COLLÈGE NATIONAL
HOSPITALIER ET UNIVERSITAIRE
DE CHIRURGIE PÉDIATRIQUE

Neuroblastomes

S.Sarnacki

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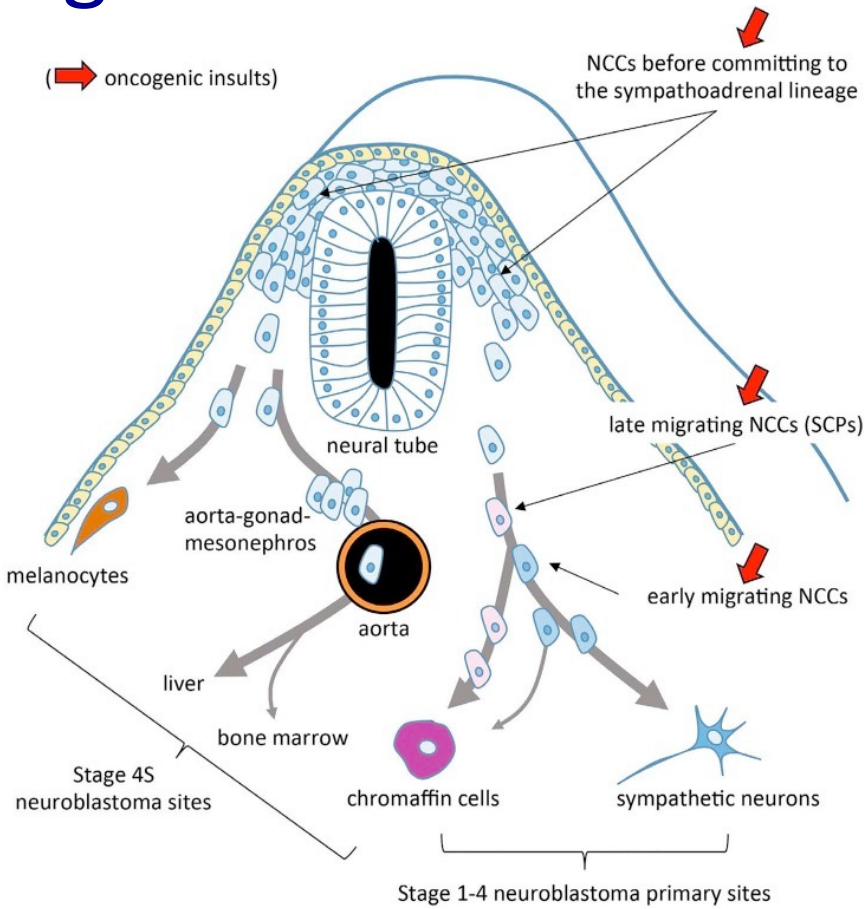
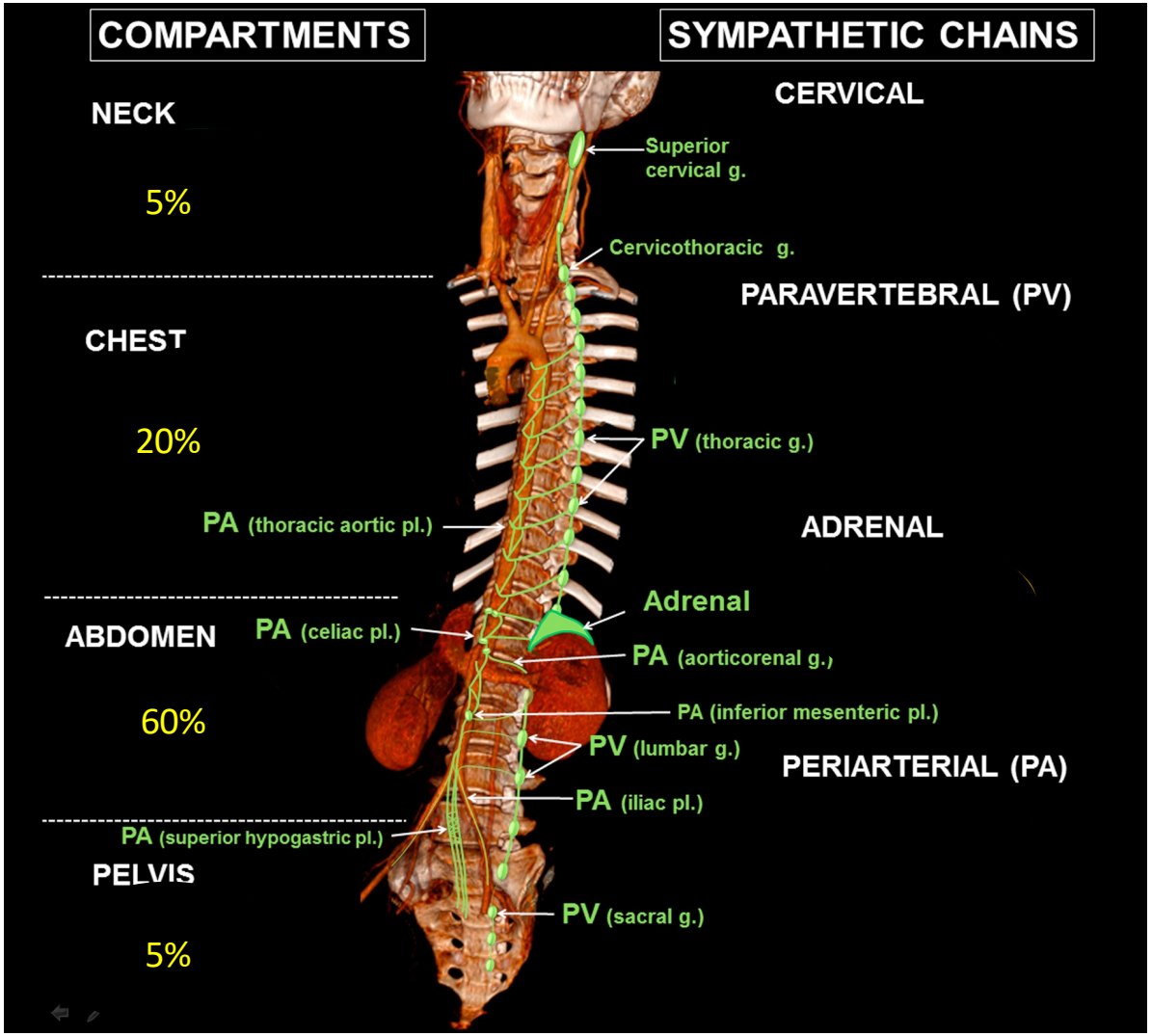
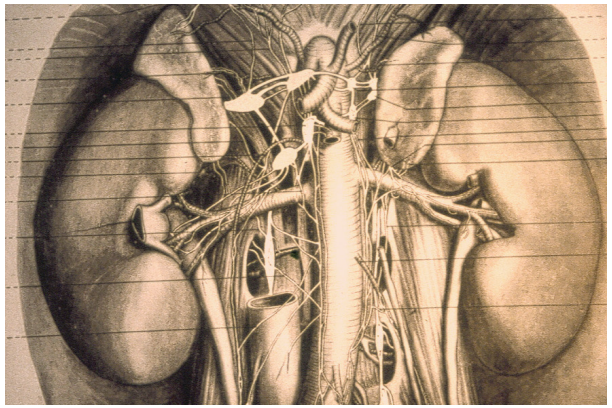
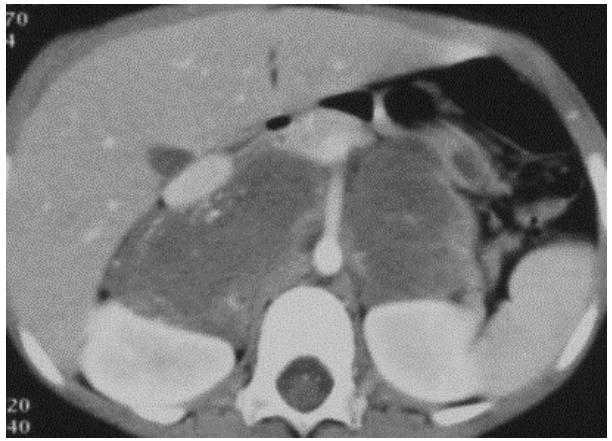
Origins of neuroblastoma



S.Tsubota & K.Kadomatsu, Oncosciences 2017







Brisse HJ et al, PlosOne 2017

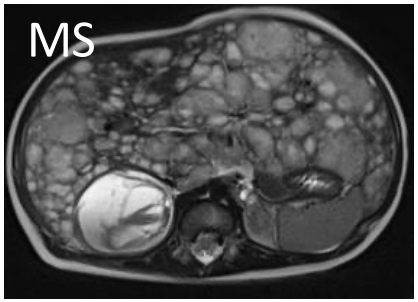
INRGSS

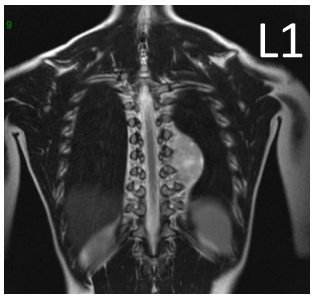
Table 2. International Neuroblastoma Risk Group Staging System

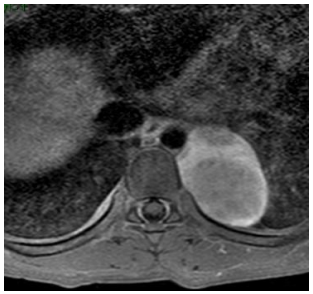
Stage	Description
L1	Localized tumor not involving vital structures as defined by the list of image-defined risk factors and confined to one body compartment
L2	Locoregional tumor with presence of one or more image-defined risk factors
M	Distant metastatic disease (except stage MS)
MS	Metastatic disease in children younger than 18 months with metastases confined to skin, liver, and/or bone marrow

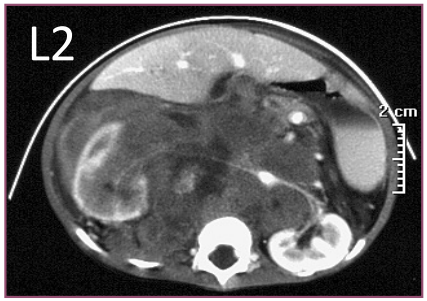
1 - metastatic disease ?

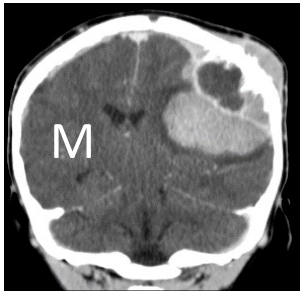
2 – Surgical risk factors (IDRF)?











Tom Monclair et al. The INRG staging system. J Clin Oncol 2009;27:298

International NBL Risk Group (INRG)

INRG Stage	Age (months)	Histologic Category	Grade of Tumor Differentiation	*MYCN*	11q Aberration	Ploidy	Pretreatment Risk Group
L1/L2		GN maturing; GNB intermixed					A Very low
L1		Any, except GN maturing or GNB intermixed		NA			B Very low
				Amp			K High
L2	< 18	Any, except GN maturing or GNB intermixed		NA	No		D Low
					Yes		G Intermediate
	≥ 18	GNB nodular; neuroblastoma	Differentiating	NA	No		E Low
					Yes		H Intermediate
			Poorly differentiated or undifferentiated	NA			
				Amp			N High
M	< 18			NA		Hyperdiploid	F Low
	< 12			NA		Diploid	I Intermediate
	12 to < 18			NA		Diploid	J Intermediate
	< 18			Amp			O High
	≥ 18						P High
MS	< 18			NA	No		C Very low
					Yes		Q High
				Amp			R High

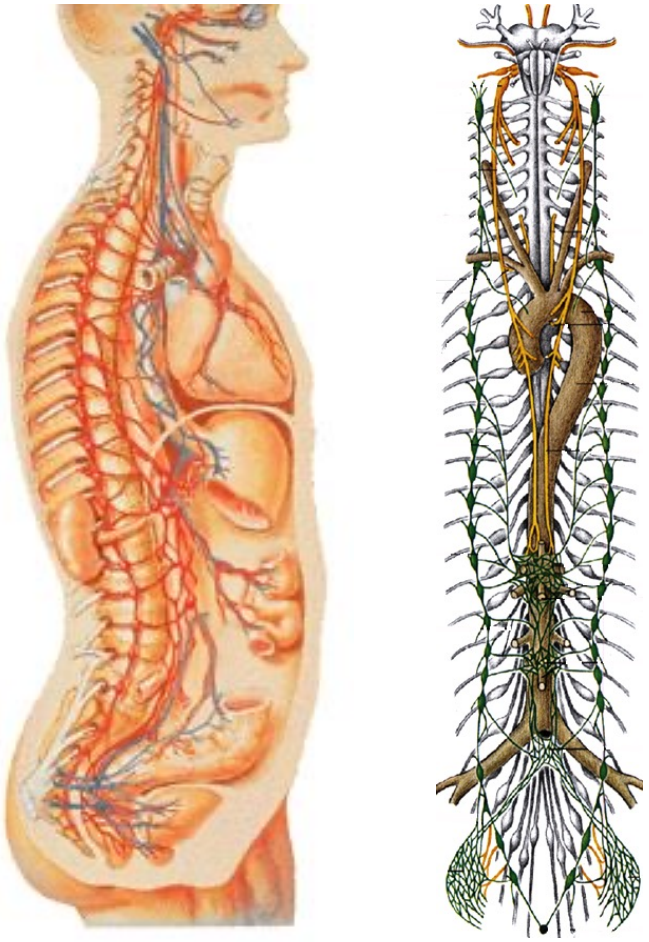
Risk Group	Predicted 5-year EFS	Proportion of patients
Very low	>85%	28%
Low	76-85%	27%
Intermediate	50-75%	9%
High	<50%	36%

Cohn SL et al. The INRG classification system. J Clin Oncol 2009;27(2):289

IDRFs

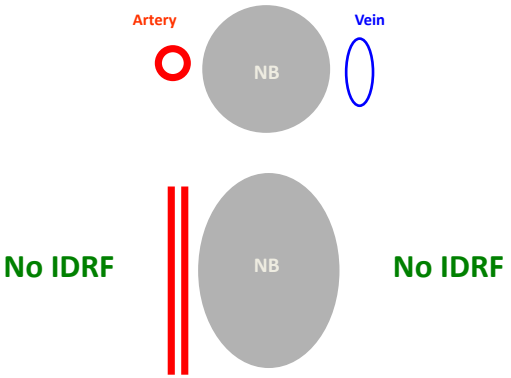
Image-defined risk factors in neuroblastic tumors
Ipsilateral tumor extension within two body compartments
Neck-chest, chest-abdomen, abdomen-pelvis
Neck
Tumor encasing carotid and/or vertebral artery and/or internal jugular vein
Tumor extending to the base of skull
Tumor compressing the trachea
Cervicothoracic junction
Tumor encasing brachial plexus roots
Tumor encasing subclavian vessels and/or vertebral and/or carotid artery
Tumor compressing the trachea
Thorax
Tumor encasing the aorta and/or major branches
Tumor compressing the trachea and/or principal bronchi
Lower mediastinal tumor, infiltrating the costovertebral junction between T9 and T12
Thoracoabdominal
Tumor encasing the aorta and/or vena cava
Abdomen/pelvis
Tumor infiltrating the porta hepatis and/or the hepatoduodenal ligament
Tumor encasing branches of the superior mesenteric artery at the mesenteric root
Tumor encasing the origin of the coeliac axis and/or the superior mesenteric artery
Tumor invading one or both renal pedicles
Tumor encasing the aorta and/or vena cava
Tumor encasing the iliac vessels
Pelvic tumor crossing the sciatic notch
Intraspinal tumor extension whatever the location provided that:
More than one third of the spinal canal in the axial plane is invaded and/or the perimedullary leptomeningeal spaces are not visible and/or the spinal cord signal is abnormal
Infiltration of adjacent organs/structures
Pericardium, diaphragm, kidney, liver, duodeno-pancreatic block, and mesentery
Conditions to be recorded, but *not* considered IDRFs
Multifocal primary tumors
Pleural effusion, with or without malignant cells
Ascites, with or without malignant cells

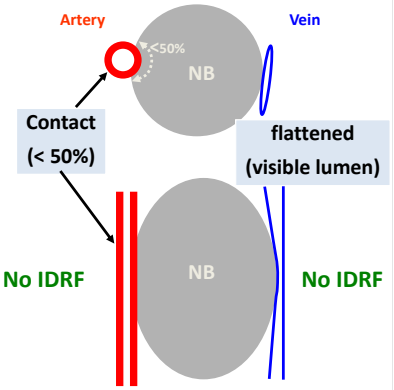
IDRFs image-defined risk factors

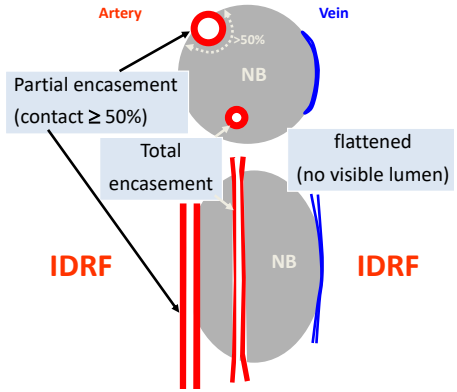


Tom Monclair et al. The INRG staging system: an INRG Task Force report. *J Clin Oncol* 2009;27(2):298-303.

