Necker ENFANTS MALADES HÔPITAL UNIVERSITAIRE

Université Paris Cité



Chirurgie robotique:
principales indications en pédiatrie et prise en charge anesthésique

Drs Stefania QUERCIAGROSSA, Mary HIDALGO et Nadège SALVI

HU Necker – Enfants Malades

Nous ne déclarons pour cette présentation aucun conflit d'intérêt.

Développement de la chirurgie robot-assistée

- 1ers robots chirurgicaux: 1983 , Vancouver, Canada

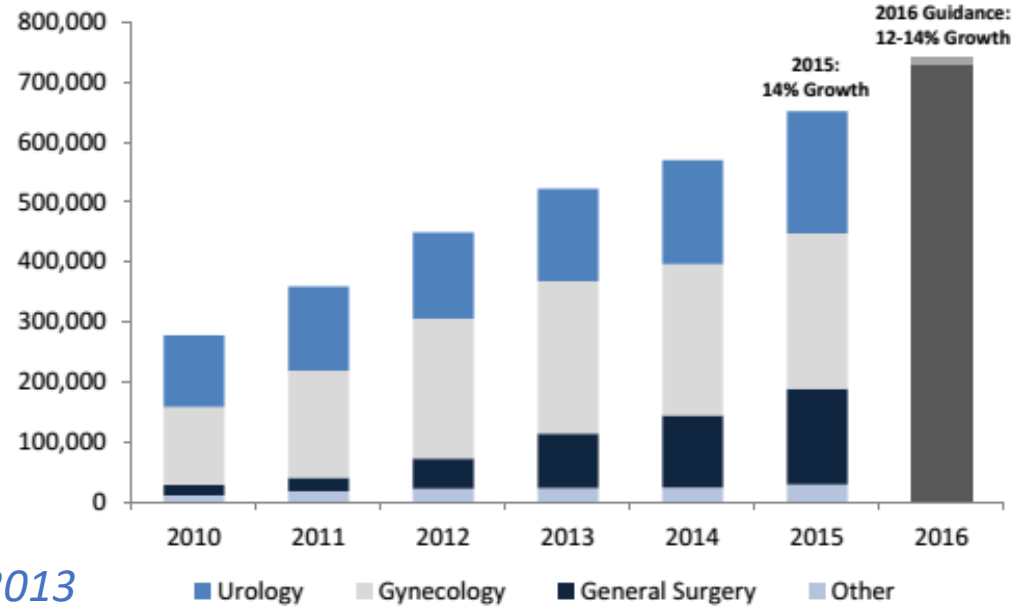
- Début: 90's – 00's
  - Zeus
  - Da Vinci, 2 puis 3 bras
  - Juillet 2000: autorisation FDA pour chirurgie abdominale avec le robot da Vinci

- Essor: 2ème décade

ZEUS Surgical Robotic System







Cundy TP, J Pediatr Surg, 2013

da Vinci Xi



REVOLUTIONARY ANATOMICAL ACCESS



CRYSTAL-CLEAR 3D HD VISUALIZATION





PLATFORM FOR ADVANCED TECHNOLOGIES

ROSA, Medtech



neuronavigation

Chirurgie mini-invasive en pédiatrie

- Diminution de la durée d'hospitalisation
- Diminution de la morbidité pariétale
- Diminution de la douleur post opératoire
- Retour précoce aux activités quotidiennes

Coelio-chirurgie

- Vision 2D
- Mouvements limités
- Espace restreint
- Positions non ergonomiques

- Courbe d'apprentissage

vs

Chirurgie robot-assistée

- Vision 3D
- Degré de liberté

- Simulation
- Enseignement
- Diffusion aux équipes

Principales indications

- Urologie
  - RAP: pyéloplastie robot-assistée
  - Réimplantation urétérale
  - Urétéro-urétérostomie
  - Reconstruction vésicale et Mitrofanoff
  - Divers: néphrectomie, chirurgie vésicale ou prostatique
- Chirurgie générale
  - Fundoplicature
  - Chirurgie hépato-biliaire, cholécystectomie et splénectomie
  - Divers: chirurgie Oe, gynécologie, chirurgie ano-rectale
- Chirurgie cardio-thoracique
  - Cure de canal artériel
  - Cure de HD, cure d'AOe , chirurgie médiastinale
- Chirurgie oncologique
- Neurochirurgie

Paediatric robotic surgery

A review of the current status of robotic surgery use in paediatrics

Annals of the Royal College of Surgeons of England

Cave j, Clarke S, 2018 Sep;100(Suppl 7):18-21

> *Those surgeries that must access the pelvis and therefore have a narrow field may well suit a robotic approach*

A Necker…

Anaesthesia management during paediatric robotic surgery: preliminary results from a single centre multidisciplinary experience

Caroline Harte [a,*], Melissa Ren [a], Stefania Querciagrossa [a], Emilie Druot [a], Fabrizio Vatta [b], Sabine Sarnacki [b], Souhayl Dahmani [c], Gilles Orliaguet [a,d], Thomas Blanc [b,e]

Anaesth Crit Care Pain Med 40 (2021) 100837

Robotic procedures according to surgical speciality (Number of cases n = 200).

