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14.10.2026

Innovations in Pediatric Surgical Oncology

Disclosures of Name Surname

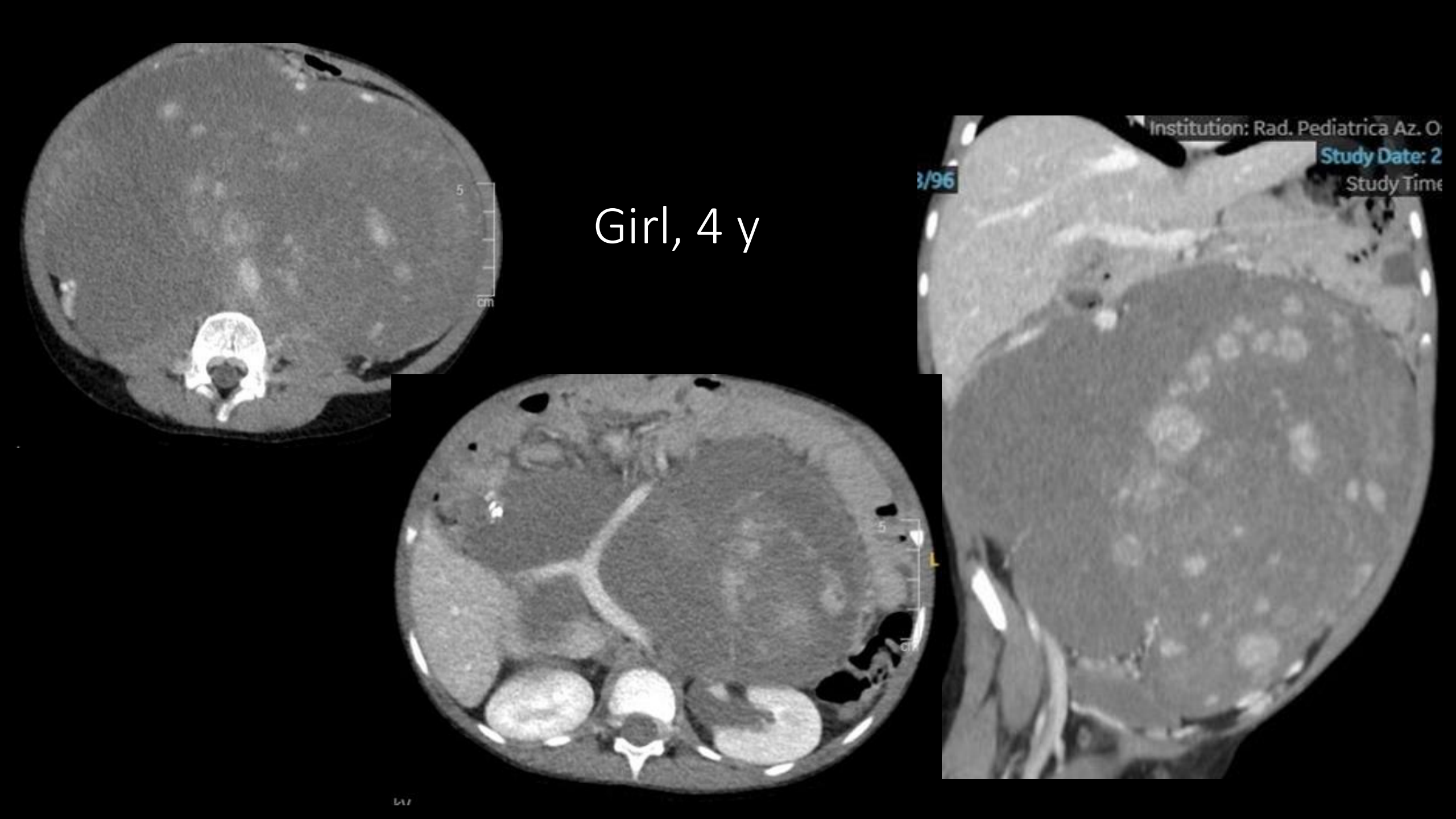
Company name	Research support	Employee	Consultant	Stockholder	Speakers bureau	Advisory board	Other

Why pediatric surgical oncology is different

- Low-incidence, high-complexity tumors
- Care concentrated in expert centers
- Surgery integrated with chemotherapy, targeted agents, radiation, and trials
- Outcomes tied to specialized training and multidisciplinary care

The Innovation Landscape

- Precision planning in defining tumors: advanced imaging, 3D modeling, Augmented Reality
- Intraoperative precision: fluorescence guidance, minimally invasive
- Collaboration with Interventional Radiologists
- Collaboration with Radiation Oncologists
- ERAS pathways, Care coordination, Training pipelines
- Translational links: liquid biopsy and genomics informing surgical timing


Girl, 4 y
Institution: Rad. Pediatrica Az. O
Study Date: 2
Study Time

Advanced Imaging for Surgical Planning

Exploring the potential of 3-Dimensional Imaging, Printing, and Modeling in Pediatric Surgical Oncology

To clarify tumor–vessel–organ relationships

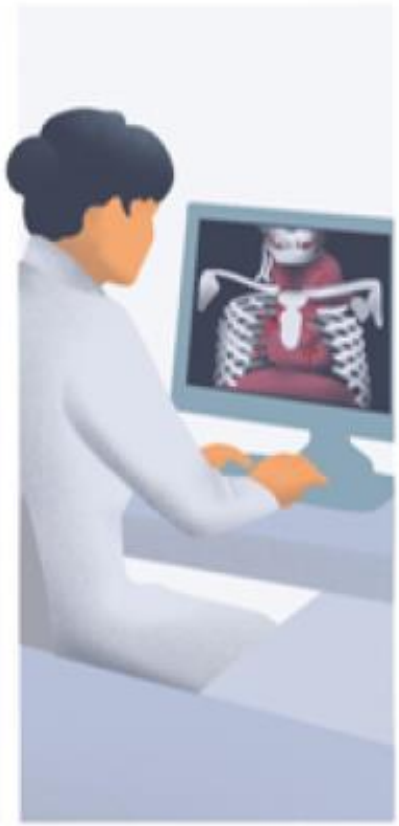
Better margin planning, shorter OR time, fewer surprises

Surgical planning remains crucial to assess the feasibility of adhering to oncologic principles, achieving en-bloc macroscopically complete resection or preserving neighboring organs, while avoiding injury to adjacent vital structures

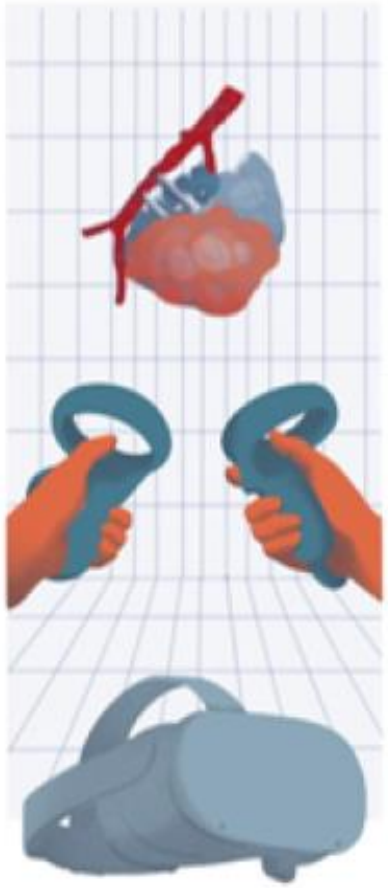
From 2D Imaging to Extended Reality: Current Tools for Medical Imaging

2D image acquisition	3D image and Projections (VolR / CR)	3D Printing	Virtual Reality (VR)	Augmented Reality (AR)	Mixed Reality (MR)











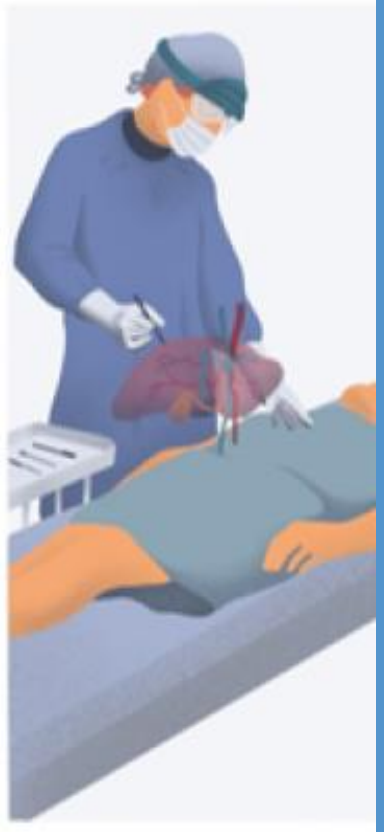
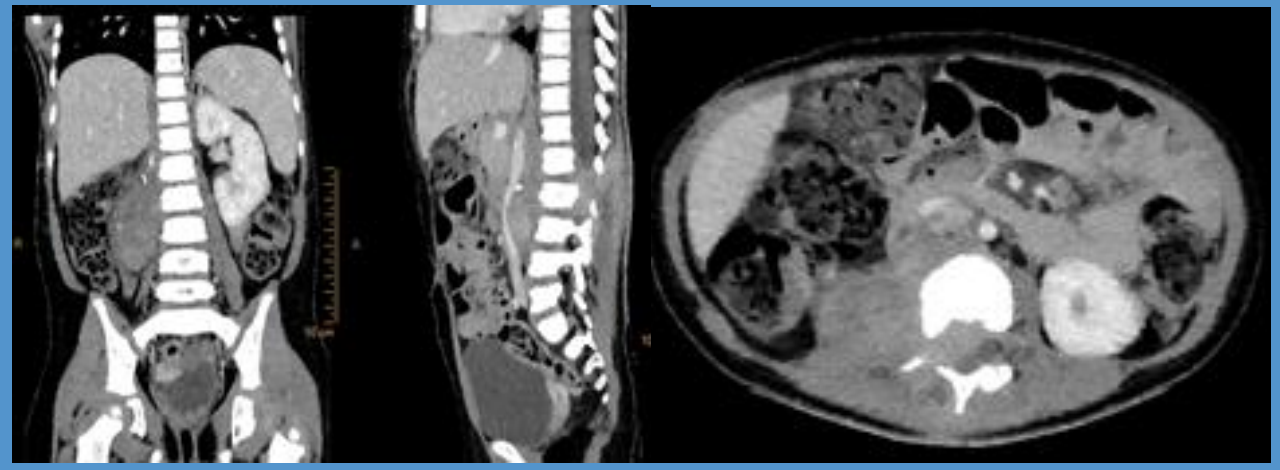


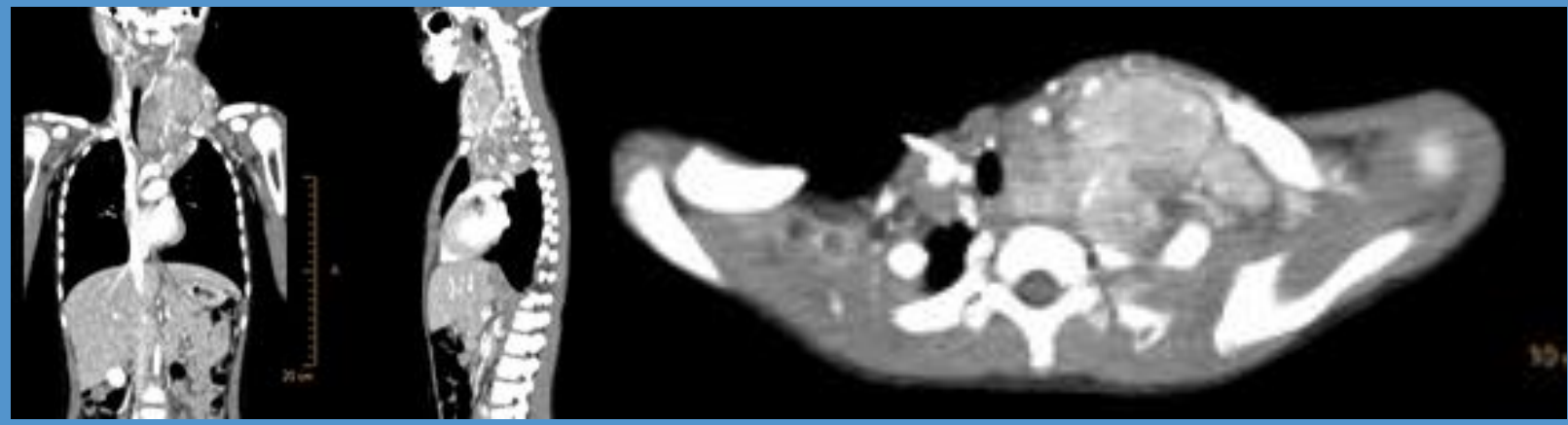
Image acquisition
CTscan - MRI

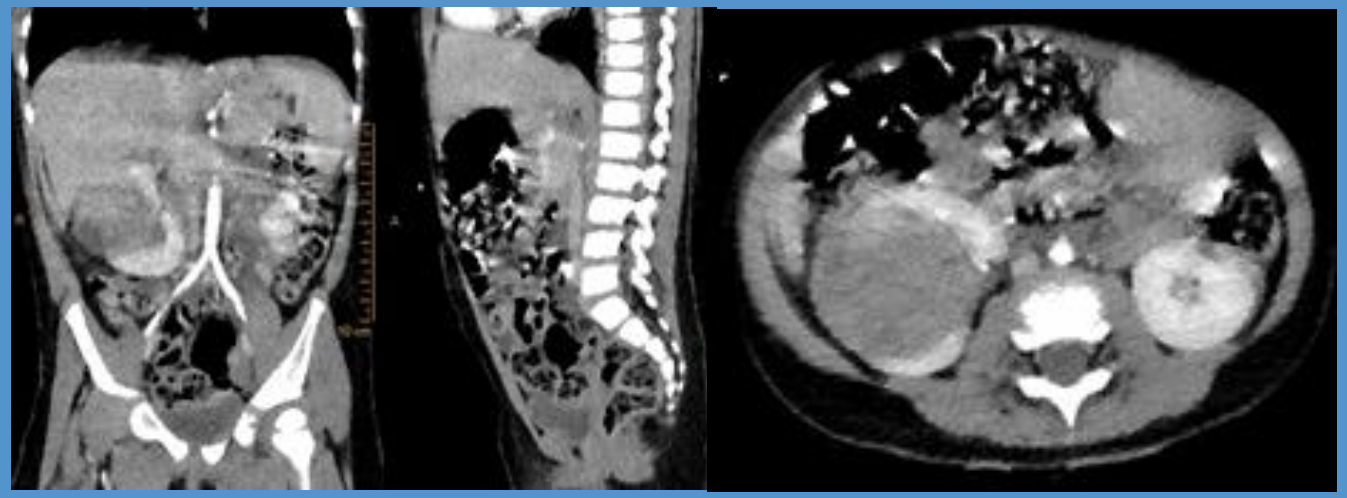
Images converted to Digital Imaging and Communications in Medicine (DICOM) format