Definition of terms in the IDRFs classification

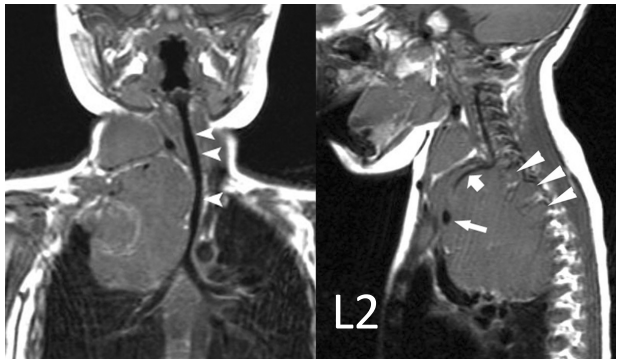






Separation

Contact (exception for renal pedicle)

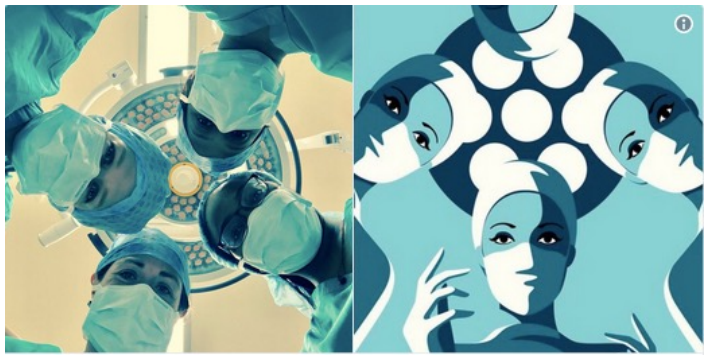


Encasement

Brisse HJ et al, Radiology 2011

Critical questions for surgeons

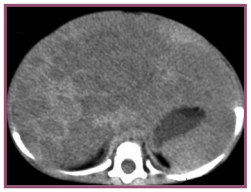
- To operate or not to operate?
- When to operate ?
- What should be the extent of resection?



The wait and see strategy

Fœtal NBL

- Prenatal
- Neonatal < 3 months
- L1, Size < 5 cm
- No LTS



Ms Neuroblastoma

- < 6 months
- Liver, BM, SC mets
- No bone mets
- No LTS

72- 81% are cured without any treatment

Beckwith JB and Perrin EV, Am J Pathol 1963
Nutchern JG et al, Ann Surg 2012
SIOPEN communication, 2020

LINES SIOPEN study for perinatal NBL

(ClinicalTrials.org:NCT01728155)

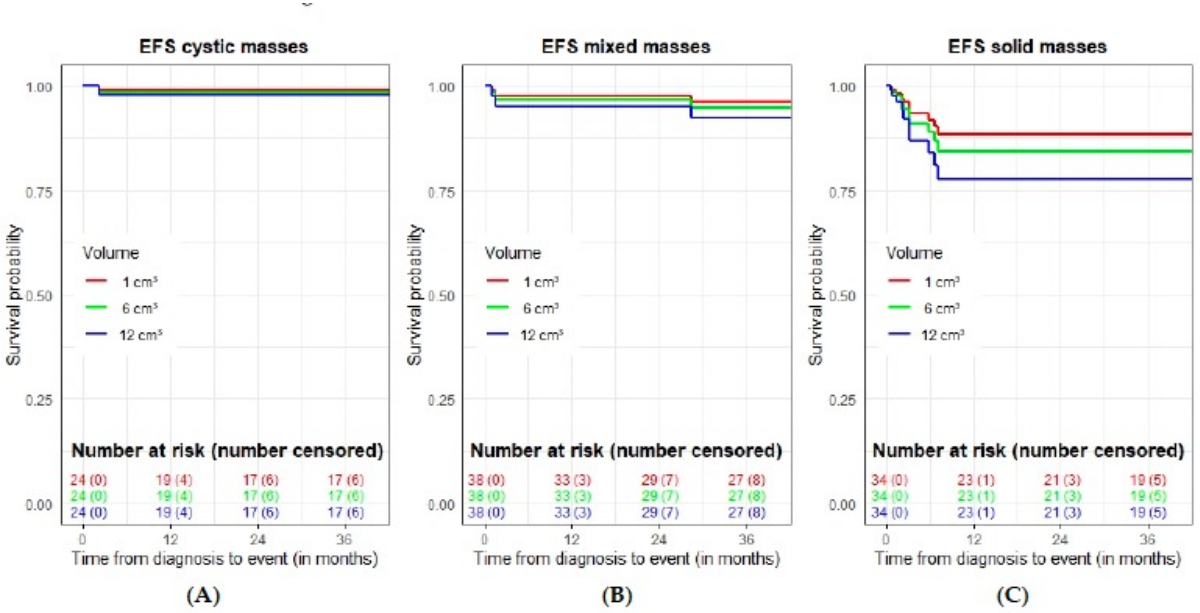
- Infants ≤ 90 days
- Mass ≤ 5 cm
- No lymph node or distant spread
- US, MRI and urinary CA
- Surgery indicated if
  - >40%volume increase or
  - mass persisting after 48 weeks

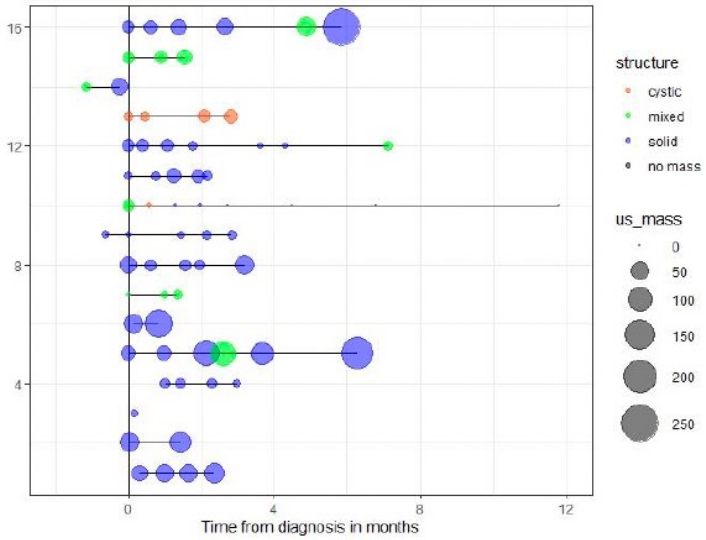
- N=128
  - 42% detected prenatally
  - 58% detected postnatally
- All MYCNA
- Surgery in 30% of case
  - 45% before and
  - 55% after the 48 wks observation
- 74% NBL on pathology

Vassilios Papadakis et al, Cancers 2022

- 3years OS: 100%
- 3 years EFS: 87.1%
- Lesser chance of spontaneous regression
  - solid masses
  - mass volume

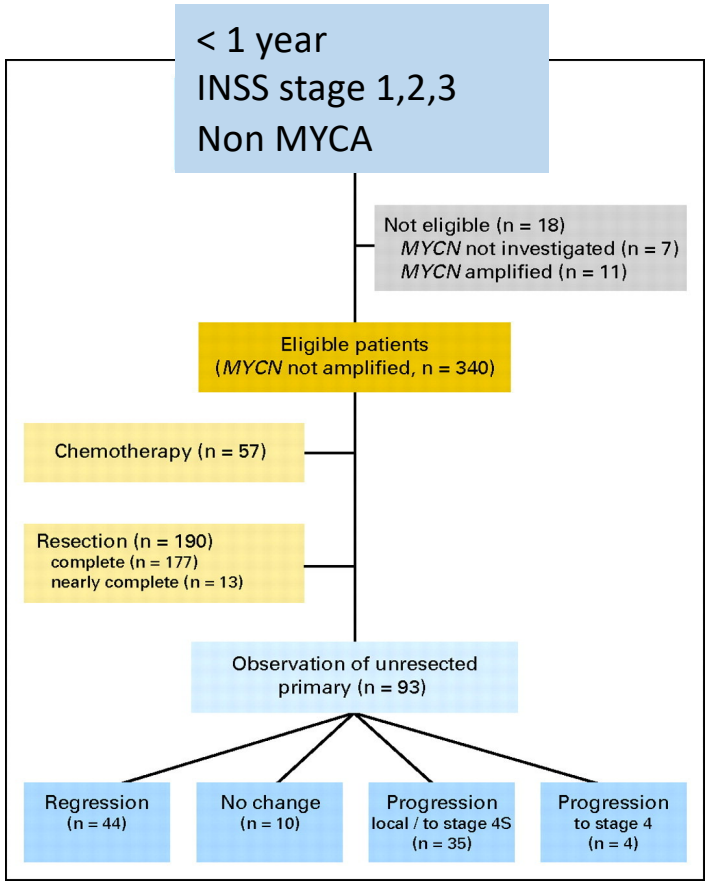
16 events (12.5%)
- ○11 volume increase
- ○5 progression to MS

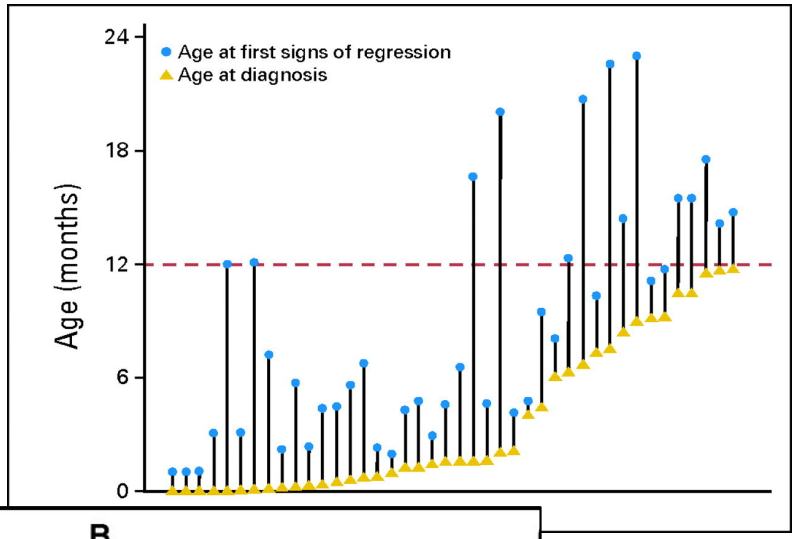


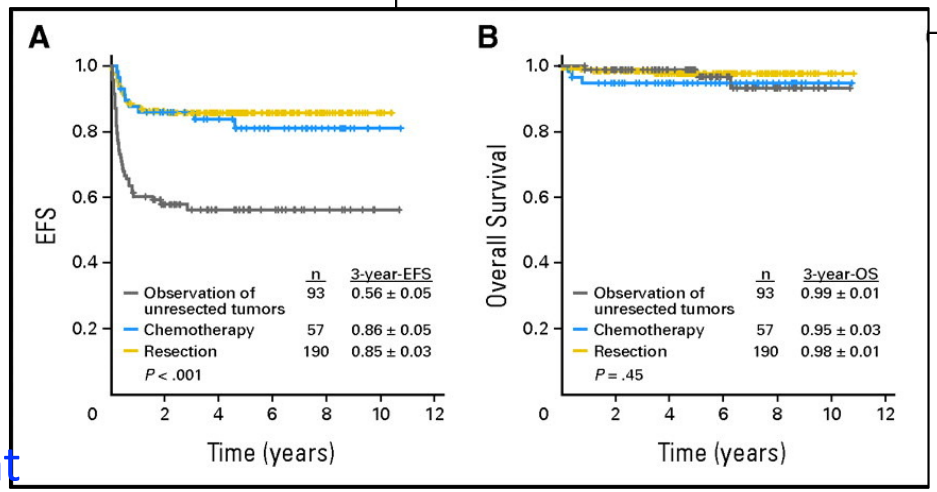


Vassilios Papadakis et al, Cancers 2022

Wait and See strategy: GPOH experience







B.Hero et al, JCO 2008

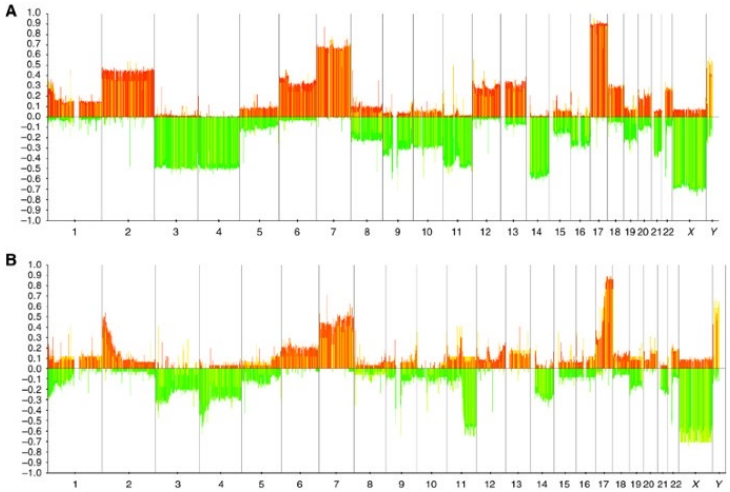
60% are cured without any treatment

SIOPEN R-NET

European Low and Intermediate Risk Neuroblastoma

A SIOPEN Study

NCA

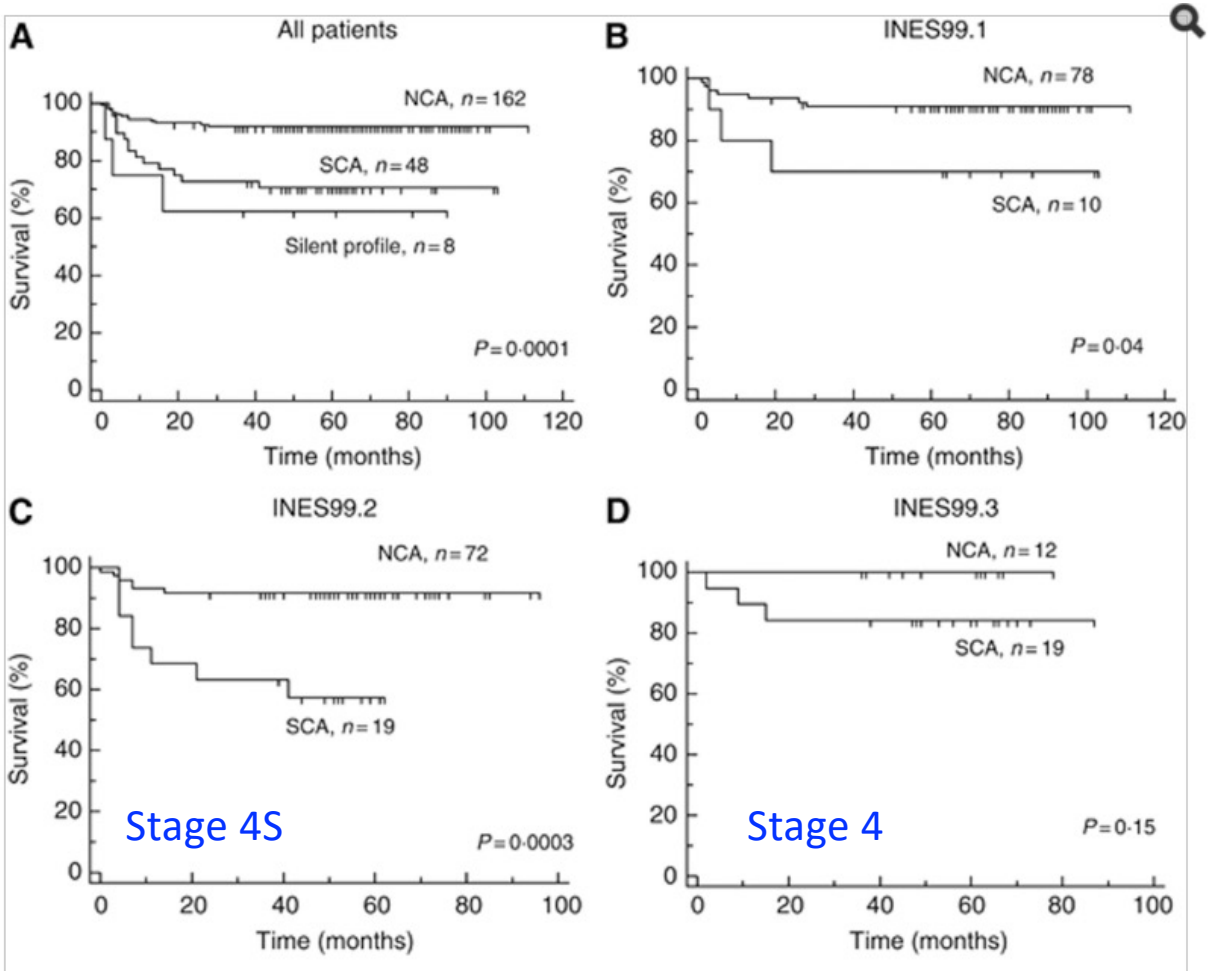


SCA

Janoueix-Lerosey I, J Clin Oncol 2009, 27:1026-1033
G.Schleiermacher et al, Br J Cancer 2011
Ambros IM et al, JCO 2020

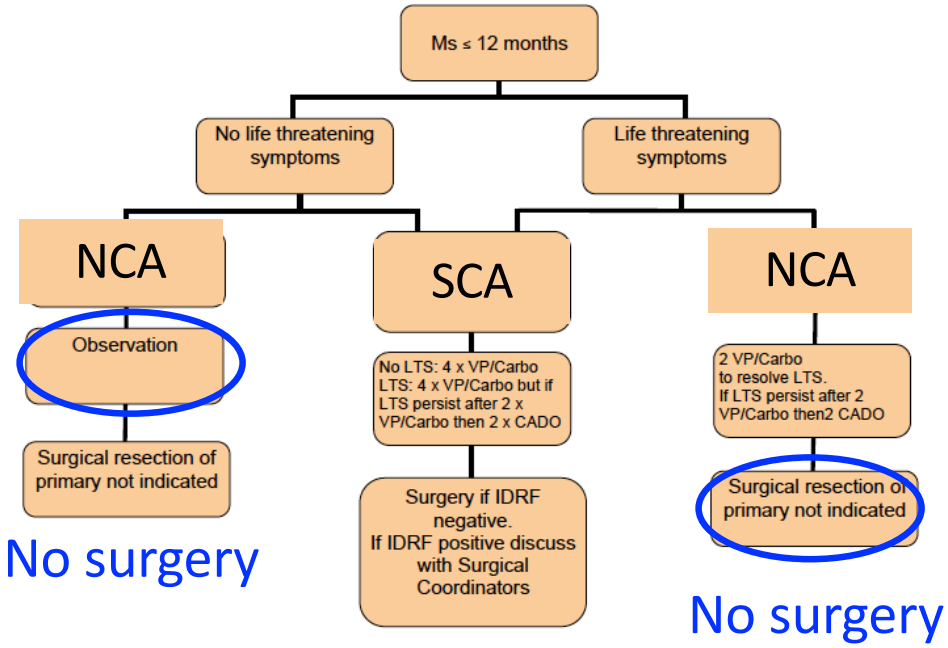
All patients
< 1 year, NMYC NA

Localised unresectable



Wait and see strategy in the LINES protocol (SIOPEN)