Urology (n = 78) 39%	Digestive (n = 56) 28%	Thoracic (n = 10) 5%	Tumor (n = 40) 20%	ENT (n = 16) 8%
Upper tract (n = 68) Pyeloplasty for UPJ obstruction (n = 56) Nephro-ureterectomy for non-functioning kidney (n = 3) Marsupialisation of renal cyst (n = 4) Ureteroureterostomy for duplex system (n = 5)	**Upper (n = 19)** Oesophageal atresia type A repair (n = 1) Oesophageal diverticulum excision (n = 1) Nissen fundoplication +/- gastrostomy for gastroesophageal reflux (n = 8) Gastric banding for morbid obesity (n = 6) Heller myotomy for achalasia (n = 2) *Trichobezoar* (n = 1)	Lobectomy for bronchiectasis (n = 7) Congenital diaphragmatic hernia repair (n = 2) Bronchogenic cyst (n = 1)	**Posterior mediastinum (n = 5)** Thymoma (n=2) Teratoma (n = 1) Ganglioneuroblastoma (n = 2) **Stomach (n = 2)** Inflammatory myofibroblastic tumor (n = 2) **Abdominal (n = 3)** Paraganglioma (n = 3) **Renal (n = 14)** Wilms (n = 12) Sarcoma (n = 1) Tubulopapillary carcinoma (n = 1) **Adrenal (n = 13)** Neuroblastoma (n = 6) Pheochromocytoma (n = 3) Carney complex (n = 2) McCune-Albright syndrome (n = 2) **Pelvic (n = 3)** Teratoma (n = 1) Ganglioneuroblastoma (n = 1) Neurofibromatosis NF1 (n = 1)	**Thyroid (n = 13)** Thyroidectomy -partial (n = 8) Thyroidectomy -total (n = 4) Parathyroidectomy (n = 1) **Transoral surgery (n = 3)** Thyroglossal cyst (n = 2) Oropharynx-meningeal fistula for Gorham-Stout disease (n = 1)
Bladder (n = 6) Mitrofanoff, detrusorotomy for neurogenic bladder	**Mid (n = 3)** Ladd procedure for intestinal malrotation (n = 2) Duodenal diaphragm (n = 1)			
Other (n = 4) Zinner syndrome (n = 1) Rectovaginal pouch (Denys-Drash) (n = 1) Ileal vaginoplasty for cloacal malformation (n = 1) Persistent Müllerian duct syndrome (n = 1)	**Lower (n = 5)** Colectomy for familial adenomatous polyposis (n = 3) Anorectal malformation (n = 2)			
	Biliary (n = 15) Cholecystectomy (n = 13) Choledochal cyst (n = 2)			
	Other (n = 14) Extra lobar sequestration (n = 1) Splenectomy -partial for sickle cell disease (n = 9) Splenectomy -total for sickle cell disease (n = 4)			

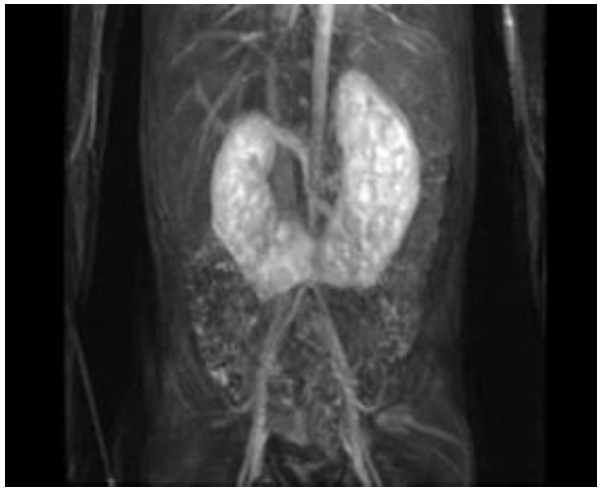
+ neurochirurgie:
SEEG, Visualase avec ROSA

