Anesthetic Considerations For Robotic Surgery

Warning Will Robinson, Warning

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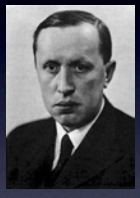
Robots

Definition

- **Describes an autonomous device capable of various tasks**
  - ***Industrial robots***
  - ***Stereotactic navigation assist device***
  - ***Telemanipulators***

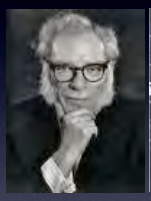
History

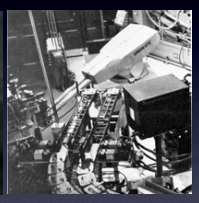
Josef Capek-1917
- **Opilec**



Karel Capek-1921
- **Rossum's Universal Robots (RUR)**

History





- Isaac Asimov 1938-1942
- GM Introduces Unimate-1958

History

- NASA Developed Robots For Space
- Telemanipulators Capable Of Doing Manual Tasks
- Dexterous Telemanipulators For Surgical Use

History

- Department Of Defense Investigates Robots For Treating Battlefield Wounded
- Latency Of The Signal Over Distance Limited Its Effectiveness
- 1985-First Surgical Application Using Modified Industrial Robotic Arm

Laparoscopy

Phillipe Mouret - 1987

- *First Video Laparoscopic Cholecystecomy*

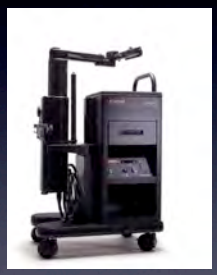
Advantages

- *Reduced Tissue Trauma*
- *Reduced Postoperative Pain*
- *More Rapid Recovery*
- *Shorter Hospital Stay*
- *Improved Patient Satisfaction*

Robodoc-1992

- Used In Orthopedics
- Fulcrum Effect
  - *Non-intuitive Motion Of The Instrument Tips In Opposite Direction About A Fixed Point*

AESOP And TISKA Endoarm



1994

Development of Active Robotics

- Overcoming Dexterity Problems
- Development Of Manipulators That Mimick Hand Movements
- Development Of Three Dimensional Video Imaging, Robot Camera Holders And Robotic Flexible Instrumentation

Two Robotic Systems

da Vinci

Zeus

First Robotic-Assisted Surgical Procedure April 1997

Jacques Himpens

Guy Cardiere

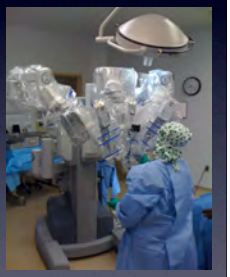
The da Vinci Robotic Surgical System

Advantages of Robotic Surgery

- Magnified 3D Vision
- Digitalized Hand Movements
- Superior Maneuverability Of Robotic Instruments
- Safety System Prevents Un-attended Movement Of Arms

Disadvantages Of Robotic Surgery

- Bulky, Large Equipment
- Costly
- Instrumentation Has Finite Life Of Ten Procedures
- Invasion Of Anesthetic Work Space
- Loss Of Tactile Feedback
- Requires Staff Training



Initiating A Robotic Program

- Major Financial Outlay And Recurring Cost
- Surgical Growth Potential And Recognition Offsets The Cost Of The Program
- Teamwork Is Essential To Success
- Challenges Include
  - *Increased Operating Time*
  - *Surgical Learning Curve*

Procedures Performed Using Robotics

Urologic Procedures Include

- *Pyeloplasty*
- *Cystectomy With Diversion*
- *Adrenalectomy*
- *Radical And Partial Nephrectomy*
- *Radical Prostatectomy*

Prostate Cancer

- Affects 235,000 Annually
- Death Rate Approximates 12%
- Treatment Options Include:
  - *Radiation*
  - *Observation*
  - *Surgery*

