

OVERVIEW OF CURRENT ROBOTIC SYSTEMS:

Financial & Non-financial metrics

Vivek Bindal

MBBS, MS, MRCS (Glasgow), DNB, FNB (MAS), MNAMS, FACS (USA)

Head of Department,
Institute of Minimal Access, Bariatric & Robotic Surgery,
Max Super Specialty Hospitals, Delhi NCR, India

Regent, Clinical Robotic Surgery Association (India)
Secretary, Association of Robotic Innovative Surgeons
Secretary, Abdominal Wall Reconstruction Surgeon Community
President Elect, Surgery for Society of Alimentary Tract (India)
Joint Secretary, Obesity Surgery Society of India

**"Too big,too expensive ,too dangerous ...
... Lack of proper training
it will never...never become accepted,
what we have now is fine..."**

**Said in 1911 about automobile
In 1925,about Airplane**

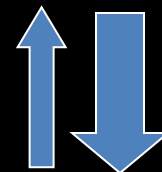
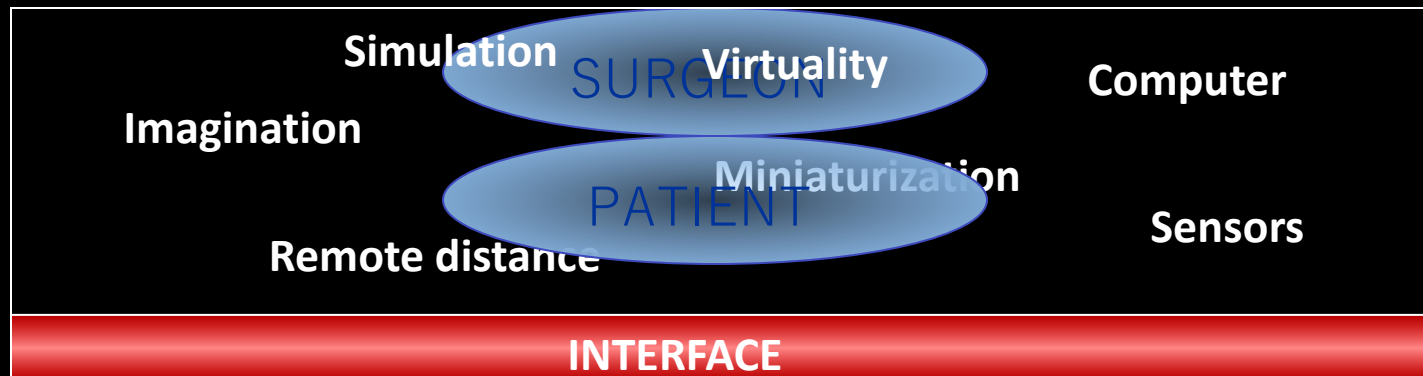
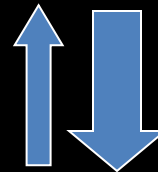
The Robotic System...

MORE THAN JUST AN INSTRUMENT...



Robotic Surgery...

- *New interface between surgeon and patient*
- *Expanding human ability with technology*
- *Overcoming the limitations of the laparoscopy*
- *Preserving the minimally invasiveness*



An iceberg floating in a blue ocean under a blue sky with white clouds. The visible tip of the iceberg is labeled 'Current Clinical Use'. The much larger submerged part of the iceberg is labeled 'RESEARCH' and contains a bulleted list of research topics.

Current Clinical Use

- **Miniaturization**
- **Simulation**
- **Telepresence**
- **Images integration**
- **New “senses”**
- **New tools**
- **New generation of robots**
- **OR of the future**

RESEARCH

With Chandrayaan-2 launch, India's ISRO shoots for the Moon on a shoe-string budget



Manish Singh @refsrc / 5:32 am EDT • July 22, 2019

Comment



First country to land on south pole of moon



Discussing Robotic Surgery with PM Modi





Why did we start with Robotic Bariatric in 2012?

Challenges in Super Obese

- Enlarged liver
- Limited working space
- Excessive torque on instruments
- Severe co-morbidities
- High risk anesthesia







BMI 84.64kg/m²





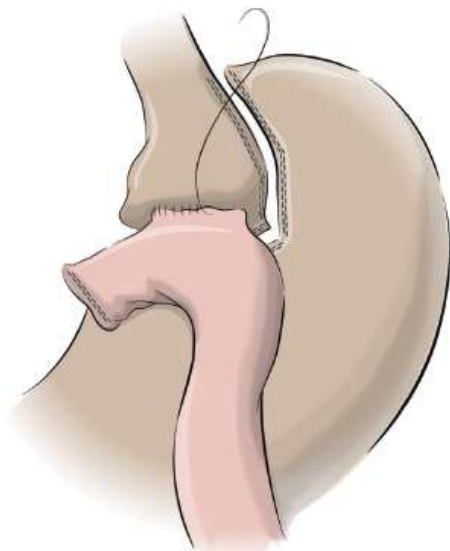
MAX
Healthcare

Ht.: 168cm Wt.: 233kg BMI: 81kg/m²

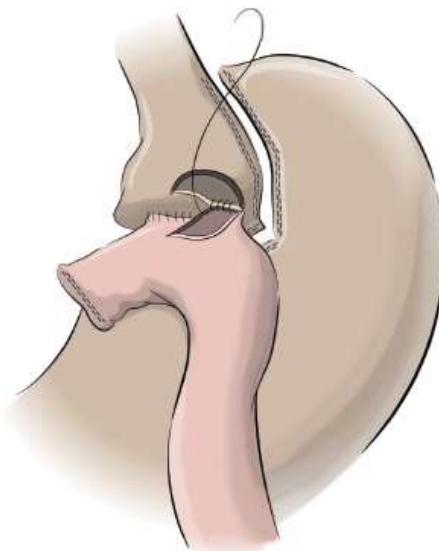


Institute of Minimal Access, Metabolic & Bariatric Surgery

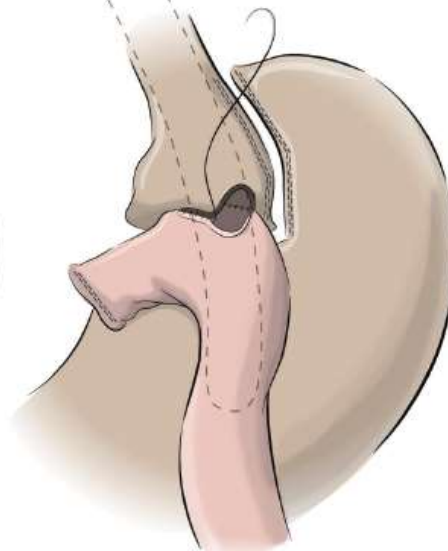
Hand sewn gastrojejunostomy



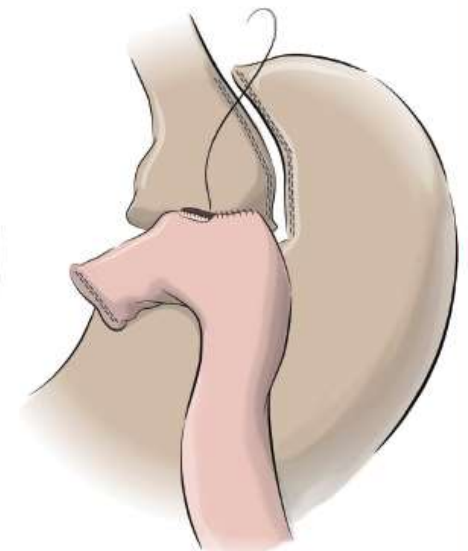
a. Back Outer Suturing



b.-c. Back Inner Suturing



d.-e. Front Inner Suturing



f. Front Outer Suturing

Two-layer hand-sewn GJ anastomosis

Port placement and Docking

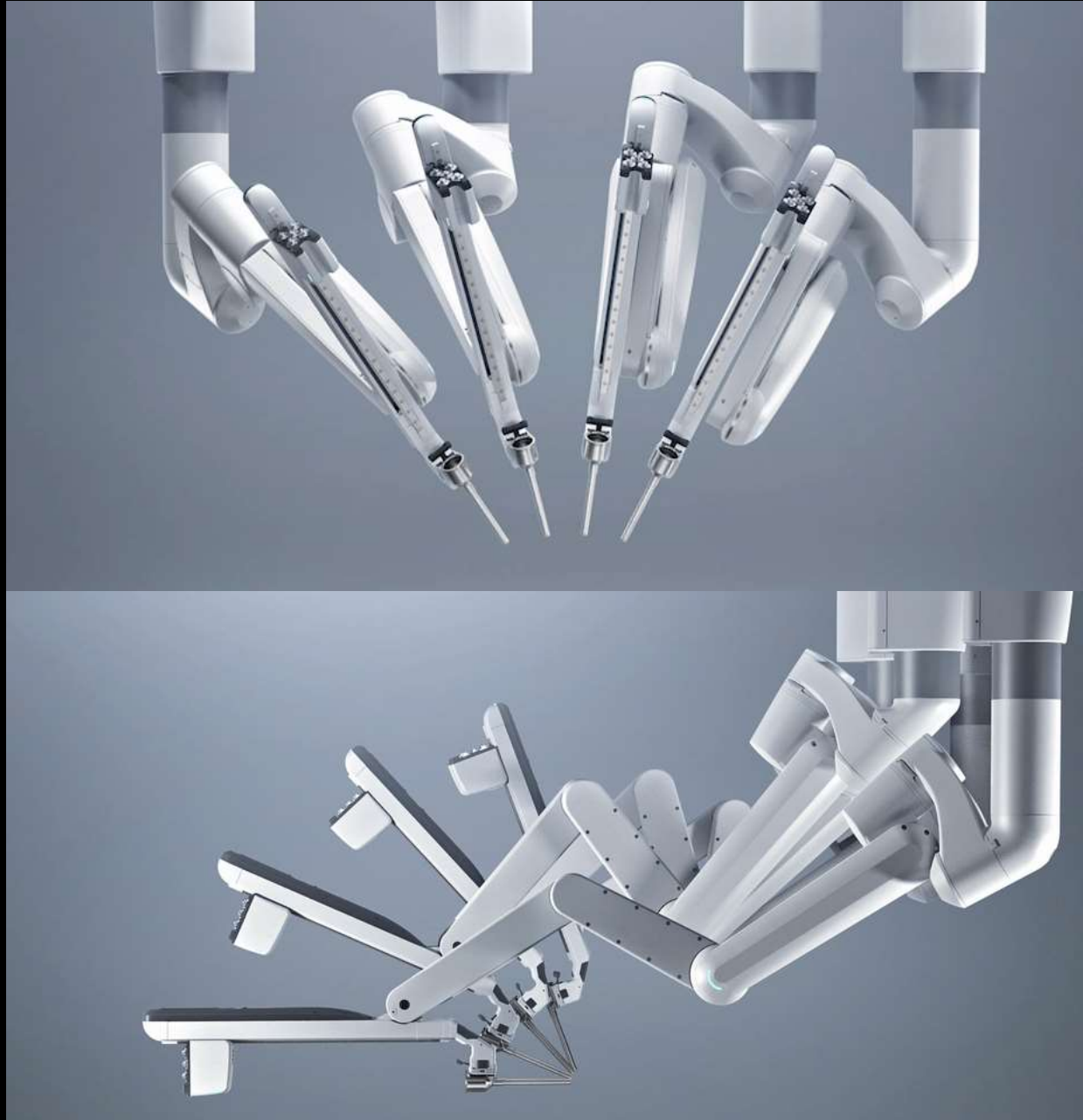


Da Vinci Si system



Da Vinci Xi System

- Smaller thinner arms
- Longer reach



Da Vinci Xi System

- 4th generation Intuitive surgical system
- Has staplers & advanced energy
- Boom mounted arms, long instruments
- Maximum installations & experience worldwide