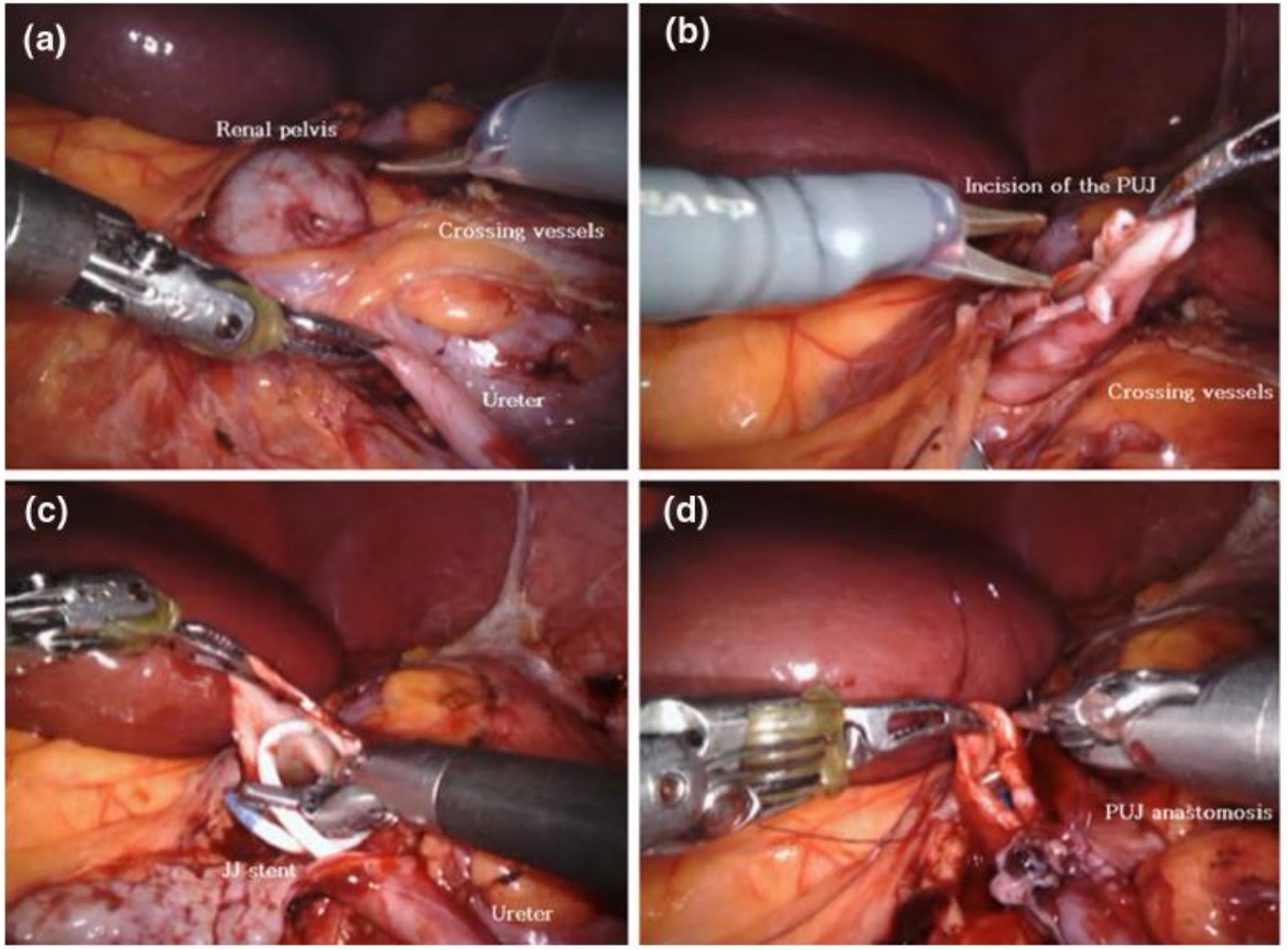
Chirurgie urologique

Robot-assisted laparoscopic pyeloplasty (RALP) in children with horseshoe kidneys: results of a multicentric study

Ciro Esposito[1] · Lorenzo Masieri[2] · Thomas Blanc[3] · Gianantonio Manzoni[4] · Selcuk Silay[5] · Maria Escolino[1]

World Journal of Urology (2019) 37:2257–2263



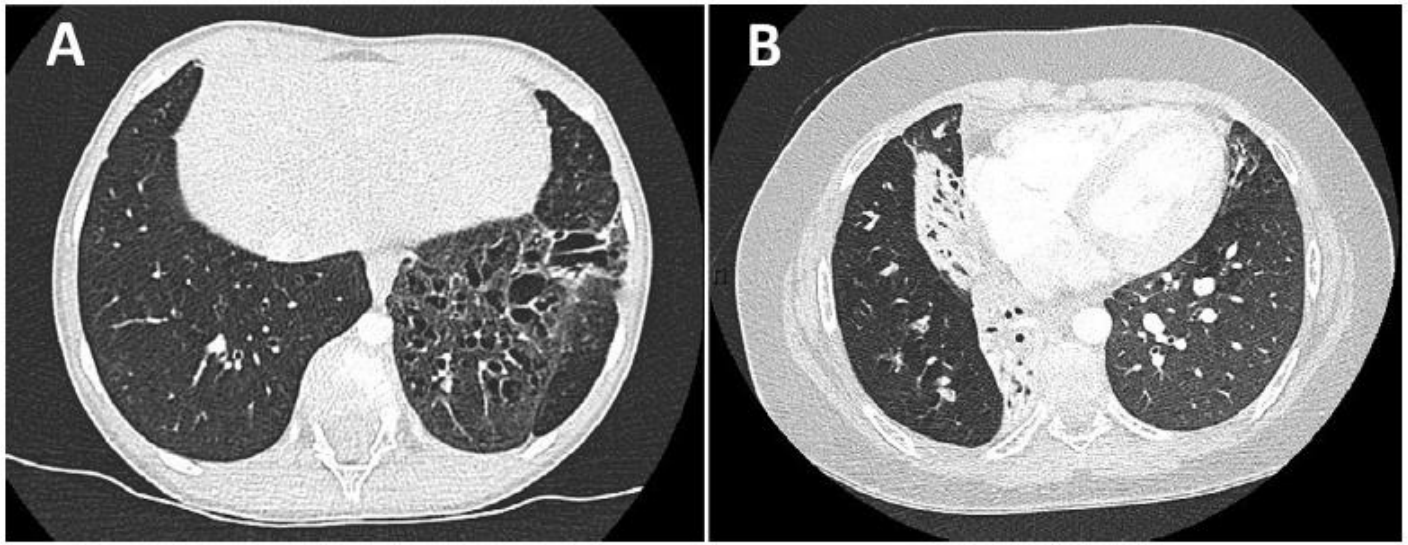


Chirurgie thoracique

Robotic lobectomy in children with severe bronchiectasis: A worthwhile new technology

Marion Durand[a,1], Layla Musleh[b,c,1], Fabrizio Vatta[c,d], Giorgia Orofino[e], Stefania Querciagrossa[e], Myriam Jugie[f], Olivier Bustarret[f], Christophe Delacourt[g,h], Sabine Sarnacki[c,h], Thomas Blanc[c,h], Naziha Khen-Dunlop[c,h,*]

Journal of Pediatric Surgery 56 (2021) 1606–1610



Comparative results between RATS and VATS.