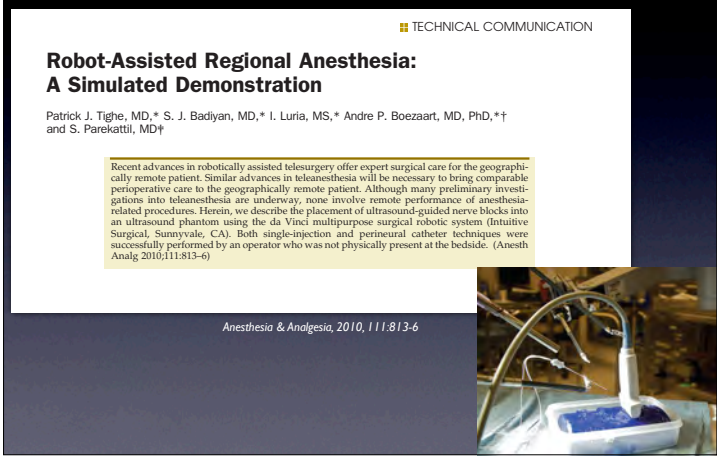
Radical Prostatectomy

- Changes Quality Of Life
- Discourages Treatment
- Complications From Damage To Urinary Sphincter And Penile Nerve
- Minimally Invasive Technique
  - *Nerve-Sparing Technique*
  - *Has Increased Patient Acceptance*
  - *Allows More Rapid Discharge*

Procedures Performed Using Robotics

- GI Procedures
  - *Cholecystectomy*
  - *Gastrectomy, Gastric Bypass, Pancreatoduodenectomy*
  - *Colon Resection*
- Thoracic
  - *Lobectomy And Wedge Resection*
  - *Esophogastrectomy*
  - *Thymectomy*
- Cardiac
  - *Coronary Bypass Graft*
  - *Atrial Septal Defect Repair*
  - *Mitral Valve Replacement*
- Otolaryngology
- Orthopedics
- Opthalmology

On The Horizon?



TECHNICAL COMMUNICATION

Robot-Assisted Regional Anesthesia: A Simulated Demonstration

Patrick J. Tighe, MD,* S. J. Badiyan, MD,* I. Luria, MS,* Andre P. Boezaart, MD, PhD,*† and S. Parekattil, MD†

Recent advances in robotically assisted telesurgery offer expert surgical care for the geographically remote patient. Similar advances in teleanesthesia will be necessary to bring comparable perioperative care to the geographically remote patient. Although many preliminary investigations into teleanesthesia are underway, none involve remote performance of anesthesia-related procedures. Herein, we describe the placement of ultrasound-guided nerve blocks into an ultrasound phantom using the da Vinci multipurpose surgical robotic system (Intuitive Surgical, Sunnyvale, CA). Both single-injection and perineural catheter techniques were successfully performed by an operator who was not physically present at the bedside. (Anesth Analg 2010;111:813–6)

Anesthesia & Analgesia, 2010, 111:813-6

Differences Between Robotic And Laparoscopic Surgery

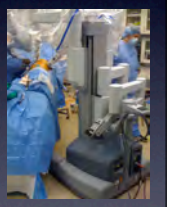
- Challenges To Patient Access
- Securing And Preventing Patient Movement
- Importance Of Adequate Muscle Relaxation

Anesthesia Considerations

- Patient Positioning
- Hemodynamic And Respiratory Effects Of Pneumoperitoneum
- Duration Of Procedure
- Spatial Restrictions Due To Equipment
- Possibility Of Unsuspected Visceral Injury Or Blood Loss
- Development Of Hypothermia

Positioning

- Robot May Be Positioned At The Foot, Side Or Close To Head
- Once Robot Is Engaged, Bed And Patient Position Cannot Be Changed
- Protect The Patient From Pressure And Crush Injuries From Robotic Arms



Protecting Your Patient From Nerve Injury

- 2.7% Incidence Of Neuromuscular Injury Annually
  - *Radial And Ulnar Nerves*
  - *Brachial Plexus*
  - *Sciatic Nerve*
  - *Obturator Nerve*
  - *Peroneal Nerve*
  - *Lateral Femoral Cutaneous Nerve*
- Pad All Areas

Protecting Your Patient From Nerve Injury

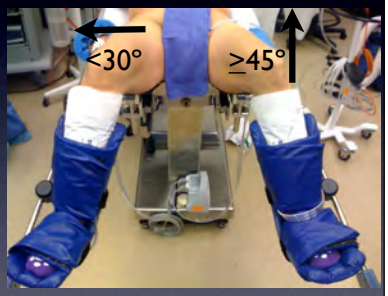
- Patient Strapped With Chest Binding In X Pattern
- Protect The Face

Positioning In Trendelenburg

- Gel Mat Placed Under Patient To Minimize Slipping And Provide Padding
- Bean Bag Is An Option But Rarely Used
- Avoid Use Of Shoulder Braces