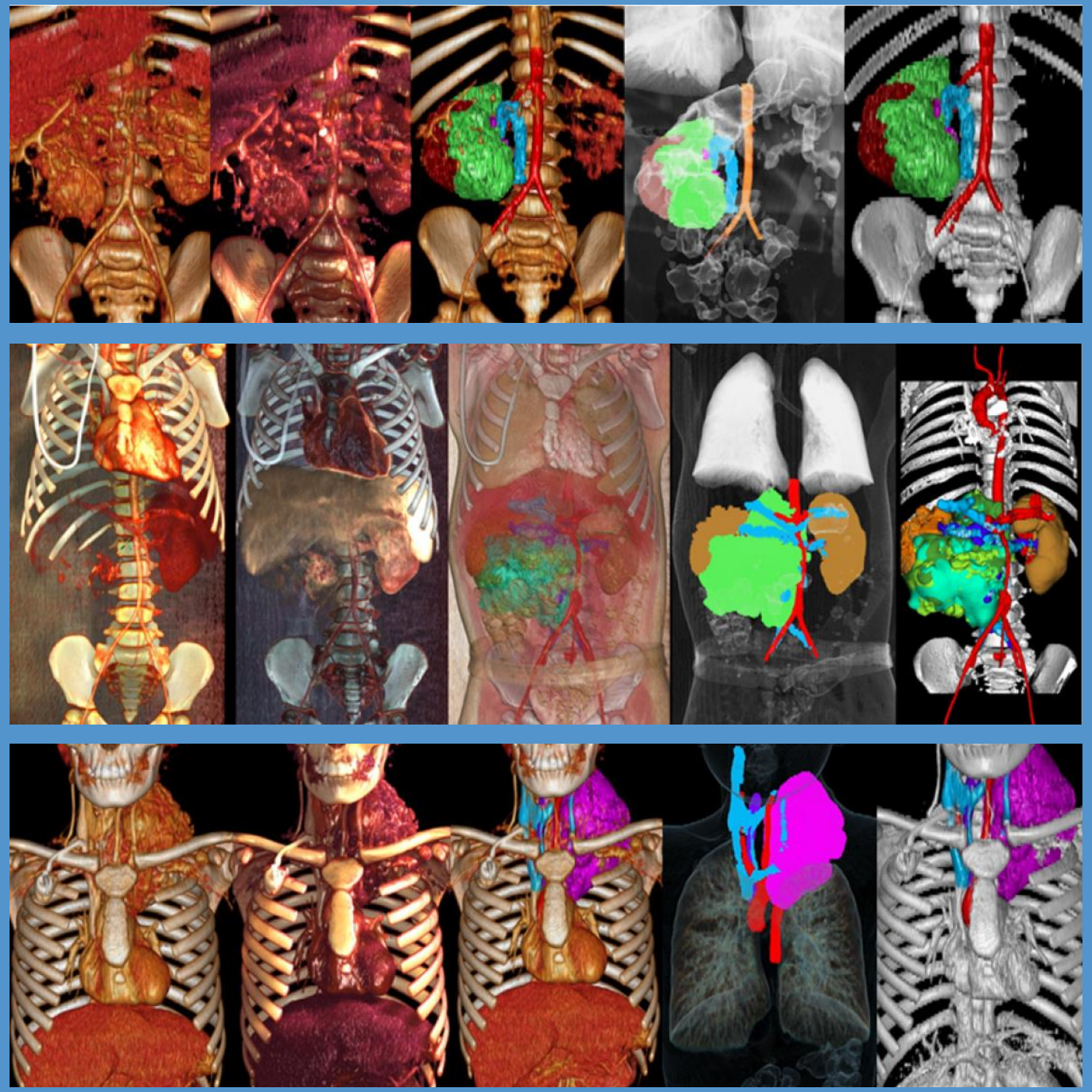
MPR - Multiplanar reconstruction

Displays 3D datasets from two-dimensional images acquired from different planes









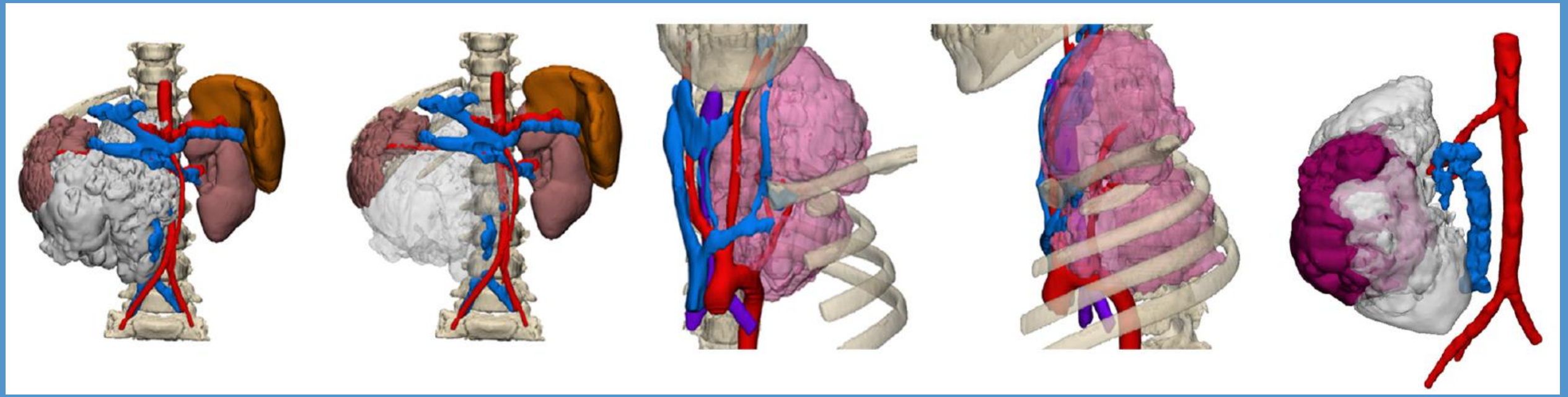
Specific post-processing medical imaging Techniques utilized to automatically convert the standardized 2D into 3D images

- MPR - Multiplanar reconstruction
- VolR – Volume Rendering
- CR - Cinematic Rendering
- Combination of VolR + CAD (Computed Aided Design)
- Combination of airway with segmentation

CAD – Computed Aided Design

The use of computer software to create, modify, analyze, and optimize designs

Transformation of patient's anatomical data into highly precise, 3D digital models

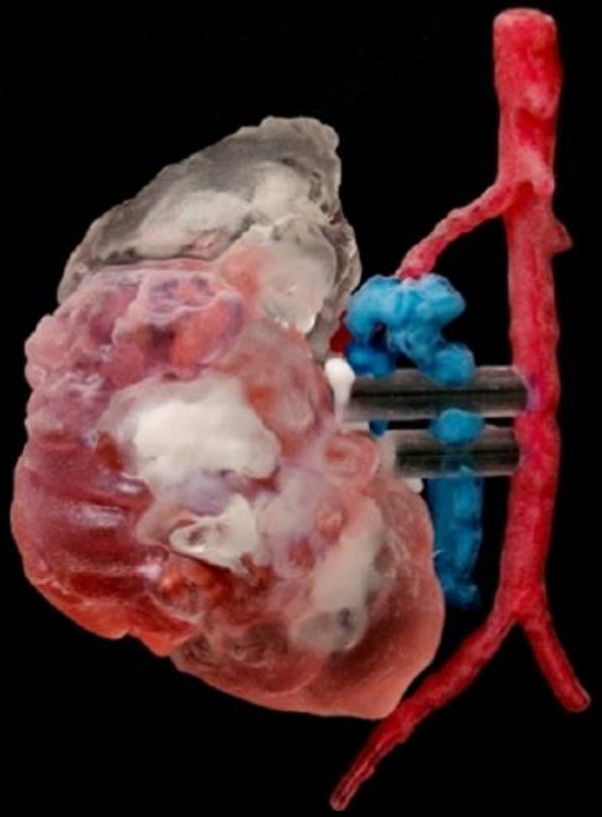


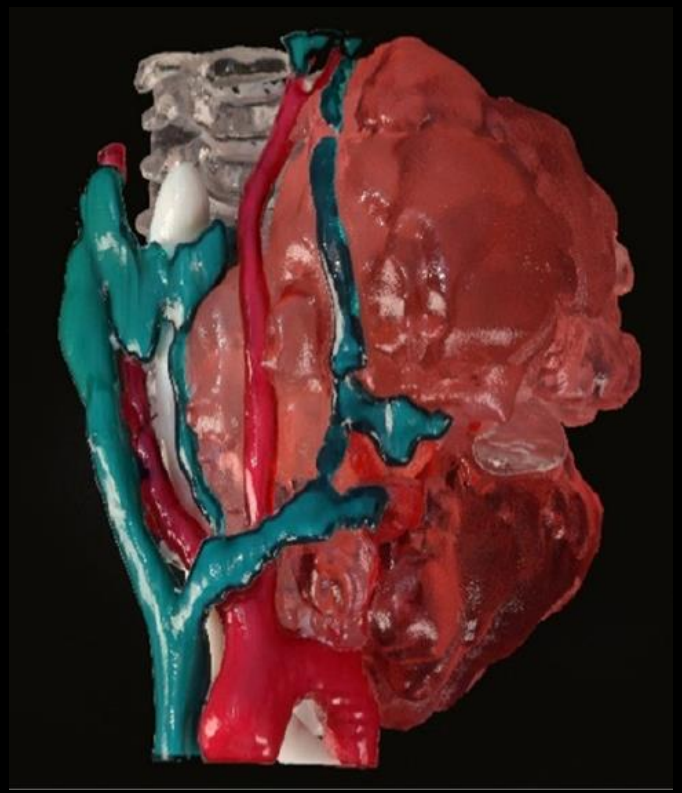
3-Dimensional Printing

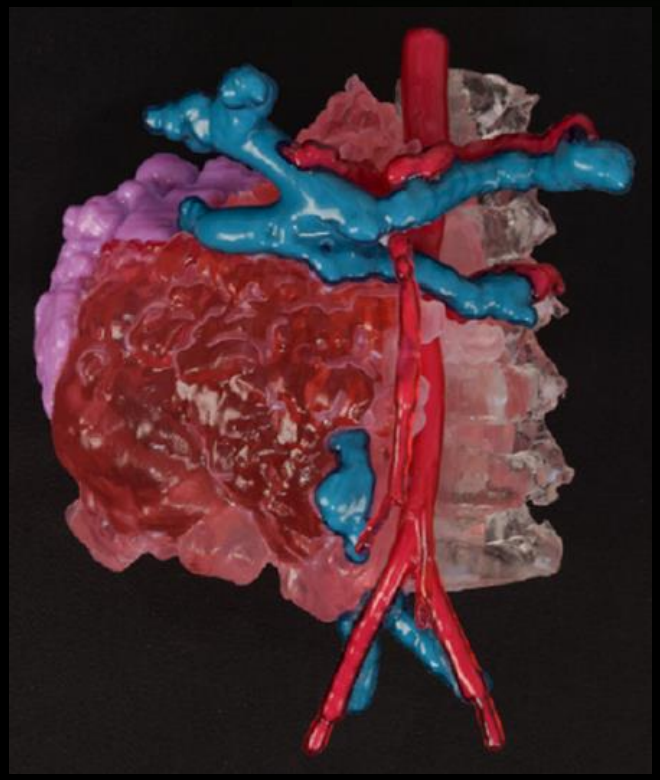
- Digital 3D model created using CAD software
- Model exported into a printable format, most commonly STL file, which converts the geometry into a mesh of small surfaces
- Then, the file processed using slicing software, which divides the model into thin layers and generates the instruction for the printer
- After that, the 3D printer builds the object layer by layer following these instructions
- Finally, post-processing steps are performed, such as removing supports, cleaning, and refining the model

3-Dimensional Printing

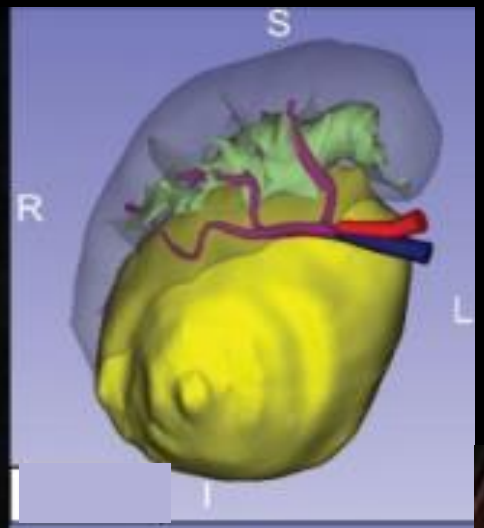


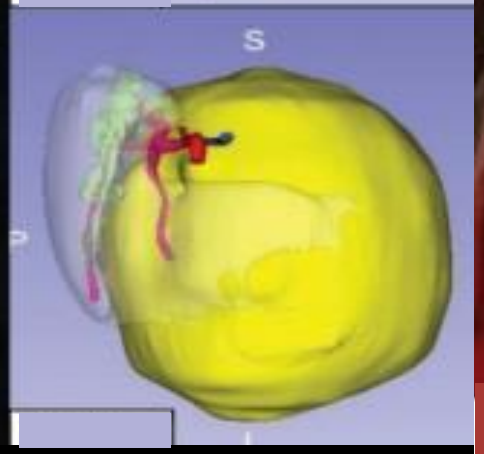









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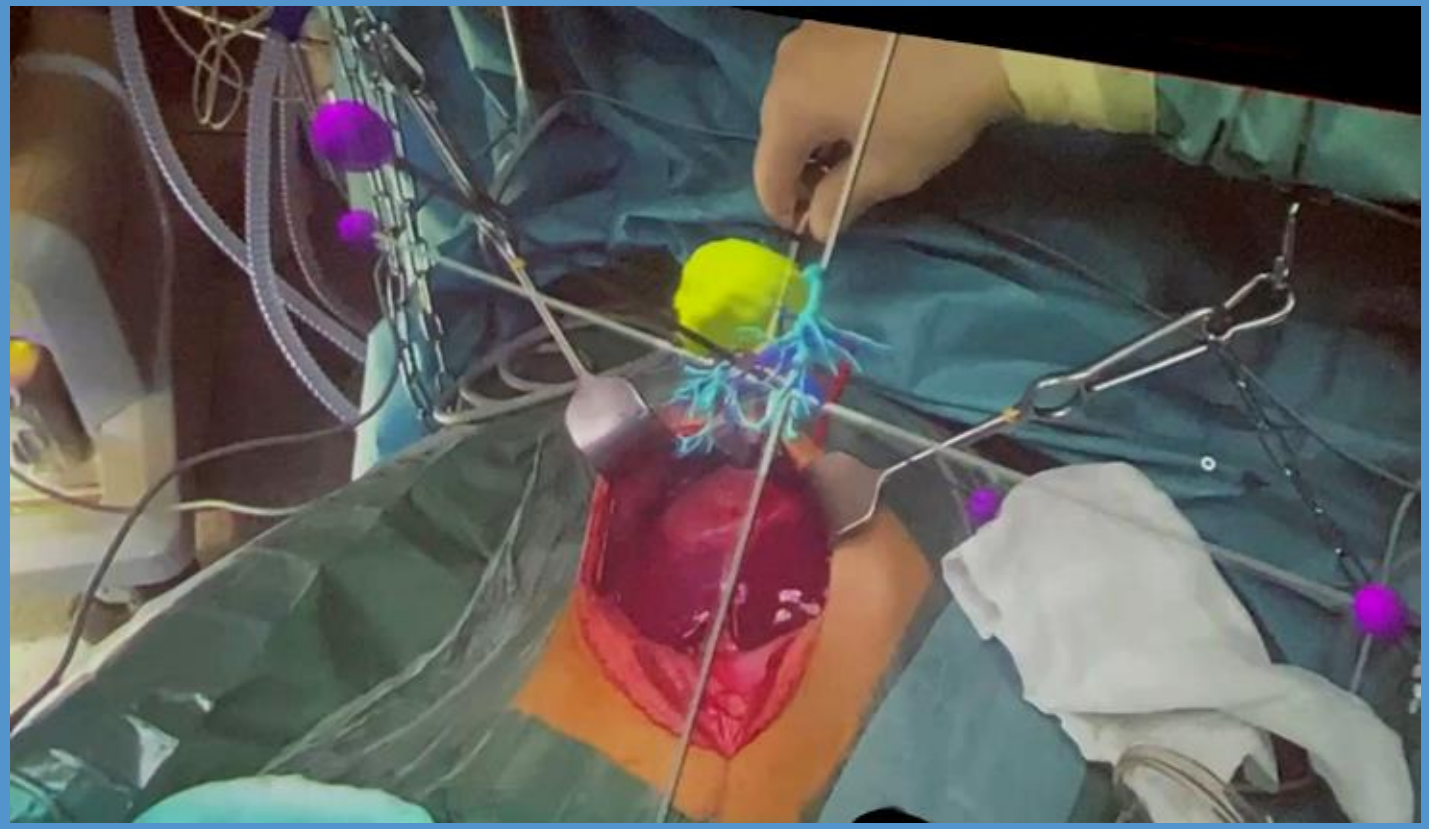


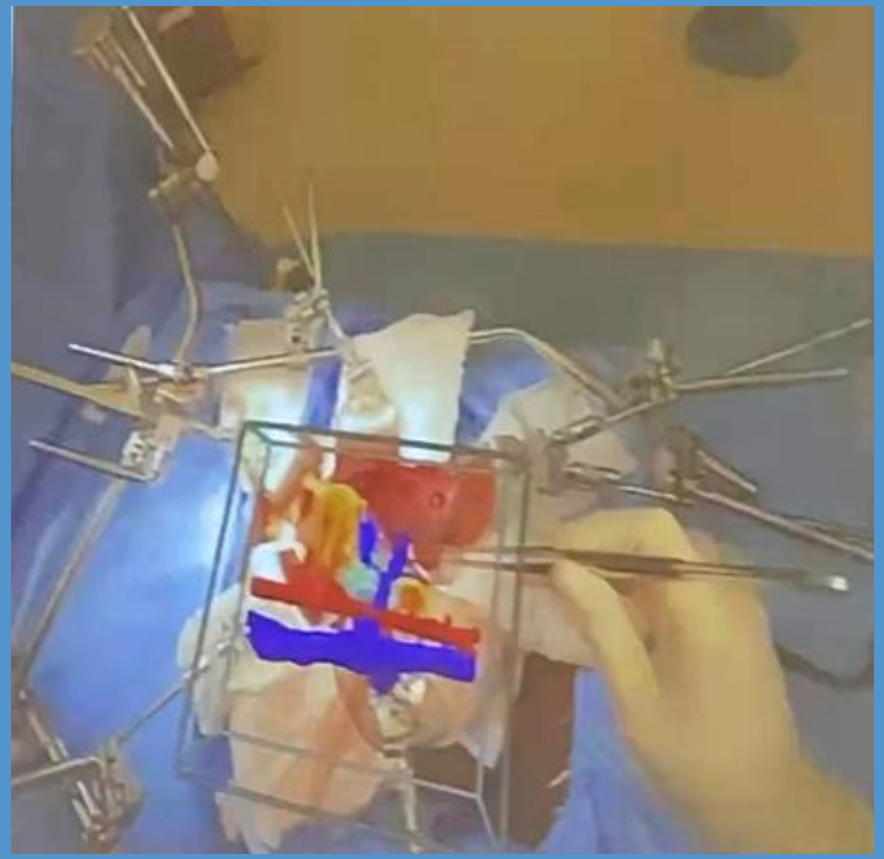


Virtual Visualization Hologram

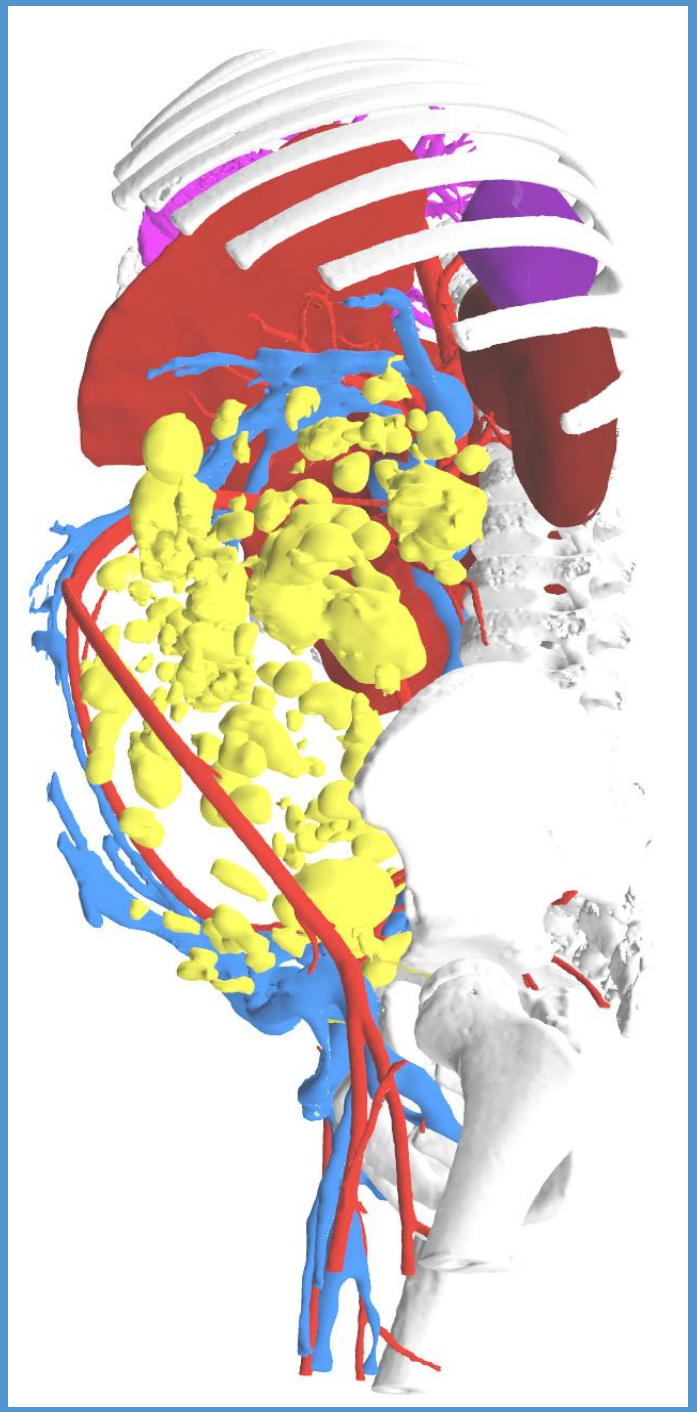
- To visualize human organs in a virtual way
- Reconstruction of a patient’s heart, liver, kidney, brain as a hologram and manipulation of the hologram during surgery
- Dynamic 3D representation (with “time” as a fourth dimension) created from digital images
- Provides operators with reliable information and predictive scenarios, helping evaluate the possible consequences of their decisions