	RATS ($n = 7$)	VATS ($n = 11$)	p-value
Anesthesiology time (min)			
Operative time (min)	67 (49.5–75.5)	33 (22.5–41.5)	**0.016**
Conversions	268 (221.5–286.5)	131 (115.5–190)	**0.004**
Blood transfusion	0	5 (45%)	**0.03**
Chest tube duration (days)	0	0	–
Length of stay (days)	4 (3–4.5)	4 (3.5–5.5)	0.45
	6 (5–9)	6.5 (6–12.5)	0.55

p-value < 0.05 was considered to be statistically significant (in bold). RATS, robot-assisted thoracoscopic surgery; VATS, video-assisted thoracoscopic surgery.



Chirurgie oncologique

Robotic Surgery in Pediatric Oncology: Lessons Learned from the First 100 Tumors—A Nationwide Experience

Thomas Blanc, MD, PhD[1,2,3], Pierre Meignan, MD[1,4], Nicolas Vinit, MD[1], Quentin Ballouhey, PhD[5], Luca Pio, MD[1], Carmen Capito, PhD[1], Caroline Harte, MD[6], Fabrizio Vatta, MD[1], Louise Galmiche-Rolland, PhD[7], Véronique Minard, PhD[8], Daniel Orbach, PhD[9], Laureline Berteloot, MD[10], Cécile Muller, PhD[1], Jules Kohaut, MD[1], Aline Broch, MD[1], Karim Braik, MD[4], Aurélien Binet, MD[4], Yves Heloury, PhD[1,2], Laurent Fourcade, PhD[5], Hubert Lardy, PhD[4], and Sabine Sarnacki, PhD[1,2]

Ann Surg Oncol (2022) 29:1315–1326

2016-2020
Necker, Tours
93 procédures/ 89 patients

Neuroblastomes 31
T rénales 24

8 procédures converties
5 complications nécessitant reprise

TABLE 4 Guidelines for patient selection based on tumor histology and location

	Robotic surgery may be considered	Relative contraindications	Formal contraindications
Thoracic tumors	Paravertebral neuroblastoma *OR* Tumor limited to the thymic bed (teratoma, thymoma) *OR* Lung resection (single metastasis)	Age < 2 years (limited access)	Encasement of vessels *AND/OR* Extension to the median mediastinum (pericardium, esophagus, trachea)
Renal tumors	Tumor not crossing the ipsilateral border of the spine column *AND* Tumor with a thick rim of normal parenchyma *AND* Tumor without any sign of infiltration of extrarenal structures *AND* ETV/EPBV < 1.5%	Tumor with a thin rim of normal parenchyma *OR* Tumor crossing the ipsilateral border of the spine column but not the midline *OR* ETV/EPBV 1.5–2%	Tumor crossing the midline *OR* Tumor infiltrating extrarenal structures, especially liver or diaphragm infiltration *OR* Tumor with encasement of renal vessels (e.g. sarcomas, carcinomas) *OR* ETV/EPBV > 2%
Neuroblastic tumors	Paravertebral (thoracic, abdominal, or pelvic) neuroblastoma without foramen extension *OR* Adrenal tumor *OR* Neuroblastoma of the zuckerkandl ganglia *OR* ETV/EPBV < 1% *AND* No IDRF[12]	One or two IDRFs *OR* Paravertebral (thoracic, abdominal, or pelvic) neuroblastoma with foramen extension but without a spinal component *OR* ETV/EPBV 1–2%	More than two IDRFs *OR* Any IDRF number involving median vessels (celiac artery, superior mesenteric artery) and/or both renal pedicles *OR* Paravertebral (thoracic, abdominal, or pelvic) neuroblastoma with foramen extension and an intraspinal component *OR* ETV/EPBV > 2%
Paragangliomas			Encasement of major vessels
Pheochromocytomas			
Adrenocortical carcinomas			All adrenocortical carcinomas
Solid pseudopapillary neoplasms			All solid pseudopapillary tumors

ETV/EPBV ellipsoid tumor volume [width (mm) × length (mm) × height (mm) × 0.52] and estimated patient blood volume (75 mL/kg for children aged > 3 months), *IDRF* image-defined risk factor

