Robotic And laparoscopic Vascular Surgery:Where Do They Stand And Why Bother Continuing To Consider Them

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Chicago

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Disclosures

- Intellectual Property on Branch Grafts and Short Limb Cannulation

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What is a Robot?

An automated, mostly human-like, machine that can execute specific tasks with little or no human intervention

What is a Robot?

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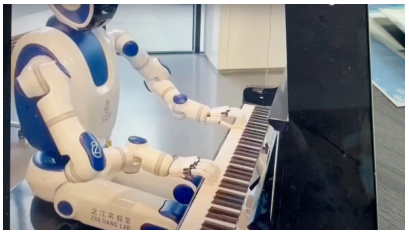

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Why Robots? Telesurgery!

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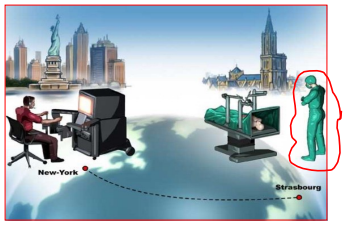
"Lindberg operation"



Marescaux et al, Ann Surg 2003

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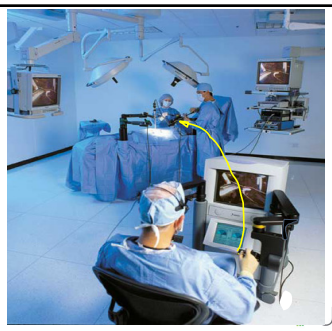

Technology in search of an application!

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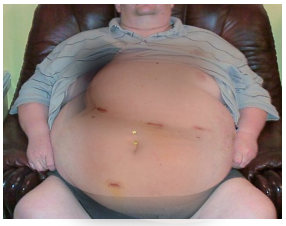
Early 2000's



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Robot-assisted laparoscopic aortobifemoral bypass for aortoiliac occlusive disease: A report of two cases

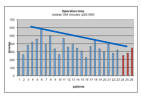
Willem Wisselink, MD,[a] Miguel A. Cuesta, MD,[b] Carlos Gracia, MD,[b] and Jan A. Rauwerda, MD,[a]
Amsterdam, The Netherlands; and Los Angeles, Calif

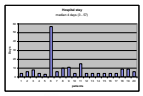
(J Vasc Surg 2002;36:1079-82.)

31 patients, AIOD

•ABF or

•endarterectomy





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ELSEVIER

Seminars in Vascular Surgery
Volume 34, Issue 4, December 2021, Pages 225-232

Review article

Review and current update of robotic-assisted laparoscopic vascular surgery

Petr Štádler [a], James Dorosh [b], Libor Dvořáček [a], Petro Vitásek [a], Pavel Matouš [a], Judith C. Lin [c]

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My Co-Moderator, Dr. Lumsden

Journal of Robotic Surgery (2024) 18:328
https://doi.org/10.1007/s11701-024-02087-2

REVIEW

Robot-assisted vascular surgery: literature review, clinical applications, and future perspectives

Balazs C. Lengyel[1,2] · Ponraj Chinnadurai[1] · Stuart J. Corr[1] · Alan B. Lumsden[1] · Charudatta S. Bavare[1]

Received: 6 August 2024 / Accepted: 17 August 2024

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- Coronary artery bypass.
- Esophagectomy
- Gastrectomy
- Colectomy
- Cholecystectomy
- Hip replacement.
- Hysterectomy.
- Kidney removal, total or partial.
- Kidney Transplantation.
- Prostatectomy, bladder resection
- Thymectomy
- Thyroidectomy
- Mastectomy

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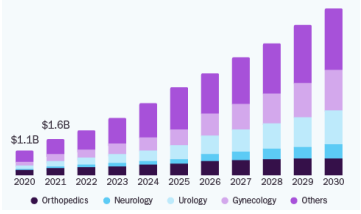
US Surgical Robots Market



Annual growth rate 18%

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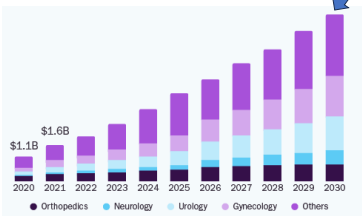
US Surgical Robots Market

USD 6 BILLION



Annual growth rate 18%

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Review Article on Techniques and Innovations in Liver Surgery

Robotic liver surgery: technical aspects and review of the literature

Pier Cristoforo Giulianotti[1], Francesco Maria Bianco[1], Despoina Daskalaki[1], Luis Fernando Gonzalez-Ciccarelli[1], Jihun Kim[1], Enrico Benedetti[2]