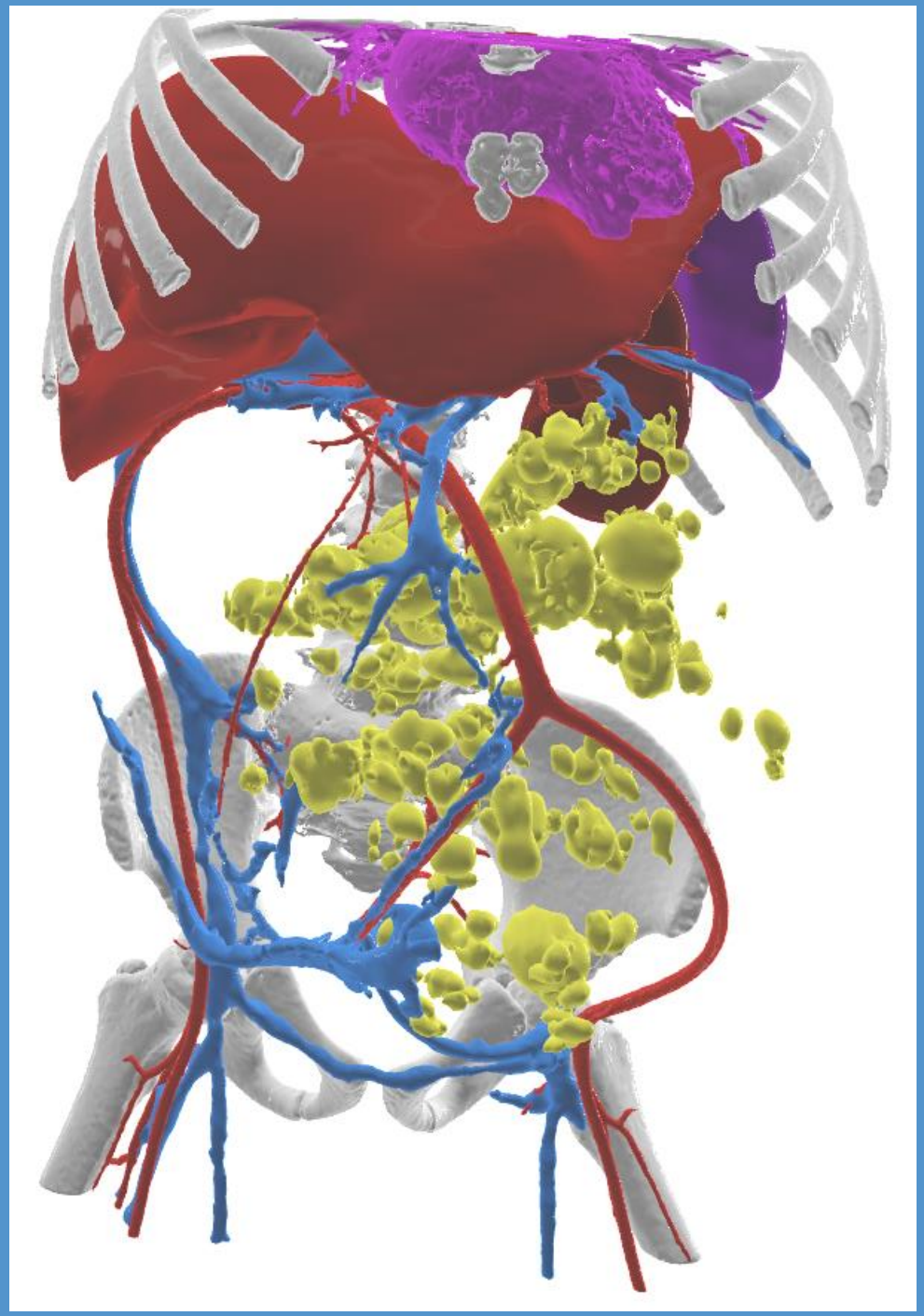







Girl, 4 y
Institution: Rad. Pediatrica Az. Os
Study Date: 23
Study Time:
48/96





Girl, 4 y

INTERVENTIONAL RADIOLOGY

Experience limited in children in whom

less invasive methods should be the choice for the diagnosis or the identification of small pulmonary nodules that need to be removed, sparing lung tissue

INTERVENTIONAL RADIOLOGY

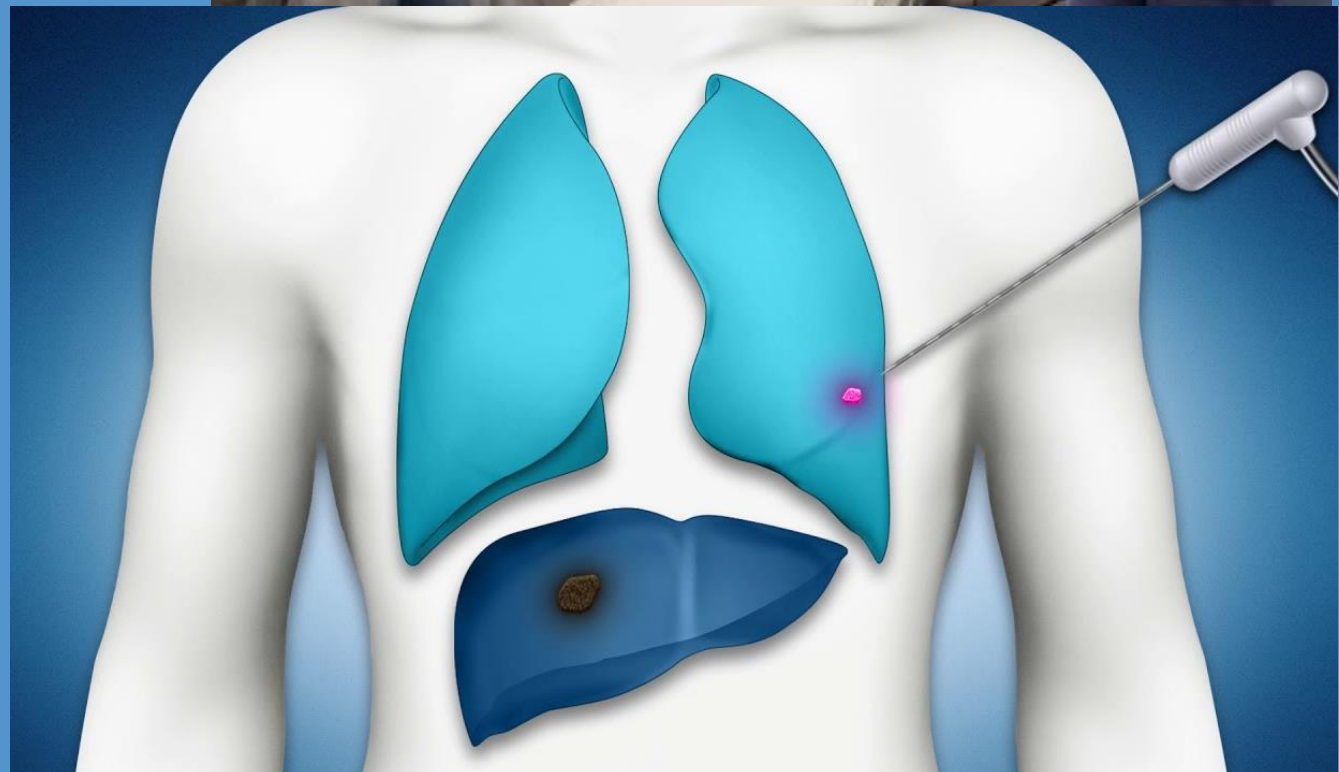
CTscan-guided biopsies

US-guided biopsies

CTscan-guided hook wire positioning or Lipiodol Injection

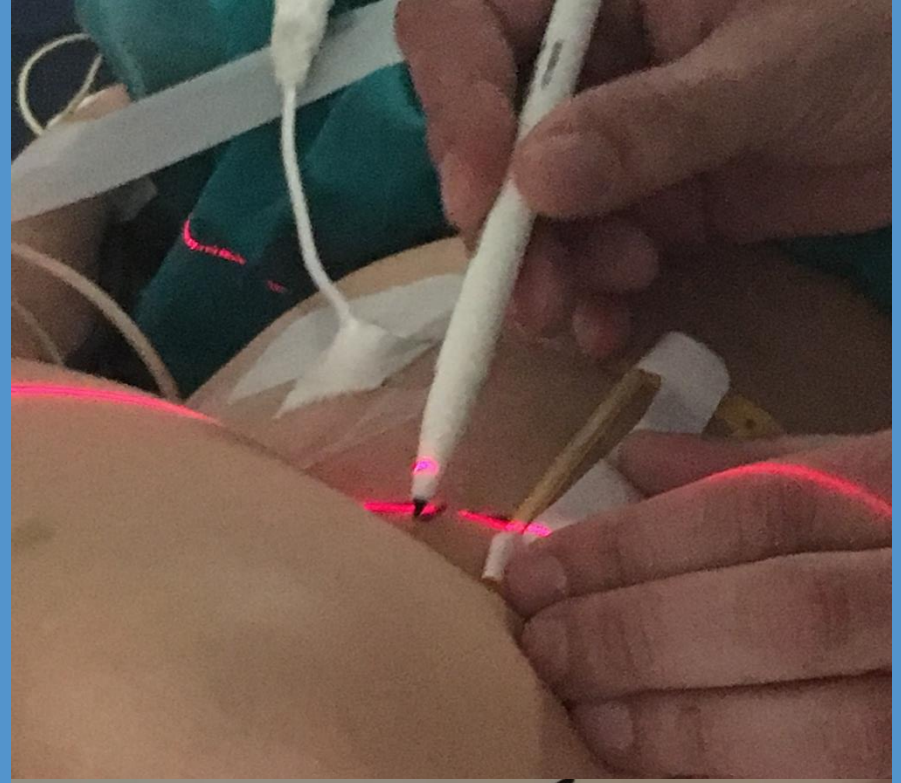
Ablation



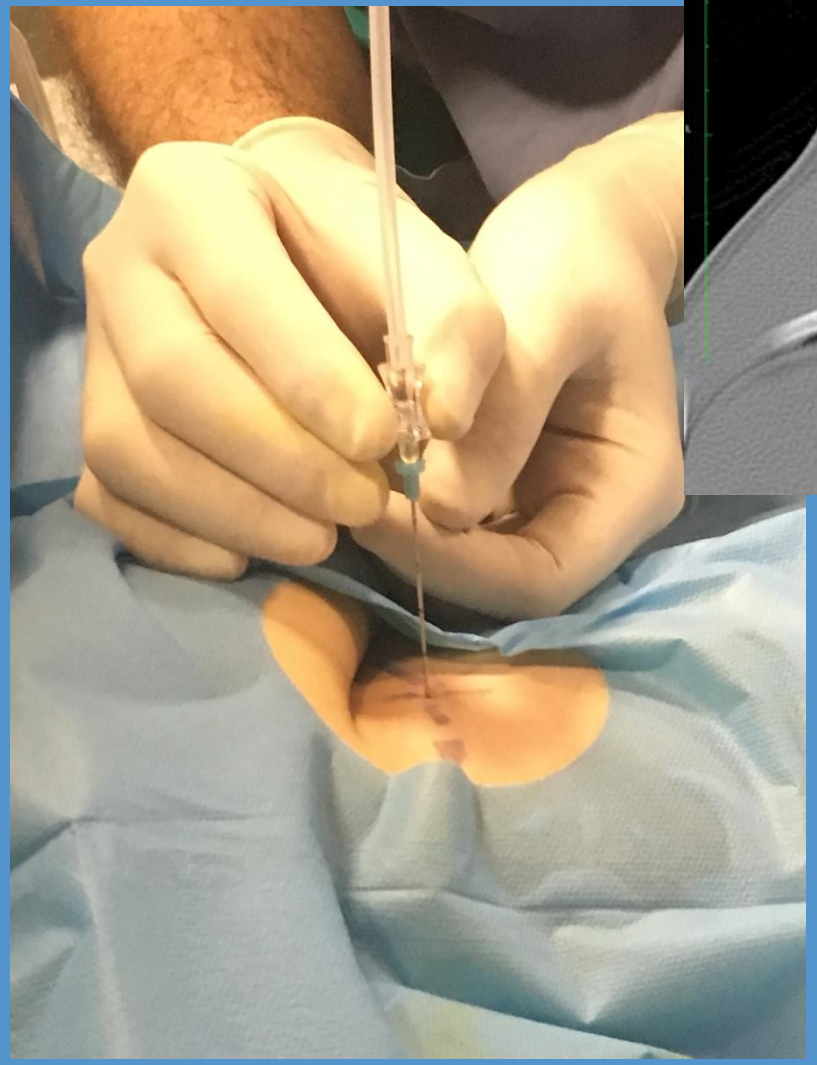


CT-guided Hook wire positioning

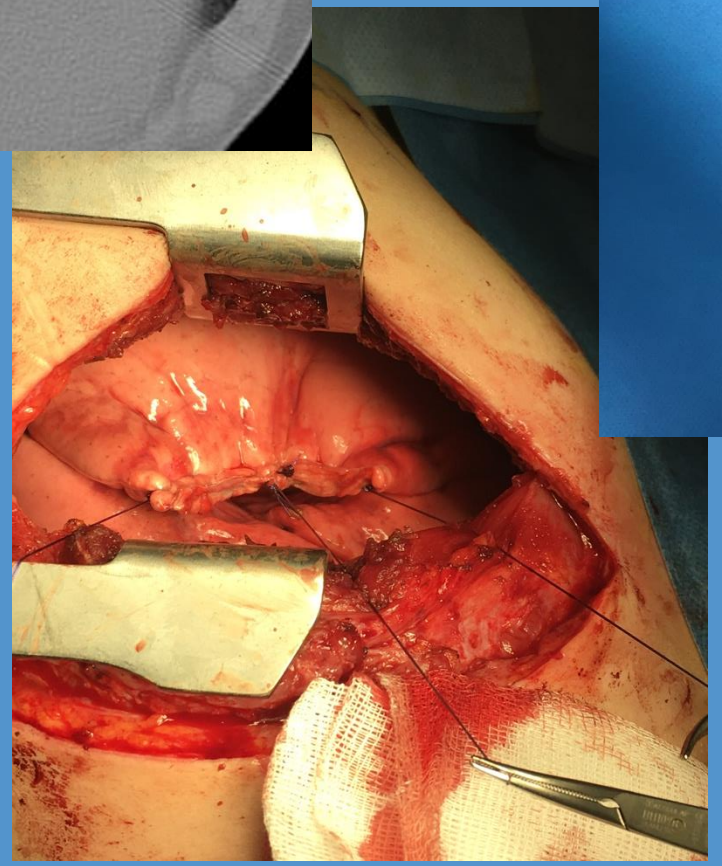
- For localization of lung nodules before surgery, two 20G-Hook Wires positioned beyond the nodule
- CT images after each manipulation of the needles obtained
- A final image obtained to confirm the correct position