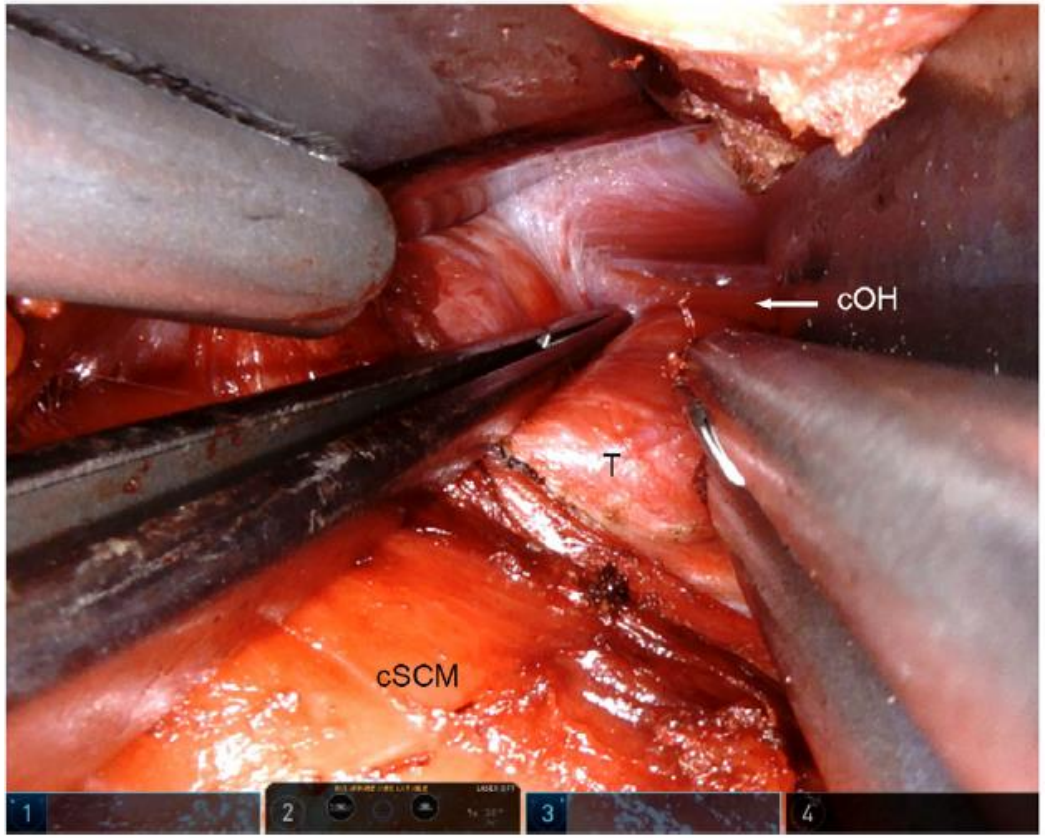
Chirurgie ORL - cervicale

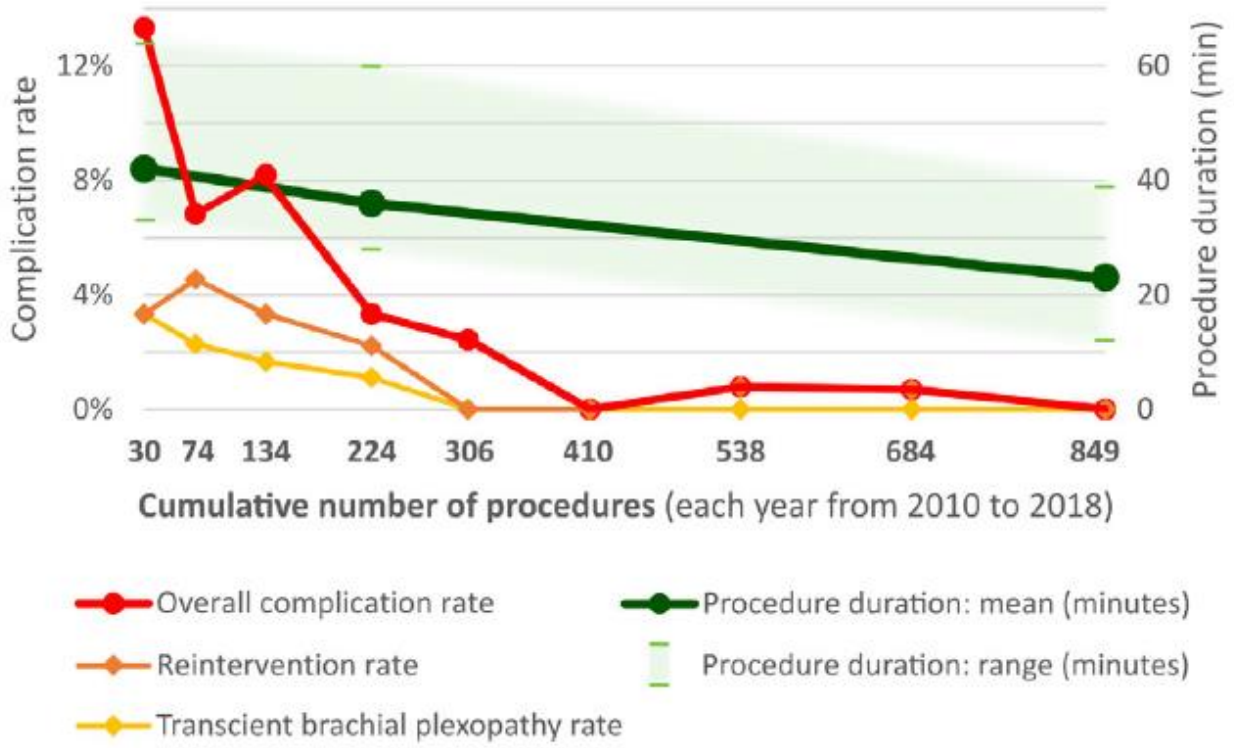


Technique, Pearls, and Pitfalls of the Transaxillary Approach for Robotic Thyroidectomy (With Video)

François Simon, MD, PhD; Romain Luscan, MD, MSc; Thomas Blanc, MD, PhD; Sabine Sarnacki, MD, PhD; Françoise Denoyelle, MD, PhD; Vincent Couloigner, MD, PhD; Patrick Aidan, MD

***Laryngoscope*, 132:488–492, 2022**





Anesthésie pour chirurgie robot-assistée

- Contraintes – enjeux
  - Retentissement du pneumopéritoine
  - Risque d'hypothermie
  - Gestion des apports hydro-électrolytiques et de la douleur

  - Positions opératoires diverses ± complexes
  - Accès très limité au patient
  - L'installation initiale est DEFINITIVE : docking !!!