- Boom mounted system with a mobile platform
- Four quadrant access



Laser targeting system for docking



Robotic instruments

■ Integrated Energy Instruments (today)

- Monopolar Energy
- Bipolar Energy
- Advanced Bipolar
- Harmonic
- Advanced Graspers



■ New Tissue Interaction Tools

- Suction/Irrigation
- Linear Cutters
- Seal and Cut

■ Training Instruments

- Robotic Simulator
- Dual console

■ Future Directions

- Smart Instruments



SUREFORM STAPLERS

- A new breed of staplers.
- Integrated software - SmartFire technology.
- Uses ibeam technology.



Intuitive Surgical. Products and Services. Stapling Devices, Sureform Stapler. Sunnyvale, CA, California; 2022:
Intuitive Surgical; 2019. Available from: <http://www.intuitive.com/en-us/products-and-services/da-vinci/stapling/sureform>.

SUREFORM STAPLERS

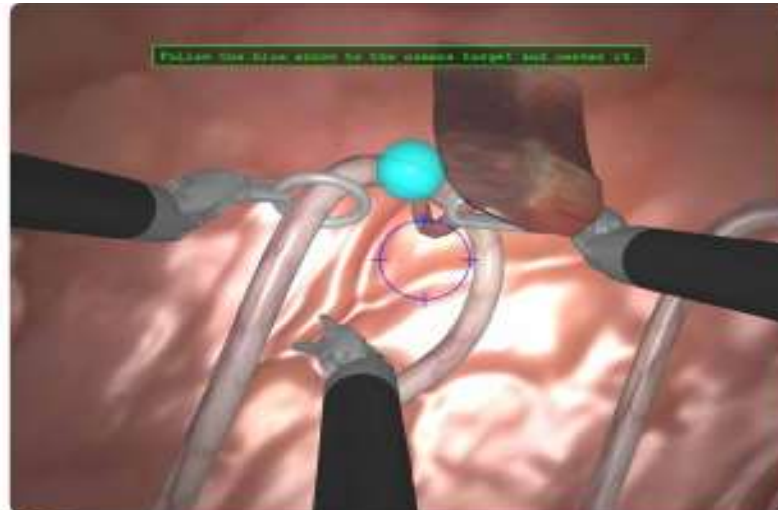
- Robotic stapler offers stability with the da Vinci's tremor filtration.
- 120° cone articulation (greater range of motion than other available staplers) gives freedom to approach tissue in its natural lie, thus less traction over anastomosis.



Intuitive Surgical. Products and Services. Stapling Devices, Sureform Stapler. Sunnyvale, CA, California; 2022: Intuitive Surgical; 2019. Available from: <http://www.intuitive.com/en-us/products-and-services/da-vinci/stapling/sureform>.

Robotic Simulator

- “Back-pack” add on
- da Vinci Si compatible
- Works with any console
- Skill-based exercises
- Surgery/Procedure skills (suturing)



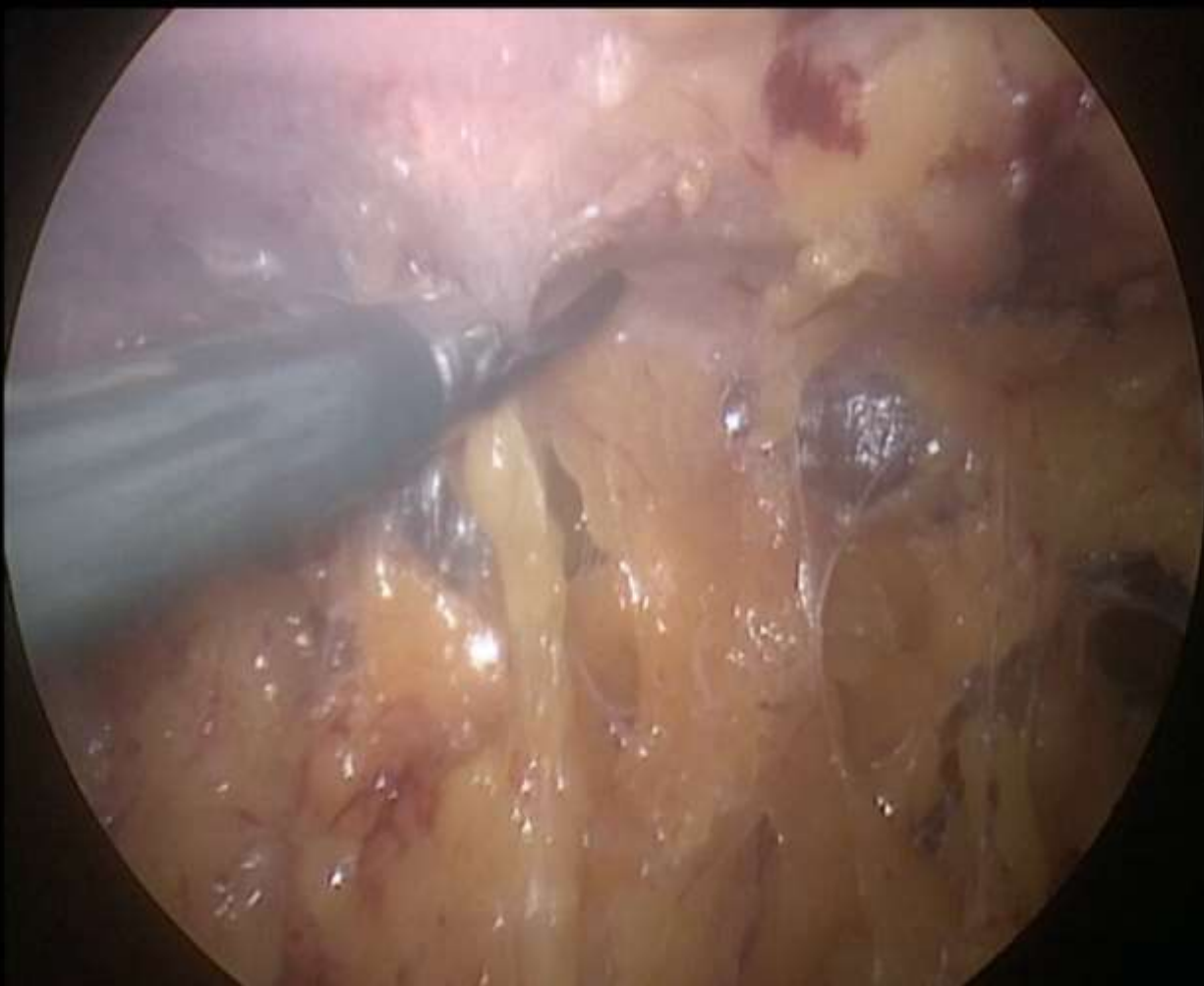
Dual Console



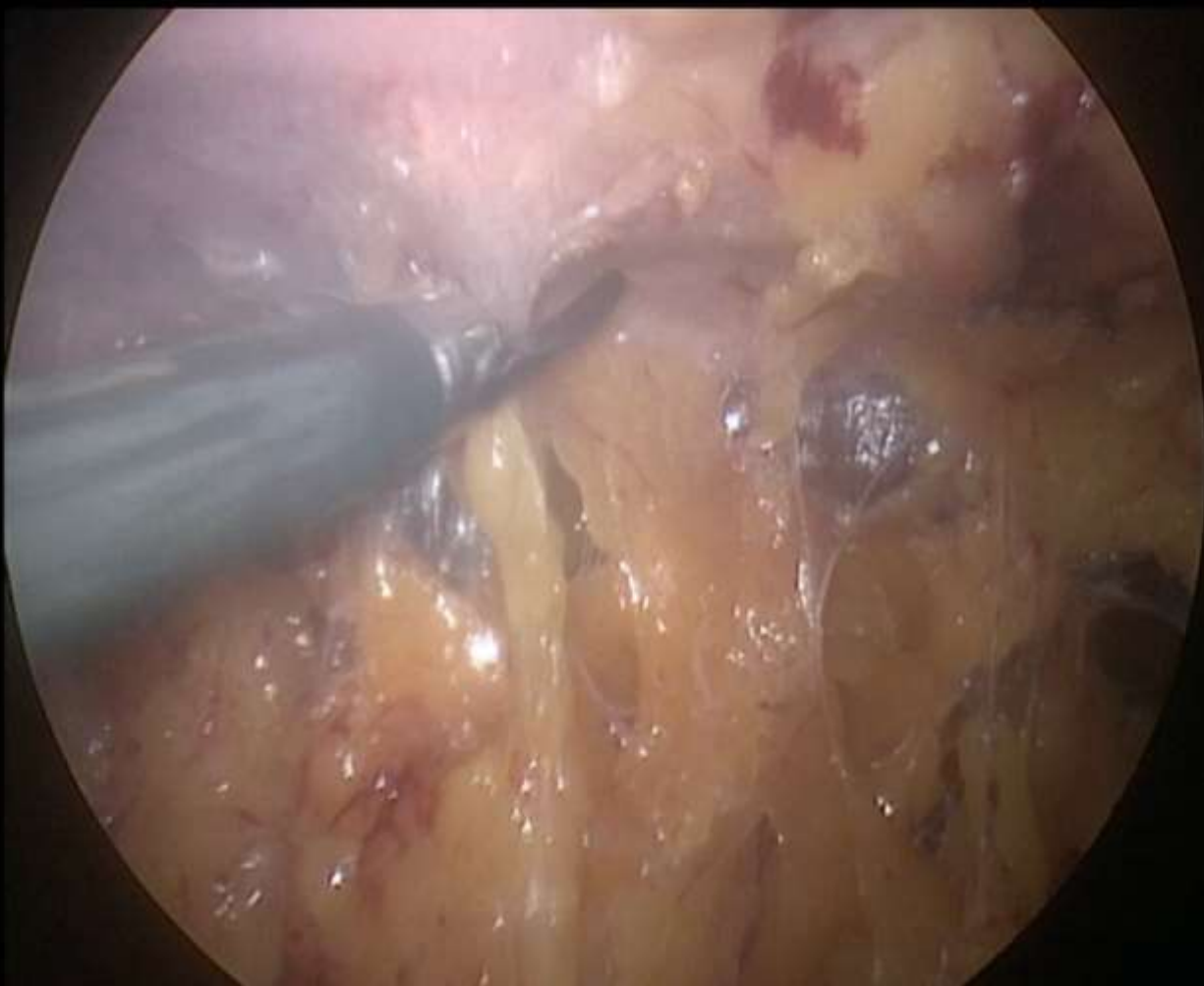
- New surgeon training
- New procedure mentoring
- Cross-specialty collaboration
- Shortened learning curve