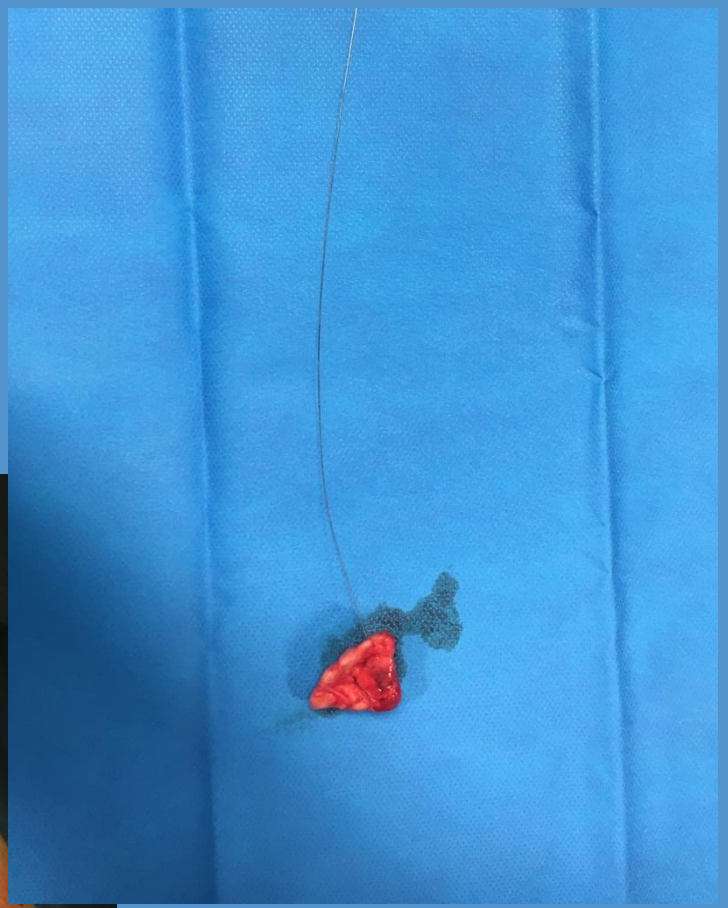






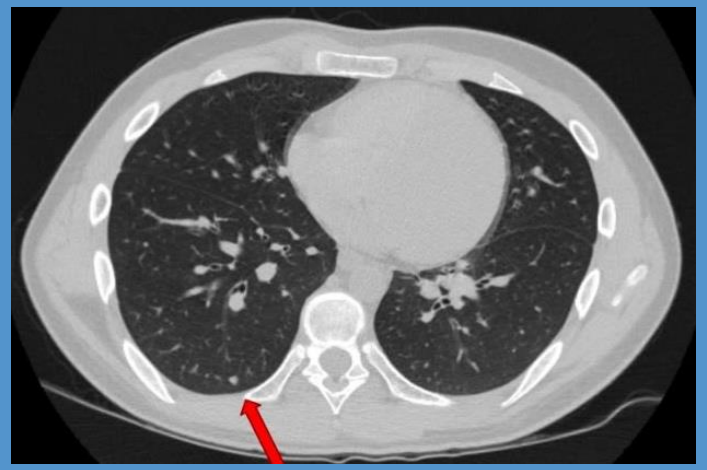




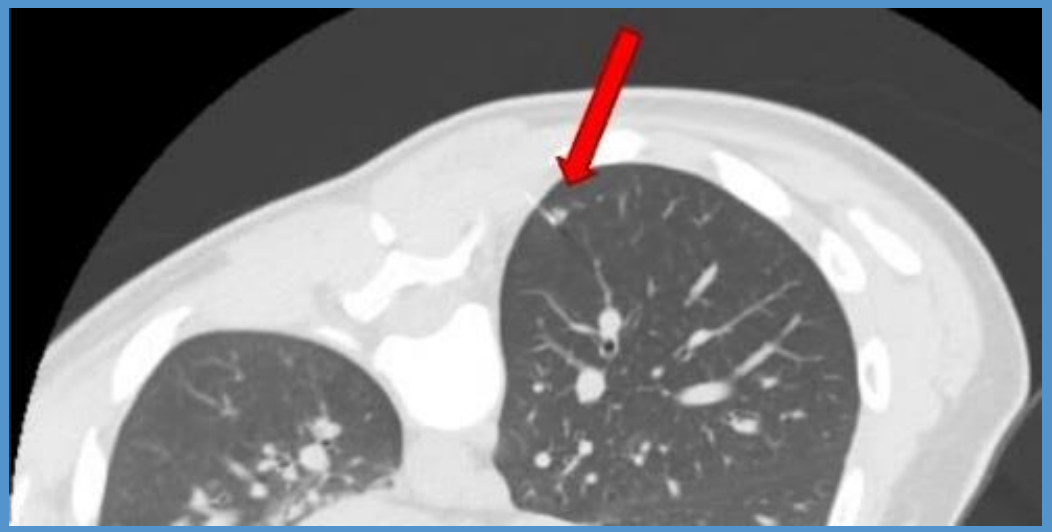


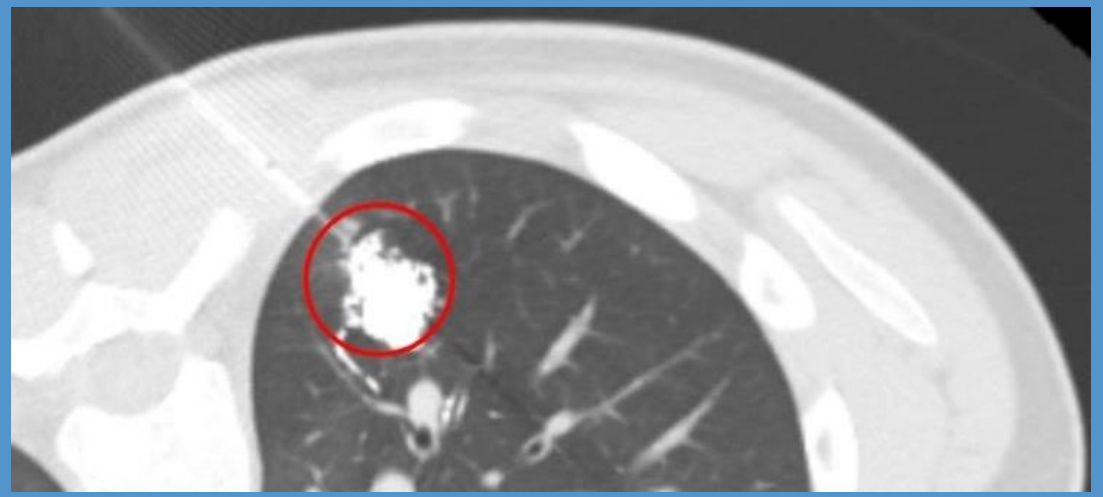
CT-guided Lipiodol injection for nodule marking

Minimally invasive interventional radiology procedure used to precisely locate and mark small nodules (commonly in the lungs or liver) prior to surgical resection or targeted treatment



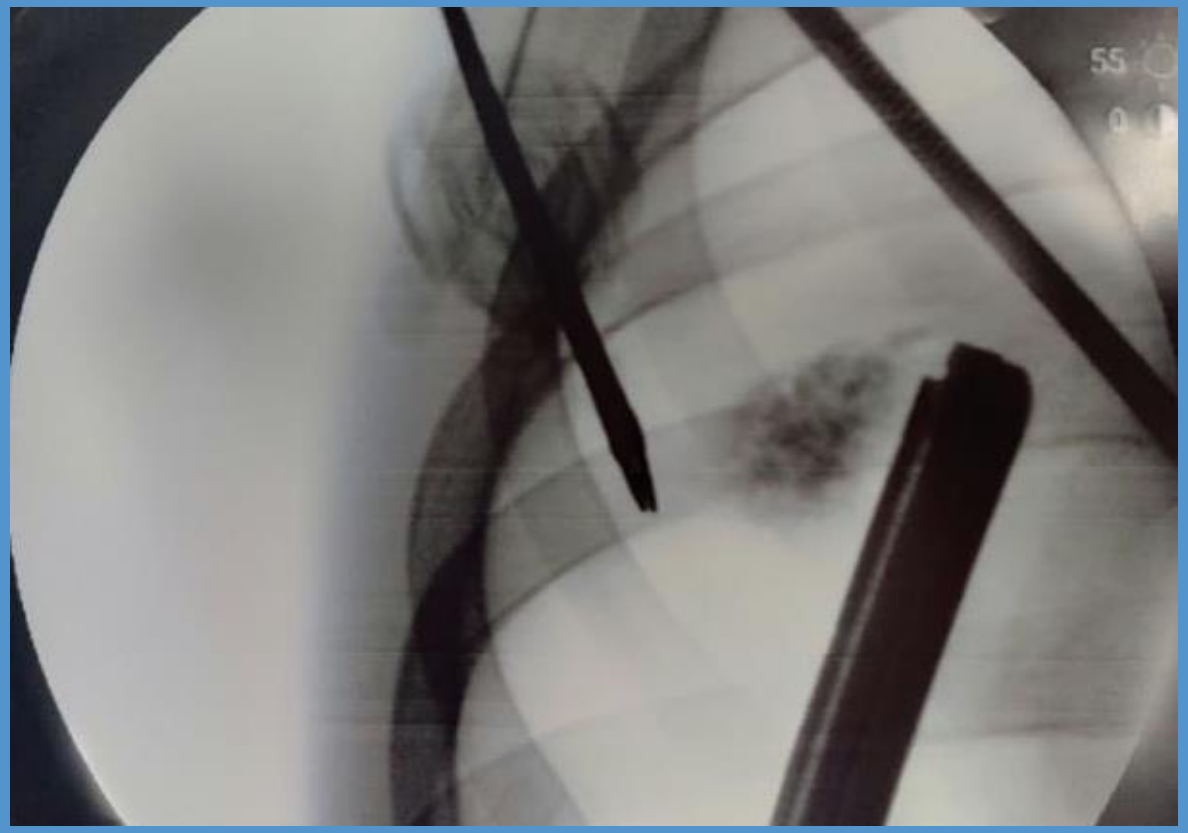


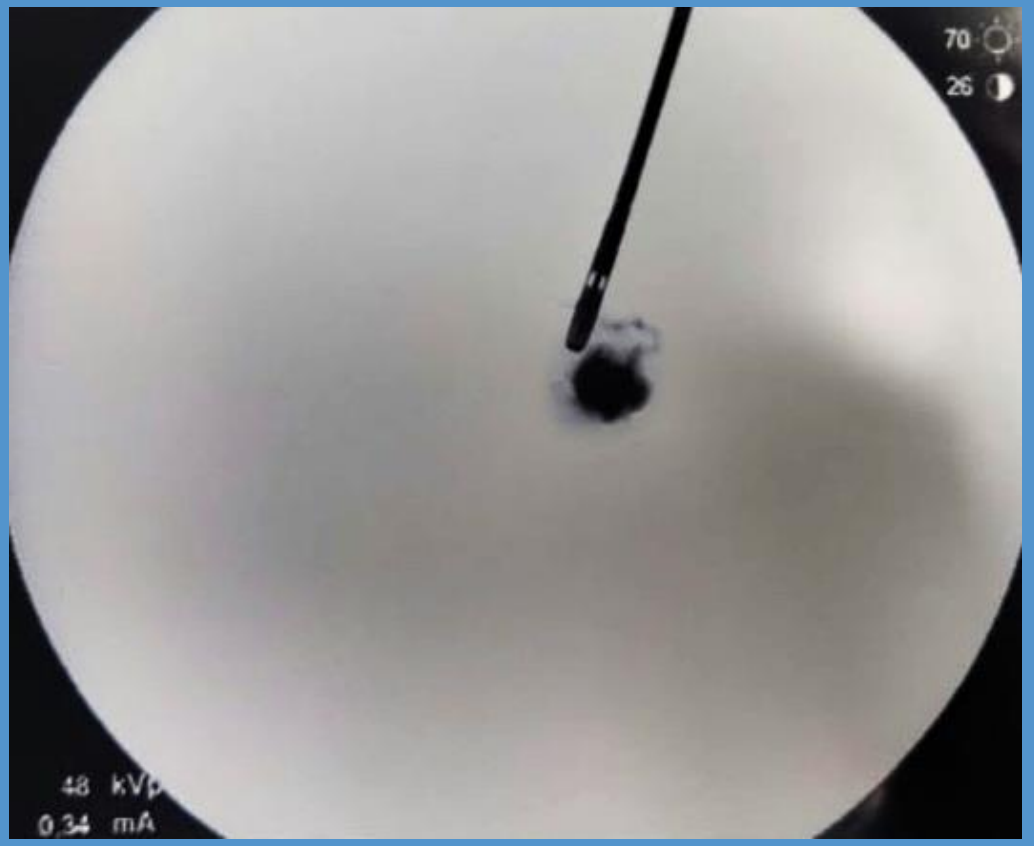




CT-guided Lipiodol injection for nodule marking

Improved identification of the target area to be resected using fluoroscopic guidance during VATS (video-assisted thoracoscopic surgery)





US-guided biopsies

- For subpleural lesions, mediastinal masses or chest wall tumors
- Through a needle bracket to the linear probe (9 MHz)
  - The needle bracket is an accessory attached to the ultrasound probe that guides the needle along a predetermined trajectory displayed on the ultrasound screen
  - Without coaxial technique: biopsy needle inserted directly into the lesion. To obtain additional samples, repeated needle insertions may be necessary
  - With coaxial technique: an outer needle, known as an introducer needle or coaxial cannula, inserted first. One or more sampling devices are then passed through it to obtain multiple specimens without having to repeat the entire passage from the skin to the lesion each time





F, 17 years. Hodgkin lymphoma relapse suspected
Mediastinal mass biopsy (parasternal approach)
Needle path between the sternum and internal mammals vessels



F, 16 year. Lung nodule biopsy (PET-positive) in gastric GIST

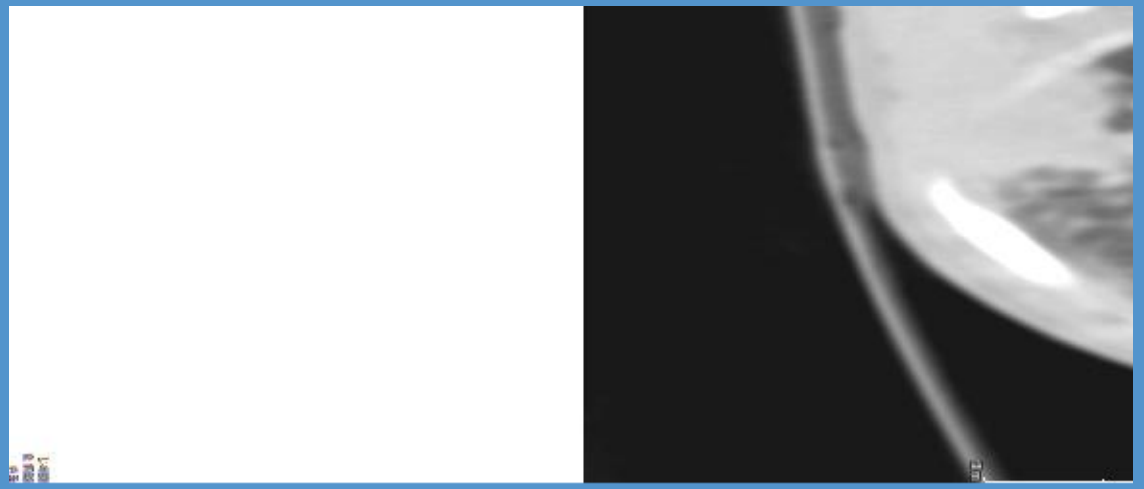
M, 9 year. Hook wire positioning for hepatoblastoma metastasis



M, 4 year

Hook wire positioning for WT metastasis (dislodgement)





Case 1 – F, 10 y

PB of the head of pancreas with liver metastases

CT with reduction of pancreatic mass and liver mets

(one superficial in VI, one deep in VIII)





Case 1 – F, 10 y

Planned surgery:

- Duodenocefalopancreasectomy
- Resection of the superficial liver mets

What do we do with the deep lesion?