- ANTICIPATION +++

Mishra P, J Anesthesia, 2020

Evaluation pré-opératoire

- Evaluation habituelle en fonction des antécédents du patient et de l'indication – ASPECIFIQUE / coelio-chirurgie
- Contre-indications non spécifiques
  - Glaucome
  - HTIC
  - Cardiopathie non stabilisée
  - Pathologie pulmonaire sévère, mal équilibrée

- Equipement
- Techniques d'ALR, ttt antalgiques
- Orientation post-opératoire

Installation



- MINUTIEUSE +++

- Vérification des points d'appui
  - Table Trumpf, mémoire de forme
- Anticiper d'éventuels conflit patient/ robot
- Protection oculaire ± casque
- Réchauffement
  - Matelas chauffant/ plastiques
  - Réchauffeur



- Docking: table et robot sont liés
- Apprendre à manipuler la télécommande !!!

Installation

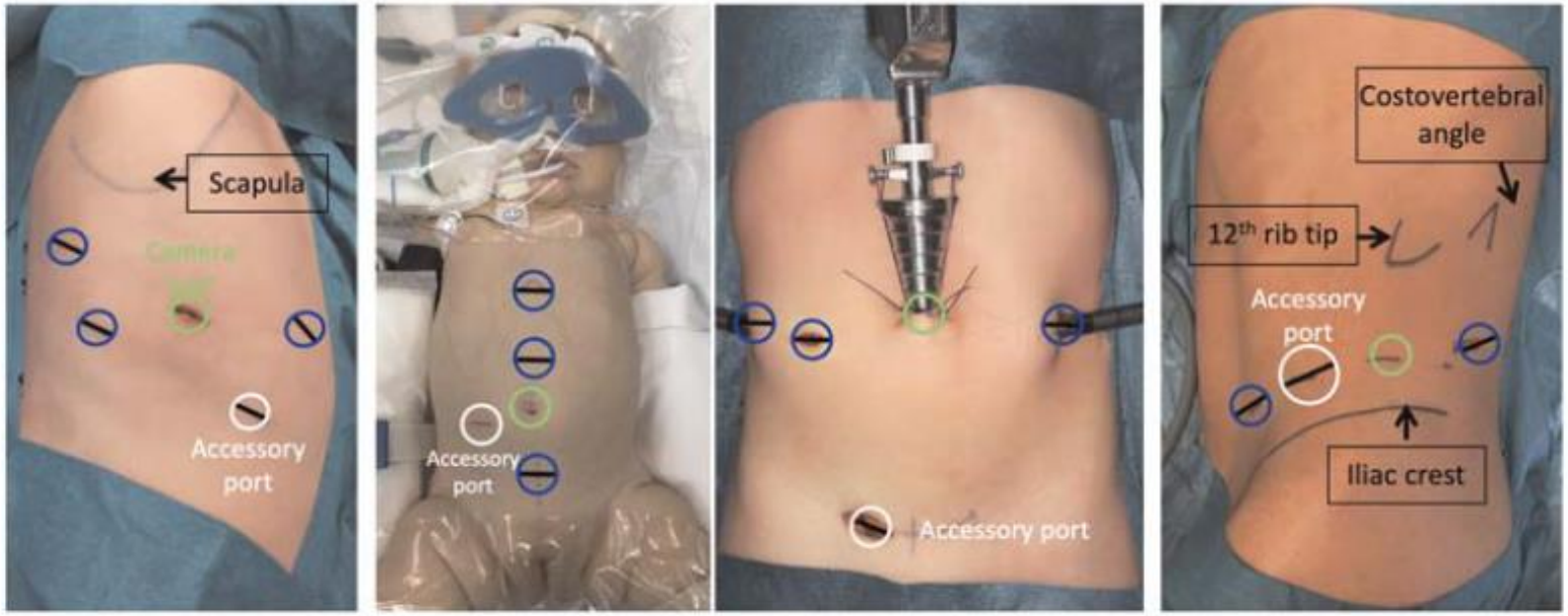




Thorax

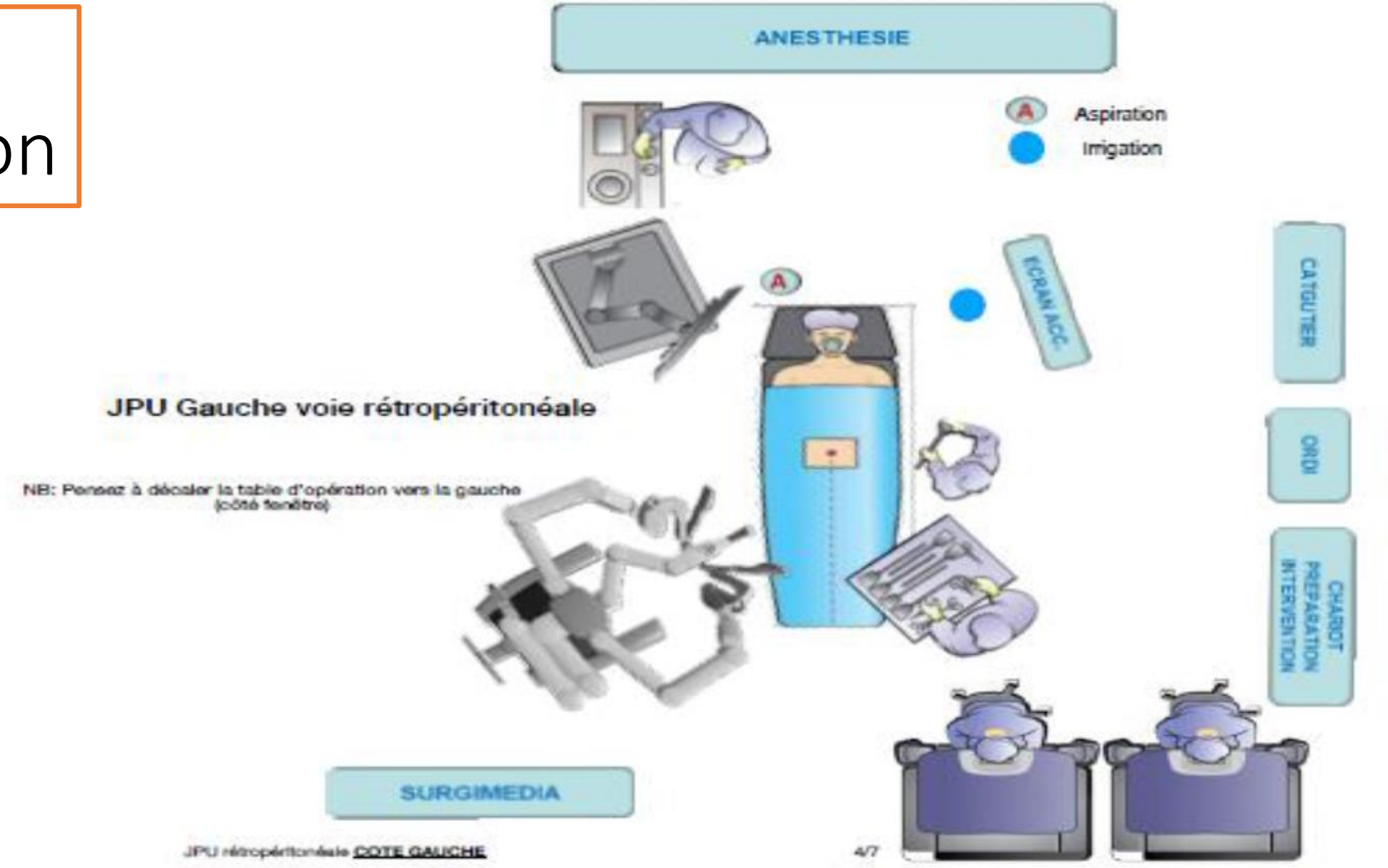
Transperitoneal

Retroperitoneal



Harte C. et al, Anaesth Crit Care Pain Med, 2021

Exemple installation



Installation définitive :

Décubitus latéral (si JPU gauche: DLDroit; si JPU droite: DLGauche)
Billot basithoracique (prévoir tous les billots en cuir noir (x3), en cuir vert et jaune)
Prévoir l'appui bras court de la table Trumpf pour le bras opposé au côté de la jonction
Electrode neutre

Effets physiologiques de la laparoscopie

Insufflation CO2:
5-12 mmHg
5L/min

		Syst. circulatoire	Syst. respiratoire	Syst. nerveux	Autres
Pneumopéritoine	↑	PAM, RVS, PVC Arythmie	pCO2 pression VA		Stase veineuse Actv° SRA, catécho
	↓	DC, IC	CRF, pO2 C pulm		