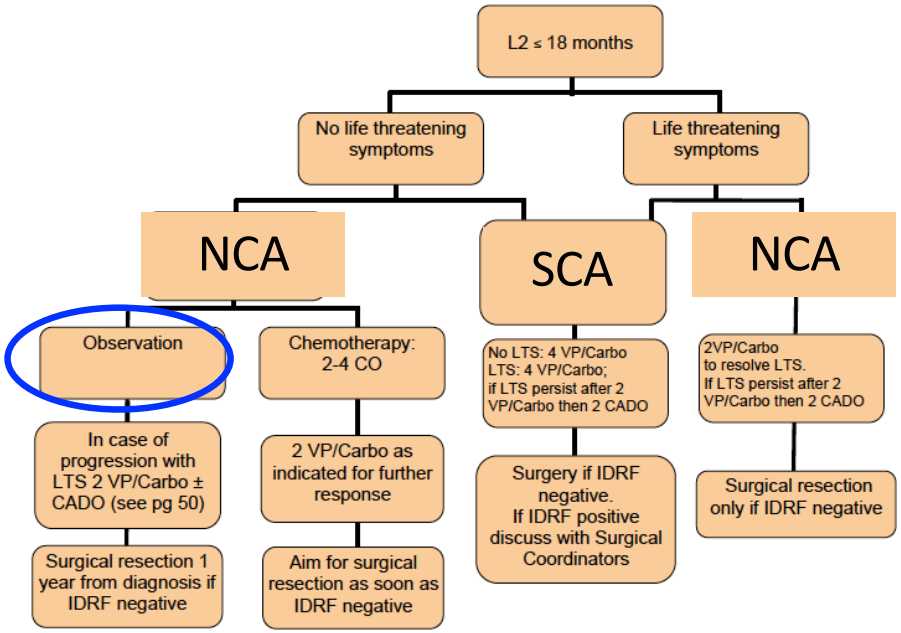
Low risk: Ms ≤ 12 months



No surgery

No surgery

Low risk: L2≤ 18 months



Surgery if IDRF negative ….if IDRF+, discussion with SIOPEN surgeon committee

Timing of surgery in all others situations

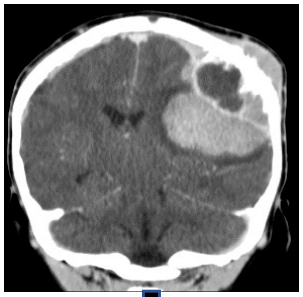
Localized L1 tumors
(MYCNA or not)

Localized L2 tumors

- 18 months
- < 18 months with LTS and/or SCA

High Risk NBL

- L2 MYCNA
- M > 18 months
- M > 12 < 18 months & SCA (SIOPEN)

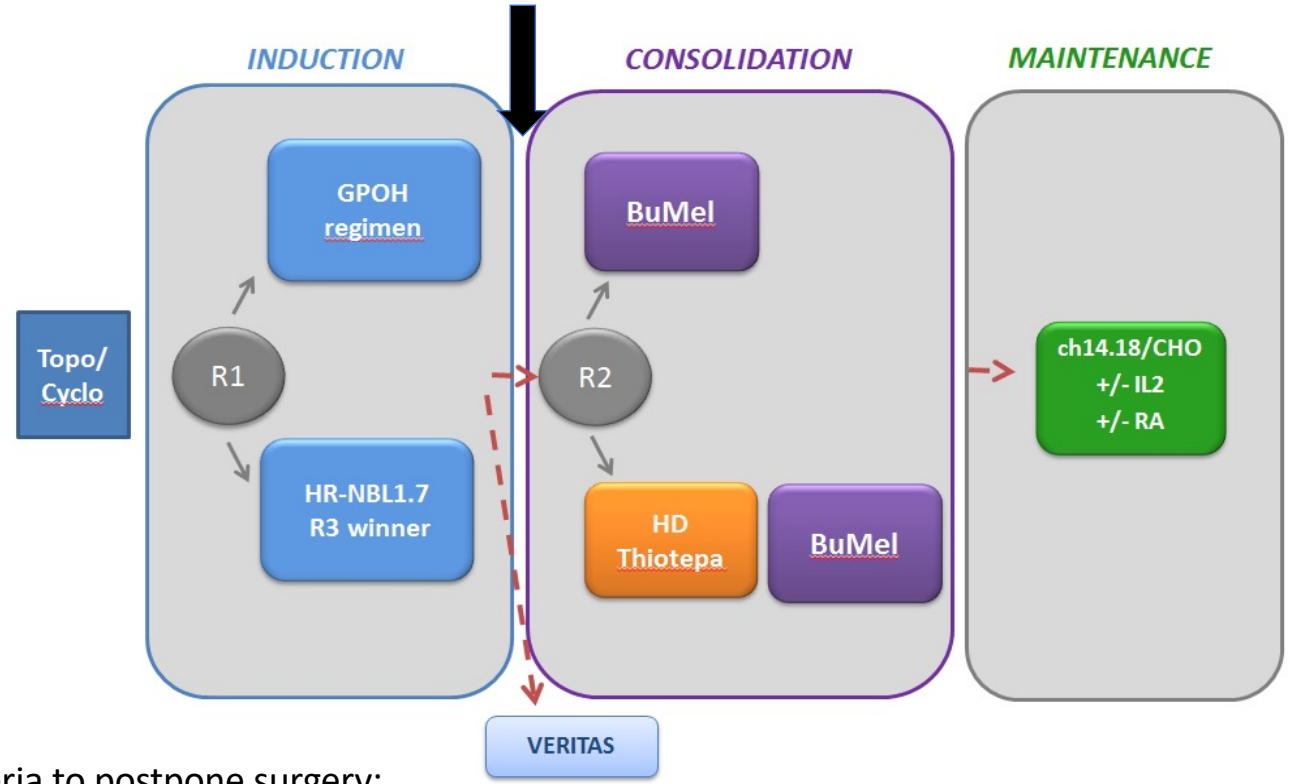


Adjuvant chemotherapy

Surgery

Post-op treatment according to risk group

HR-NBL2 design: timing of surgery



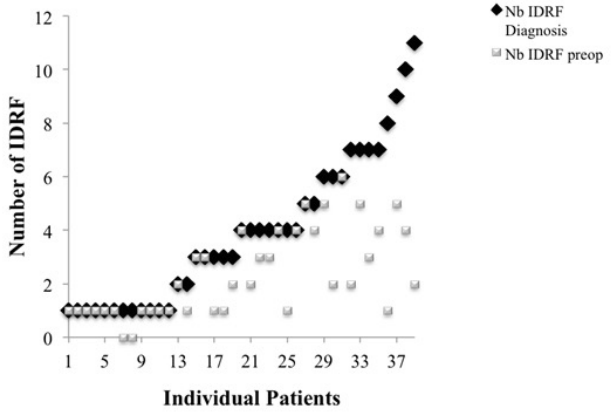
Criteria to postpone surgery:

- Encasement of celiac axis AND/OR
- Encasement of superior mesenteric artery AND/OR
- Encasement of both renal pedicles

What could the surgeon expect from neoadjuvant chemotherapy ?

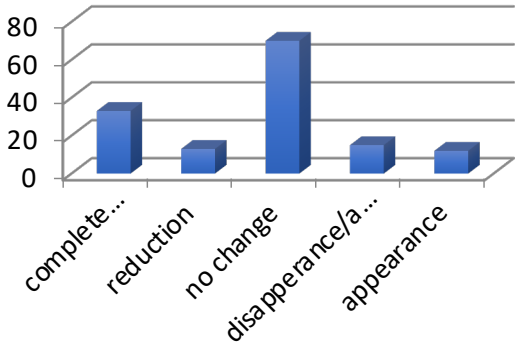
- 39 patients,
- Mean age at dg: 30 months
- INRGSS: L2= 13, M= 25, Ms= 1

143 children > 1 year age with unresectable (L2) localized NB w/o MYCNA



Factors influencing IDRFs evolution

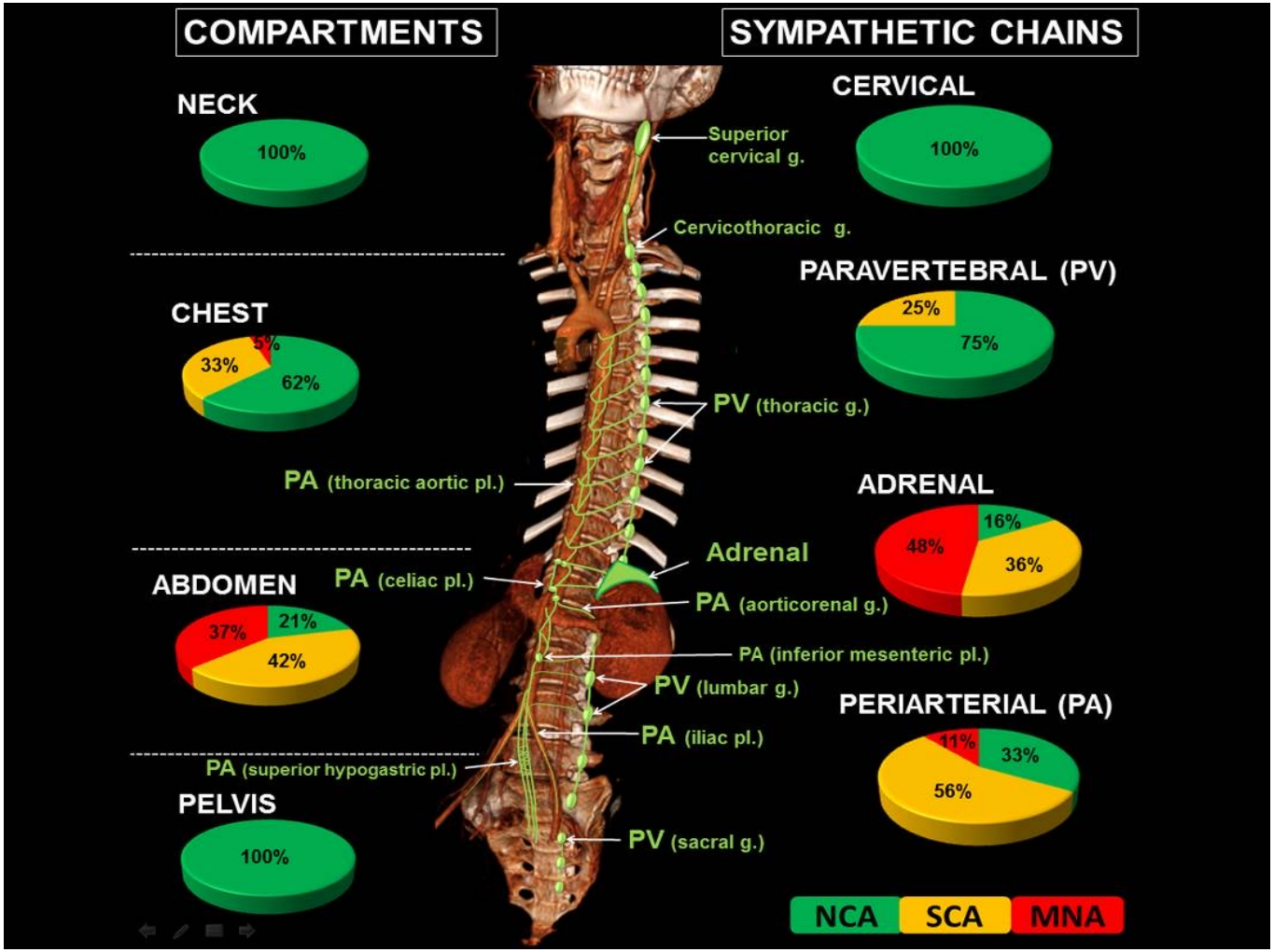
- Number of IDRFs at diagnosis
- Decrease in tumor volume
- Metastatic status
- Type of IDRF (vascular, infiltrative, extensive, neurological)



60%- 70% of IDRFs remain after chemo

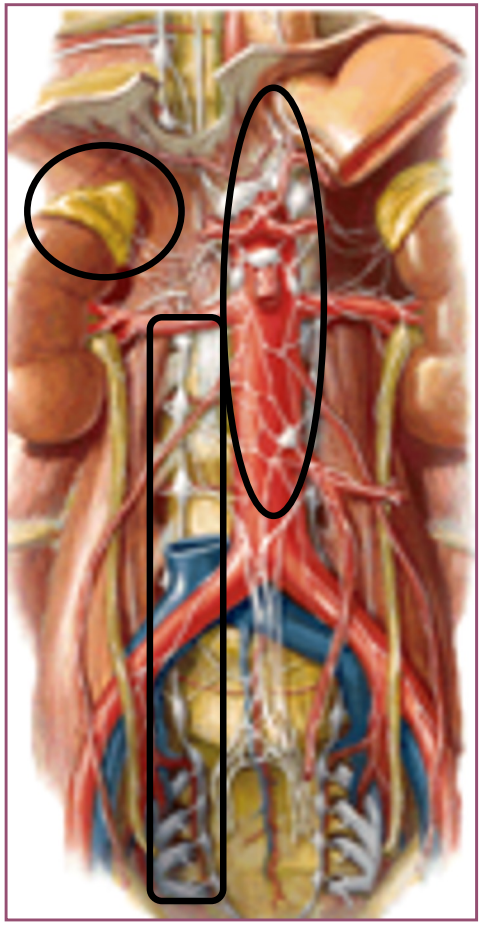
Irtan S et al, PBC 2015
Avanzini S et al, PBC 2017

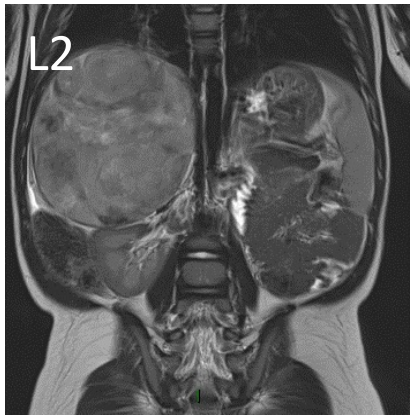
Surgical challenges of neuroblastoma surgery