Case 1 – F, 10 y

RADIOFREQUENCY ABLATION

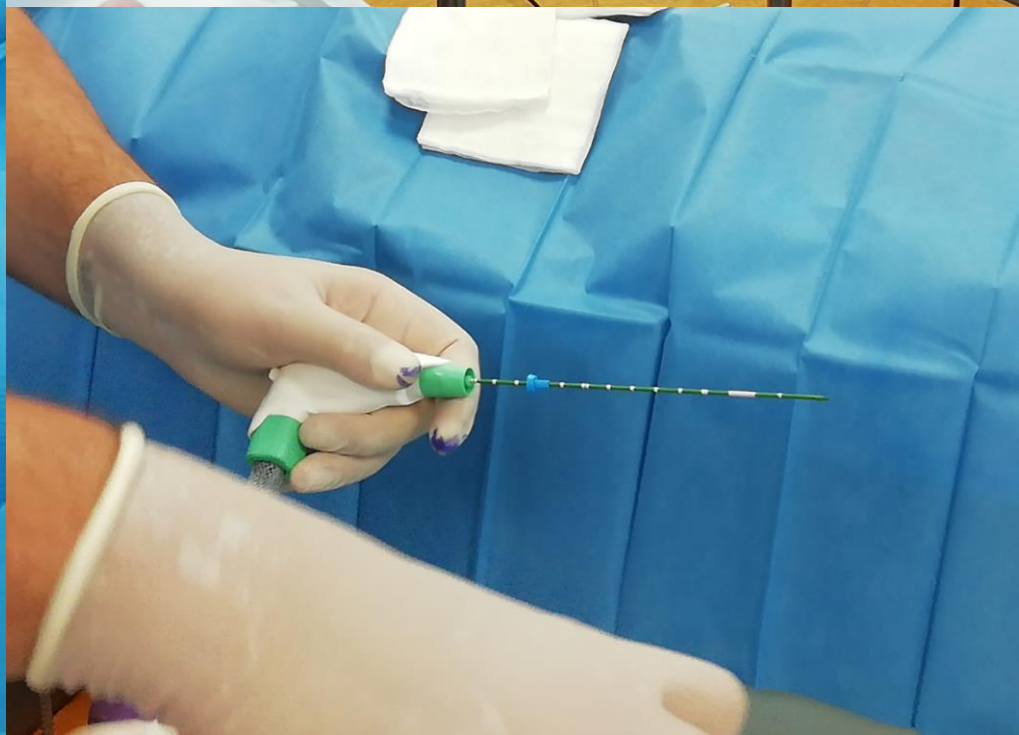
Lesion not visible at US in OR

CTscan guided procedure performed

2 weeks after the operation

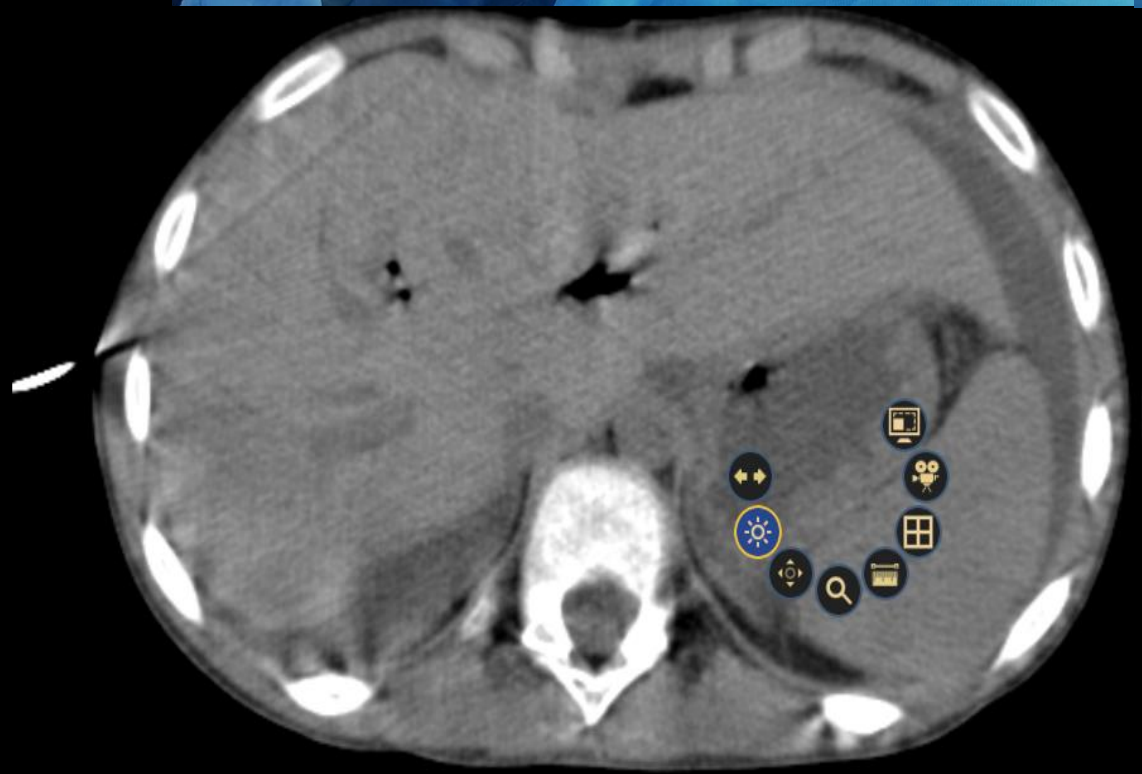














Case 2 - F, 41 GA, PN 3480 g

- Complicated vaginal delivery in the setting of premature rupture of membranes (PROM)
- Progressive deterioration with respiratory distress, mottled skin pallor, petechiae, hyporeactivity
- Palpable mass in the left hypochondrium
- Increased inflammatory markers, severe hepatic cytolysis, cholestasis, mild renal impairment, anemia, thrombocytopenia, consumptive coagulopathy, consistent with Kasabach-Merritt phenomenon associated with a possible hepatic hemangioma

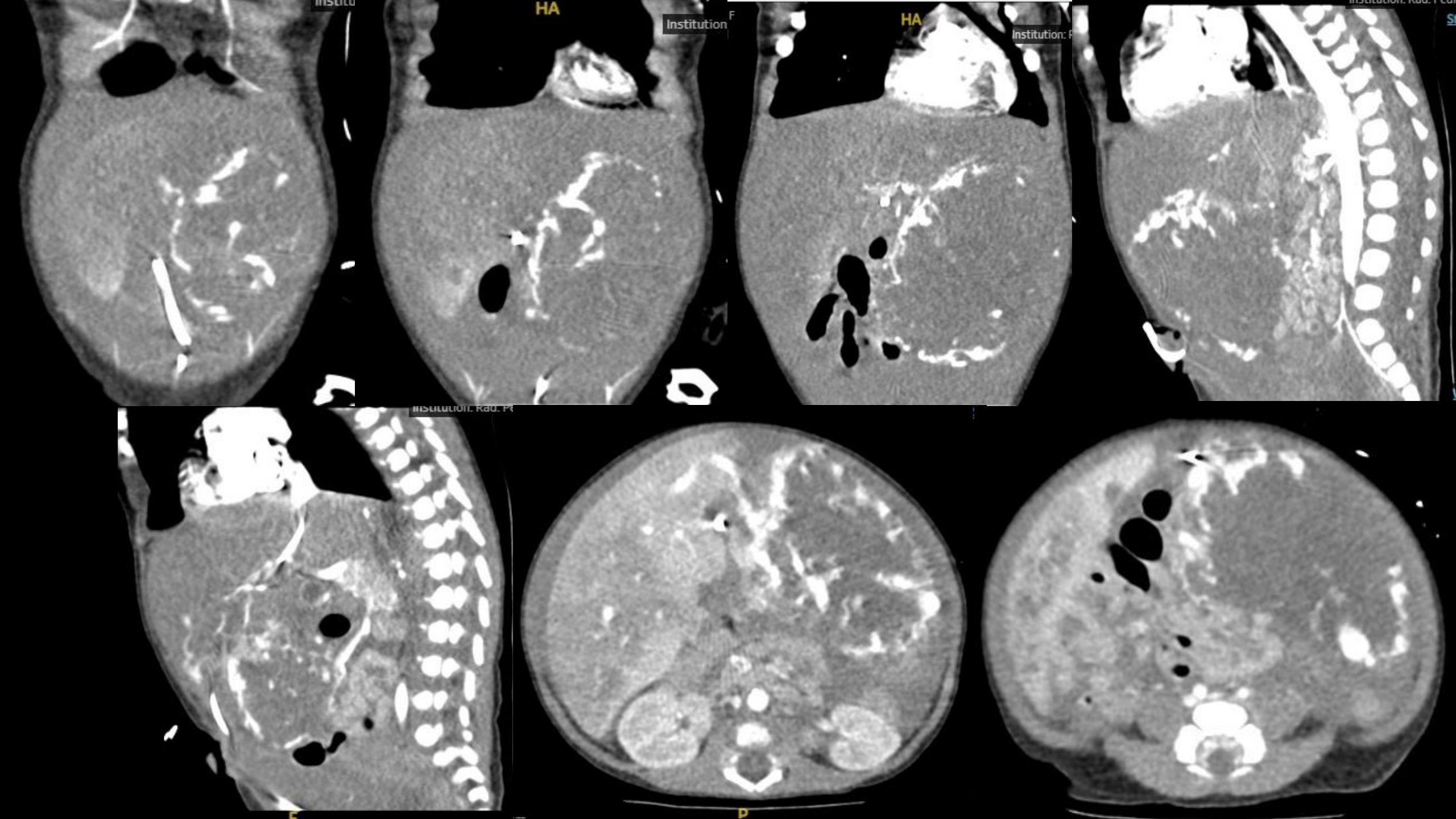
Case 2 – F, 41 GA, PN 3480 g

Abdominal US

- Heterogeneous hyperechoic liver lesion, partially exophytic, with vascular components and calcifications, in the left hepatic lobe
- Small amount of free intraperitoneal fluid

Abdominal angio CTscan

- Large hepatic vascular malformation (8 × 7.4 × 5.5 cm), likely hemangiomatous
- Evidence of vascular “steal” phenomenon involving the right hepatic lobe


HA
HA

Case 2 – F, 41 GA, PN 3480 g

- Supportive transfusion therapy (red blood cells, plasma, platelets, and fibrinogen)
- Methylprednisolone, Propranolol

Initial partial improvement, but subsequent clinical and laboratory deterioration, with worsening hematologic, coagulative, hepatic, and renal parameters

Case 2 – Multidisciplinary team discussion

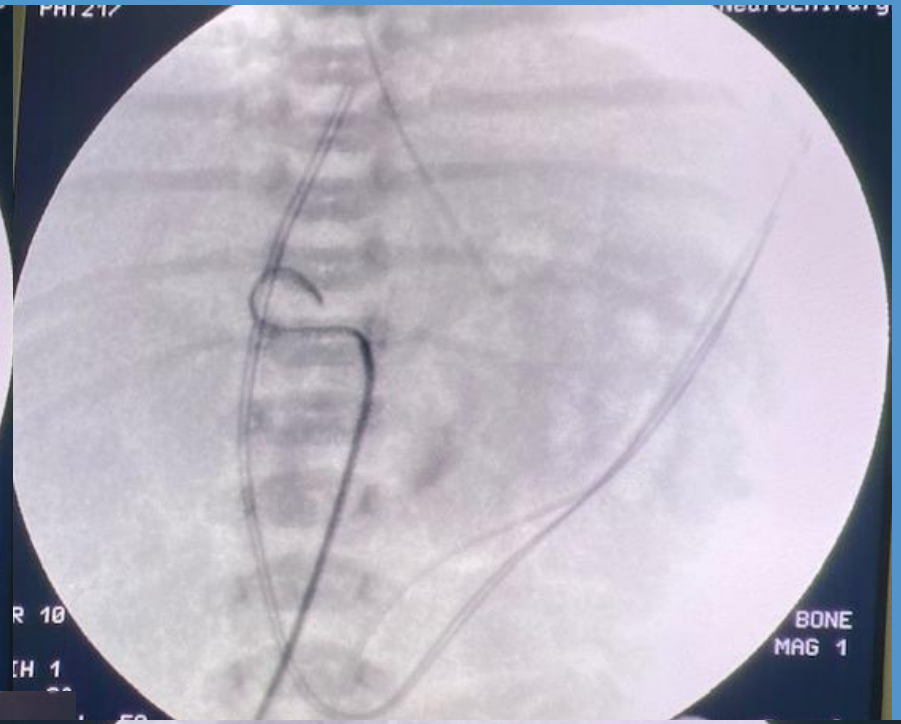
Consensus to proceed with surgical resection of the lesion

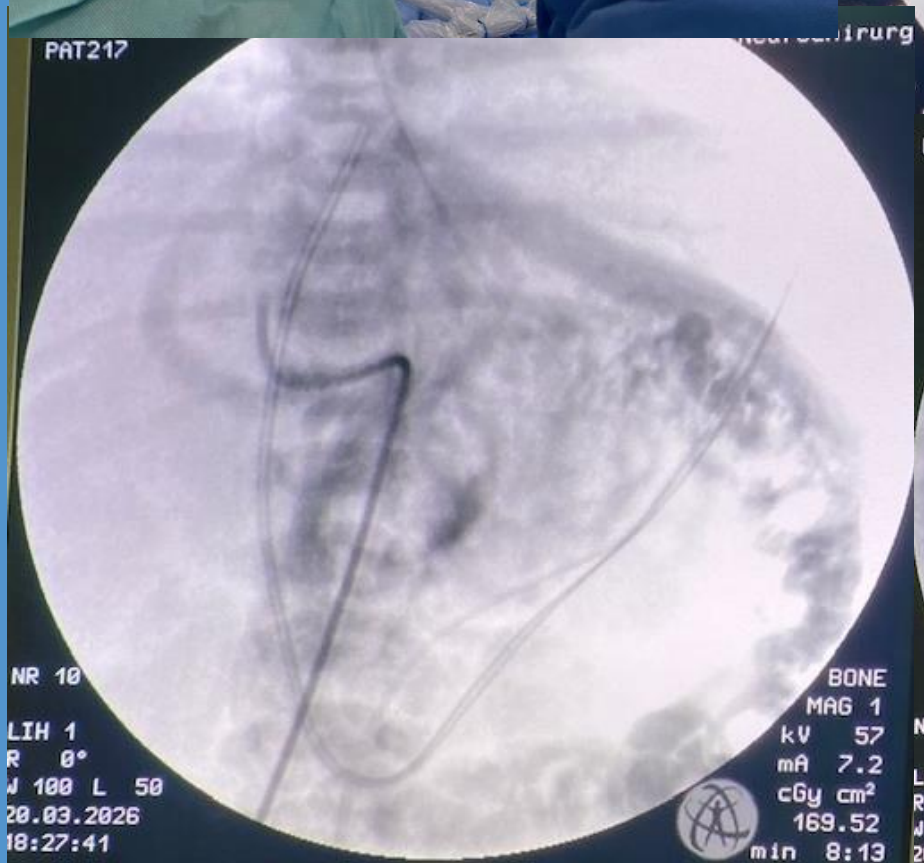
- Pre-operative strategy:
  - Selective arterial embolization via the left hepatic artery

    To reduce vascular flow and minimize risk of lesion rupture and major hemorrhage
  - Immediate surgery to avoid worsening of renal impairment
- High intraoperative risk
- Potential long-term risk of right lobe hepatic insufficiency