Trendelebourg	↑	RVP, RVS	Rpt VA/Q pression VA	PIC PIO	
	↓	DC	CRF		Flux rénal, splanchnique et portal
Proclive	↑			Drainage veineux tête et cou	Risque EG
	↓			PIC	Retour veineux
Décubitus latéral	↑		Inad° VA/Q +++	Lés° plexus nerveux	

Mishra P. et al. , J Anesthesia, 2020

Gestion de la douleur

Perioperative analgesic administration in 170 patients (m = *median*).

	Perioperative analgesia (*operating theatre and recovery room*)			
	Regional block	Morphine	No morphine	
			Level 2 analgesic Tramadol/Nalbuphine	Level 1 analgesic only
Pyeloplasty (n = 51) Remifentanil (19) – no morphine (3) Sufentanil (32) – no morphine (28)	0	20 *m* = 0.12 mg/kg	23	8
Other Urology (n = 19) Remifentanil (2) – no morphine (0) Sufentanil (17) – no morphine (13)	0	6 *m* = 0.09 mg/kg	8	5
Digestive (n = 22) Remifentanil (13) – no morphine (0) Sufentanil (9) – no morphine (9)	0	13 *m* = 0.1 mg/kg	4	5
Biliary/splenic (n = 27) Remifentanil (15) – no morphine (1) Sufentanil (12) – no morphine (11)	2 TAP block	15 *m* = 0.14 mg/kg	10	2
Abdominal Tumor (n = 23) Remifentanil (9) – no morphine (0) Sufentanil (14) – no morphine (12)	3 TAP block 1 epidural	11 *m* = 0.12 mg/kg	11	1
Thoracic + tumor (n = 13) Remifentanil (6) – no morphine (0) Sufentanil (7) – no morphine (3)	7 PVB 1 Epidural	10 (2 spinal morphine) *m* = 0.15 mg/kg	2	1
ENT (n = 15) Remifentanil (6) – no morphine (1) Sufentanil (9) – no morphine (9)	0	5 *m* = 0.1 mg/kg	9	1
Total (n = 170)	**14**	**80** *m* = 0.12 mg/kg	**67**	**23**

TAP (*transversus abdominis* plane), PVB (paravertebral block).