[1]Division of General, Minimally Invasive, and Robotic Surgery, [2]Division of Transplantation, Department of Surgery, University of Illinois Hospital and Health Sciences System, Chicago, IL 60612, USA

Contributions: (I) Conception and design: PC Giulianotti, E Benedetti; (II) Administrative support: FM Bianco; (III) Provision of study materials or patients: D Daskalaki, LF Gonzalez-Ciccarelli, J Kim; (IV) Collection and assembly of data: D Daskalaki, LF Gonzalez-Ciccarelli, J Kim; (V) Data analysis and interpretation: PC Giulianotti, FM Bianco, D Daskalaki; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

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CASE REPORT

Robotic approach to treat Median Arcuate Ligament syndrome: a case report

Roberto Bustos*, Michail Papamichail, Alberto Mangano, Valentina Valle, and Pier Cristoforo Giulianotti

Division of General, Minimally Invasive and Robotic Surgery, Department of Surgery, University of Illinois at Chicago, Chicago, IL, USA

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Curr Transpl Rep (2015) 2:122–126
DOI 10.1007/s40472-015-0051-z

KIDNEY TRANSPLANTATION (ML HENRY, SECTION EDITOR)

Robotic-assisted Kidney Transplantation: Our Experience and Literature Review

Ivo Tzvetanov[1,2] · Giuseppe D'Amico[1] · Enrico Benedetti[1,2]

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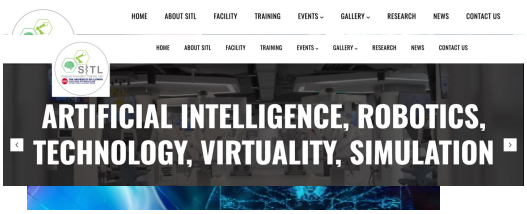

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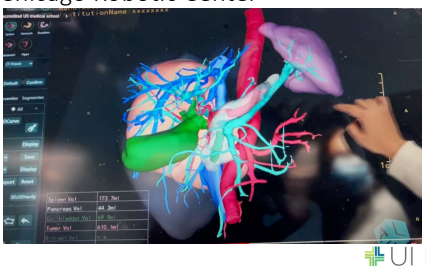

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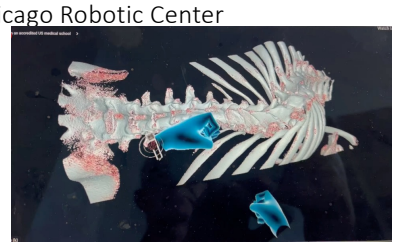

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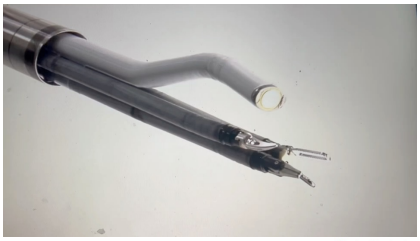
Robot Wars:

Single Port Robot



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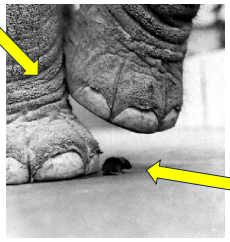
Robotic Aortic World Experience

	Year	Robotic system	Patients (number)	Operation	Conversion (number)	Operating time (min)	Clamping time (min)	Morbidity (number)	Mortality (number)
Wisselink et al	2002	Zeus	Case report	AIOD	0	300	75	0	0
Rölvenbach et al.[ ]	2003	Zeus	10	10 AAA	2 (20%)	242 ± 40.5	96 ± 21.6	1 (10%)	0
Desgranges et al.[ ]	2004	Da Vinci	5	5 AIOD*	1 (25%)	188 (mean)	75 ± 28	1 (20%)	0
Jonglönd et al.[ ]	2011	5 Zeus 23 Da Vinci	28	28 AIOD	4 (14%)	350 (median)	70 (median)	4 (14%)	1 (3,5%)
Stadler et al. [ ]	2016	Da Vinci	285	61 AAA	8 (13%)	253 (median)	93 (median)	0 (0%)	1 (1,6%)
				224 AIOD	2 (0,9%)	194 (median)	37 (median)	3 (1,33%)	0
Lin et al. [ ]	2012	Da Vinci	21	3 AIOD	0 (0%)	494 ± 36	60 ± 21		
				9 AIOD**	0 (0%)	425 ± 94	102 ± 93	N.R.	0
				7 AAA**	1 (14%)	396 ± 146	87 ± 48		

Endovascular



Laparoscopic/ robotic

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PRO

- Better stability of the catheter tip,
- catheter stays in the center of the lumen
- Reduction of radiation. Weisz et al. demonstrated a median radiation reduction of 95.2% compared to traditional interventions

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CON

- No haptic feed back.
- At present, not compatible to all materials such as guidewires and catheters, some devices need to be deployed manually
- Per operation $3,000 to $6,000 more than a traditional laparoscopic surgery or endovascular surgery: 80 percent increase to the cost
- Cyberattacks against surgical robots! (A 2022 report in the journal Digital Medicine).