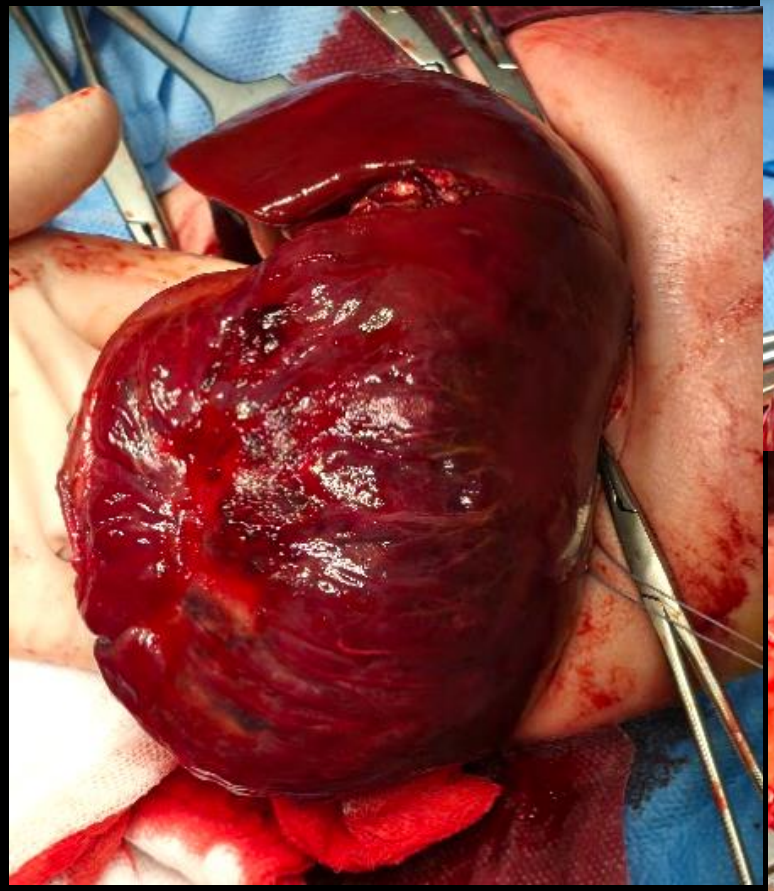

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cGy cm²

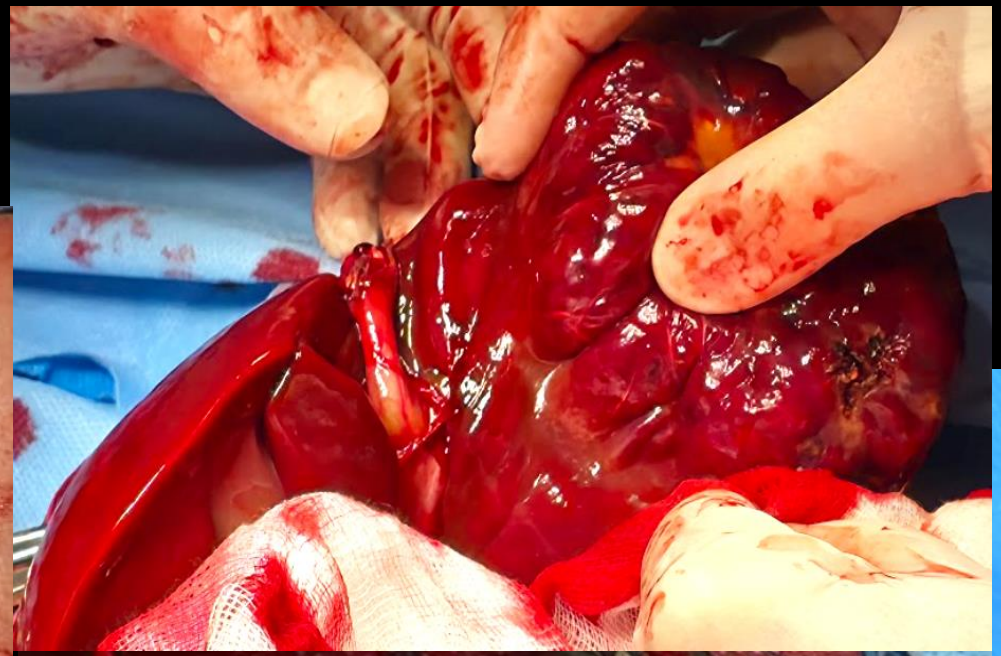

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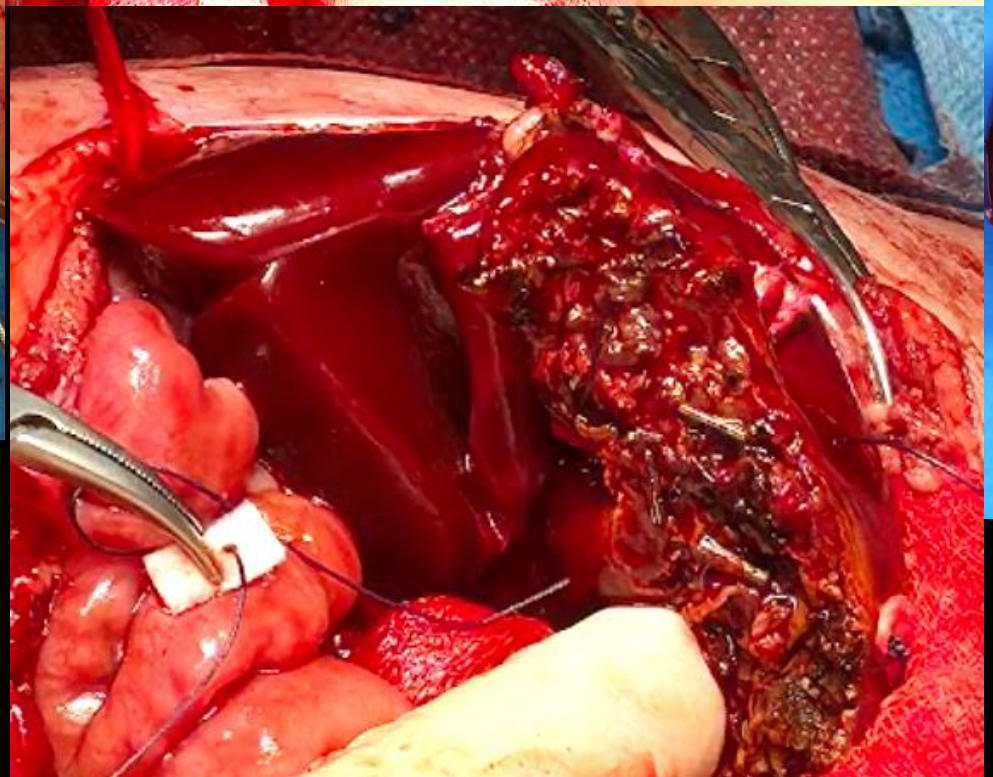

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18:27:41
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MAG 1
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cGy cm²
169.52
min 8:13

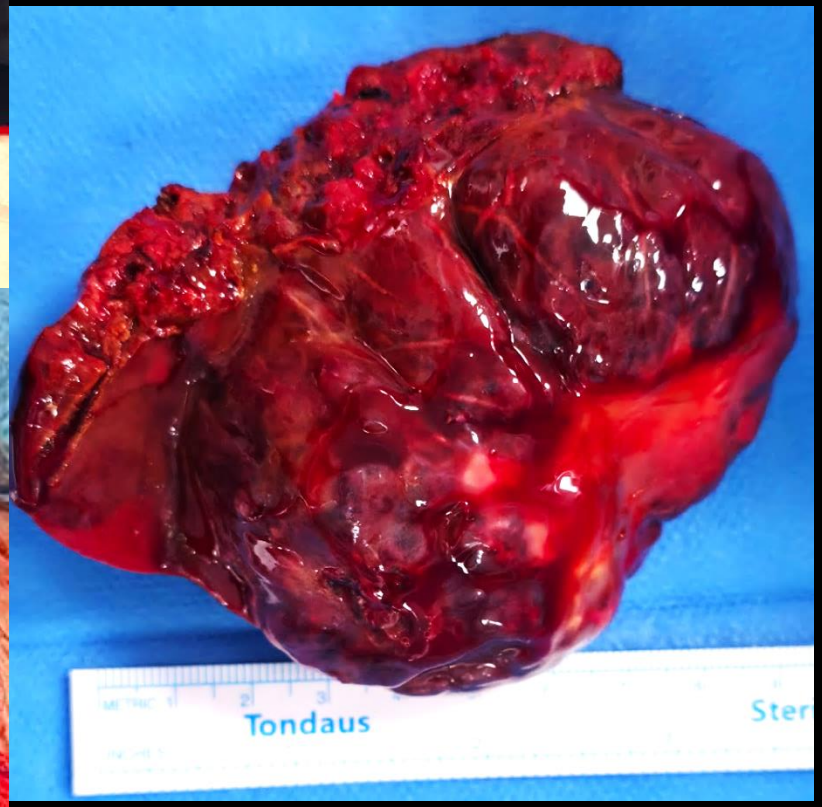

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Case 2

Histology

Overall, findings consistent with a vascular malformation, most likely venous malformation

Immunophenotypic profile: positivity for vascular endothelial markers (CD31, CD34, ERG) and negativity for GLUT1, podoplanin, TFE3, and CAMTA1

Post-operative course

- Resolution of Kasabach-Merritt phenomenon
- Progressive, slow worsening of cholestatic parameters (direct hyperbilirubinemia and elevated GGT levels), due to preoperative hepatic ischemic injury caused by reduced blood flow to the right liver
- Improvement in a few weeks
- Surgical and GI follow up

Case 2 - Issues

- Did we take a major risk by performing embolization of the LH artery?

- Emergency surgery with left hepatic artery ligation
- What could be the evolution of the ischemia of the right liver ?

  Most vulnerable structures are usually bile ducts: Stenosis of intrahepatic bile ducts, Recurrent cholangitis, Liver failure

  Future transplant?



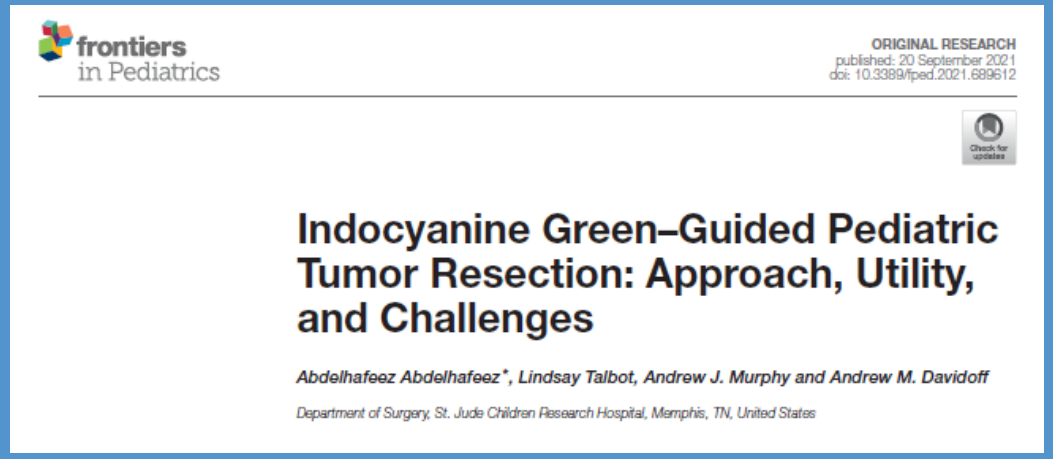
Indocyanine Green (ICG)

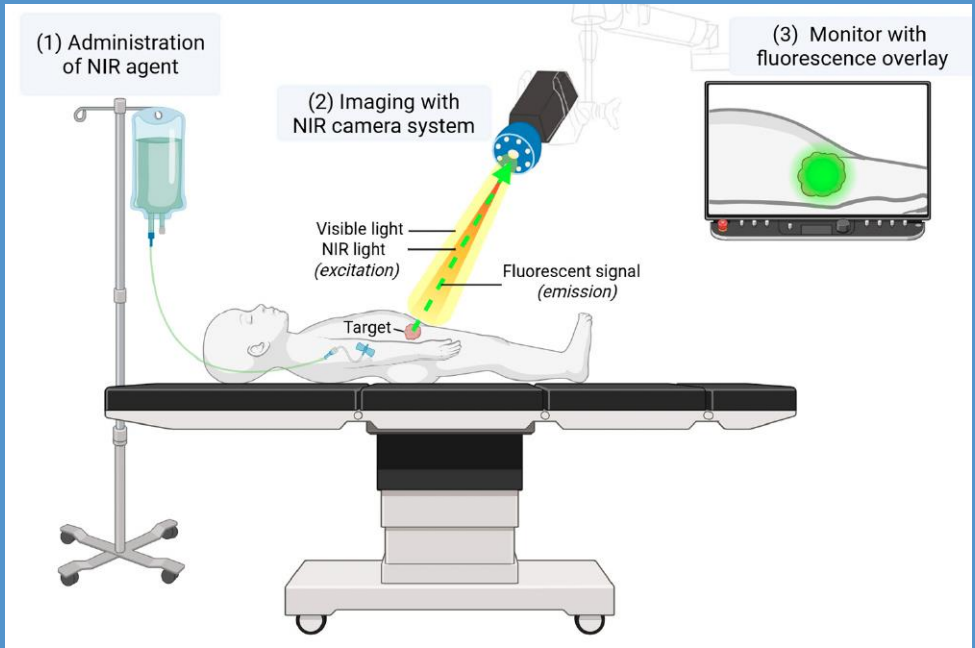
- Food and Drug Administration (FDA) approved water-soluble tricarbocyanine fluorophore
- Initially used in clinical settings for measuring cardiac output, liver function, retinal angiography
- More recently for blood, biliary, and lymphatic flow imaging
- Demonstrated the high sensitivity of this technique in identifying tumor cells

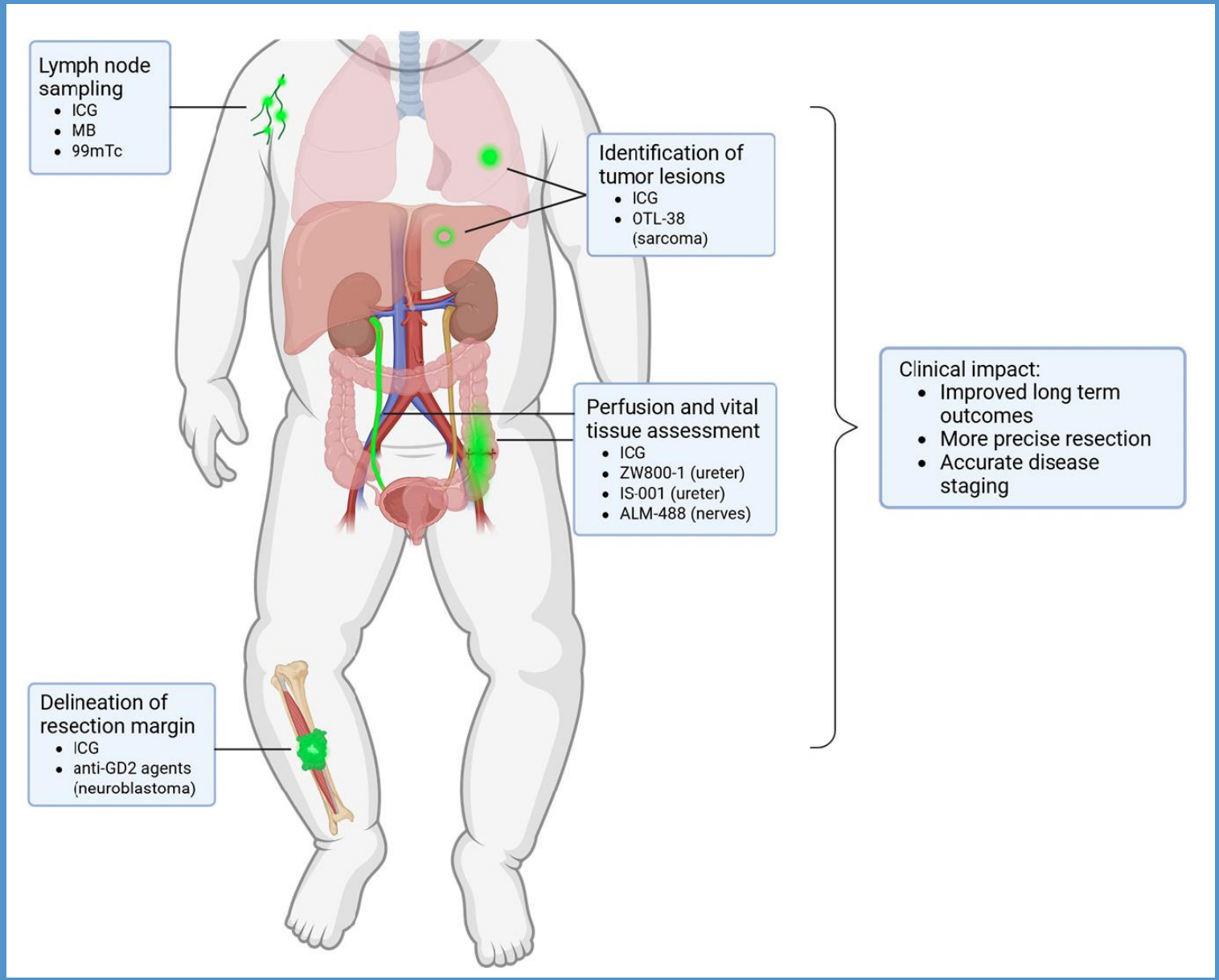


Indocyanine Green (ICG)

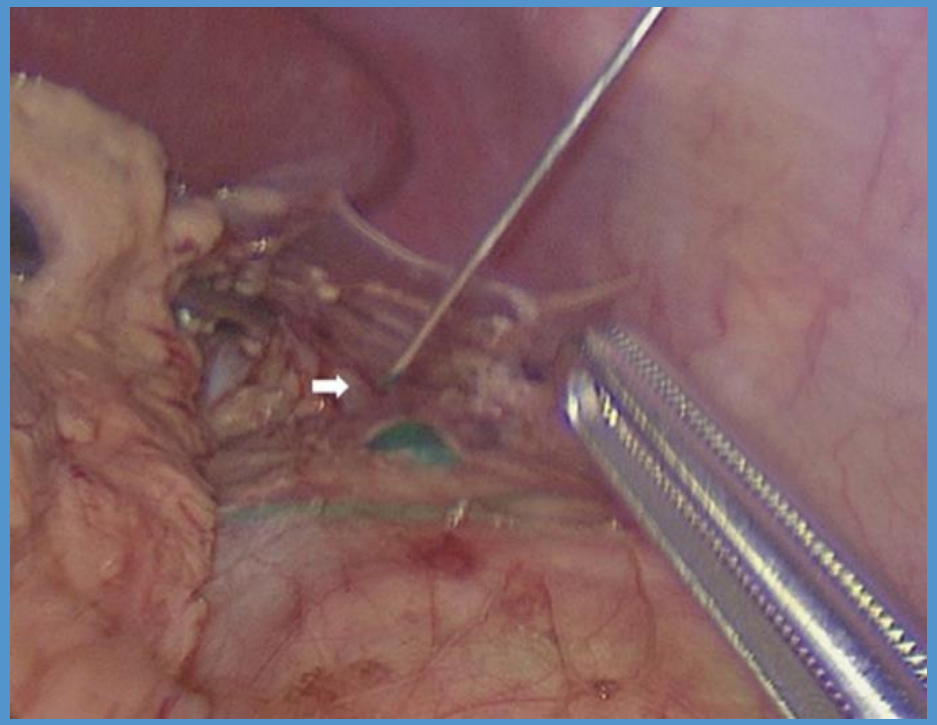
- The difference in retention of ICG between tumor and normal tissue due to increased vascular permeability and impaired lymphatic drainage in tumor microenvironment, which creates an EPR effect (enhanced permeability and retention) in small molecules
- Intraoperative visualization with Iridium system which provides excitation light at 805 nm, causing ICG to emit bands between 825 and 850 nm, captured by a near infrared (NIR) camera




(1) Administration of NIR agent
(2) Imaging with NIR camera system
(3) Monitor with fluorescence overlay
Visible light
NIR light
(excitation)
Fluorescent signal
(emission)
Target

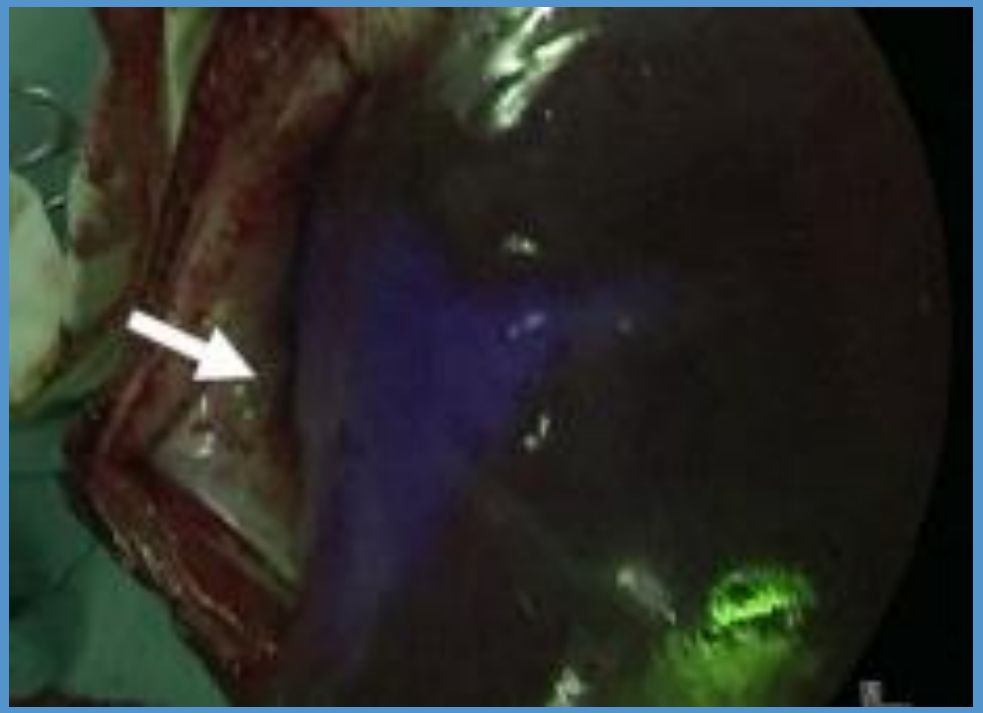

Lymph node sampling
ICG
MB
99mTc
Identification of tumor lesions
ICG
OTL-38 (sarcoma)
Perfusion and vital tissue assessment
ICG
ZW800-1 (ureter)
IS-001 (ureter)
ALM-488 (nerves)
Delineation of resection margin
ICG
anti-GD2 agents (neuroblastoma)
Clinical impact:
Improved long term outcomes
More precise resection
Accurate disease staging