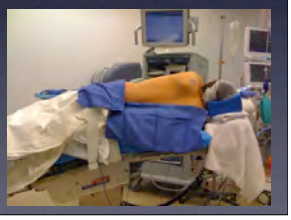
Positioning In Lithotomy

- Goal Is To Minimize Hip Abduction And Maximize Flexion To Accommodate Robot Arms
- Cushioned Stirrups
- Arms And Hands Padded And Tucked
- Ensure IV Access And Functional Monitoring Ability
- Only Opportunity To Gain Access For IVs And Invasive Monitors Is Before Docking



Positioning In Lateral Position

- Axillary Roll Placed
- Kidney Rest Positioned Over Iliac Crest
  - *Prevents Lung Splinting And Atelectasis*
- Plan On Variations Of Trendelenburg Or Reverse Trendelenburg



Effects Of Trendelenburg

Pulmonary Effects of Trendelenburg

- Abdominal Contents Push Diaphragm Cephalad
- Increased Pulmonary Blood Content And Gravitational Force On Mediastinal Structures
- Swelling Of Face, Eyelids, Conjunctivae, And Tongue
  - *Pharyngeal And Laryngeal Edema Is Possible*

Cardiovascular Effects of Trendelenburg

- Increased CVP, Myocardial Work And Pulmonary Vascular Resistance
- Increased SV, CO
- MAP Unchanged Or Slightly Increased
- Increased Cerebral Venous Pressure
  - *Decrease In CBF*

Effects Of Pneumoperitoneum

- Well Tolerated By Health Individuals
- Myriad Of Issues
  - *Cardiovascular Effects*
  - *Pulmonary Effects*

Cardiovascular Effects Of Pneumoperitoneum

- **Increase In Intraabdominal Pressure Causes:**
  - ***Compression Of Vena Cava***
  - ***Increase In SVR, MAP, HR, PVR***
  - ***Increase In CVP, PCWP, PAP***
  - ***Decrease In SV, CO, CI***
- **Pronounced In Patients With Pre-existing Disease**

Pulmonary Effects Of Pneumoperitoneum

- **Elevation Of Diaphragm**
- **Decreased FRC**
- **Peak Pressure, Plateau Pressure And Intrathoracic Pressure Increase By More Than 50%**
- **Decreased Compliance Up To 68%**
- **V-Q Mismatch**
- **Pulmonary Shunting**
- **CO2 Absorption Hypercarbia And Acidosis Corrected With Ventilation**

Comparative Effects

Trendelenburg	Pneumoperitoneum
↑ SV	↓ SV
↑ CO	↓ CO
↑ CVP	↑ CVP
± MAP or slightly ↑	↑ MAP
↓ FRC	↓ FRC
↓ Compliance	↓ Compliance
↓ CBF, ICP	↑ CBF, ICP

Combined Effects Of Pneumoperitoneum And Trendelenburg

- **MAP Decreased 17%**
- **HR Decreased 21%**
- **CO Decreased 10-30%**
- **27% Of Patients Experience Dysrhythmias**

Hepatic Effects Of Pneumoperitoneum

- **Decreased Portal Vein Flow**
- **Decreased Hepatic Vein Flow**
- **Decreased Total Hepatic Blood Flow And Flow Through Hepatic Microcirculation**
- **No Change In Hepatic Arterial Flow**

GI And Renal Effects Of Pneumoperitoneum

- **Decreased Gastric PH**
- **Decreased Mesenteric Blood Flow And Microcirculation**
- **Decreased Renal Blood Flood**

CNS Effects Of Pneumoperitoneum

- Increased CBF
- Increased ICP
- Decreased CPP

Complications Of Pneumoperitoneum

- Subcutaneous Emphysema
- Pneumothorax
- Cephalad Shift Of Diaphragm
- Venous Gas Embolism

Venous Gas Embolism

Caused By Rapid Insufflation Into Vessel

- *Mill-wheel Murmur*
- *Hypoxia*
- *Decreased CO^2*
- *Cyanosis*
- *Sudden Cardiac Collapse*

Treatment

- *Removal Of Pneumoperitoneum*
- *Hyperventilation With Oxygen*
- *Left Lateral Decubitus And Trendelenburg Position*
- *Aspiration Of Air Via CVP*

Anesthesia Management

- Everyone Is Not A Candidate
- Proper Screening Will Minimize Complications Of Positioning And Pneumoperitoneum