Harte C. et al, Anaesth Crit Care Pain Med, 2021

Gestion de la douleur

Postoperative analgesia and hospital length of stay in 170 patients.

	Level 1 analgesics	Level 2 analgesics	Level 3 analgesics	Level 2 or 3 > 48 hours	LOS in days m (range) [IQR]
Pyeloplasty (n = 51)	50	25	3	0	1 (1-3) [1]
Urology (n = 19)	19	12	2	1	3 (1-8) [2-3]
Digestive (n = 22)	20	14	3	3	4 (1-34) [2-6]
Biliary/splenic (n = 27)	26	23	7	0	3 (1-14) [2-4.5]
Tumor (n = 23)	23	17	9	5	3 (1-21) [2-4.5]
Thoracic (n = 13)	13	3	9	6	4 (1-9) [3-5]
ENT (n = 15)	15	4	0	0	2 (1-4) [1-4]
Total (n = 170)	**166 (97%)**	**98 (57%)**	**34 (19%)**	**15 (9%)**	**2 (1-34) [1-4]**

n = number of patients; m = median; (. . .) = total range; [. . .] = interquartile range.

Harte C. et al, Anaesth Crit Care Pain Med, 2021

Protocole d'anesthésie

Monitoring

Systematic

- ECG, SpO2, NIBP and core temperature monitoring
- IV access: two peripheral cannulas (one for the administration of maintenance fluids and medications on continuous infusion, one for fluid filling)

Often

- Nasogastric tube insertion and TOF monitoring - excluding thyroid surgery
- BIS monitoring if TIVA used
- Urinary catheter placement – excluding ENT and upper abdominal surgery < 4 h

Occasionally

- Invasive arterial blood pressure monitoring – secretory tumour excision, particular patient comorbidity $\pm$ surgery $>$ 4 h
- Oesophageal Doppler – optional
- Central venous access – if limited peripheral IV access, anticipated intra operative vasopressors, postoperative therapy/blood sampling

Technique Guidelines

- Inhalational or IV induction depending on child's age or wishes
- Oral intubation - excluding trans oral surgery or in babies where nasal route might be preferred, a special oral tracheal tube for laryngeal nerve monitoring in thyroidectomy
- Single lung ventilation by selective bronchial intubation or double lumen tube placement in certain thoracic cases after discussion with the surgeon
- Ventilation with PEEP 3–5 and accepting ETCO2 $\leq$ 50 mmHg
- Fluid administration: 10 mL/kg the first hour to compensate for fasting, then 4-2-1 regime with Ringer's Lactate or Isopedia® solution depending on the child's age with fluid boluses by normal saline or colloid as indicated; mild tachycardia should be tolerated

Anaesthetic agent

- Propofol for gastric banding $\pm$ thyroid/thoracic cases; sevoflurane for other cases
- Remifentanil for gastric band + thyroid cases; sufentanil for other cases
- Atracurium bolus or infusion excluding thyroid surgery
- Ketamine bolus $\pm$ infusion for all abdominal and thoracic cases

Analgesia intraoperatively

- Paracetamol $\pm$ NSAIDS $\pm$ clonidine $\pm$ nefopam depending on age
- Regional analgesia
  - Paravertebral block for all thoracic cases and conversions to laparotomy (tumour)
  - *Transversus abdominis* plane block if a Pfannenstiel incision is performed
  - Surgical local anaesthetic infiltration of incisions in all other surgeries

Postoperative analgesia on the ward

- Morphine (oral or PCA) reserved for thoracic cases without paravertebral catheter, conversions to open surgery, children with sickle cell disease with pain not controlled by level 2 analgesics
- Tramadol or nalbuphine as required for all other cases

Harte C. et al, Anaesth Crit Care Pain Med, 2021

Pyéloplastie robot-assistée ambulatoire

ENJEU

- Pyéloplastie = chirurgie robot-assistée la plus fréquente
- Sd JPU
  - Sténose intrinsèque
  - Vaisseau polaire

=> résection de la JPU, plastie de réduction du bassinet, anastomose PU, sonde JJ

- Complications
  - Chirurgicales: urinome, caillotage (douleur)
  - Anesthésiques: douleur, NVPO

Critères de sélection

- Patients > 2 ans, > 10 kgs
- ASA 1, 2 et 3 stable
- Critères habituels de PEC en chirurgie ambulatoire
- Durée geste chirurgical ≤ 4h
- ECBU stérile
- Sortie de SSPI à 14h au plus tard

Conclusion

- Travail d’équipe +++
- Procédures

- Rigueur et minutie

Teamwork is the key

Conclusion

Our preliminary findings regarding the provision of anaesthesia for children undergoing robotic surgery across a large range of surgical procedures indicate overall good physiological tolerance, although hypothermia was common. Adverse intraoperative events were infrequent. A consistent approach and clear communication are key. Postoperative analgesia requirements are low except following thoracic and some complex abdominal cases.

Mishra P. et al. , J Anesthesia, 2020
Harte C. et al, Anaesth Crit Care Pain Med, 2021



- Election CA
- Clôture des votes à 17h30