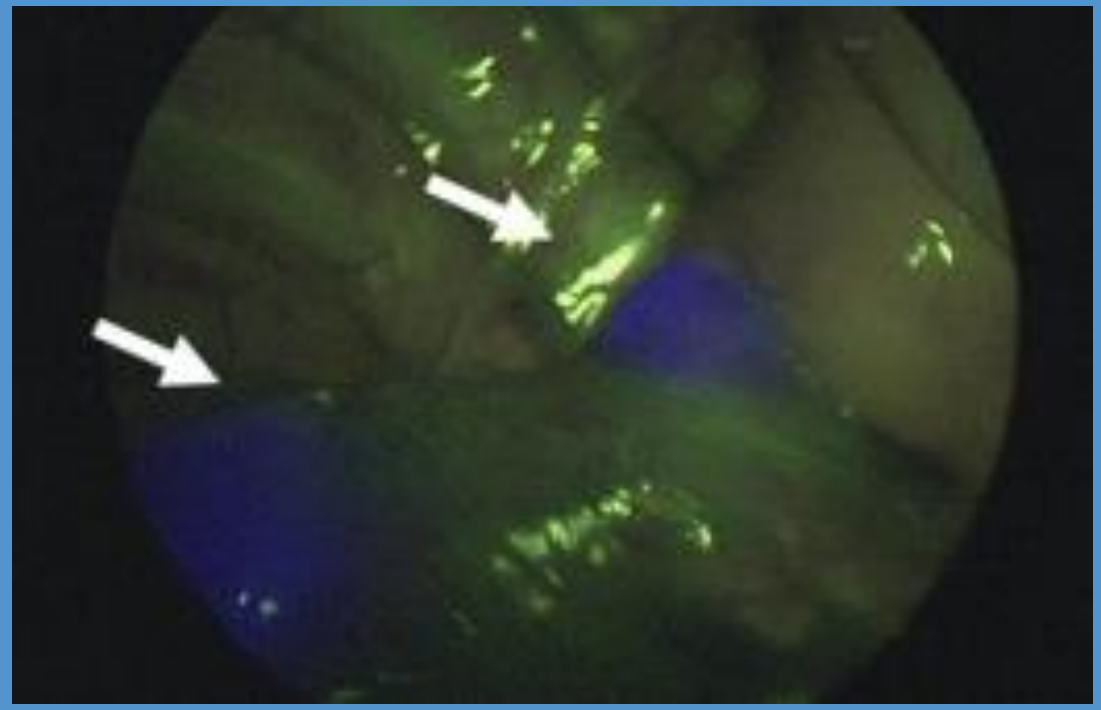
LUNG



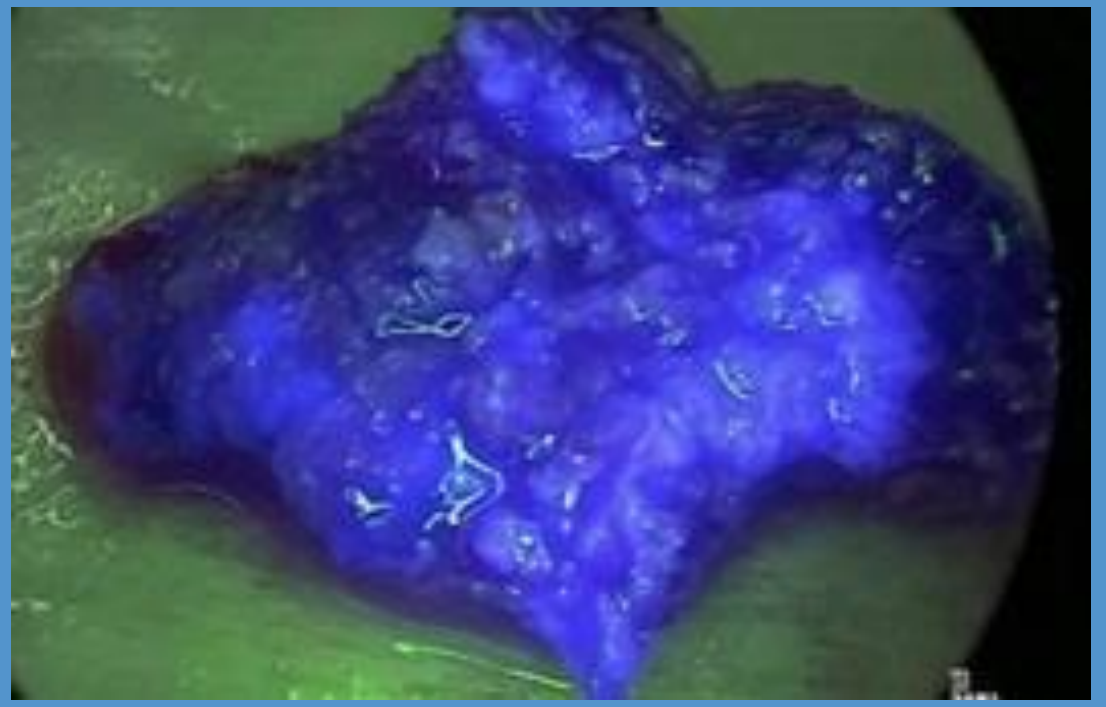








LIVER

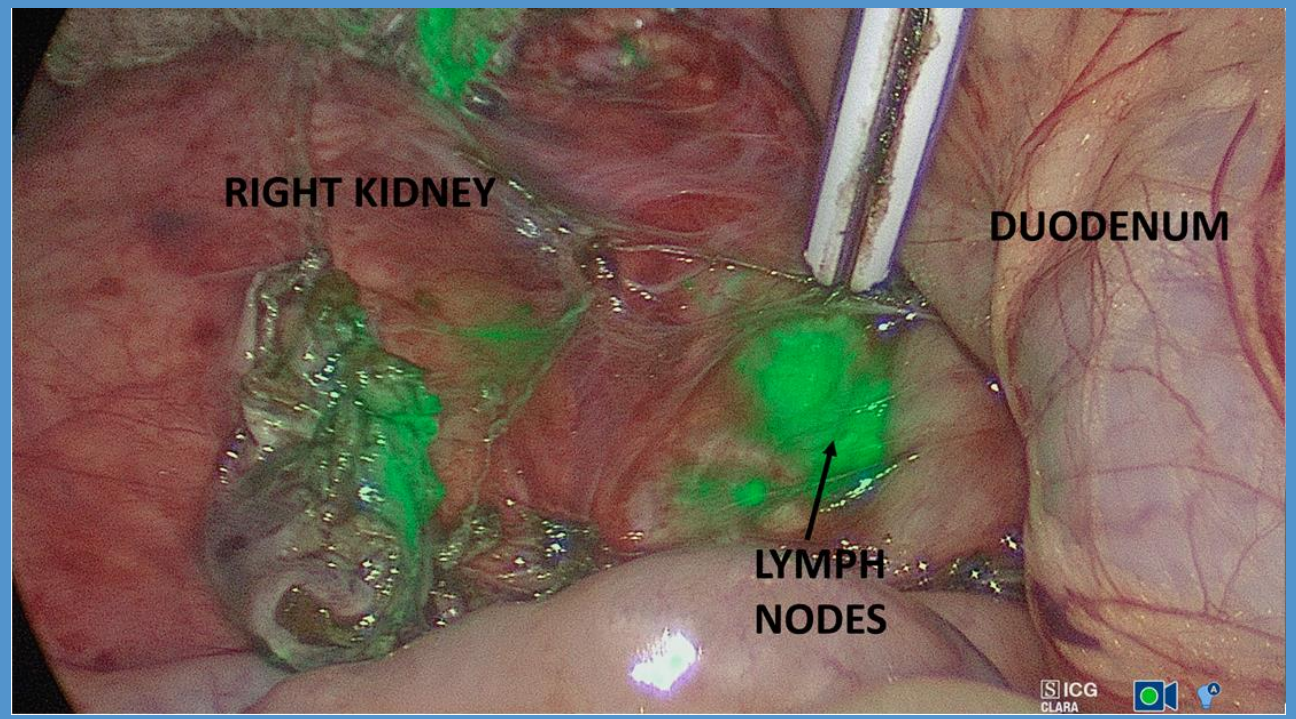


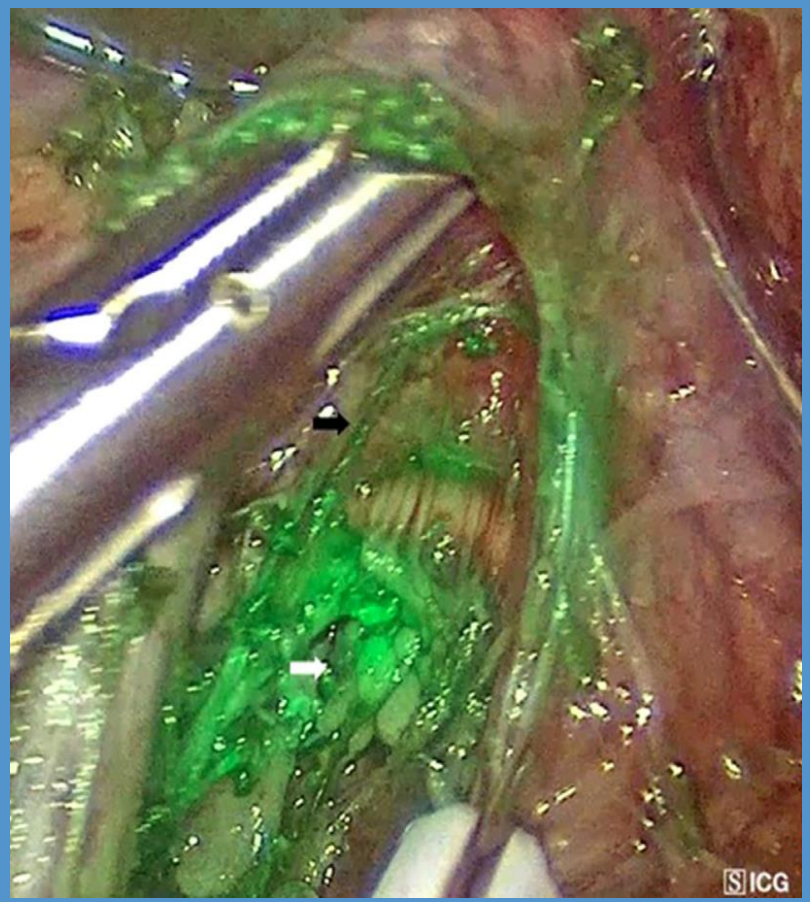
Fluorescence-guided lymphatic mapping of Wilms tumor drainage feasible by both

Intra-Parenchymal injection and

Peri-Hilar injection techniques

LYMPH NODES





Sentinel node biopsy (SN)

improved accuracy of nodal assessment

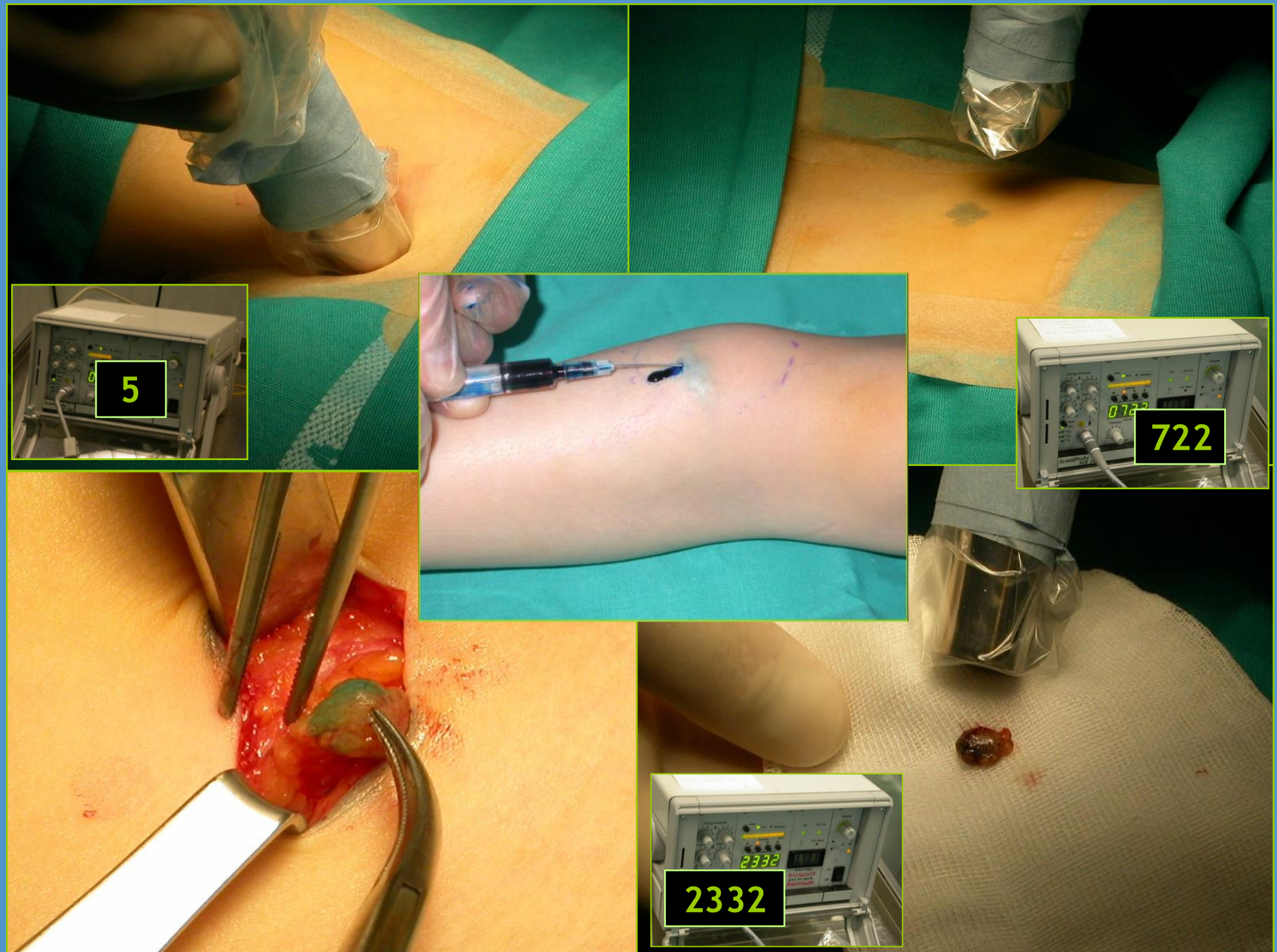
SN - first lymph nodes to receive afferent lymphatic drainage from the tumor

Absence of metastatic cells in SN: further nodal involvement unlikely

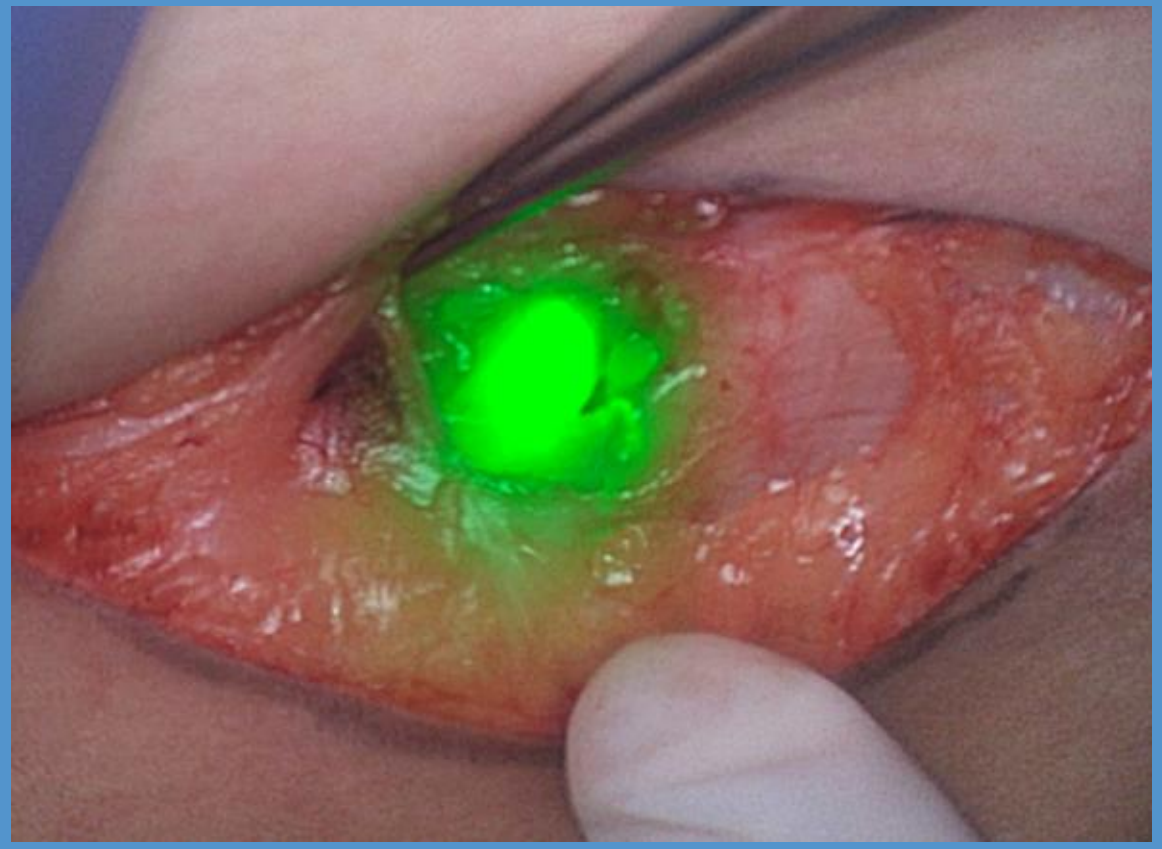







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722
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Surgeons and Radiotherapists Brachytherapy