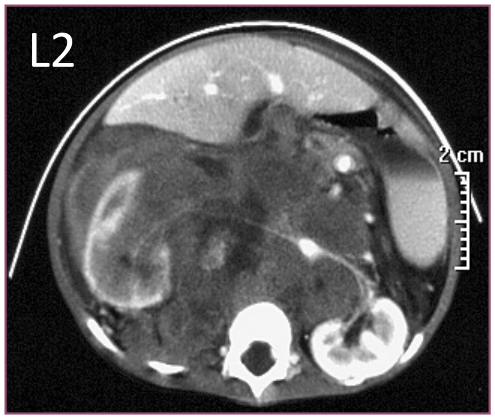


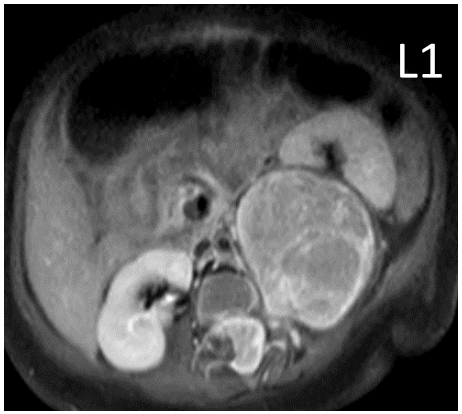
Brisse HJ et al, PlosOne 2017

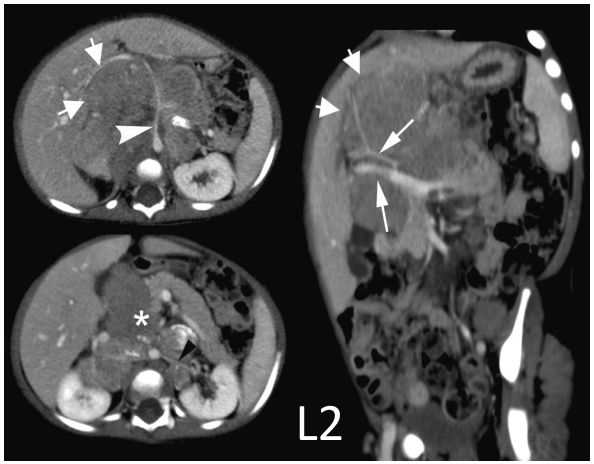
Abdominal -Pelvic NBL

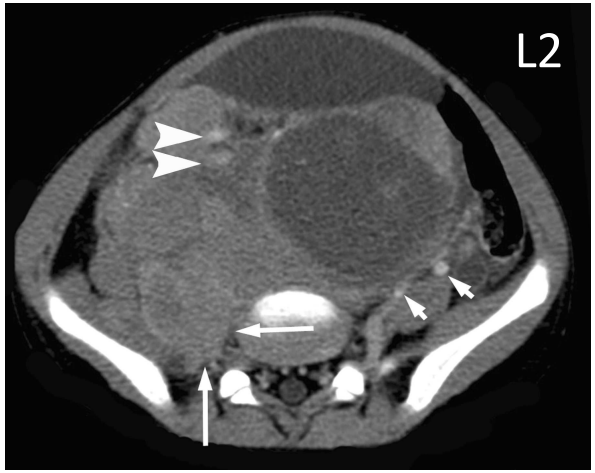




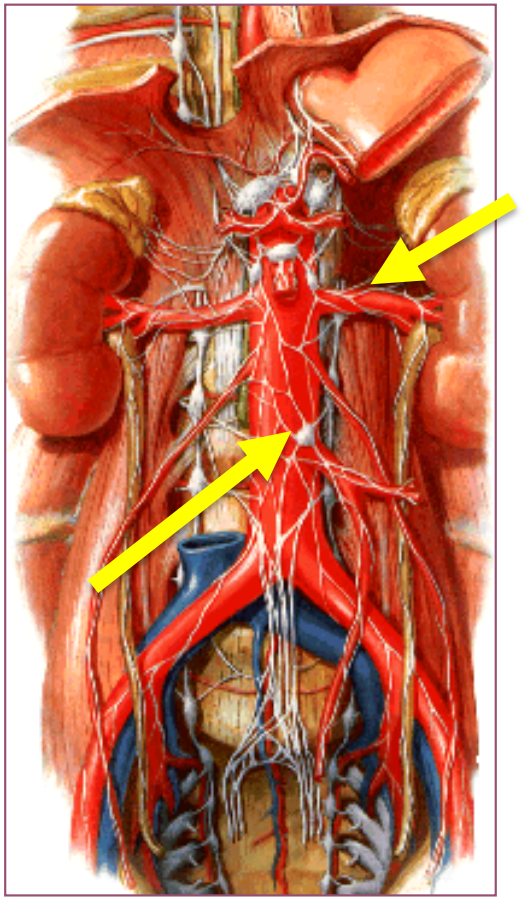


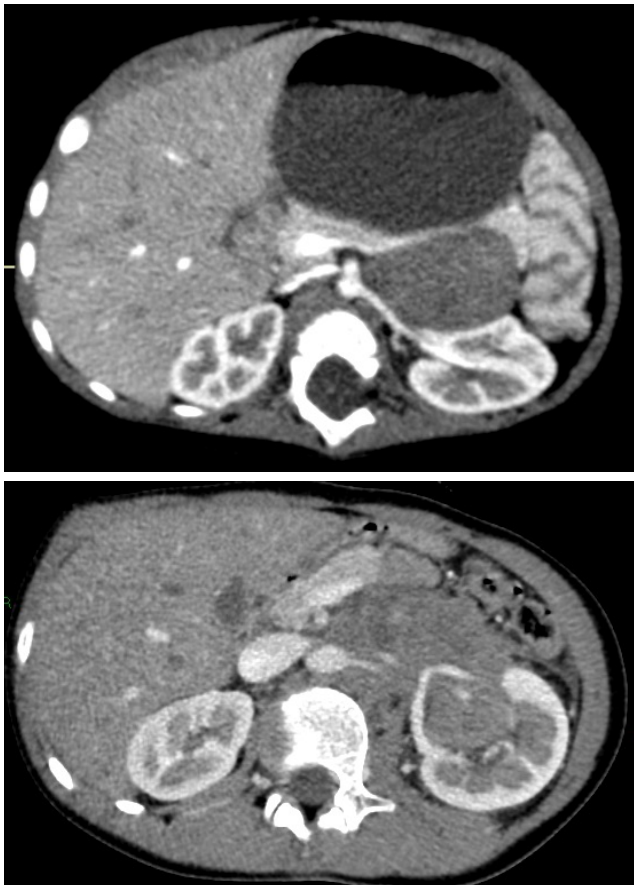




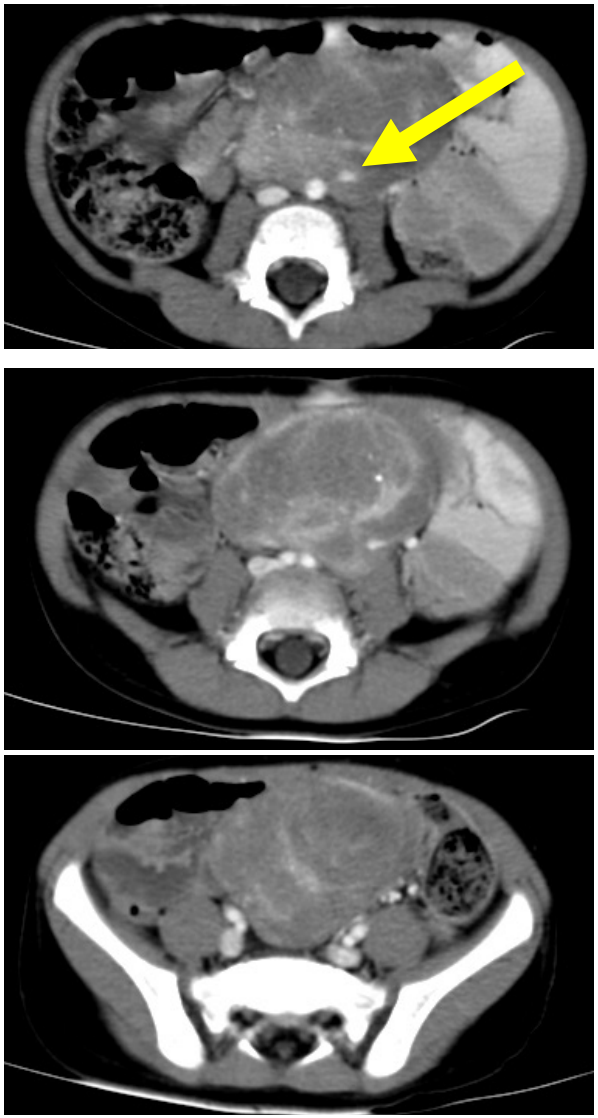


Other abdominal locations

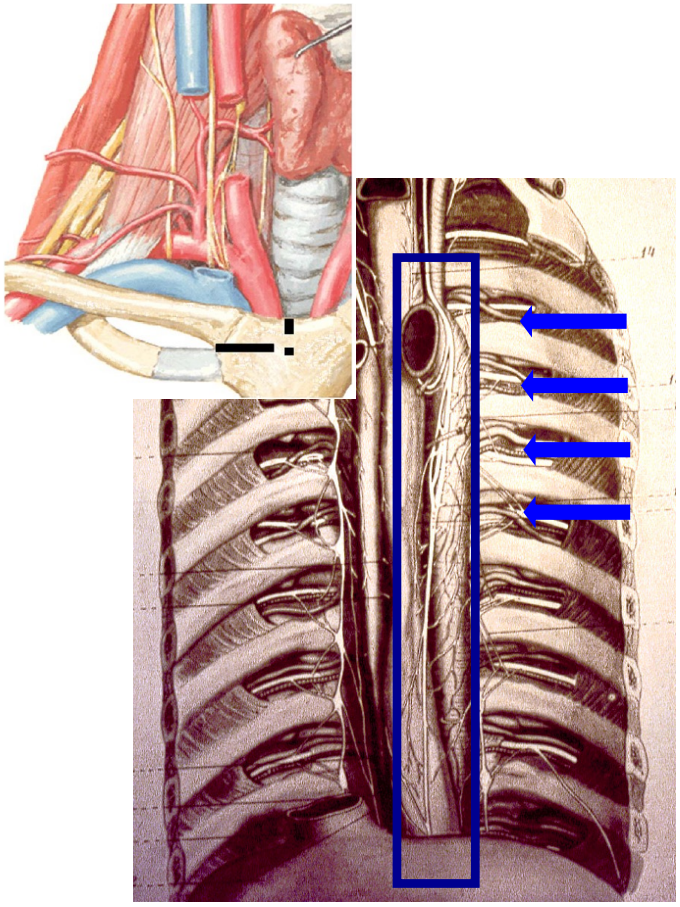


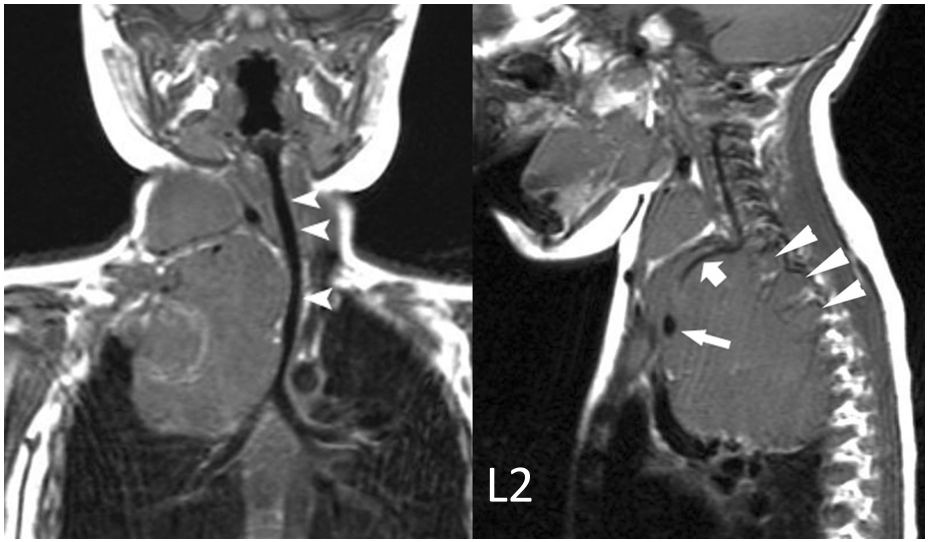


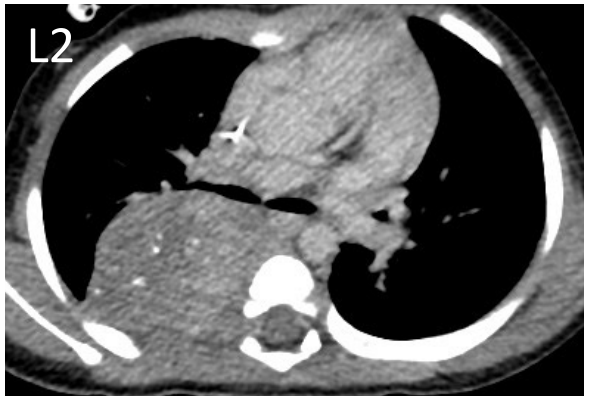
High risk of nephrectomy

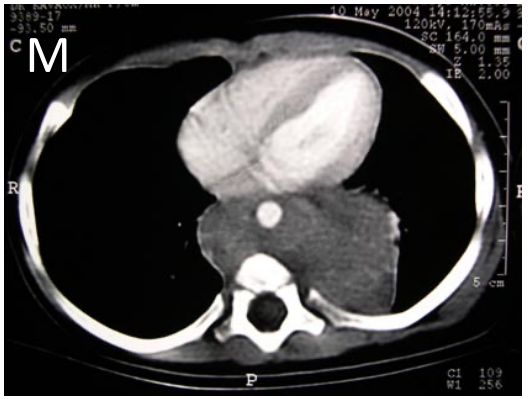


Cervical – Thoracic NBLs





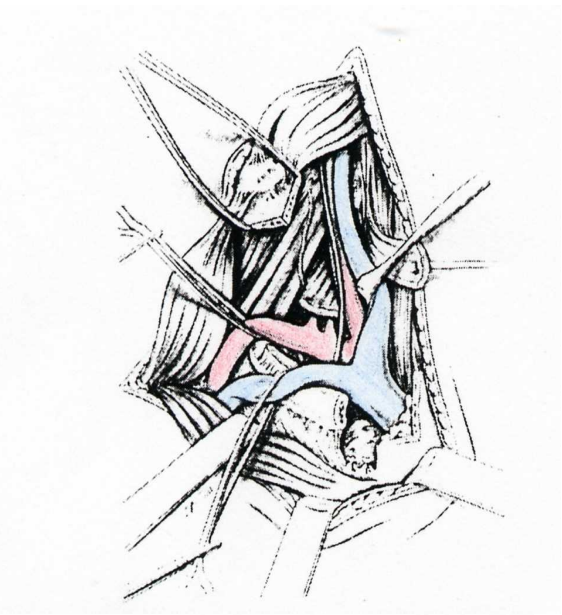


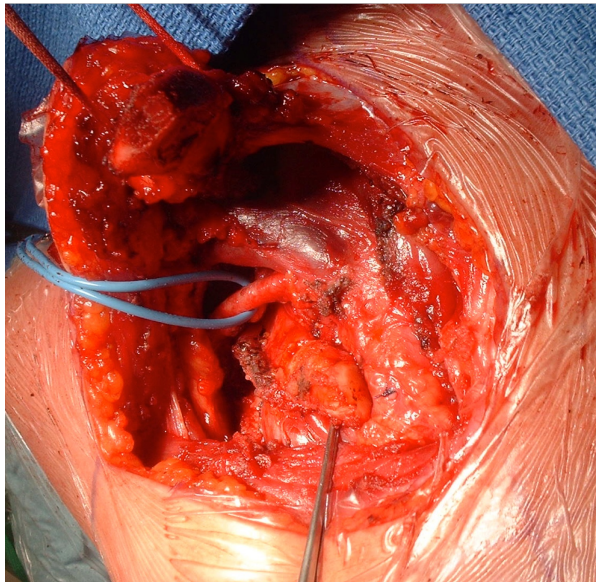


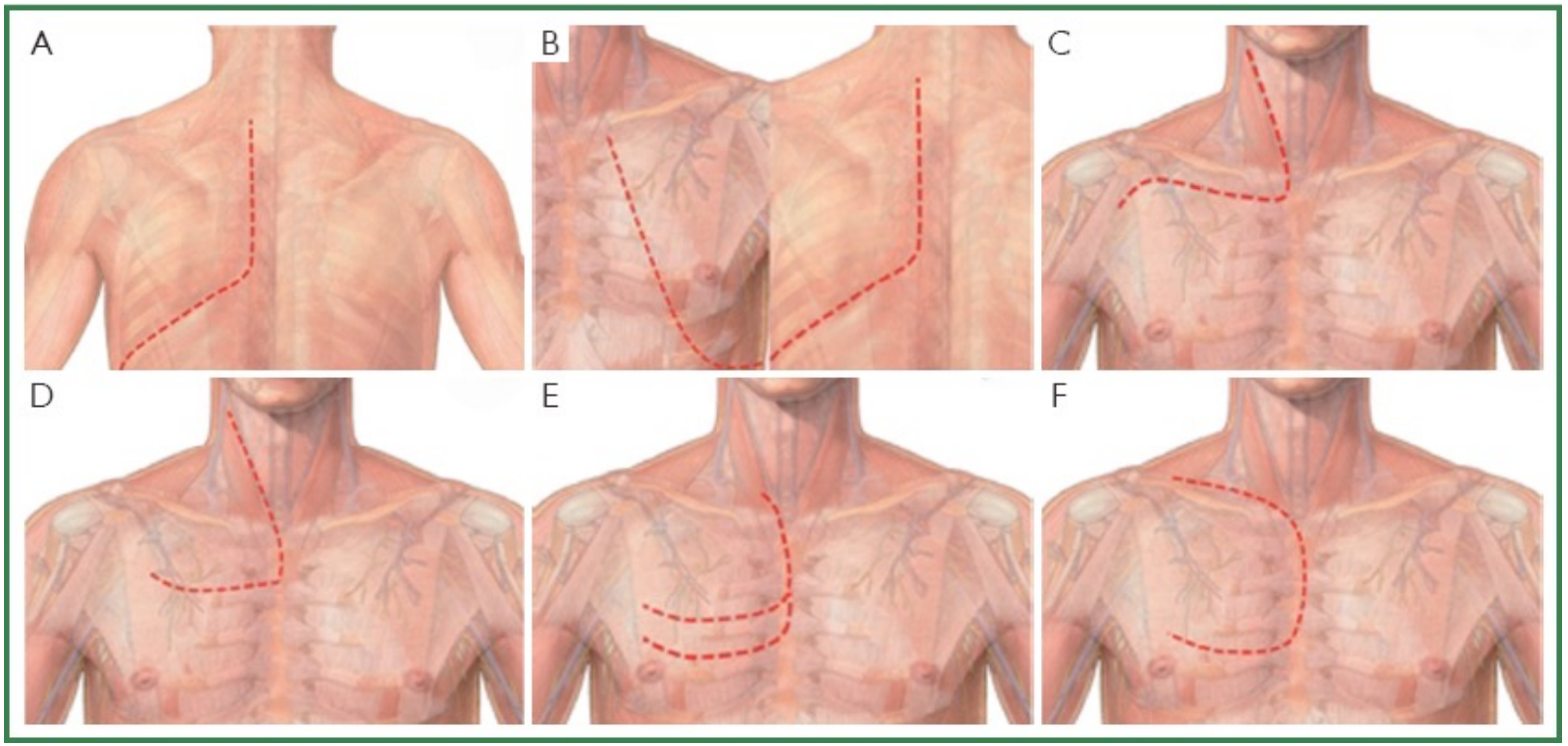
The transmanubrial approach: A new operative approach to cervicothoracic neuroblastoma in children

Frédérique Sauvat, MD,[a] Hervé Brisse, MD,[b] Pierre Magdeleinat, MD,[c] Manuel Lopez, MD,[a] Pascale Philippe-Chomette, MD,[d] Daniel Orbach, MD,[b] Isabelle Aerts, MD,[b] Laurence Brugieres, MD,[c] Yann Revillon, MD,[a] *and* Sabine Sarnacki, MD, PhD,[a]
Paris and Villejuif, France

Grunenwald D et al, Ann Thorac Surg 1997
El Madi A et al, PBC 2017
Sauvat F et al, Surgery 2006