Pre-operative Evaluation

- Optimization Of Cardiorespiratory And Metabolic System
- Discontinuation Of Anti-coagulants
- Identify Past History Of Abdominal Surgery
- Document Pre-existing Nerve Injury

Obesity And Robotics

- Predisposed To HTN, CAD, DM
- Challenge On Pulmonary Physiology
- Hindrance On Diaphragmatic Movement
- Difficulty Achieving Minute Ventilation

Intra-operative Management

- No Specific Technique Or Drug Preference
- Standard Monitors
  - *Consider Arterial Line Placement*
- Regional Anesthesia Not Indicated

Ventilation

- Increase In Airway Pressures
  - *Augmented In Patients With Restrictive Or Obstructive Disease*
- Utilize Pressure Controlled Ventilation Provides Better Ventilation And Lower Peak Airway Pressures Over Volume Control Mode

Muscle Relaxation

- Complete Muscle Relaxation Is Essential
- Spontaneously Breathing Diaphragm Causes Abdominal Contents To Move
- Facilitates Ease Of Mechanical Ventilation
- Facilitates Introduction Of Surgical Equipment
- Eases Creation Of Pneumoperitonium
- Consider Using Continuous Infusion

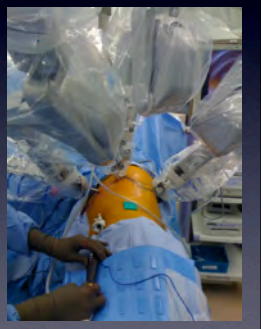
Special Considerations

Anesthetic Considerations For Robotic-Assisted Thoracoscopy

- Same Principles Apply As Thoracoscopic Surgery
- Improved Patient Outcome
- Selection Criteria Limited
- Side Cart Is Positioned Close To Head
- Limited Access To Airway And Neck

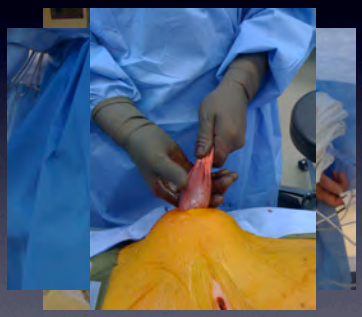
Anesthetic Considerations For Robotic-Assisted Thoracoscopy

- Insufflation Of CO^2 In The Chest Increases Airway Pressures
- Venous Return And Compliance Of Heart Decreases Resulting In:
  - *Hypotension And Hemodynamic Instability*
  - *Dependent Lung Develops Higher Airway Pressures*
- CO2 Rapidly Absorbed



Anesthetic Considerations For Robotic-Assisted Thoracoscopy

- One Lung Ventilation And Manipulation Alter Ventilation And Perfusion
- Lateral Position Reduces Shunting To Non-dependent Lung
- Pulmonary Shunting In Non-ventilated Lung Limited By HPV



Complications Of Thoracic Insufflation

- Emergency Conversion To Open Procedure
- Contra-lateral Pleural Can Be Violated Creating Tension Pneumothorax In Dependent Chest
  - *CO2 Discontinued To Alleviate Tension Pneumothorax*

Gynecologic Surgery

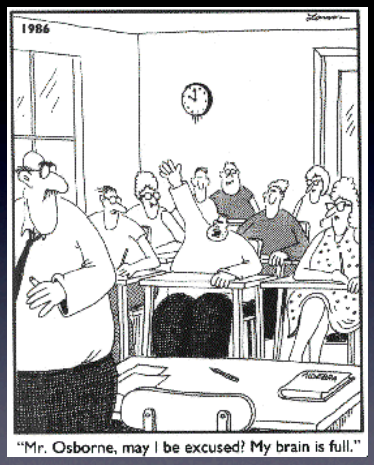
- Marked Improvement Over Laparoscopic Procedures
- Improved Micro-surgical Techniques

Otolaryngology Surgery

- Posterior Pharyngeal Resection
  - *Total Laryngectomy*
- Field Avoidance
- Protection Of Airway

Fluids

- Minimizes Facial Edema
- Restricted To Prevent Obscuring Surgical Field During Resection Of Bladder Neck
- Restoration Of Volume Possible After Return To Supine Position



Summary

- Learning Curve For The Surgeon
- Positioning And Pneumoperitoneum Provide A Great Challenge
- Robotics Gives New Meaning To Field Avoidance
- Patient Satisfaction And Surgical Outcomes High
- Much More Lies Over The Horizon