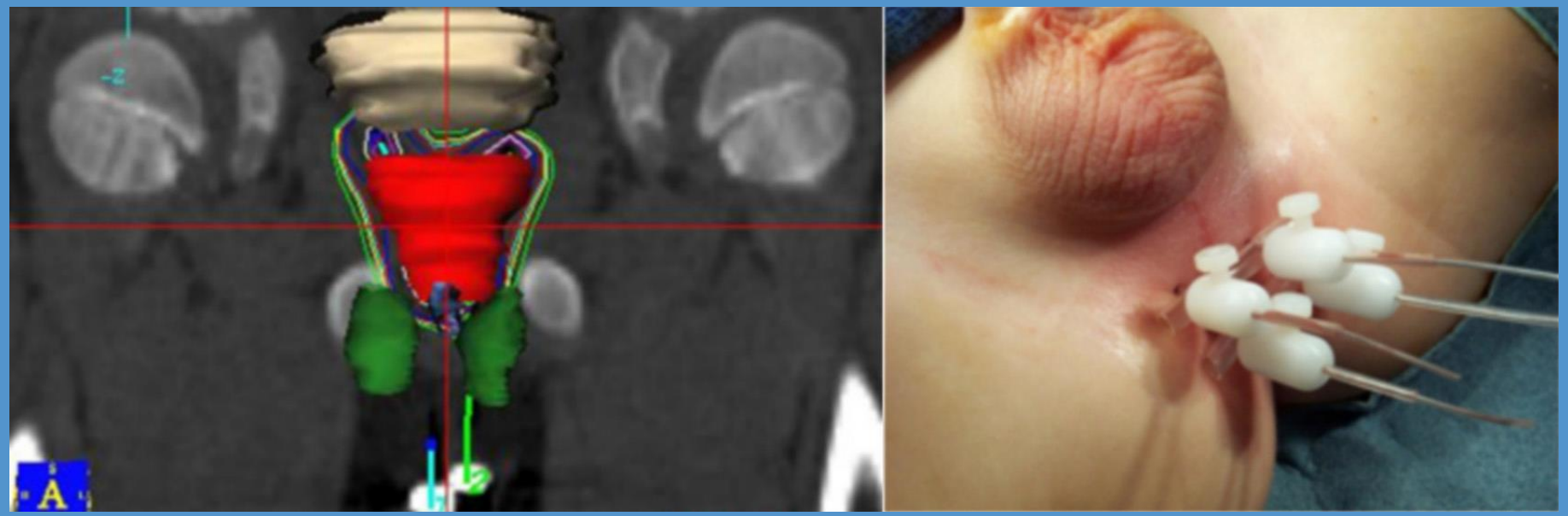
A type of radiotherapy with energy from radionuclides inserted directly into the tumor bed

Compared to external beam RT, brachytherapy has the potential to deliver an ablative radiation dose over a short period of time directly to the altered tissue area with the advantage of a rapid fall-off in dose, and consequently, sparing of adjacent organs






Brachytherapy in vescico-prosthatic RMS



Courtesy of dr. Helene Martelli
Pediatric Surgery
Hôpital du Kremlin-Bicêtre, Le Kremlin-Bicêtre cedex, France

Brachytherapy in vescico-prosthatic RMS

Absence of tumor extension more than 1 cm above the level of the trigona in the posterior bladder wall

Decrease extent of resection (particularly avoiding partial bladder neck resection or resection of the whole bladder wall)

Partial cystectomy for tumors of the anterior wall extending above the trigona, respecting the bladder neck

Partial prostatectomy with urethra preservation for tumors involving the prostate

Brachytherapy in vescico-prosthatic RMS

QoL Questionnaire (18/22)

- 13 considered themselves has having normal QoL and bladder function (very rare diurnal dribbling in 4)
- 5 frequent diurnal dribbling (3 requiring protection, 1 intermittent catheterism)
- All pubertal patients normal erections (3 sexually active reported satisfying normal sex)

H. Martelli et al: Ouality of life and functional outcome of male patients with bladder-prostate rhabdomyosarcoma treated with conservative surgery and brachytherapy during childhood. Brachytherapy 2016

Endocavitary perineal gynecological brachytherapy

Appareil moulé vaginal à la fin de sa fabrication avec trois catheters encadrant la tumeur



Courtesy of dr. Helene Martelli
Pediatric Surgery
Hôpital du Kremlin-Bicêtre, Le Kremlin-Bicêtre cedex, France

Surgeons and Oncologists - HIPEC

Heated cisplatin (40-41°) at 100-130 mg/m^2 infused into the peritoneal space for 90 min after cytoreductive surgery aimed at removing as much visible tumor bulk as possible

- Peritoneum provides a relative barrier allowing higher doses of CT to be delivered into the abdominal cavity without the systemic toxicity
- CispLatin, being a large molecule, diffuses very slowly, so that < 10% is absorbed into the blood stream

Courtesy of Andrea Hayes MD

Indications

Desmoplastic Small Round Cell Tumor (DSRCT)

Primary indication in children and young adults

Abdominal/Peritoneal Rhabdomyosarcoma

Relapsed or advanced forms with peritoneal spread

Wilms Tumor

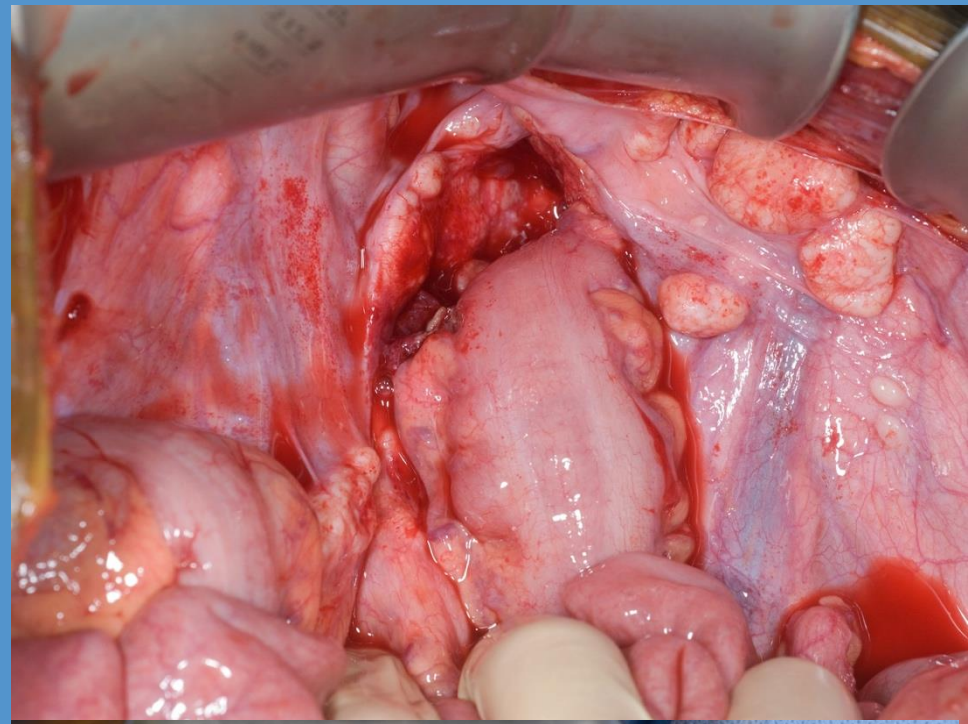
Selected cases involving abdominal recurrence or tumor rupture with peritoneal seeding

Ovarian or Testicular Germ Cell Tumors

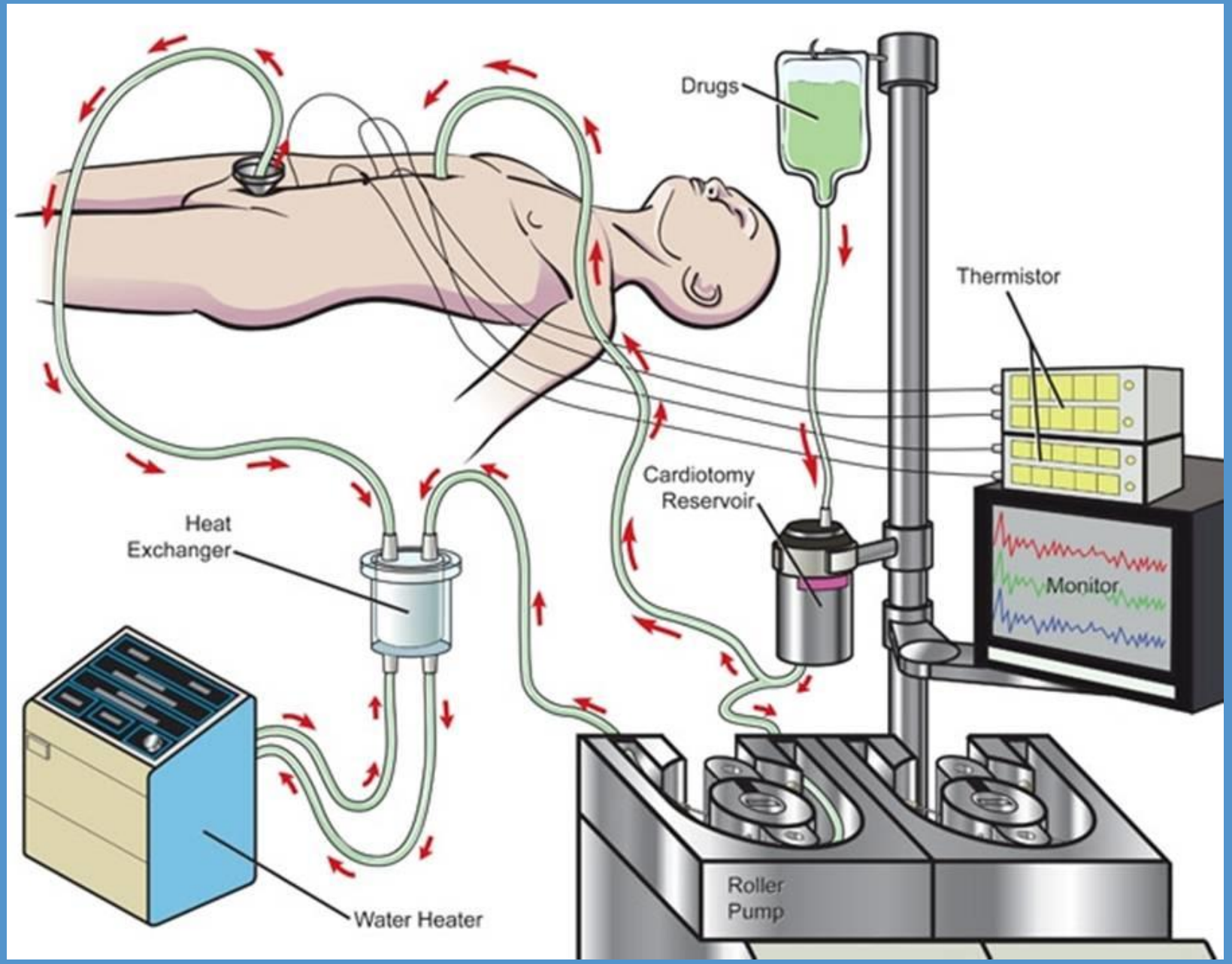
Refractory forms with peritoneal involvement

Rare tumors

Mesothelioma, Colorectal Carcinoma






Drugs
Thermistor
Cardiotomy
Reservoir
Heat
Exchanger
Monitor
Roller
Pump
Water Heater


USCITA
HIPP
TERAPIA: CIRCOLAZIONE
RISCALD.
T1 42.4
T2 39.8
T3 40.2
T4 37.7
T5 38.6
T6 ----
T7 ----
T8 ----
W85: FASE DI CIRCOLAZIONE AVVIATA
SW 1.5



Surgeons and Oncologists - HIPEC

Prognosis is still poor

CRS with HIPEC may potentially improve survival in patients with certain types of peritoneal sarcomatosis or carcinomatosis

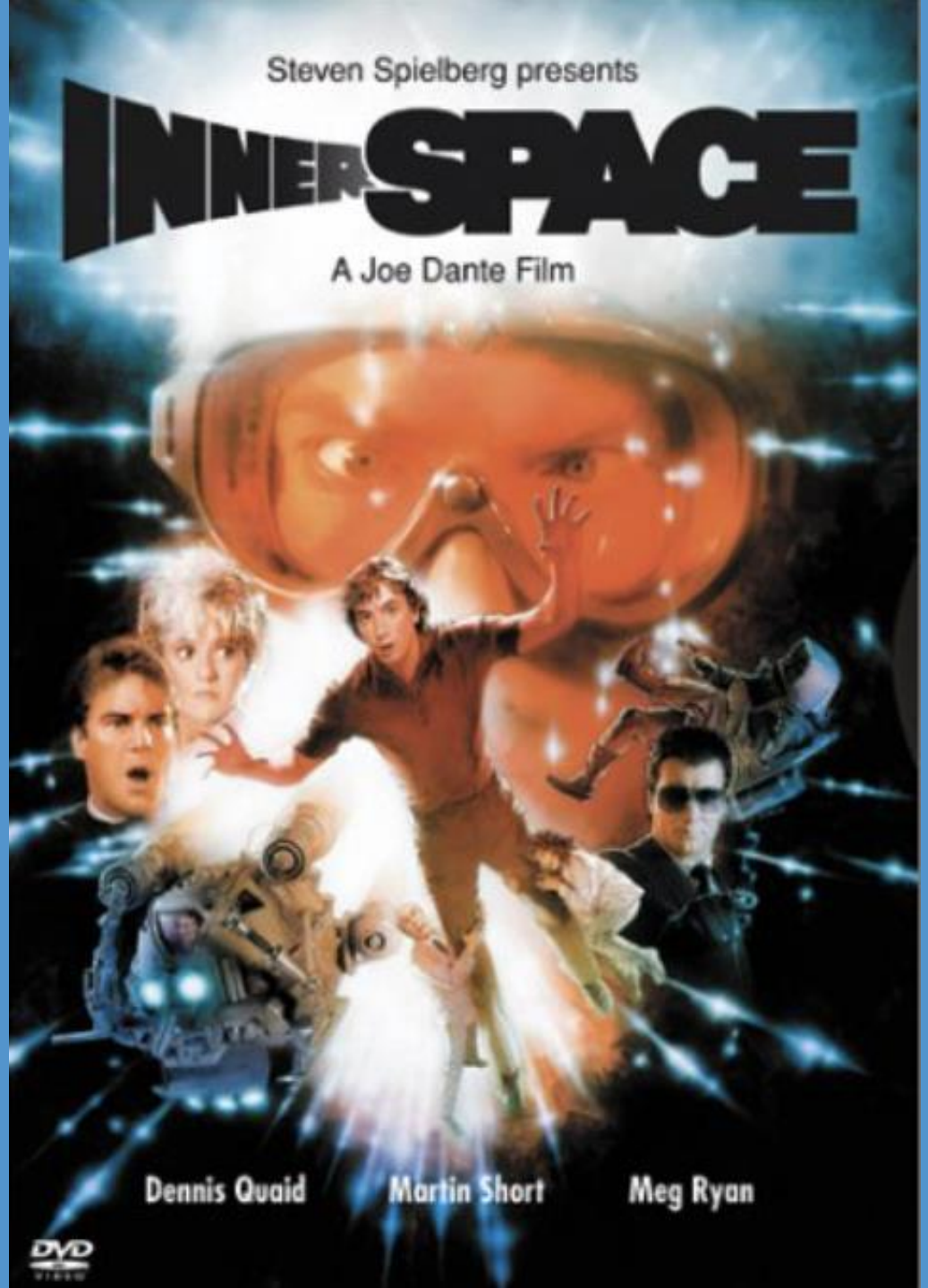
Possible complications: small bowel obstruction, fistulas, ureteral obstruction, major vascular thrombosis, impaired gastrointestinal absorption

WART (whole abdominal radiotherapy): most impactful complications gastroparesis, adhesive bowel obstruction secondary to sclerosing peritonitis, and hemorrhagic cystitis

Further investigation required

Considerations

- Trust innovation!
  - Difficult surgery in some patients
  - Surgeons need help
  - Collaborations!!
  - Evaluation of case reports, collection of case series, modify protocols


Steven Spielberg presents
INNER SPACE
A Joe Dante Film
Dennis Quaid
Martin Short
Meg Ryan
DVD

1987!!