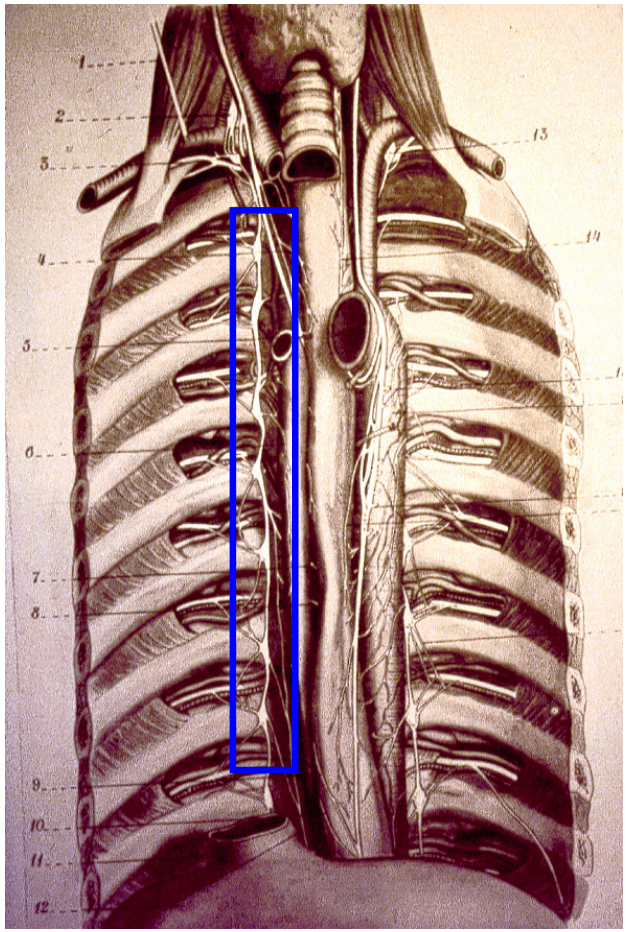


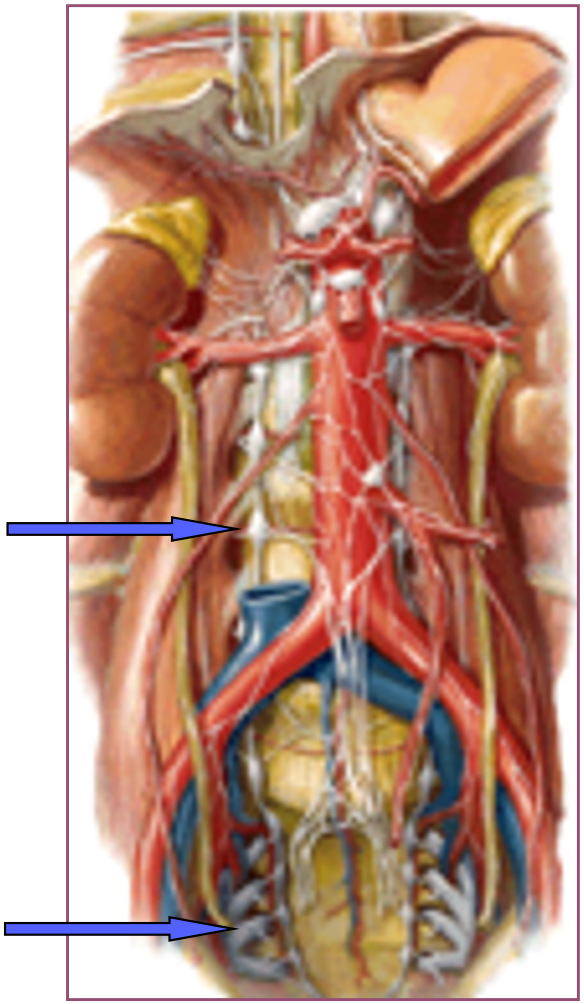


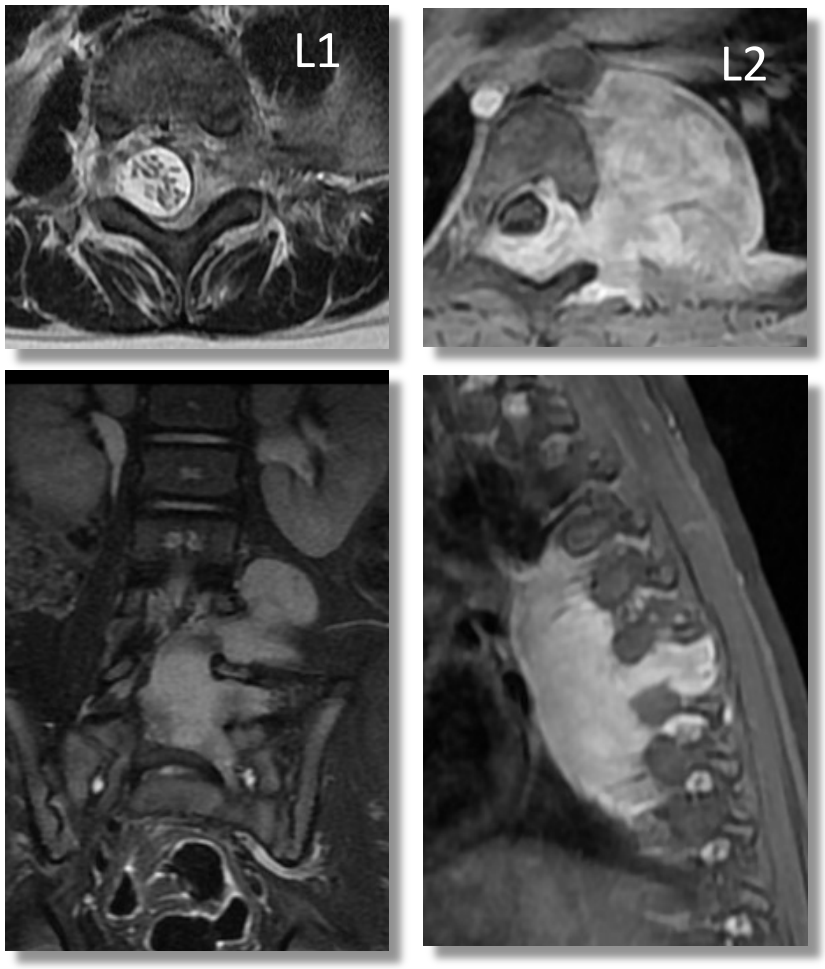


Foroulis CN et al, J Thorac Disease 2013

Paravertebral NBL : risk of spinal canal extension







Dumbell NBL

1. Neurological impairment

- chemotherapy + steroid in emergency
- Neurosurgery only if neurological symptoms does not resolve

2. No neurological impairment

- Primary chemotherapy if IDRF + (> 1/3 extension in the spinal canal in the axial plane)
- Surgery of the extraspinal component if IDRF -

Plantaz D et al, Cancer 1996
De Bernardi B et al, JCO 2001
De Bernardi B et al, Pediatr Blood & Cancer 2014
Kraal K et al, Pediatr Blood & Cancer 2016
Trahair T et al, J Pediatr. 2017
L.Pio et al, Pediatr Blood & Cancer 2019

Role of surgery in Neuroblastomas

- High Risk
  - Pro:
  - La Quaglia MP et al, Stage 4 neuroblastoma diagnosed at more than 1 year of age: gross total resection and clinical outcome. J Pediatr Surg 1994
  - La Quaglia M.P. The role of Primary Tumor resection in Neuroblastoma: When and How Much? Ped Blood Cancer, 2015
  - Englum B.R. et al. Value of surgical resection in children with high risk neuroblasoma. Ped Blood Cancer. 2015
  - Von Allmen D et al: Impact of Extent of Resection on Local Control and Survival in Patients From the COG A3973 Study With High-Risk Neuroblastoma, JCO 2017
  - Holmes K et al: Influence of surgical exicision on the survival of patients with 4 HR NBL: a report from the HR-NBL1/SIOPEN study, JCO 2020
  - Contra:
  - Losty P.D.et al. Does aggressive surgical resection improve Survival in Advanced Stage 3 and 4 Neuroblastoma? A Systematic review and meta-analysis. Ped Hemat Onco, 2014
  - Simon T. et al Role of surgery in the treatment of patients with stage 4 neuroblastoma age 18 months or older at diagnosis. J Clin Onco 2013
- Localized
  - De Bernardi et al. Treatment of localised resectable neuroblastoma. Results of the LNESG1 study by the SIOP Europe Neuroblastoma Group. Br J Cancer 2008
  - Fischer J et al, Complete surgical resection improves outcome in INRG high-risk patients with localized neuroblastoma older than 18 months, BMC cancer 2017.

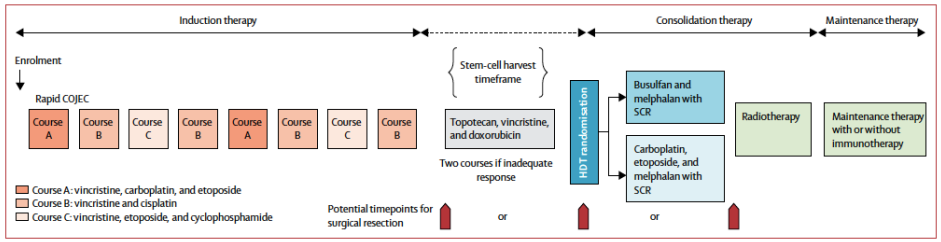
original reports

Influence of Surgical Excision on the Survival of Patients With Stage 4 High-Risk Neuroblastoma: A Report From the HR-NBL1/SIOPEN Study

Keith Holmes, ChM, DCH[1]; Ulrike Pötschger, MSc[2]; Andrew D. J. Pearson, MD[3]; Sabine Sarnacki, MD[4]; Giovanni Cecchetto, MD[5]; Javier Gomez-Chacon, MD[6]; Roly Squire, MBBS[7]; Enrique Freud, MD[8,9]; Adam Bysiek, PhD[10]; Lucas E. Matthyssens, MD[11]; Martin Metzelder, MD, PhD[12]; Tom Monclair, MD, PhD[13]; Jakob Stenman, MD, PhD[14]; Michal Rygl, PhD[15]; Lars Rasmussen, MD[16]; Jean-Marc Joseph, MD, PhD[17]; Sabine Irtan, MD, PhD[18] Stefano Avanzini, MD[19]; Jan Godzinski, MD, PhD[20]; Kristin Björnland, PhD[13,21]; Martin Elliott, MBChB, PhD[7]; Roberto Luksch, MD[22]; Victoria Castel, MD, PhD[6]; Shifra Ash, MD[8]; Walentyna Balwierz, MD, PhD[23]; Geneviève Laureys, PhD, MD[24]; Ellen Ruud, PhD[13,21]; Vassilios Papadakis, MD, PhD[25]; Josef Malis, MD[15]; Cormac Owens, MBBS[26]; Henrik Schroeder, MD, DrMedSci[27]; Maja Beck-Popovic, MD[17]; Toby Trahair, MBBS, PhD[28]; Ana Forjaz de Lacerda, MD, MSc[29]; Peter F. Ambros, PhD[2]; Mark N. Gaze, MD[30]; Kieran McHugh, MB, BCh[31]; Dominique Valteau-Couanet, MD, PhD[32]; and Ruth Lydia Ladenstein, MD, PhD[33] for the International Society of Paediatric Oncology Europe Neuroblastoma Group (SIOPEN)

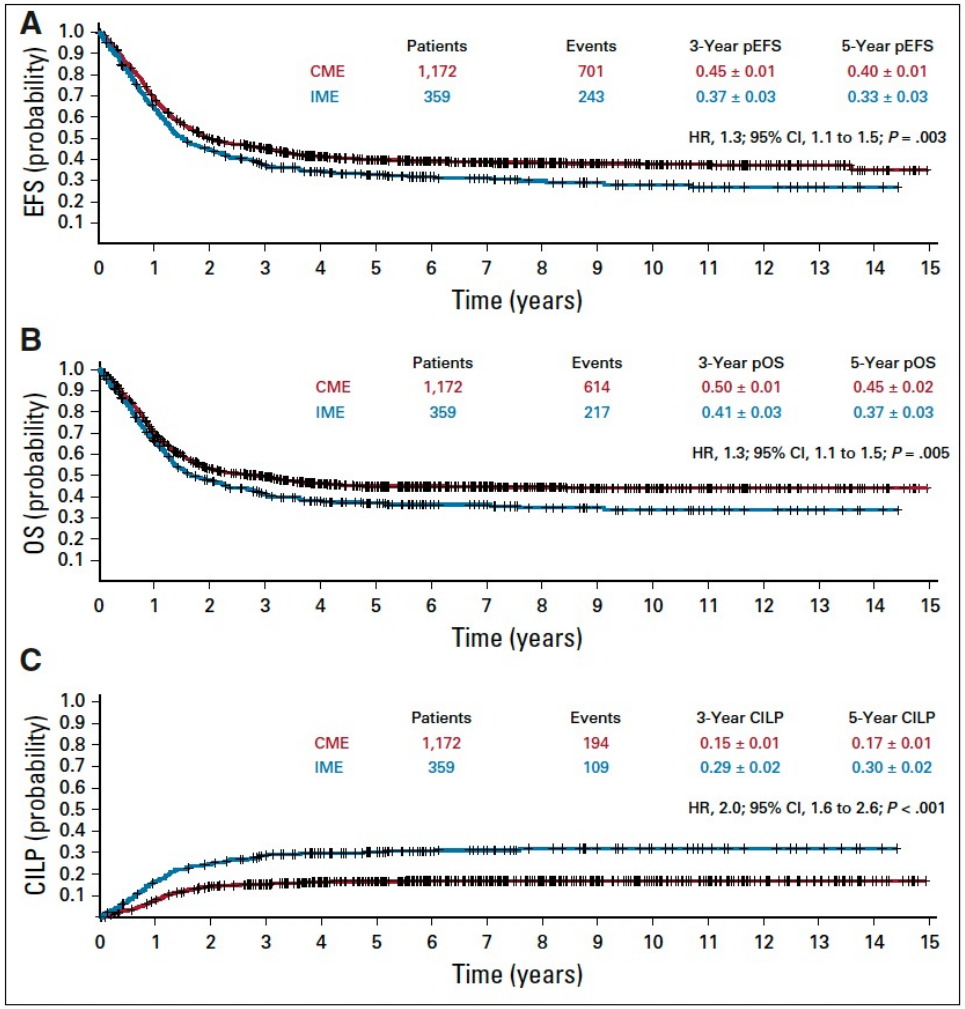
2002-2015

1531 patients



Quality of resection improved

EFS and OS in HR NBL



Contents lists available at ScienceDirect

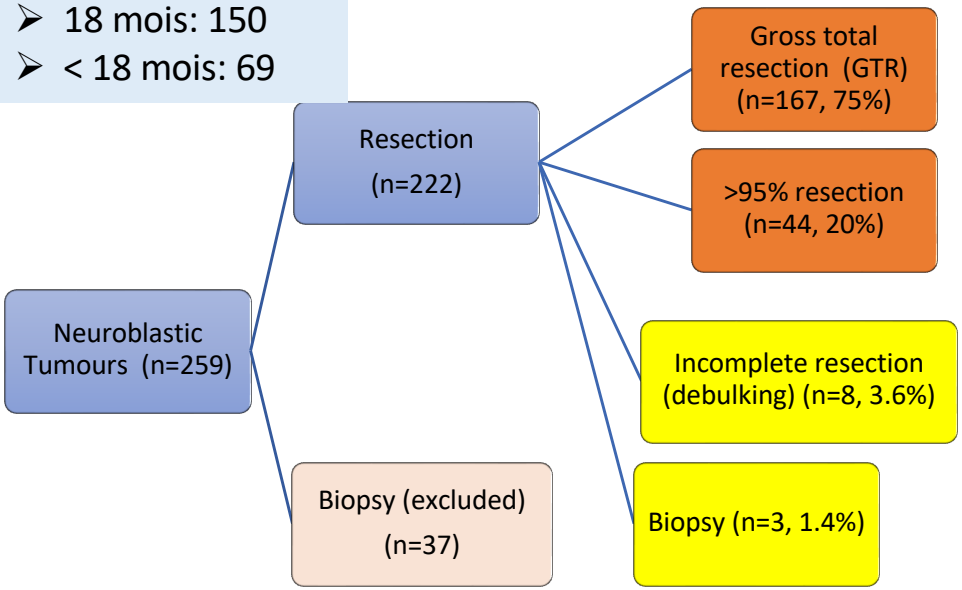
European Journal of Surgical Oncology

journal homepage: www.ejso.com

Minimally invasive surgery for neuroblastic tumours: A SIOPEN multicentre study: Proposal for guidelines

H.O. Gabra [a,*], S. Irtan [c], K. Cross [d], P. Lobos [e], A. Froeba-Pohl [t], L. Pio [b], C. Virgone [k], G. Guillén Burrieza [f], J. Gómez Chacón Villalba [g], G. Riccipetitoni [h], F. Guérin [i], M. Nightingale [j], Y. Heloury [j], S. Faraj [l], M. Leclair [l], A. Scalabre [m], G. Mattioli [n], S.W. Warmann [s], J. Fuchs [s], N. Basta [p], K. Bjørnland [q], L.E. Matthyssens [r], P.D. Losty [o], S. Sarnacki [b]

Median age 3 years
- 18 mois: 150
- < 18 mois: 69



Stage
L1: 114
L2: 40
M: 47
MS: 17
MYCN amplified: 26

Locations
Adrenal : 116
Abd non adrenal : 26
Thoracic: 77

Histology
Neuroblastoma 137
Ganglioneuroblastoma: 27
GGNB intermixed: 17
Ganglioneuroma: 38

Risk Group	Number	Conversion To open surgery		Gross total resection (GTR)		Recurrence		Complications	
		Unadjusted OR (95% CI)	P-value	Unadjusted OR (95% CI)	P-value	Unadjusted OR (95% CI)	P-value	Unadjusted OR (95% CI)	P-value
Age group									
<18 months	71	–		–					
>18 months	151	3.5 (1–12)	0.051	1.1 (0.6–2.1)	0.84	2.0 (0.8–5.2)	0.14	0.9 (0.3–2.3)	0.762
Sex									
Males	110	–		–					
Females	110	0.9 (0.4–2.6)	0.86	1.6 (0.8–2.9)	0.16	0.6 (0.3–1.3)	0.17	1.0 (0.4–2.5)	1.0
Weight in Kgs	162	0.97 (0.9–1.0)	0.18	1.0 (0.9–1.0)	0.33	1.0 (0.9–1.0)	0.502	1.0 (0.9–1.0)	0.63
INRG staging									
L1	114	–		–					
L2	41	3.7 (1.3–10.5)	0.01*	3.6 (1.7–7.8)	0.001*	2.4 (0.6–9.2)	0.22	3.7 (1.3–10.5)	0.01*
M	49	1.5 (0.47–4.9)	0.4	1.4 (0.6–3.0)	0.45	15.6 (5.4–45.1)	<0.001*	0.9 (0.2–3.4)	0.84
MS	18	0.8 (0.09–6.6)	0.8	0.5 (0.1–2.4)	0.41	2.9 (0.5–16.3)	0.22	–	–
IDRF									
One IDRF	163	–		–					
>1 IDRF	59	2.9 (1.2–7.0)	0.018*	2.3 (1.2–4.4)	0.01*	2.2 (1.0–4.9)	0.044*	3.1 (1.2–7.8)	0.02*
Histology									
GNBL&GN	82	–		–					
Neuroblastoma	140	0.6 (0.3–1.4)	0.25	0.9 (0.5–1.7)	0.83	6.7 (2.0–22.8)	0.002*	0.4 (0.2–0.9)	0.03*
***MYCN* status**									
Non-*MYCNA*	195	–		–					
MYCNA	27	1.6 (0.5–5.2)	0.42	0.3 (1.0–1.18)	0.09	3.1 (1.2–7.9)	0.017*	1.3 (0.4–4.8)	0.7
Risk group									
Low & Int	172	–		–					
High	50	1.6 (0.6–4.1)	0.34	1.0 (0.5–2.0)	0.96	8.4 (3.7–19.1)	<0.001*	0.5 (0.2–1.9)	0.34
Total Volume									
<50 ml	167	–		–					
>50 ml	55	2.1 (0.9–5.3)	0.098	1.5 (0.8–3.0)	0.23	1.5 (0.7–3.5)	0.32	2.0 (0.8–5.2)	0.14
Total volume									
<60 ml	175	–		–					
>60 ml	47	2.7 (1.1–6.8)	0.031*	1.6 (0.8–3.2)	0.20	2.0 (0.8–4.5)	0.12	2.6 (1.0–6.6)	0.052
Total volume									
<75 ml	181	–		–					
>75 ml	41	2.7 (1.1–6.8)	0.039*	1.8 (0.9–3.7)	0.13	2.0(0.8–4.8)	0.11	3.1 (1.2–8.2)	0.02*
Total Volume									
<100 ml	190	–		–		–			
>100 ml	32	3.9 (1.5–10.1)	0.005*	1.7 (0.8–3.9)	0.18	1.9 (0.7–4.9)	0.18	4.5 (1.7–12.1)	0.002*
Anatomical Compartment									
Abdominal	144	–		–		–		–	
Thoracic	78	1.8 (0.8–4.3)	0.183	0.24 (0.13–0.46)	0.000*	0.60 (0.25–1.42)	0.25	5.4 (2.0–14.8)	0.001*