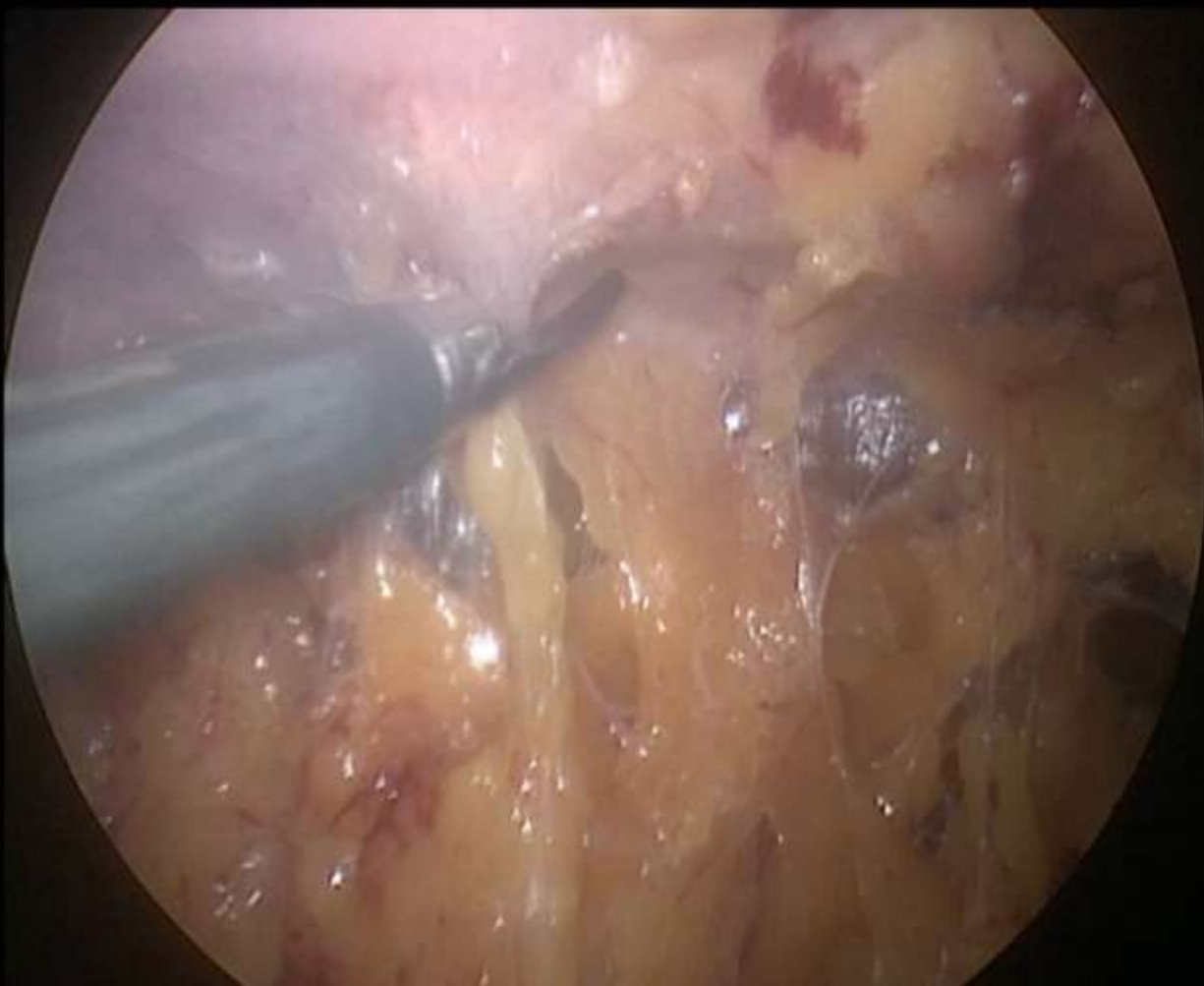
Robotic RYGB with DV Xi & Sureform



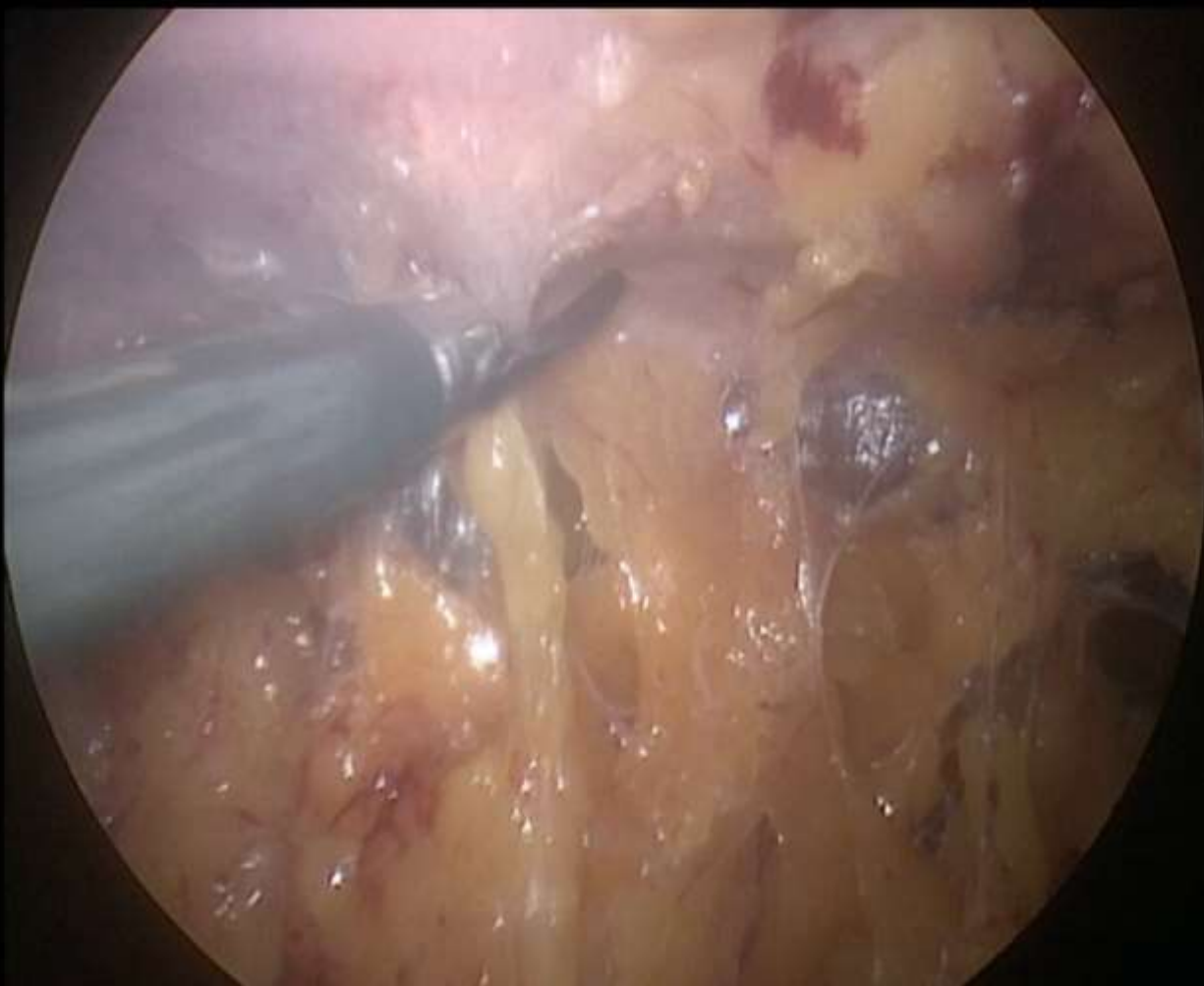
Robotic RYGB with DV Xi & Sureform



Robotic RYGB with DV Xi & Sureform



Robotic RYGB with DV Xi & Sureform



Installed base across countries

- Global installed base of about 8200 Da Vinci Systems (+ ~300 other systems)
- Spread over 70 different countries

