vicente, E.; Ferri, V.; Naldini, C.; Pizzuti, G.; Caruso, R. Robot-assisted Nissen fundoplication with the new HUGO Robotic assisted system: First worldwide report with system description, docking settings and video. *Int. J. Surg. Case Rep.* **2023**, *106*, 108178. [CrossRef]
129. de'Angelis, N.; Khan, J.; Marchegiani, F.; Bianchi, G.; Aisoni, F.; Alberti, D.; Ansaloni, L.; Biffl, W.; Chiara, O.; Ceccarelli, G.; et al. Robotic surgery in emergency setting: 2021 WSES position paper. *World J. Emerg. Surg.* **2022**, *17*, 4. [CrossRef]
130. O'Meara, S. Medical robotics in China: The rise of technology in three charts. *Nature* **2020**, *582*, S51–S52. [CrossRef]
131. Guo, Y.; Chen, W.; Zhao, J.; Yang, G.-Z. Medical Robotics: Opportunities in China. *Annu. Rev. Control Robot. Auton. Syst.* **2022**, *5*, 361–383. [CrossRef]
132. Harbin Sagebot Intelligent Medical Equipment Co., Ltd. KangDuo Robot Has Passed the Registration Review of the NMPA. Available online: http://www.hrbszr.com (accessed on 23 May 2023).
133. Medbot. FAHZU Completed the First DomesticChinese-Developed 4-Arm Laparoscopic Robot-Assisted Total Intracavitary Radical Cystectomy & Orthotopic Neobladder in China. Available online: https://www.medbotsurgical.com/ (accessed on 23 May 2023).
134. Ronovo Surgical. Ronovo Wins Resounding KOL Accolades in Latest Carina™ RAS Platform Animal Labs. Available online: https://www.ronovosurgical.com (accessed on 23 May 2023).
135. Kikuchi, K.; Suda, K.; Shibasaki, S.; Tanaka, T.; Uyama, I. Challenges in improving the minimal invasiveness of the surgical treatment for gastric cancer using robotic technology. *Ann. Gastroenterol. Surg.* **2021**, *5*, 604–613. [CrossRef]
136. Orsi Academy. Orsi Academy Welcomes Medicaroid's Hinotori™ Surgical Robot System*, a World's First! Available online: https://www.orsi-online.com/news/worlds-first-orsi-welcomes-hinotoritm-surgical-robot-medicaroid (accessed on 23 May 2023).
137. Tuliao, P.H.; Kim, S.W.; Rha, K.H. New technologies in robotic surgery: The Korean experience. *Curr. Opin. Urol.* **2014**, *24*, 111–117. [CrossRef]
138. Bora, G.S.; Narain, T.A.; Sharma, A.P.; Mavuduru, R.S.; Devana, S.K.; Singh, S.K.; Mandal, A.K. Robot-assisted surgery in India: A SWOT analysis. *Indian. J. Urol.* **2020**, *36*, 1–3. [CrossRef]
139. Cisu, T.; Crocerossa, F.; Carbonara, U.; Porpiglia, F.; Autorino, R. New robotic surgical systems in urology: An update. *Curr. Opin. Urol.* **2021**, *31*, 37–42. [CrossRef] [PubMed]
140. Lin, H.; Zhang, J.; Li, X.; Li, Y.; Su, S. Comparative outcomes of single-incision laparoscopic, mini-laparoscopic, four-port laparoscopic, three-port laparoscopic, and single-incision robotic cholecystectomy: A systematic review and network meta-analysis. *Updates Surg.* **2023**, *75*, 41–51. [CrossRef] [PubMed]
141. de'Angelis, N.; Marchegiani, F.; Schena, C.A.; Khan, J.; Agnoletti, V.; Ansaloni, L.; Barria Rodriguez, A.G.; Bianchi, P.P.; Biffl, W.; Bravi, F.; et al. Training curriculum in minimally invasive emergency digestive surgery: 2022 WSES position paper. *World J. Emerg. Surg.* **2023**, *18*, 11. [CrossRef] [PubMed]
142. Stefanidis, D.; Huffman, E.M.; Collins, J.W.; Martino, M.A.; Satava, R.M.; Levy, J.S. Expert Consensus Recommendations for Robotic Surgery Credentialing. *Ann. Surg.* **2022**, *276*, 88–93. [CrossRef]
143. Burke, J.R.; Fleming, C.A.; King, M.; El-Sayed, C.; Bolton, W.S.; Munsch, C.; Harji, D.; Bach, S.P.; Collins, J.W. Utilising an accelerated Delphi process to develop consensus on the requirement and components of a pre-procedural core robotic surgery curriculum. *J. Robot. Surg.* **2023**, *online ahead of print*. [CrossRef]

144. Sighinolfi, M.C.; Terzoni, S.; Scanferla, E.; Bianchi, P.P.; Formisano, G.; Gaia, G.; Marconi, A.M.; Chiumello, D.; Patel, V.; Moschovas, M.C.; et al. Impact of hands-on practice with HugoRAS and Versius System simulators on the attractiveness of robotic surgery among medical and nurse undergraduate students. *J. Robot. Surg.* **2023**, *online ahead of print*. [CrossRef]

145. Myklebust, M.V.; Storheim, H.; Hartvik, M.; Dysvik, E. Anesthesia Professionals' Perspectives of Teamwork During Robotic-Assisted Surgery. *AORN J.* **2020**, *111*, 87–96. [CrossRef]

146. Larkins, K.M.; Mohan, H.M.; Gray, M.; Costello, D.M.; Costello, A.J.; Heriot, A.G.; Warrier, S.K. Transferability of robotic console skills by early robotic surgeons: A multi-platform crossover trial of simulation training. *J. Robot. Surg.* **2022**, *17*, 859–867. [CrossRef]

147. Ghazi, A.; Schuler, N.; Saba, P.; Holler, T.; Steinmetz, A.; Yuen, K.; Doersch, K.; Ellis, E.; Tabayoyong, W.; Bloom, J.; et al. Do Skills Naturally Transfer Between Multiport and Single-Port Robotic Platforms? A Comparative Study in a Simulated Environment. *J. Endourol.* **2023**, *37*, 233–239. [CrossRef]

148. Hussein, A.A.; Mohsin, R.; Qureshi, H.; Leghari, R.; Jing, Z.; Ramahi, Y.O.; Rizvi, I.; Guru, K.A.; Rizvi, A. Transition from da Vinci to Versius robotic surgical system: Initial experience and outcomes of over 100 consecutive procedures. *J. Robot. Surg.* **2023**, *17*, 419–426. [CrossRef]

149. Nakauchi, M.; Suda, K.; Nakamura, K.; Tanaka, T.; Shibasaki, S.; Inaba, K.; Harada, T.; Ohashi, M.; Ohigashi, M.; Kitatsuji, H.; et al. Establishment of a new practical telesurgical platform using the hinotori Surgical Robot System: A preclinical study. *Langenbecks Arch. Surg.* **2022**, *407*, 3783–3791. [CrossRef]

150. Asensus. Asensus Surgical Receives CE Mark for Expanded Machine Vision Capabilities. Available online: https://ir.asensus.com/news-releases/news-release-details/asensus-surgical-receives-ce-mark-expanded-machine-vision (accessed on 23 May 2023).