Risk factors in multivariate analysis

- Conversion

> 1IDRF & vol > 100ml

- GTR

L2 & MYCA

- Recurrence

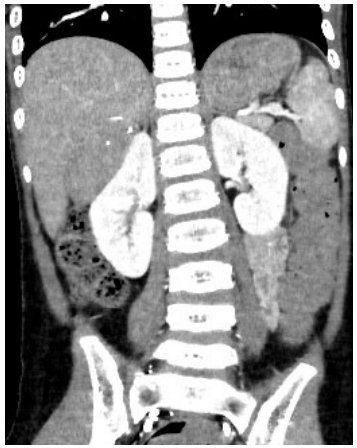
M

Complications

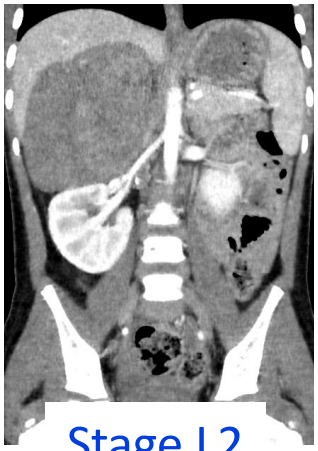
L2 & vol > 100ml

Gabra H et al, EJSO 2021

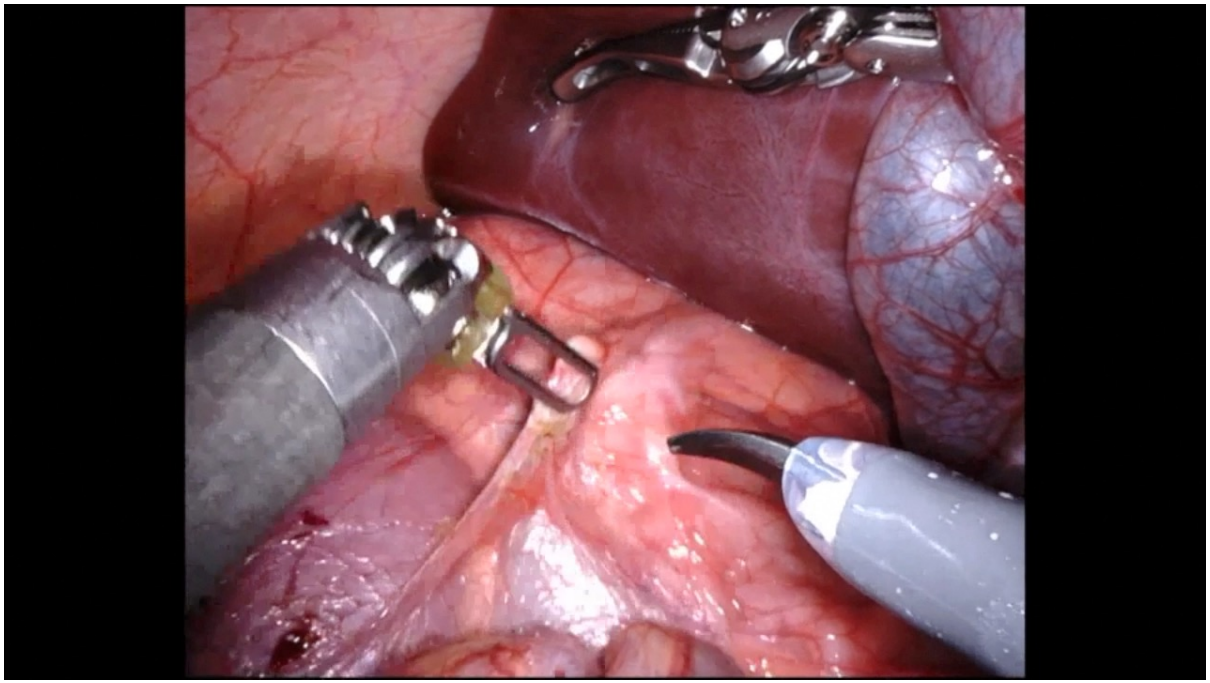
Indications of MIS: L1 tumors +/- some L2