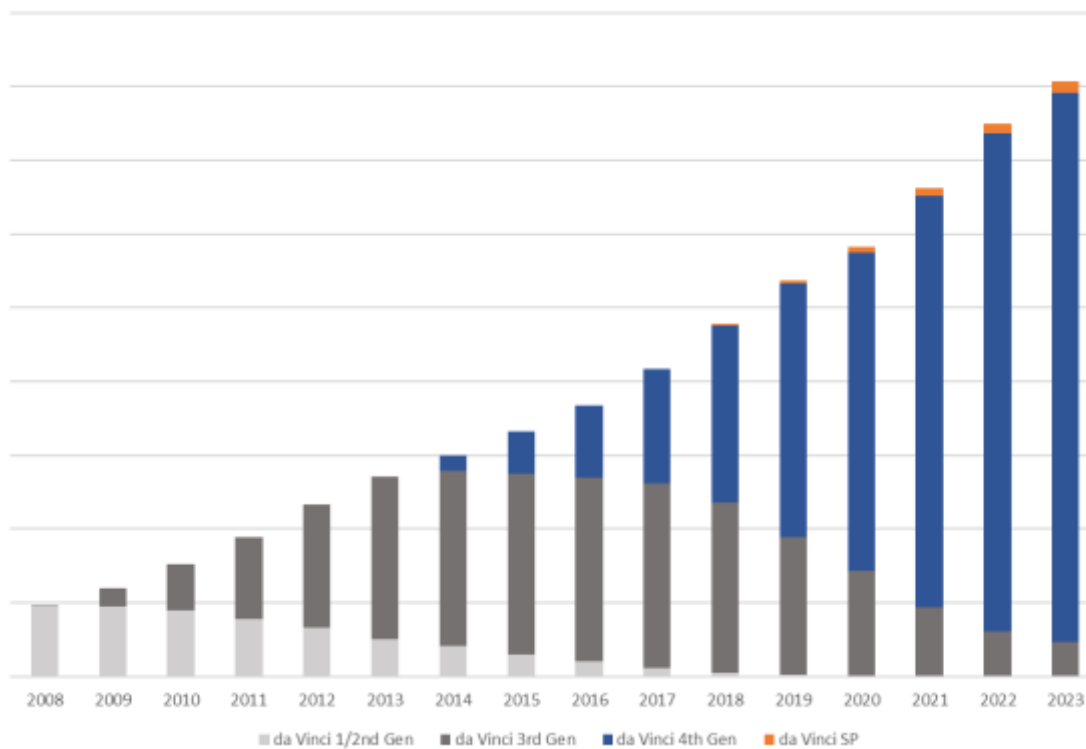


Installed base by region

- United States has the biggest installed base of about 4500+ systems
- Asia is fastest growing RAS market in the world with about 1400 systems



~95% Da Vinci installed systems are now 4th Gen



Da Vinci Single Port installations

150+

Da Vinci SP install base

34000+

Single Port Procedures

Cost estimates



Da Vinci Xi



Da Vinci X

Capital cost estimates

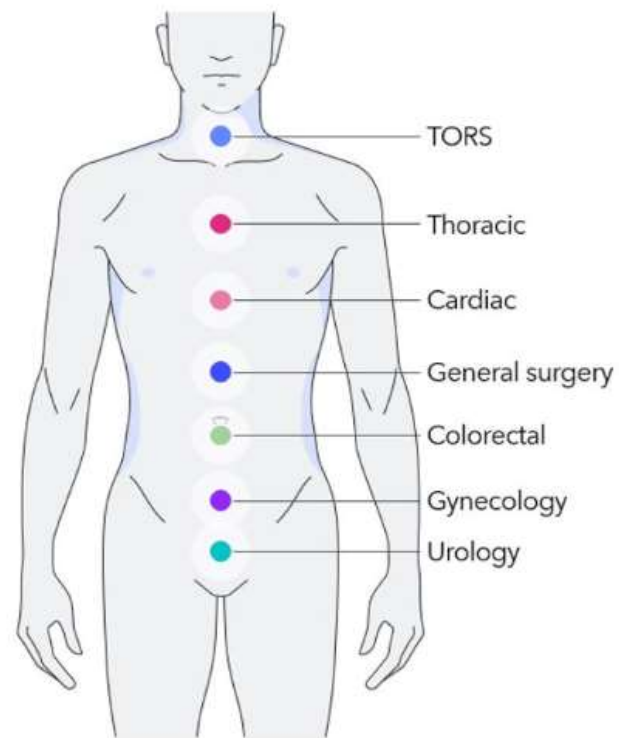
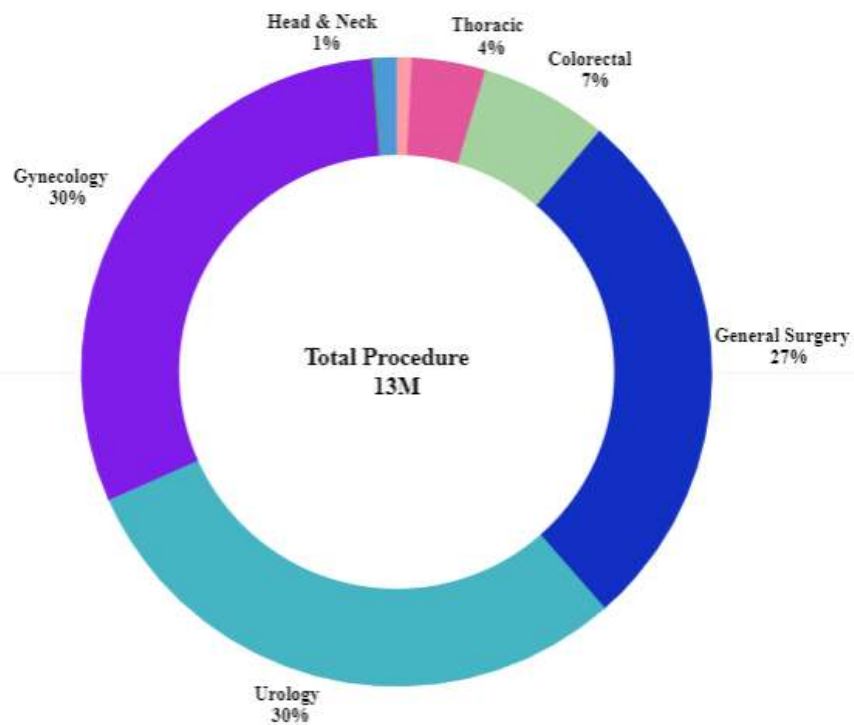
\$ 1M to 1.5M

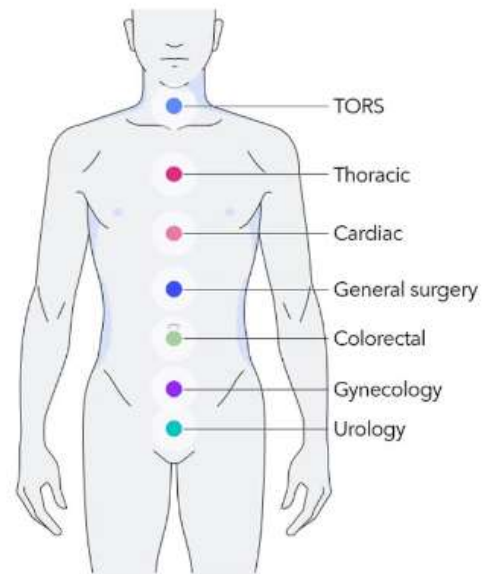
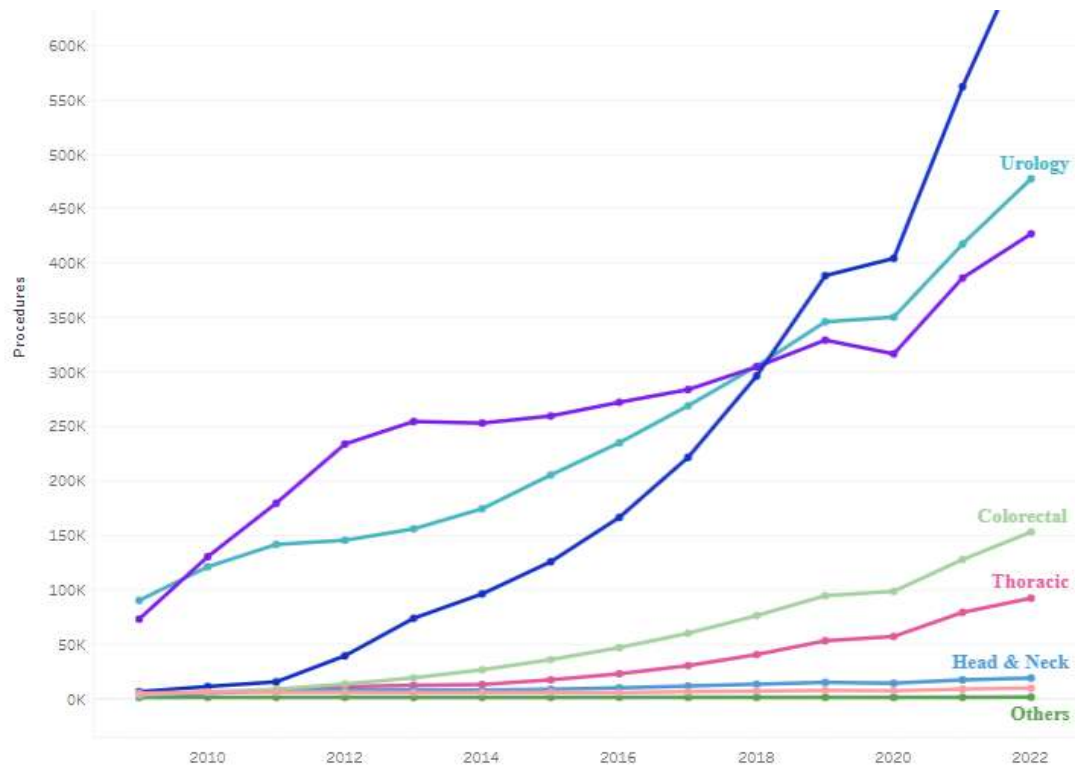
\$700k to 900k

Per procedure cost (3
instrument)