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Case Reports

Robotic-Assisted Percutaneous Coronary Intervention Through Transradial Approach:

Experience in 4 Patients with Complex Lesions

- The CorPath GRX is a current R-PCI system that includes a bedside unit with a robotic arm and a remote workspace with a control console and monitors. The cardiologist can use the remote workspace to advance guidewires and stents, and to measure lesion length.
- R-PCI has shown high technical success rates and low complication rates in clinical trials. However, it's not yet commonplace because it has some limitations, including:
- It's incompatible with some intravascular imaging catheters.
- It can't manipulate multiple guidewires and stents at once.
- Some cases, especially those with complex anatomy, may require a partial manual procedure.

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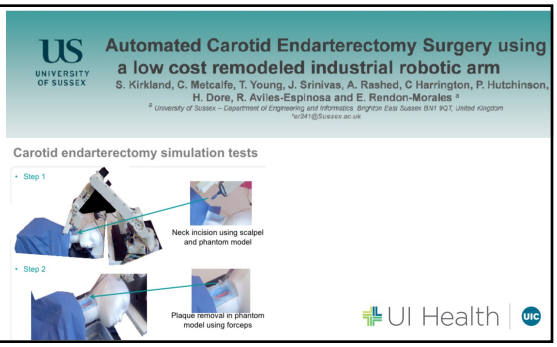

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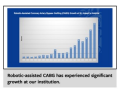
Robotic-assisted coronary artery bypass grafting simplified: Lessons learned after 20 years

Mark Lutz, BA, Zhandong Zhou, MD, Ahmad Nazem, MD, G. Randall Green, MD, JD, MBA, Anton Cherney, MD, Karikehalli Dilip, MD, and Charles J. Lutz, MD, Syracuse, NY



Robotic-assisted CABG has experienced significant growth at our institution.

Minimally invasive direct coronary artery bypass combined with robotic assistance (RA-MIDCAB) or totally endoscopic coronary artery bypass procedures allows patients to realize the benefits of minimally invasive surgery. Despite enthusiasm for minimally invasive approaches, RA-MIDCAB has still achieved limited adoption.

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NEUROSURGICAL FOCUS

Neurosurg Focus 52 (1):E17, 2022

Robot-assisted carotid artery stenting: outcomes, safety, and operational learning curve

Rawad Abbas, MD,[1] Fadi Al Saiegh, MD,[1] Kareem El Naamani, MD,[1] Ching-Jen Chen, MD,[1] Lohit Velagapudi, BS,[1] Georgios S. Sioutas, MD,[1] Joshua H. Weinberg, MD,[2] Stavropoula Tjoumakaris, MD,[1] M. Reid Gooch, MD,[1] Nabeel A. Herial, MD, MPH,[1] Robert H. Rosenwasser, MD, MBA,[1] and Pascal Jabbour, MD[1]

[1]Department of Neurological Surgery, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania; and [2]Department of Neurological Surgery, The Ohio State University Wexner Medical Center, Columbus, Ohio

- 14 patients were included.
- All patients received balloon angioplasty and stent placement.
- The overall median fluoroscopy and procedure times were 24.6 minutes and 70.5 minutes, respectively.
- Subgroup analysis showed a significant decrease in these times, from 32 minutes and 86 minutes, resp

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Robotic Endovascular techniques

- 2009: in vitro study of robotic endovascular techniques in fenestrated grafts

In humans:

- 2010: First robot-assisted endovascular EVAR
- 2016: First robot-assisted peripheral vascular platform for femoropopliteal vessels

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World Robotic Endovascular Experience