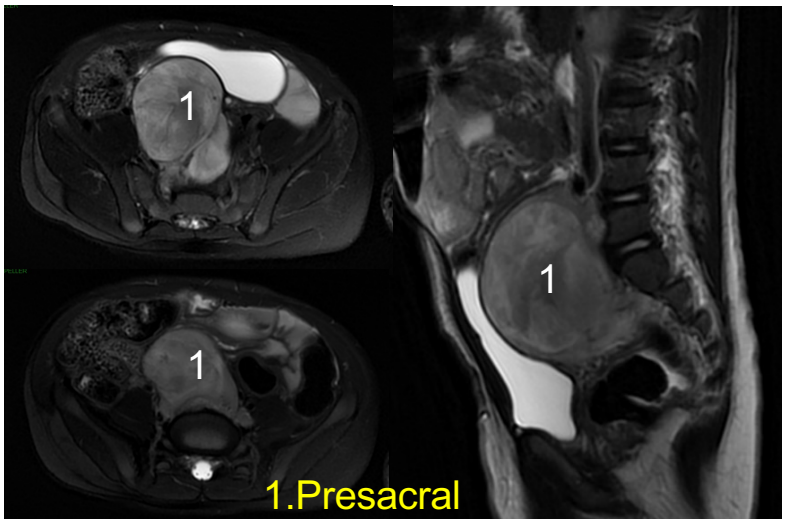
Stage L1

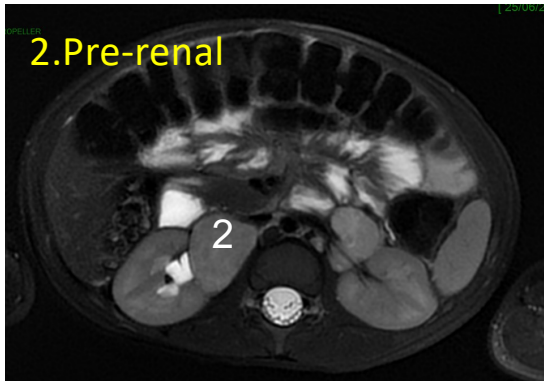


Stage L2



Multifocal ganglioneuroma in a 5 years old girl

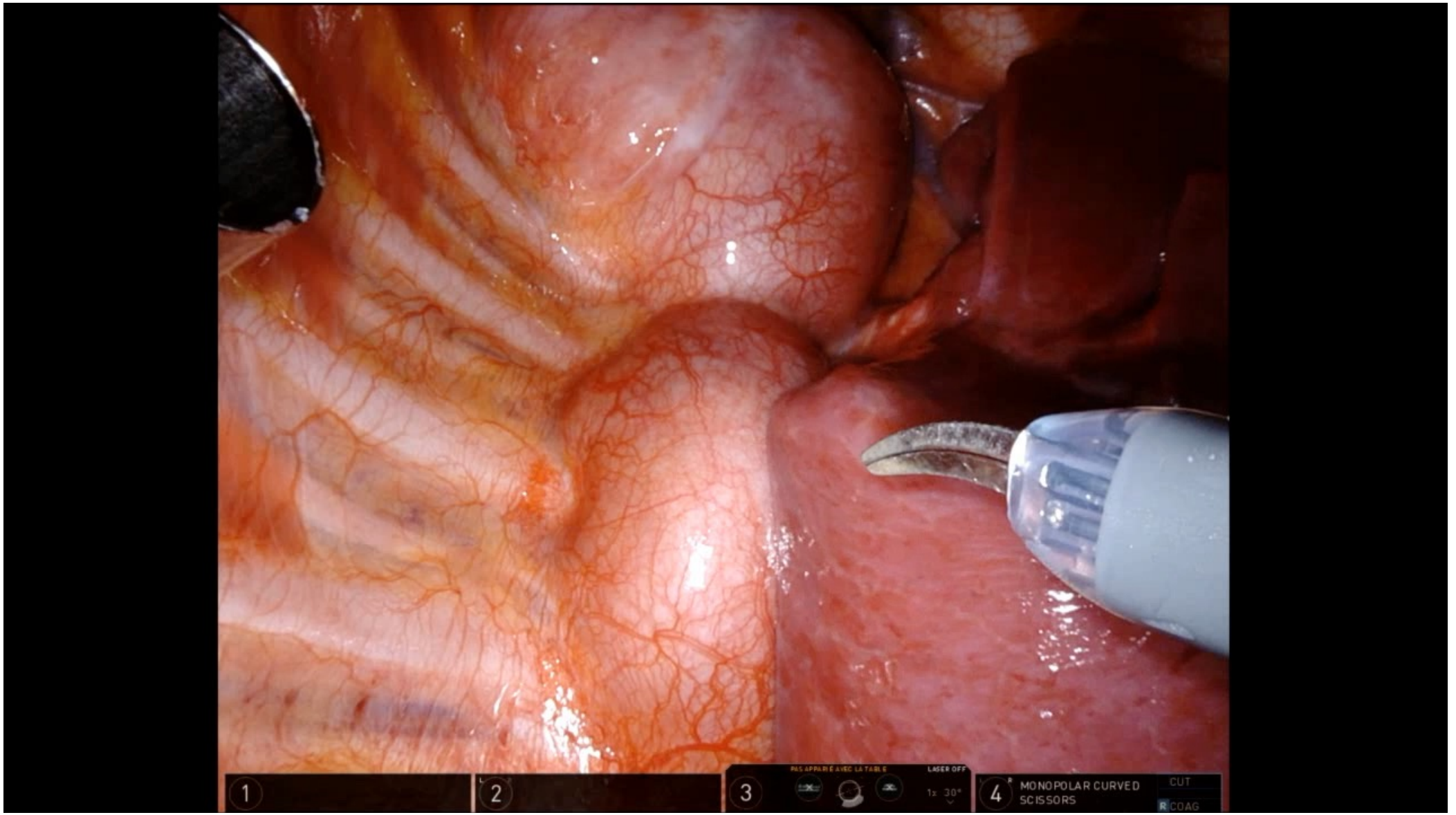




3 & 4 : Thoracoscopic robot-assisted

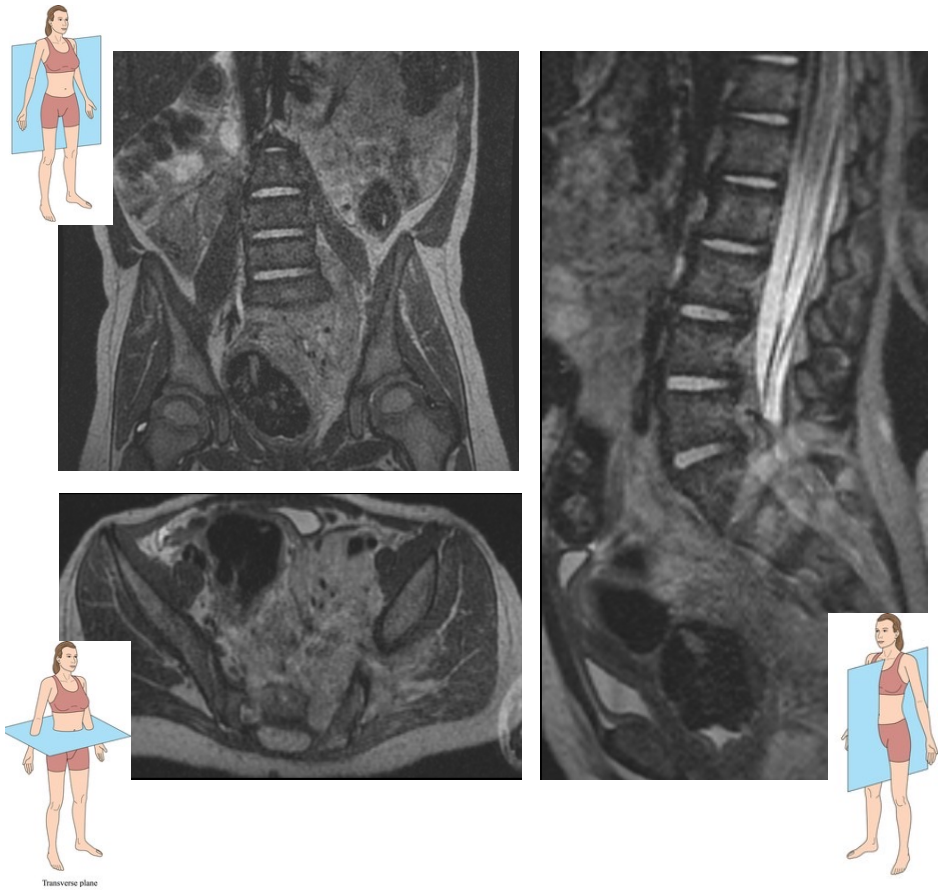
5:Thoracotomy

1 & 2 laparoscopic robot-assisted

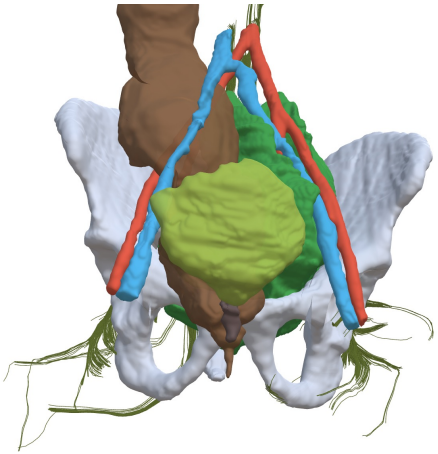

1
2
PAS APPARIÉ AVEC LA TABLE
LASER OFF
3
1x 30°
4
MONOPOLAR CURVED SCISSORS
CUT
R COAG

Petite fille de 3 ans

Neuroblastome pelvien localisé, biologie favorable



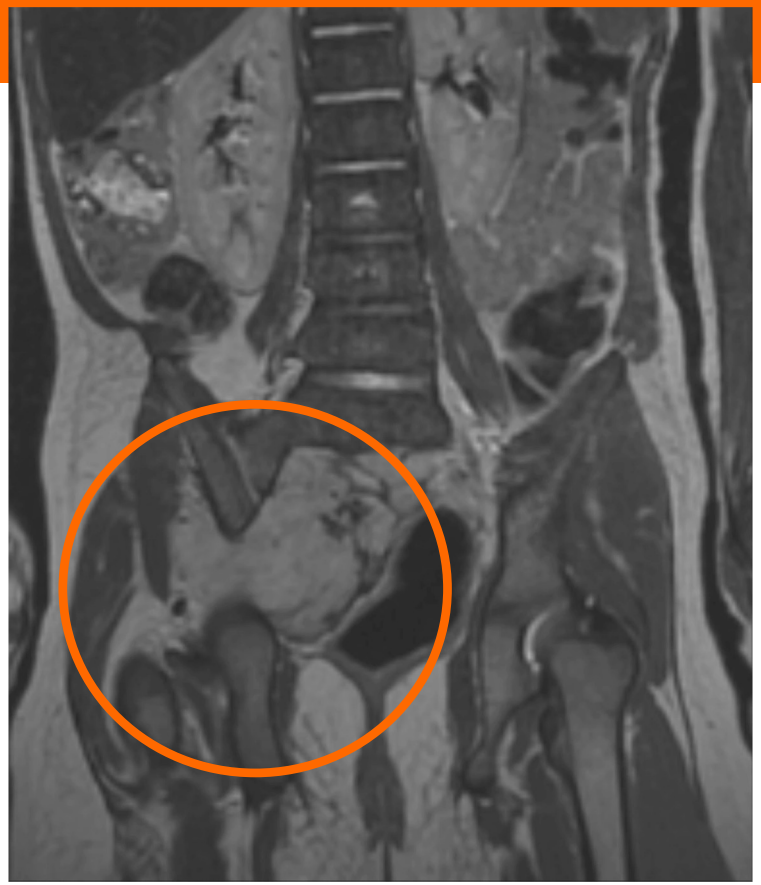
Vue antéropostérieure

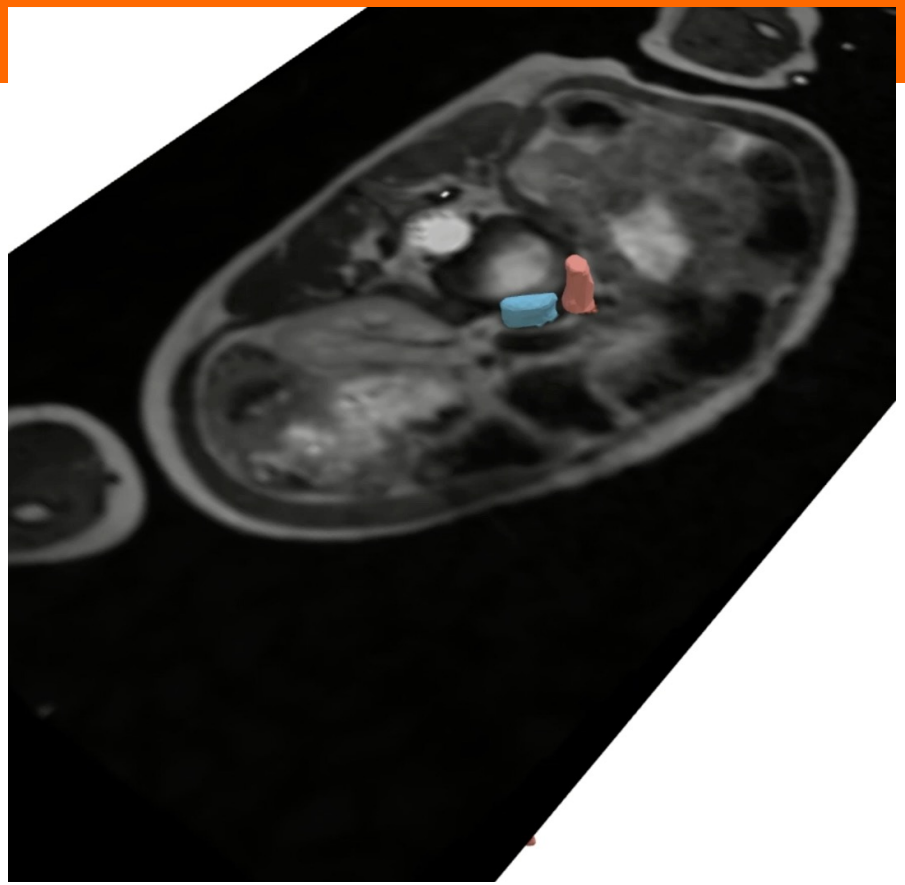


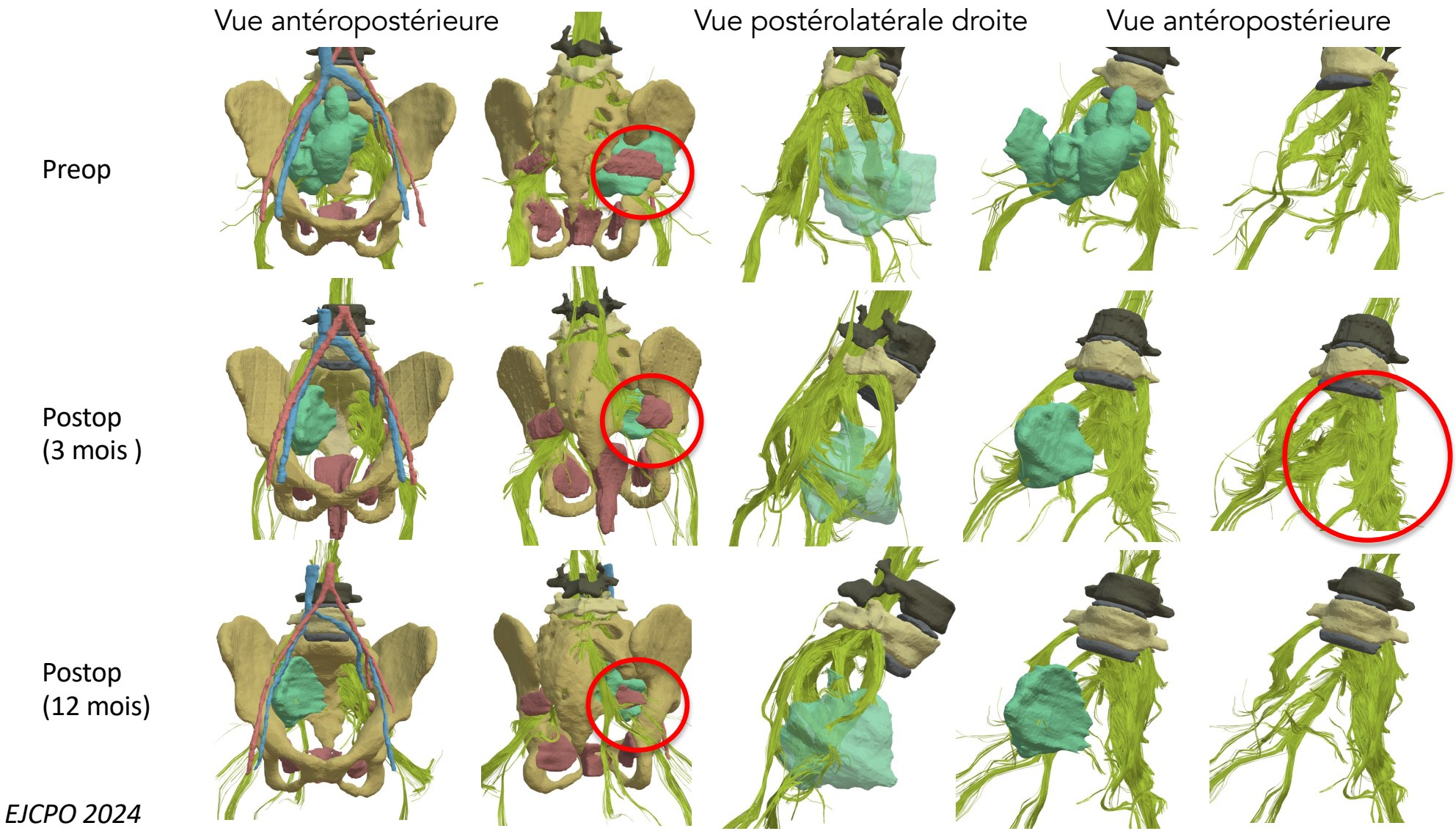
Vue latérale gauche

Vue postérieure gauche

Vue antéropostérieure

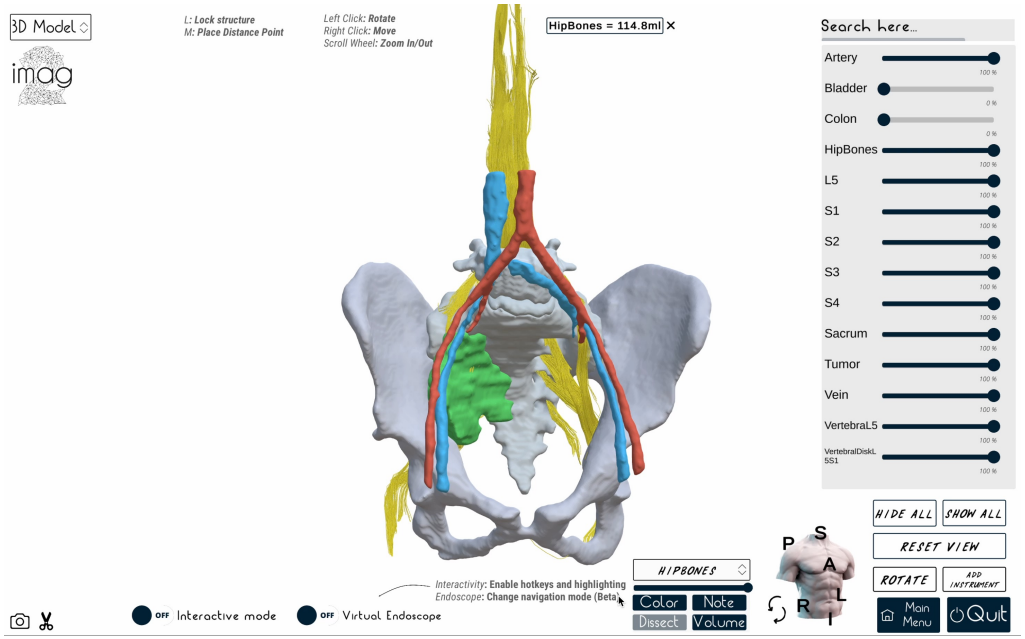


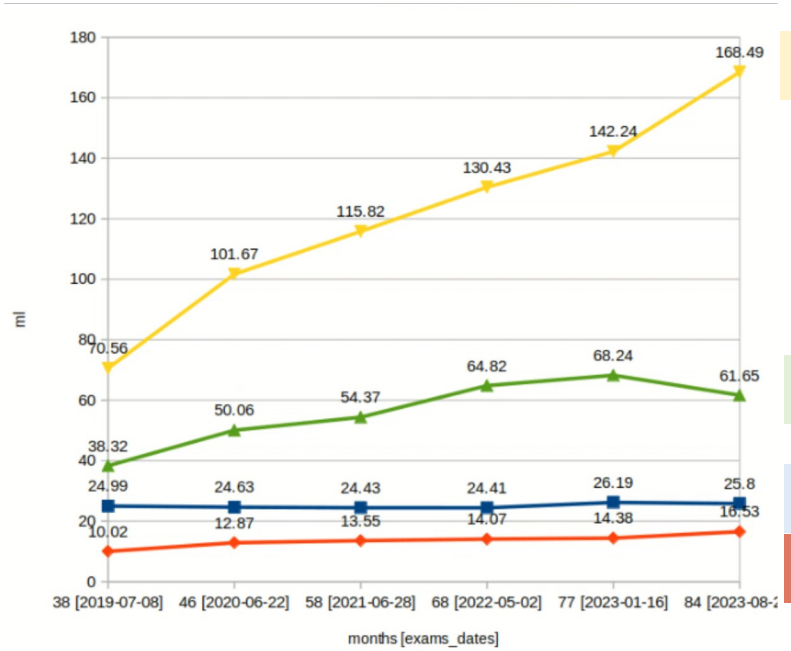



Vue antéropostérieure
Vue postérolatérale droite
Vue antéropostérieure
Preop
Postop
(3 mois)
Postop
(12 mois)

EJCPO 2024

Suivi après la chirurgie





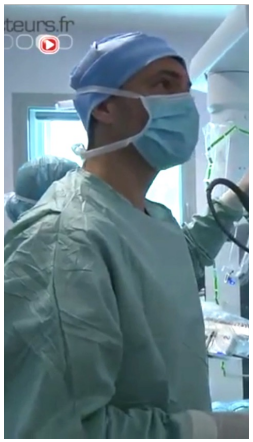
bassin

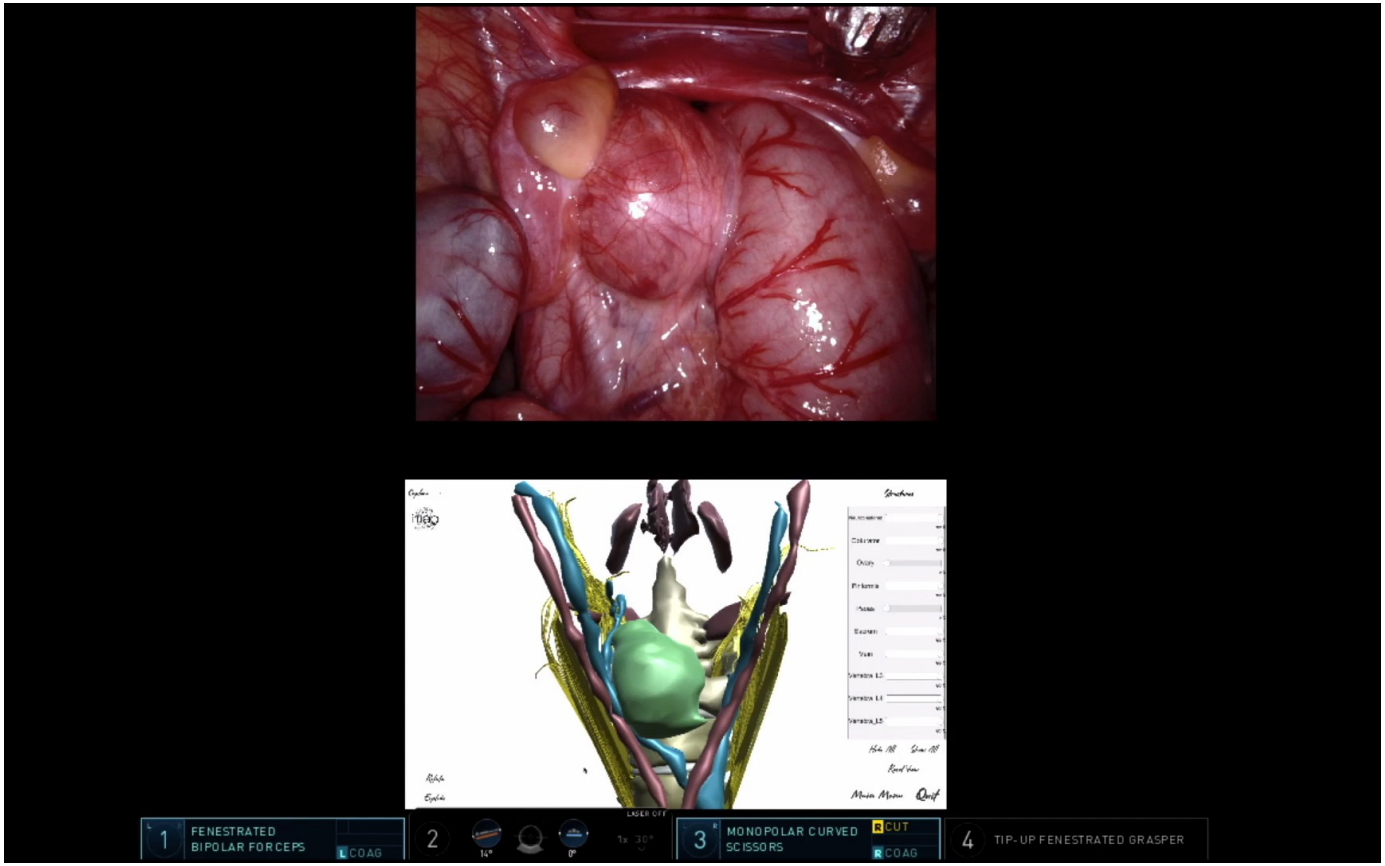
sacrum

tumeur

L5

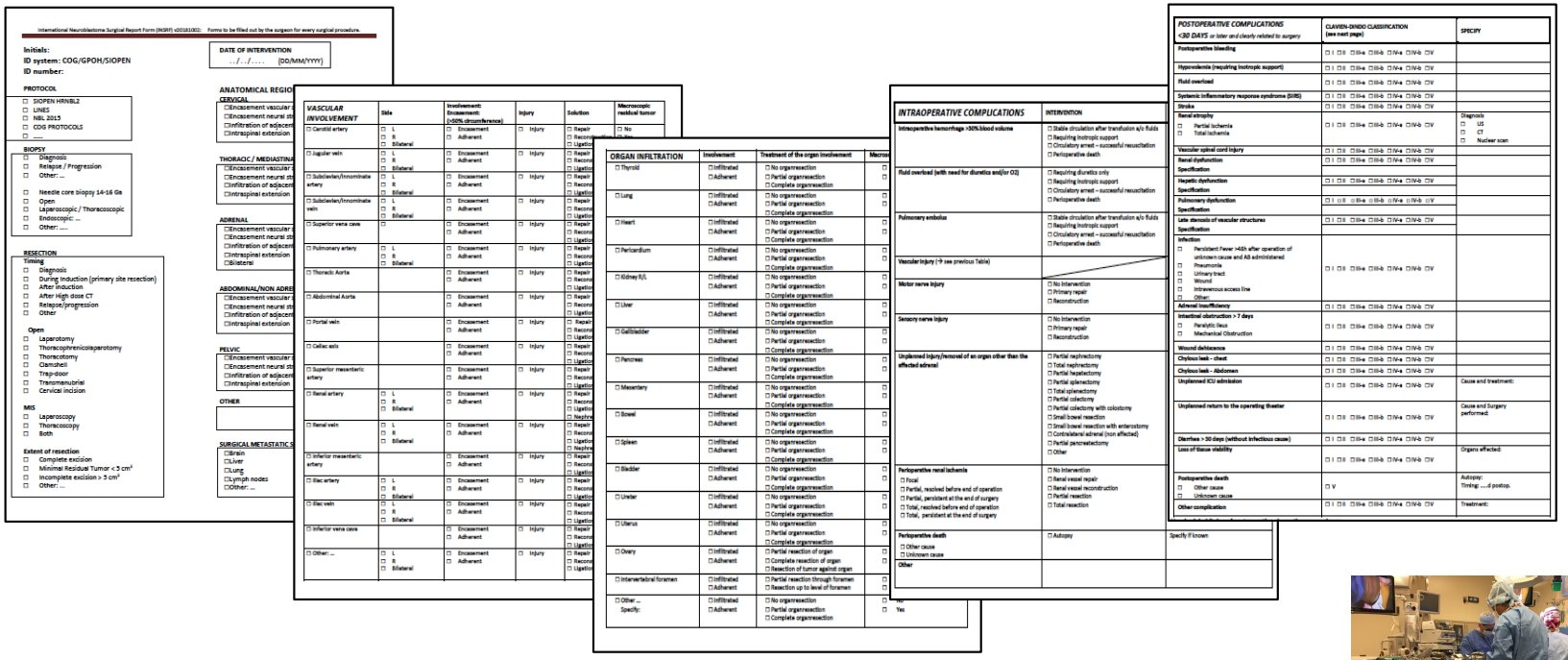
La chirurgie guidée par l’image





The International Neuroblastoma Surgical Report Form (INSRF)

Matthyssens L et al, Ann Surg 2020



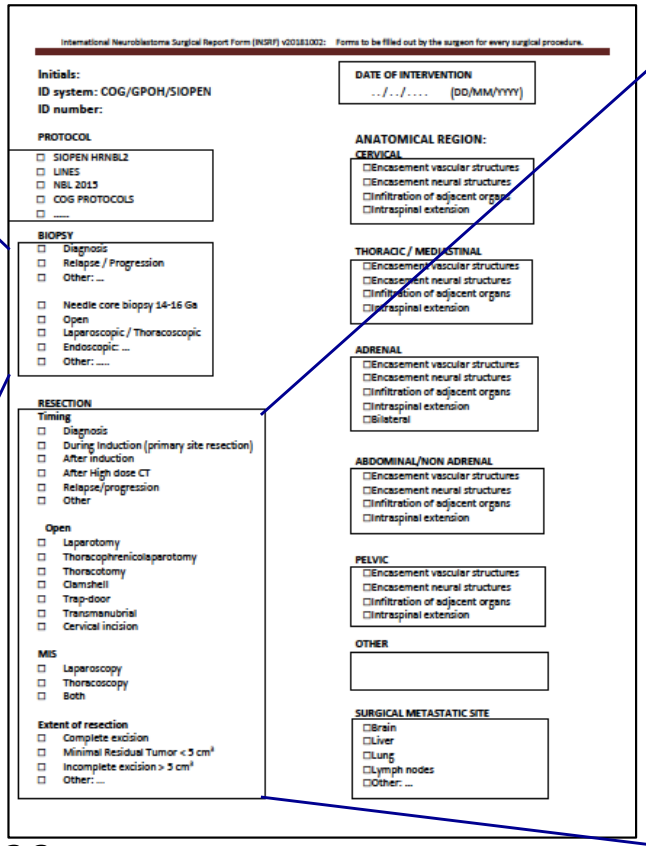
To be integrated in each protocol database, ***filled by the surgeon***

One SRF for every surgical procedure (including biopsy)

BIOPSY

- ❑ Diagnosis
- ❑ Relapse /Progression
- ❑ Other:…

- ❑ Needle cor biopsy 14-16 Ga
- ❑ Open
- ❑ Laparoscopic / Thoracoscopic
- ❑ Endoscopic
- ❑ Other: ….