\$1000-\$1200

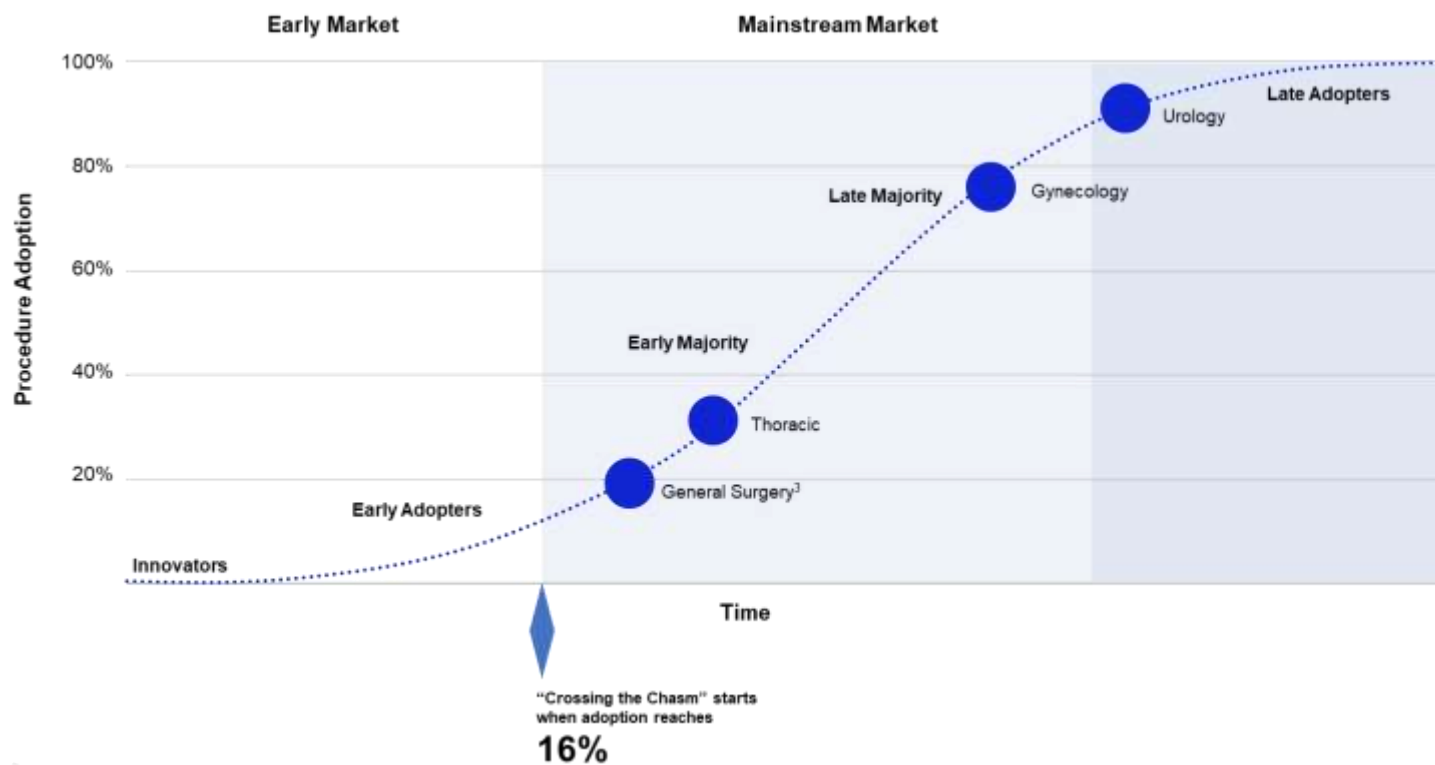
\$800-\$1000





US da Vinci® robotic-assisted surgery adoption

Conceptual presentation based on company estimates²



BORNS Surgical Robot System (BMR-5000)

Indications - General Surgery | Urology | Gynecology



Control Console



Tool Driver Robot



Surgical Cart



Lens Driver Robot



Equipment Cabinet

BMR-5000 Surgical Carts, Lens Driver and Tool Driver Robot

MODULAR DESIGN WITH OPEN INTERFACE

PRECISE

MODULAR

SCALABLE

MOBILITY



COMPATIBLE

SEC MEETING

BMR-5000 SURGICAL INSTRUMENT

MORE OPTIONS FOR SURGEONS AND PATIENT

DISPOSABLE

Material of
Construction



AESCULAP

ARTICULATE
D



Phase 1 clinical trial

- Globally first use of BORNS robotic system at our hospital in Delhi in 2023
- Needed a lot of regulatory approvals
- Took 6 months for the same
 - DCGI approval
 - IRB
 - CTRI
 - Legal



Pilot Study details

- First case – March 11, 2023
- 20th case – April 24, 2023
- Total duration (including follow up) – 8 weeks

Procedures performed

- Cholecystectomy – 6
- Bariatric (Sleeve Gastrectomy) – 7
- Ventral Hernia – 2
- Inguinal Hernia – 2
- Splenic cyst excision (preserving spleen) – 2
- Liver Hydatid - 1

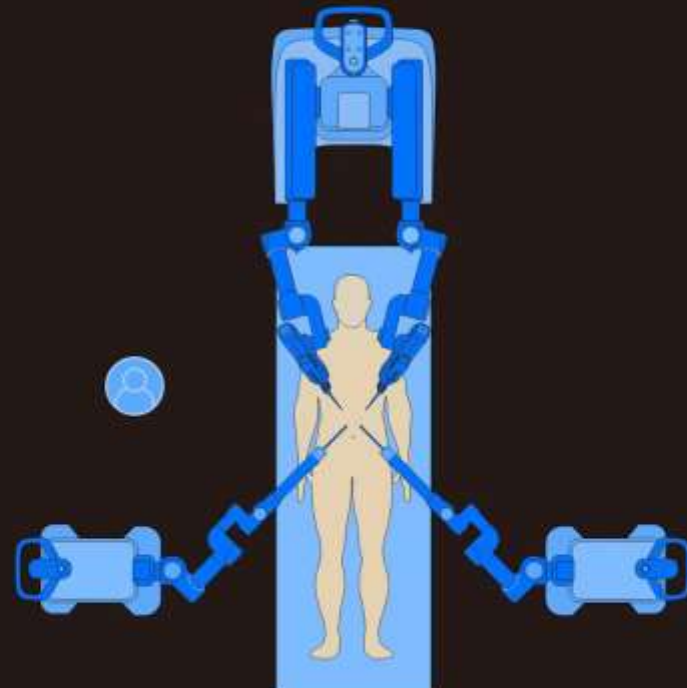
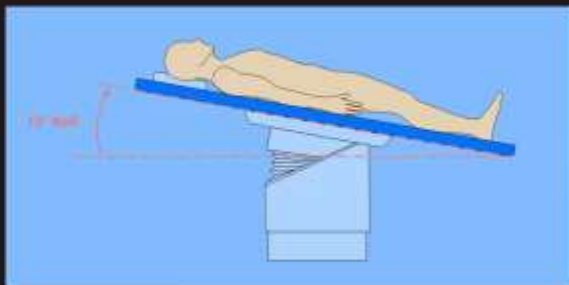
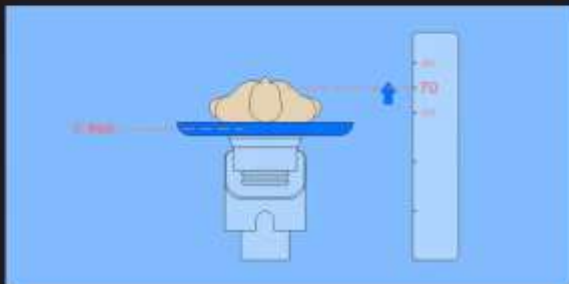
Bariatric case

Sleeve
Gastrectomy



BORNS Robotic Sleeve Gastrectomy

The Docking Setup of the BMR-5000 Surgical Robotics System



MEDTRONIC HUGO

INNOVATIVE. BY DESIGN.

- Trusted instruments and powerful analytics
- World class service, support and training





Driving Hugo



About Hugo™ RAS system

- Hugo RAS System is a **modular, flexible and immersive** soft-tissue robotic surgery platform
- Hugo RAS system is the result of a successful technology transfer between the **German Aerospace Center (DLR)** and **Medtronic**.
- **70+ Installations in 20+ countries**
- Cleared for use in Europe, India, Canada, Australia, Japan, Israel, Saudi Arabia, Taiwan and Brazil
- AIIMS Delhi: wet lab training





Current Installations and clinical program

4 active clinical sites in India

Apollo main hospital, Chennai



Care hospitals, Hyderabad



Venkateshwar hospital, Delhi



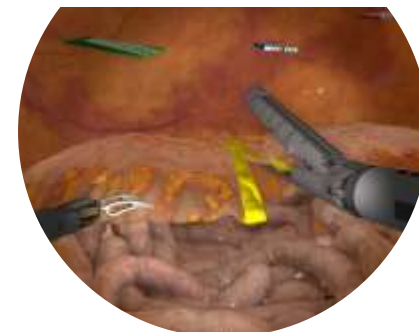
Sir Gangaram hospital, Delhi



- Successful Hugo RAS program at all clinical sites with 400+ procedures already done
- No major complications reported
- Fast learning curve
- Complex surgeries like salvage cystectomy, partial nephrectomy etc. performed on Hugo RAS

A solid foundation of technical and procedural experience

The Hugo™ ASCEND training pathway



Technical training

for surgeons, first assists and OR nurses

Pre-work

- Virtual / simulation

Technical training

- 2-day live instruction
- Dry labs on preclinical models
- Held in Medtronic partner training facilities

Procedural experience

for surgeons

- Virtual/ Simulation

- 2-day live didactic & clinical application training
- Held in Medtronic partner training facilities

Coaching

for surgeons

Case support

- 3-5 proctored cases by an experienced surgeon: Guidance and support of initial clinical cases and identify focus areas of improvement
- 3-5 video case reviews: Assessment by faculty of step-by-step proficiency and identify focus areas of improvement**



Pre-Recorded Video Library Case Observations

Ongoing Access

*For Limited Procedures

**Active Touch Surgery Enterprise subscription required for video case reviews

© 2022 Medtronic. Medtronic, Medtronic logo, and Engineering the extraordinary are trademarks of Medtronic. All other brands are trademarks of a Medtronic company.
08/2022 – US-RP-20000028

Hugo Pricing*

- Capital cost: USD 1.2- 1.5 million
- Consumable cost – USD 1000 per case (3 instruments)
- Training is offered to all surgeons who wish to use the system

*These are approximate figures.