Author	Year	Robotic system	Patients/vessels	Procedure
Bismuth et al. [ ]	2013	Hansen	20 vessels	Iliac artery and SFA cannulation
Cochennec et al. [ ]	2015	Magellan	37 vessels	Visceral and renal vessel cannulation during FEVAR/BEVAR
Mahmud et al. [ ]	2016	CorPath 200	20 patients	Percutaneous angioplasty of the SFA
Perera et al. [ ]	2017	Magellan	11 patients	Catheter placement in aortic arch during TEVAR
Cheung et al	2020	Magellan	14 patients	EVAR gate cannulation
Mahmud et al. [ ]	2020	CorPath GRX	20 patients	Percutaneous angioplasty of the SFA
Sajja et al. [ ]	2020	CorPath GRX	7 patients	Cerebral Angiography
			3 patients	Carotid artery angioplasty
Weinberg et al. [ ]	2020	CorPath GRX	6 patients	Carotid artery angioplasty
Nogueira et al. [ ]	2020	CorPath GRX	4 patients	Carotid artery angioplasty
Desai et al. [ ]	2021	CorPath GRX	6 patients	Cerebral Angiography
Jonez et al. [ ]	2021	Magellan	13 patients	Carotid artery angioplasty

Endovascular Robotic Platforms

- Sensei robotic navigation system (Hansen Medical), : an electromechanical-based system. In 2016 bought by Auris Surgical Robotics. Auris was acquired by J&J for 3.4 billion and they put it on hold.
- Niobe magnetic navigation system (Stereotaxis St. Louis), a magnetically controlled systems
- Magellan Robotic system (Hansen and Philipps), the first purely vascular robot that received FDA approval in 2012. Its production, however, was stopped in 2016.
- CorPath200 (Corindus Vascular Robotics) It was first FDA-approved for percutaneous coronary interventions (PCIs). Its successor, the CorPath GRX received FDA clearance for PCIs in 2016 and for peripheral artery disease (PAD) in 2018. In 2019 Siemens bought Corindus fo 1.1 billion.
- Siemens pulled CorPath out of the cardiology domain and is working on a neuro platform now

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Smart Tissue AUTONOMOUS Robot (STAR)

(*Science Robotics, 2022)*

- *"ML based tracking algorithm"*
- *"First surgical robot to plan, adapt and execute with minimal human intervention"*

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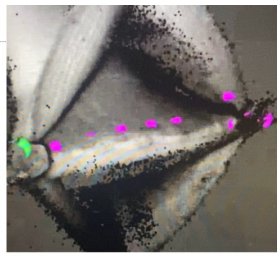

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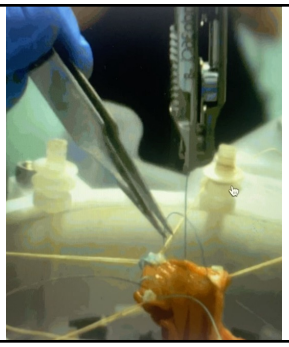

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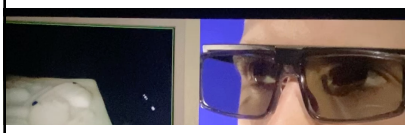

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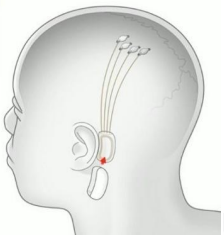
Literally connecting machines to the human brain

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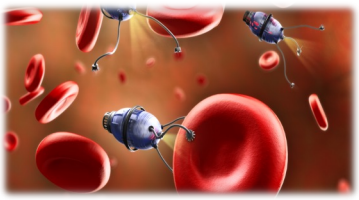
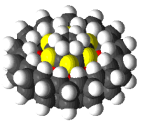
Nanotechnology

nanobots

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Conclusions

- Robotic Surgery has not unequivocably proven its efficacy in Vascular Surgery but the technology is rapidly evolving as more platforms are being developed
- However, we have to be critical in careful introduction of robotic techniques in specialized centers, monitor cost, apply rigorous and self-critical research towards clinical results and simply abandon those techniques that are not benefial to our patients

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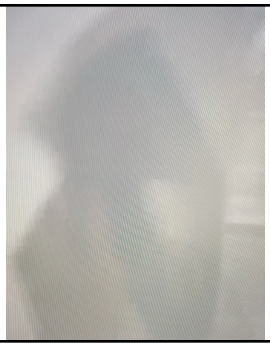

Credit:
Jolanda Kluin,MD
Cardiothoracic Surgeon,
University of Amsterdam

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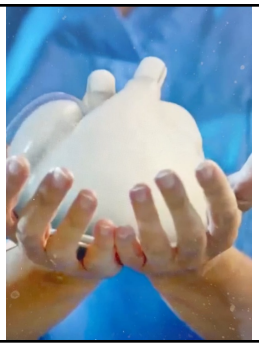

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