International Neuroblastoma Surgical Report Form (INSRF) v20181002: Forms to be filled out by the surgeon for every surgical procedure.

Initials:
ID system: COG/GPOH/SIOPEN
ID number:

DATE OF INTERVENTION
../../.... (DD/MM/YYYY)

PROTOCOL
☐ SIOPEN HRNBL2
☐ LINES
☐ NBL 2015
☐ COG PROTOCOLS
☐ .....

BIOPSY
☐ Diagnosis
☐ Relapse / Progression
☐ Other: ...
☐ Needle core biopsy 14-16 Ga
☐ Open
☐ Laparoscopic / Thoracoscopic
☐ Endoscopic: ...
☐ Other: .....

RESECTION
Timing
☐ Diagnosis
☐ During induction (primary site resection)
☐ After induction
☐ After High dose CT
☐ Relapse/progression
☐ Other
Open
☐ Laparotomy
☐ Thoracophrenicolaparotomy
☐ Thoracotomy
☐ Clamshell
☐ Trap-door
☐ Transmanubrial
☐ Cervical incision
MIS
☐ Laparoscopy
☐ Thoracoscopy
☐ Both
Extent of resection
☐ Complete excision
☐ Minimal Residual Tumor < 5 cm³
☐ Incomplete excision > 5 cm³
☐ Other: ...

ANATOMICAL REGION:
CERVICAL
☐Encasement vascular structures
☐Encasement neural structures
☐Infiltration of adjacent organs
☐Intraspinal extension
THORACIC / MEDIASTINAL
☐Encasement vascular structures
☐Encasement neural structures
☐Infiltration of adjacent organs
☐Intraspinal extension
ADRENAL
☐Encasement vascular structures
☐Encasement neural structures
☐Infiltration of adjacent organs
☐Intraspinal extension
☐Bilateral
ABDOMINAL/NON ADRENAL
☐Encasement vascular structures
☐Encasement neural structures
☐Infiltration of adjacent organs
☐Intraspinal extension
PELVIC
☐Encasement vascular structures
☐Encasement neural structures
☐Infiltration of adjacent organs
☐Intraspinal extension
OTHER
SURGICAL METASTATIC SITE
☐Brain
☐Liver
☐Lung
☐Lymph nodes
☐Other: ...

RESECTION

Timing
- ❑ Diagnosis
- ❑ During Induction (primary site resection)
- ❑ After induction
- ❑ After High dose CT
- ❑ Relapse/progression
- ❑ Other

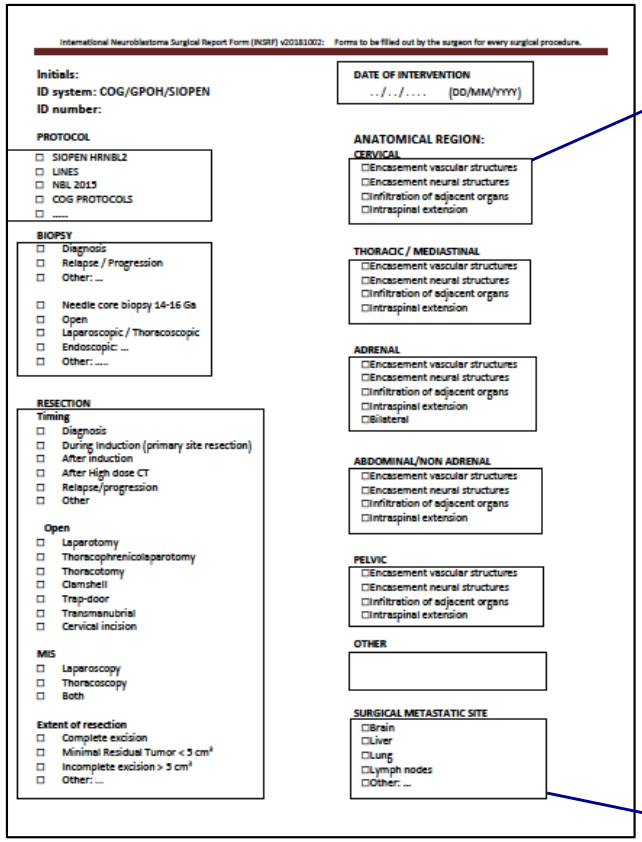
Open
- ❑ Laparotomy
- ❑ Thoracophrenicolaparotomy
- ❑ Thoracotomy
- ❑ Clamshell
- ❑ Trap-door
- ❑ Transmanubrial
- ❑ Cervical incision

MIS
- ❑ Laparoscopy
- ❑ Thoracoscopy
- ❑ Both

Extent of resection
- ❑ Complete excision
- ❑ Minimal Residual Tumor < 5 cm^3
- ❑ Incomplete excision > 5 cm^3
- ❑ Other: …

Matthyssens L et al, Ann Surg 2020

One SRF, for every anatomical region



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../../.... (DD/MM/YYYY)

PROTOCOL
- ☐ SIOPEN HRNBL2
- ☐ LINES
- ☐ NBL 2015
- ☐ COG PROTOCOLS
- ☐ .....

BIOPSY
- ☐ Diagnosis
- ☐ Relapse / Progression
- ☐ Other: ...
- ☐ Needle core biopsy 14-16 Ga
- ☐ Open
- ☐ Laparoscopic / Thoracoscopic
- ☐ Endoscopic: ...
- ☐ Other: .....

RESECTION
Timing
- ☐ Diagnosis
- ☐ During induction (primary site resection)
- ☐ After induction
- ☐ After High dose CT
- ☐ Relapse/progression
- ☐ Other

Open
- ☐ Laparotomy
- ☐ Thoracophrenicolaparotomy
- ☐ Thoracotomy
- ☐ Clamshell
- ☐ Trap-door
- ☐ Transmanubrial
- ☐ Cervical incision

MIS
- ☐ Laparoscopy
- ☐ Thoracoscopy
- ☐ Both

Extent of resection
- ☐ Complete excision
- ☐ Minimal Residual Tumor < 5 cm²
- ☐ Incomplete excision > 5 cm²
- ☐ Other: ...

ANATOMICAL REGION:

CERVICAL
- ☐Encasement vascular structures
- ☐Encasement neural structures
- ☐Infiltration of adjacent organs
- ☐Intraspinal extension

THORACIC / MEDIASTINAL
- ☐Encasement vascular structures
- ☐Encasement neural structures
- ☐Infiltration of adjacent organs
- ☐Intraspinal extension

ADRENAL
- ☐Encasement vascular structures
- ☐Encasement neural structures
- ☐Infiltration of adjacent organs
- ☐Intraspinal extension
- ☐Bilateral

ABDOMINAL/NON ADRENAL
- ☐Encasement vascular structures
- ☐Encasement neural structures
- ☐Infiltration of adjacent organs
- ☐Intraspinal extension

PELVIC
- ☐Encasement vascular structures
- ☐Encasement neural structures
- ☐Infiltration of adjacent organs
- ☐Intraspinal extension

OTHER

SURGICAL METASTATIC SITE
- ☐Brain
- ☐Liver
- ☐Lung
- ☐Lymph nodes
- ☐Other: ...

CERVICAL
1. Encasement vascular structures
2. Encasement neural structures
3. Infiltration of adjacent organs
4. Intraspinal extension

THORACICAL / MEDIASTINAL
5. Encasement vascular structures
6. Encasement neural structures
7. Infiltration of adjacent organs
8. Intraspinal extension

ADRENAL
9. Encasement vascular structures
10. Encasement neural structures
11. Infiltration of adjacent organs
12. Intraspinal extension
13. Bilateral

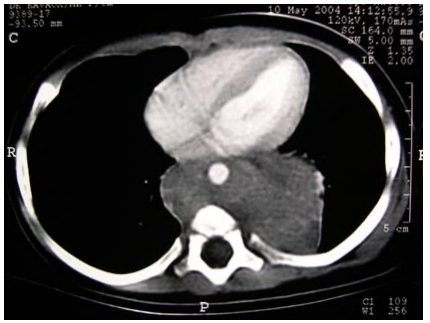
ABDOMINAL/NON ADRENAL
14. Encasement vascular structures
15. Encasement neural structures
16. Infiltration of adjacent organs
17. Intraspinal extension

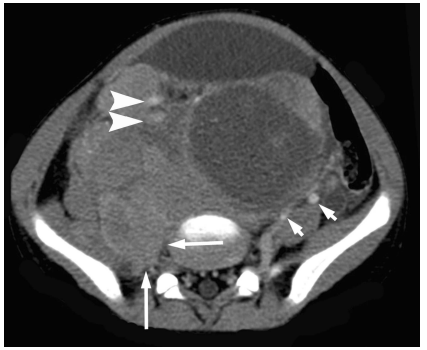
PELVIC
18. Encasement vascular structures
19. Encasement neural structures
20. Infiltration of adjacent organs
21. Intraspinal extension

OTHER

SURGICAL METASTATIC SITE
22. Brain
23. Liver
24. Lung
25. Lymph nodes

Other: ...





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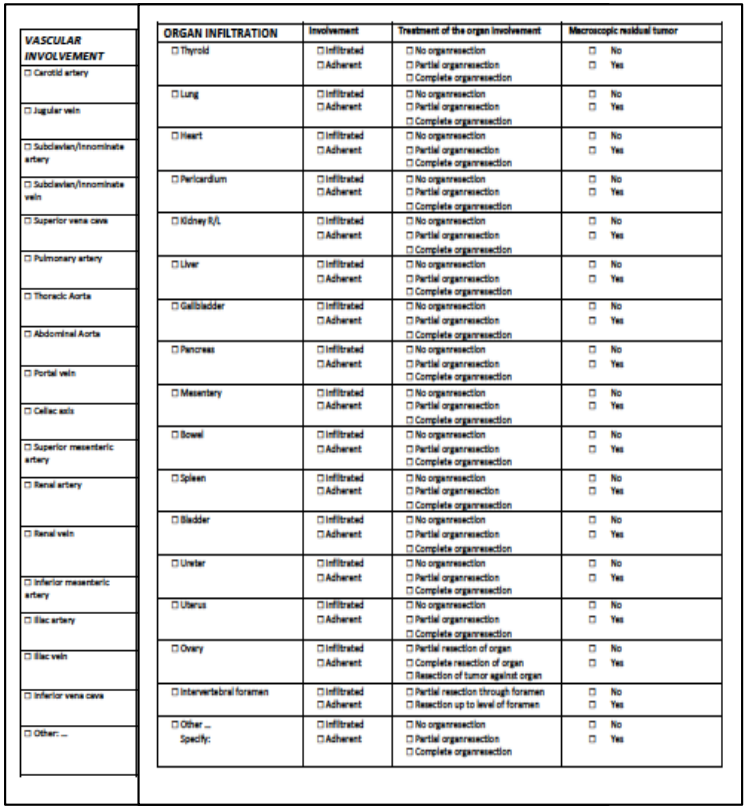
One SRF, for all structures involved

VASCULAR INVOLVEMENT	Side	Involvement: Encasement: (>50% circumference)	Injury	Solution	Macroscopic residual tumor
☐ Carotid artery	☐ L ☐ R ☐ Bilateral	☐ Encasement ☐ Adherent	☐ No ☐ Yes	☐ Repair ☐ Reconstruction ☐ Ligation	☐ No ☐ Yes
1.Jugular vein	☐ L ☐ R ☐ Bilateral	☐ Encasement ☐ Adherent	☐ No ☐ Yes	☐ Repair ☐ Reconstruction ☐ Ligation	☐ No ☐ Yes
☐ Subclavian/innominate artery	☐ L ☐ R ☐ Bilateral	☐ Encasement ☐ Adherent	☐ No ☐ Yes	☐ Repair ☐ Reconstruction ☐ Ligation	☐ No ☐ Yes

ORGAN INFILTRATION	Involvement	Treatment of the organ involvement	Macroscopic residual tumor
☐ Thyroid	☐ Infiltrated ☐ Adherent	☐ No organ resection ☐ Partial organ resection ☐ Complete organ resection	☐ No ☐ Yes
☐ Lung	☐ Infiltrated ☐ Adherent	☐ No organ resection ☐ Partial organ resection ☐ Complete organ resection	☐ No ☐ Yes
☐ Heart	☐ Infiltrated ☐ Adherent	☐ No organ resection ☐ Partial organ resection ☐ Complete organ resection	☐ No ☐ Yes
☐ Pericardium	☐ Infiltrated ☐ Adherent	☐ No organ resection ☐ Partial organ resection ☐ Complete organ resection	☐ No ☐ Yes
☐ Kidney R/L	☐ Infiltrated ☐ Adherent	☐ No organ resection ☐ Partial organ resection ☐ Complete organ resection	☐ No ☐ Yes



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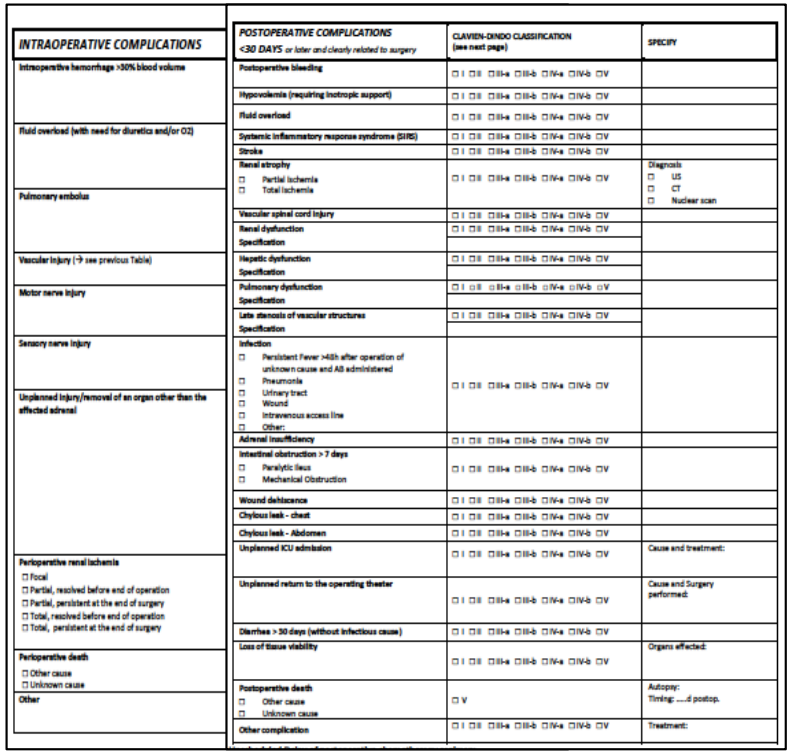
One SRF, for all complications & management

INTRAOPERATIVE COMPLICATIONS	INTERVENTION	SPECIFY
Intraoperative hemorrhage >30% blood volume	☐ Stable circulation after transfusion a/o fluids ☐ Requiring inotropic support ☐ Circulatory arrest – successful resuscitation ☐ Perioperative death	
Fluid overload (with need for diuretics and/or O2)	☐ Requiring diuretics only ☐ Requiring inotropic support ☐ Circulatory arrest – successful resuscitation ☐ Perioperative death	
Pulmonary embolus	☐ Stable circulation after transfusion a/o fluids ☐ Requiring inotropic support ☐ Circulatory arrest – successful resuscitation ☐ Perioperative death	
Vascular injury (→ see previous Table)		

POSTOPERATIVE COMPLICATIONS <30 DAYS *or later and clearly related to the surgery*	CLAVIEN-DINDO CLASSIFICATION (see next page)	SPECIFY
Postoperative bleeding	☐ I ☐ II ☐ III-a ☐ III-b ☐ IV-a ☐ IV-b ☐ V	
Hypovolemia (requiring inotropic support)	☐ I ☐ II ☐ III-a ☐ III-b ☐ IV-a ☐ IV-b ☐ V	
Fluid overload	☐ I ☐ II ☐ III-a ☐ III-b ☐ IV-a ☐ IV-b ☐ V	
Systemic inflammatory response syndrome (SIRS)	☐ I ☐ II ☐ III-a ☐ III-b ☐ IV-a ☐ IV-b ☐ V	
Stroke	☐ I ☐ II ☐ III-a ☐ III-b ☐ IV-a ☐ IV-b ☐ V	
Renal atrophy ☐ Partial ischemia ☐ Total ischemia	☐ I ☐ II ☐ III-a ☐ III-b ☐ IV-a ☐ IV-b ☐ V	Diagnosis ☐ US ☐ CT ☐ Nuclear scan



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Conclusions

- Neuroblastomas are heterogenous in their clinical presentation and biology depending on their origin in the sympathetic system
- Treatment is mostly multimodal and neoadjuvant chemotherapy is indicated in all HR tumours and in localized L2 tumours
- The wait and see strategy apply to
  - perinatal NB
  - L1- LTS neg - NCA tumours in children less than 18 months
- Surgery should be discussed if the tumour is persisting after observation
- Resection should be as complete as possible but safe – residue being treated by radiotherapy in tumours with intermediate or high risk
- MIS is a good option in L1 tumours
- INSRF should be used to better compare surgical series

Thank you to all my colleagues

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and to patients and families