The pricing may vary from country to country & financial model opted

CMR Surgicals

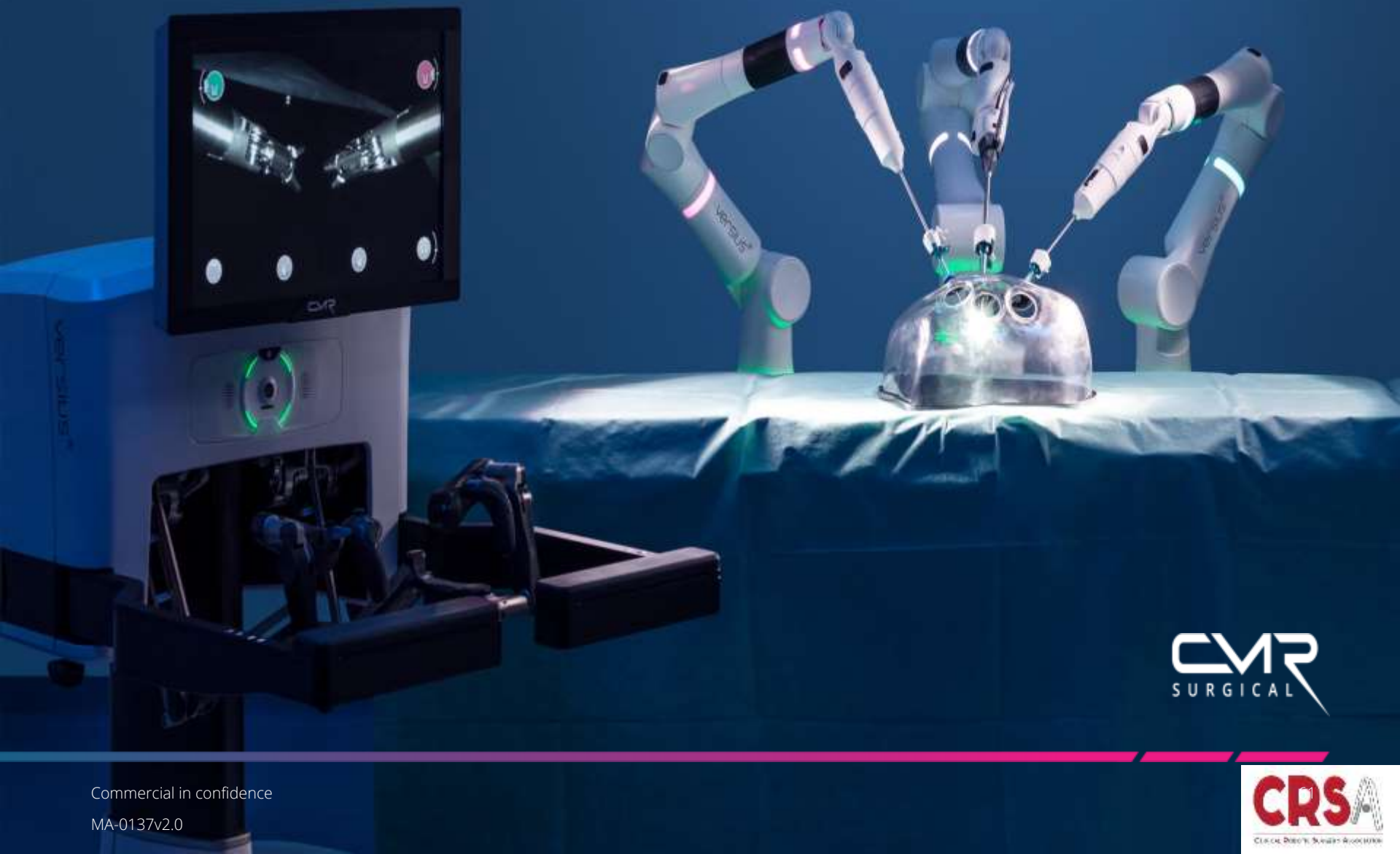
- CMR Surgical, UK installed first Versius in 2018 in India
- More than 100 installations globally now
- Has installations in India, Europe, UK, middle east

Inaugurating one of the first CMR installations in Maharashtra, India in 2019



Cambridge Medical Robotics





CVR
SURGICAL

Modular arms



CVR
SURGICAL

Open surgeon console



CVR
SURGICAL

Small, fully- wristed instrumentati on



CVR
SURGICAL

Versius trainer



CVR
SURGICAL

CMR Versus Pricing*

- Leasing models / outright purchase
- Capital cost: Approx. USD 1 million (for purchase)
- Consumable cost would depend on financial model opted & number of procedures

*These are approximate figures.

The pricing may vary from country to country & financial model opted



Advanced . Affordable . Accessible
Robotic Surgery





Surgeon Command Center

Ergonomic
Open Faced Console

Large
3D 4K Monitor
for true depth perception

Large
2D Touch Monitor
for system control

User-Friendly
Hand Control Design

Head-Tracking
Safety Feature

Advanced
Console Ergonomics
Control

Patient Side Robotic Arm Carts

Modular
Robotic Carts

Freedom of
Patient Docking

3 / 4 / 5
Patient Cart
Connectivity

**Absolute
Stability**
Parking Locks

Smaller
Individual cart
footprint

Advanced touch
screen controls





Vision Cart

Large
3D 4K Monitor
For OR Staff

OMNI 3D HD
Multimedia recording
and streaming platform

Articulating Endoscope
and Camera Control
system

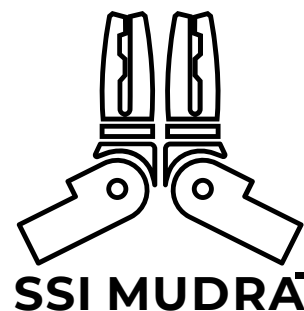
Universal
Safety features

Pre-Operative
Guidance Software

UPS
battery backup

SSI Mudra Endo-Surgical Instruments

- 4 degrees of freedom articulating Endo-surgical instruments
- Actuator driven
- 10 use life cycle per instrument
- Currently 40 types of instruments
- Novel Automated Anastomotic Connector as an integrated instrument under development
- Novel Multi-fire Clip applier



Cardiac Instruments



Cardiac
Stabilizer



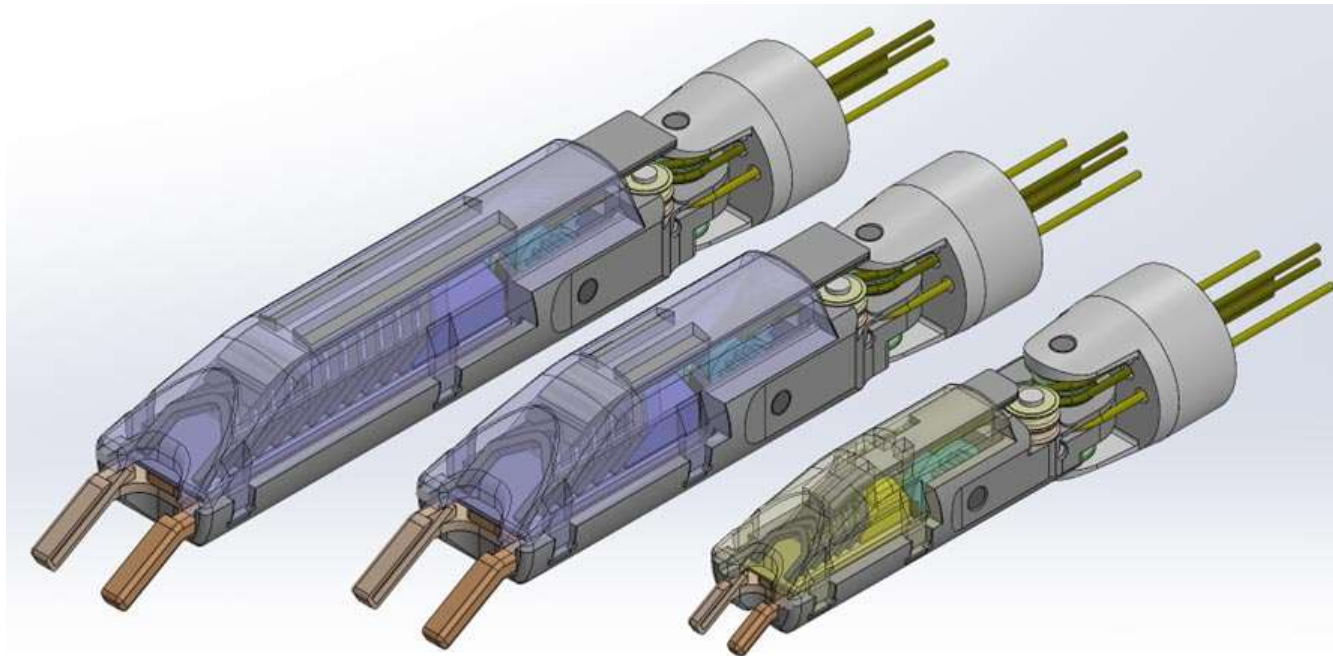
Dual Blade
Retractor



Resano
Forceps



Multi-Fire Clip Applier



Current Status

- 13 installations successfully carried out till September 2023.
- **11 centres in India**
- **Aster DM Healthcare, Dubai, UAE**
- **Johns Hopkins University Hospital, Baltimore, USA**

SYSTEM COSTS (In INDIA) (USD)

	SSI Mantra	Da Vinci X (Refurbished)	Da Vinci Xi
System Cost	670,000	975,000	1,460,000
IGST + Customs Duty (30%)	NIL	293,000	439,000
Total Cost (Including GST)	670,000	1,268,000	1,899,000

PROCEDURE COSTS COMPARISON (in INDIA)

	SSI Mantra	Da Vinci X (Refurbished)	Da Vinci Xi
	Per procedure \$600	Per procedure \$1100	Per procedure \$1500
Cost for 300 procedures	\$180,000	\$330,000	\$450,000
CMC For 9 years	\$512,000	\$880,000	\$1,029,000

Senhance Surgical System (Asensus Surgical)



Hinotori (Japan)



Our experience



SCIENTIFIC PAPER

JSLS

Robot-Assisted Sleeve Gastrectomy in Morbidly Obese Versus Super Obese Patients

Parveen Bhatia, MS, Vivek Bindal, MS, Rahul Singh, MS, Raquel Gonzalez-Heredia, MD, Sudhir Kalhan, MS, Mukund Khetan, MS, Suviraj John, MS

ABSTRACT

Background and Objectives: This study evaluates our technique for robot-assisted sleeve gastrectomy for morbidly obese and super obese patients and our outcomes.

Methods: A retrospective analysis of patients who underwent robot-assisted sleeve gastrectomy at a single center was performed. The procedure was performed with the da Vinci Si HD Surgical System (Intuitive Surgical, Sunnyvale, California). The staple line was imbricated with No. 2-0 polydioxanone in all cases. The super obese (body mass index ≥ 50 kg/m²) subset of patients was compared with the morbidly obese group in terms of demographic

times with the growing experience of the entire operative team. Robot-assisted sleeve gastrectomy can be a good procedure by which to introduce robotics in a bariatric surgery center before going on to perform Roux-en-Y gastric bypass and revision procedures.

Key Words: Sleeve gastrectomy, Robot-assisted bariatric surgery, Super obese, Robotic surgery, Laparoscopic bariatric, Robotic sleeve.

INTRODUCTION

Our experience

OBES SURG
DOI 10.1007/s11695-014-1502-9



ORIGINAL CONTRIBUTIONS

Technique Evolution, Learning Curve, and Outcomes of 200 Robot-Assisted Gastric Bypass Procedures: a 5-Year Experience

Vivek Bindal • Raquel Gonzalez-Heredia •
Mario Masrur • Enrique F. Elli

© Springer Science+Business Media New York 2014

Abstract

Background We evaluate our 5-year experience, evolution of technique, and clinical outcomes with robot-assisted RYGB. **Methods** Two hundred consecutive patients who underwent robot-assisted RYGB at our center were included. Among them, 118 patients underwent a hybrid robot-assisted laparoscopic

Conclusions Use of robot assistance to perform RYGB and may reduce the associated complications, robotic stomotic leak, gastrojejunostomy (GJ) stricture, reflux, rhage. Excess weight loss at 2 years after RRYGB comparable to laparoscopic RYGB.



Our experience

OBES SURG

DOI 10.1007/s11695-015-1632-8



ORIGINAL CONTRIBUTIONS

Outcomes of Robot-Assisted Roux-en-Y Gastric Bypass as a Reoperative Bariatric Procedure

Vivek Bindal · Raquel Gonzalez-Heredia ·
Enrique Fernando Elli

© Springer Science+Business Media New York 2015

Abstract

Background We evaluate the outcomes of robot-assisted Roux-en-Y gastric bypass (RRYGB) as a reoperative bariatric procedure (RBP).

Methods A retrospective analysis was done from 2007 to

Keywords Robot · Revisional · Gastric bypass · Reoperation · Bariatric surgery · Gastric band

Introduction



Review of published evidence

JMAS_87_14R1

Journal of
Minimal Access Surgery

Review Article

Review of contemporary role of robotics in bariatric surgery

Vivek Bindal, Parveen Bhatia, Usha Dudeja, Sudhir Kalhan, Mukund Khetan, Suviraj John, Sushant Wadhera

Institute of Minimal Access, Metabolic and Bariatric Surgery, Sir Ganga Ram Hospital, New Delhi, India

Address for Correspondence: Dr. Vivek Bindal, Institute of Minimal Access, Metabolic and Bariatric Surgery, Room No. 400, 4th Floor, SWB, Sir Ganga Ram Hospital, New Delhi - 110 060, India. E-mail: bindal.vivek@gmail.com



Conclusion: Robotics in bariatric surgery is safe and feasible. It provides specific advantages in some situations, and the results compare favorably with laparoscopy

SAGES Atlas of Robotic Surgery

Robot-Assisted Roux-en-Y Gastric Bypass

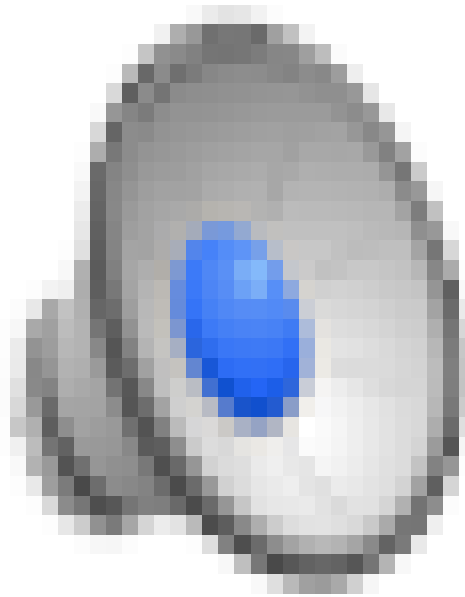
31

Vivek Bindal and Enrique E. Elli

This chapter reviews the technique and outcomes of robot-assisted Roux-en-Y gastric bypass (RYGB). With the rise in obesity and bariatric procedures, surgeons are encountering patients with high body mass index (BMI) and revisional bariatric procedures. The use of digital platforms holds great promise for these complex procedures. Many specialists consider RYGB, which involves two anastomoses (gastrojejunostomy and jejunojejunostomy), to be the gold-standard surgical procedure for morbid obesity. Robotic surgery is currently considered to be an attractive technology that could help perform RYGB, given its well-described advantages. It is also the most-studied robotic bariatric procedure. This chapter describes the instrumentation, patient positioning, oper-

dissection, and reconstruction difficult [4]. Super-obese (SO) patients with a BMI of 50 kg/m² or higher are difficult to manage because of limited working space, excessive torque on instruments due to thick abdominal walls, super-obese patients' comorbidities, and high risk for anesthesia [5]. The maneuvering of instruments while performing LRYGB becomes challenging, especially while doing intracorporeal suturing. The learning curve of LRYGB has been estimated to be about 75–100 cases [6, 7]. Moreover, surgeons encounter very difficult ergonomic positions that can potentially shorten their careers, so surgeons have been looking for methods that will improve patient outcomes and surgical technique, decrease complications, and also reduce the learning curve.

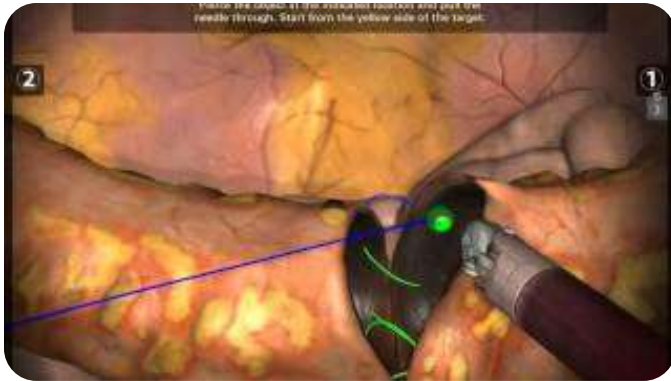
Intuitive SP System



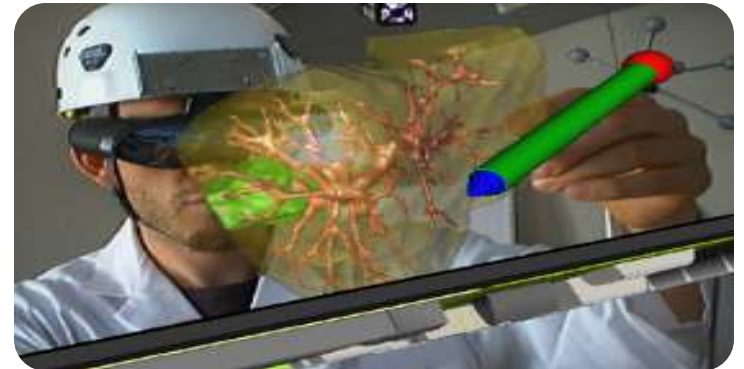
Robotic surgery

THE FUTURE

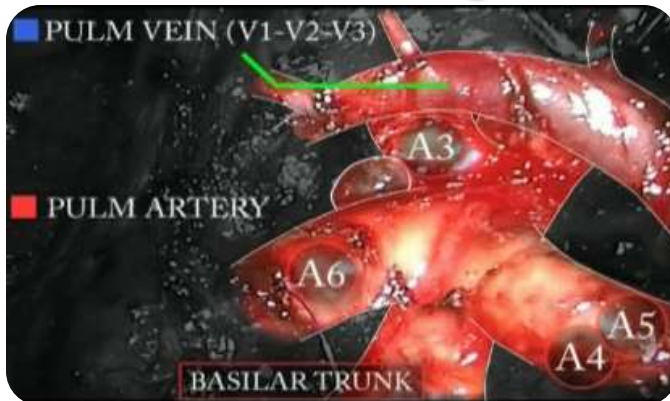
Advanced Simulation:



Augmented reality:



Real time warnings:



Memory:



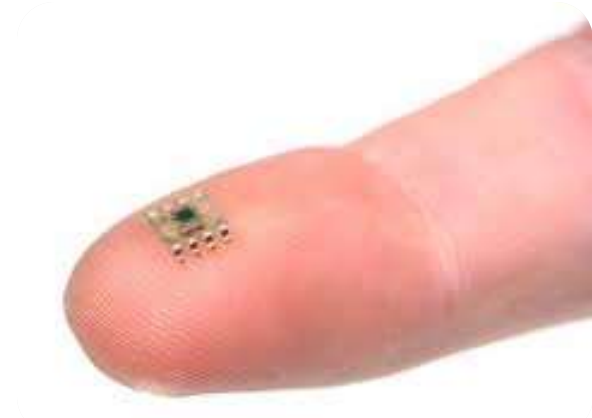
Robotic surgery

THE FUTURE

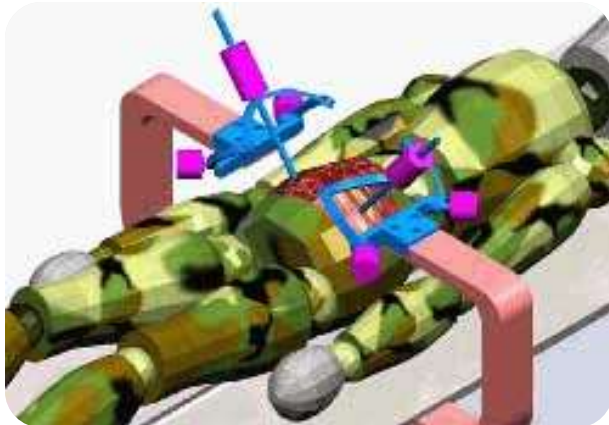
Telepresence:



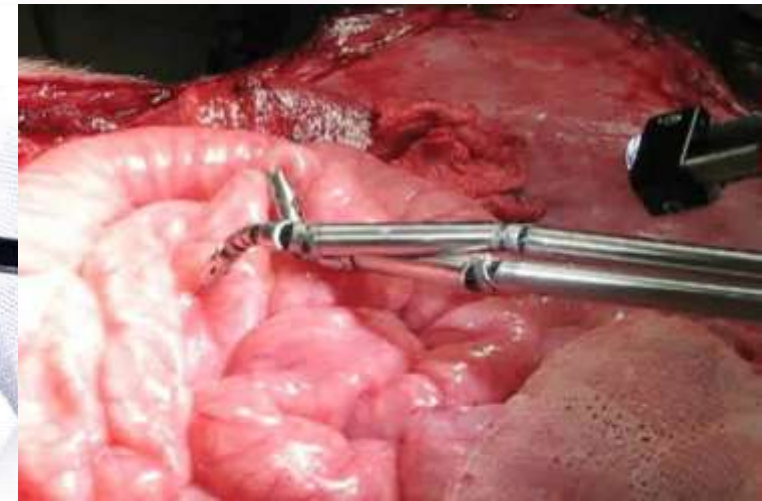
Miniaturization:



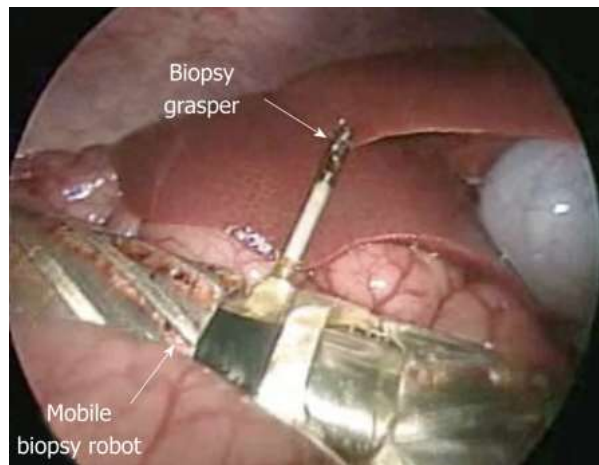
Remote surgery:



Natural orifice surgery:



In Vivo Miniature Intraperitoneal Robots: NOTES



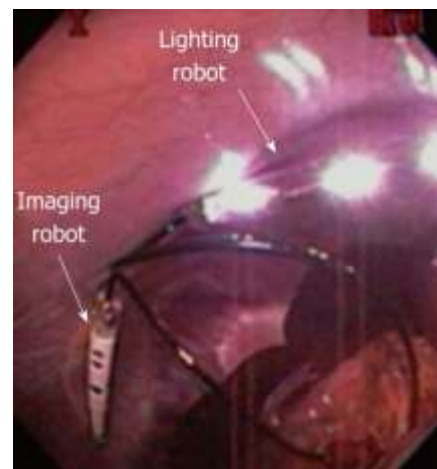
Biopsy robot



Imaging robot



Dextrous robot



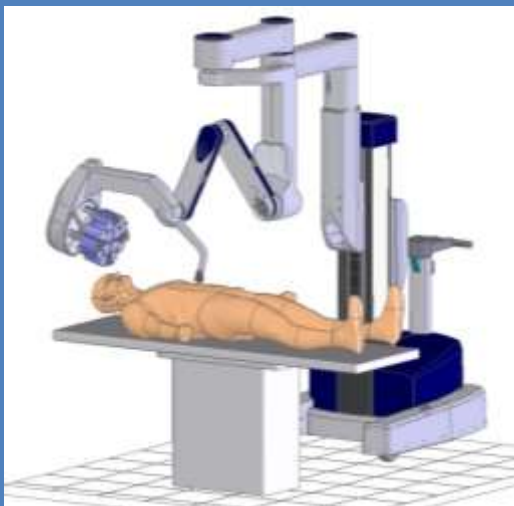
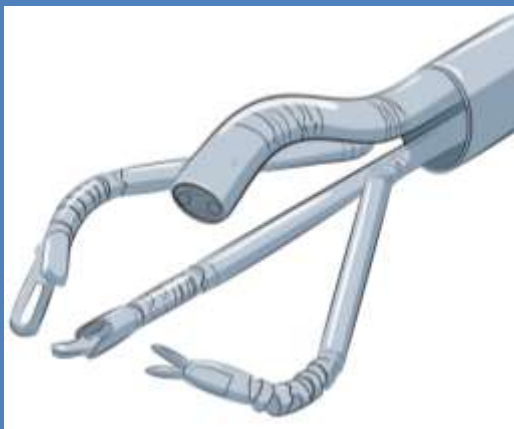
Cooperative robot

Tiwari MM et al. *In vivo* miniature robots for natural orifice surgery: State of the art and future perspectives. *World J Gastrointest Surg*; 2(6): 217–23.

The instruments shown are in pre-clinical stage of development, not approved for human use

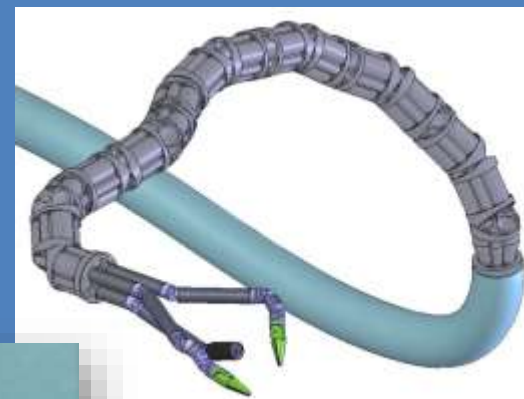
Advanced Single Port or NOTES

Single Port



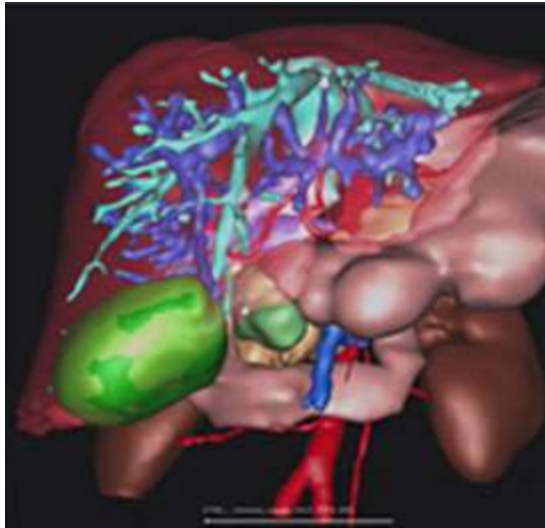
- Natural orifice / trans-umbilical
- da Vinci-like capability
- Large range of motion (multi-quadrant capability)

Flexible Systems

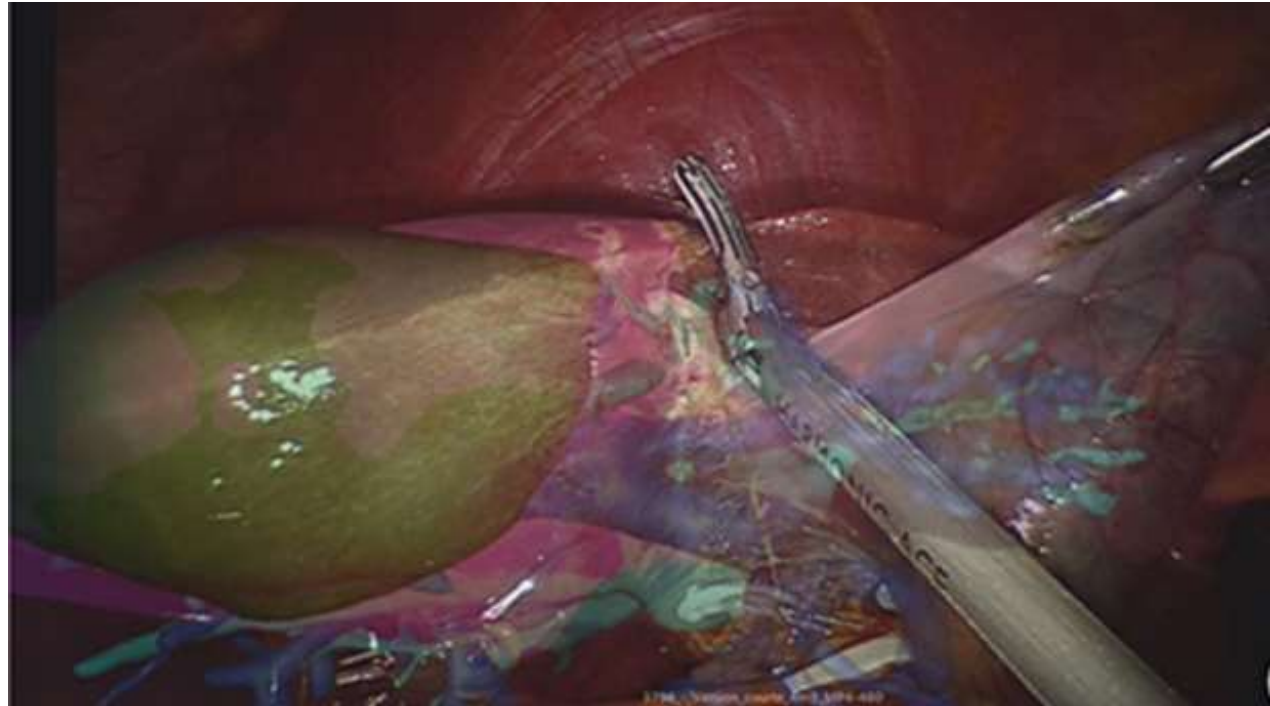


New technologies for single-site robotic surgery in hepato-biliary-pancreatic surgery. Diana M, Pessaux P, Marescaux J. J Hepatobiliary Pancreat Sci. 2013 Sep 30

Virtual Reality and Simulation



- 3D virtual reality model of a patient's anatomy
- navigate through the human's anatomy
- perform a virtual exploration
- simulate the operative strategy



3D virtual reality model may be superimposed intraoperatively with real-time patient images to obtain **Augmented Reality**

New technologies for single-site robotic surgery in hepato-biliary-pancreatic surgery. Diana M, Pessaux P, Marescaux J. J Hepatobiliary Pancreat Sci. 2013 Sep 30

Thank You



OR of the future

Patient: John L.
Procedure: Prostatectomy
Surgeon: Giulianotti
Critical Information:
Jehovah's Witness