



SOCIEDAD DE PEDIATRIA DE ANDALUCIA OCCIDENTAL Y EXTREMADURA.

**CIX REUNION CIENTIFICA DE LA SPAOYEX
SEVILLA 10 -11 DE MARZO 2023**

Utilidad del Verde de Indocianina (ICG) en Cirugía Pediátrica

María Molina Mata

F.E.A. Cirugía Pediátrica, Unidad de Cirugía Oncológica

UGC Cirugía Pediátrica

Hospital Universitario Virgen del Rocío, Sevilla

¿QUÉ ES EL VERDE DE INDOCIANINA?

- Contraste hidrosoluble
- Fluorescencia cercana al infrarrojo (805 - 835 nm)
- Aprobado por la FDA en 1956
- Presentación en polvo verde liofilizado
 - 25mg/vial con <5% de yoduro de sodio
 - Disolución en agua estéril
- Eliminación hepática

Administración intravenosa

Vida media: 3-5 min

Administración subcutánea

Vida media (en ganglio): 1-2 h

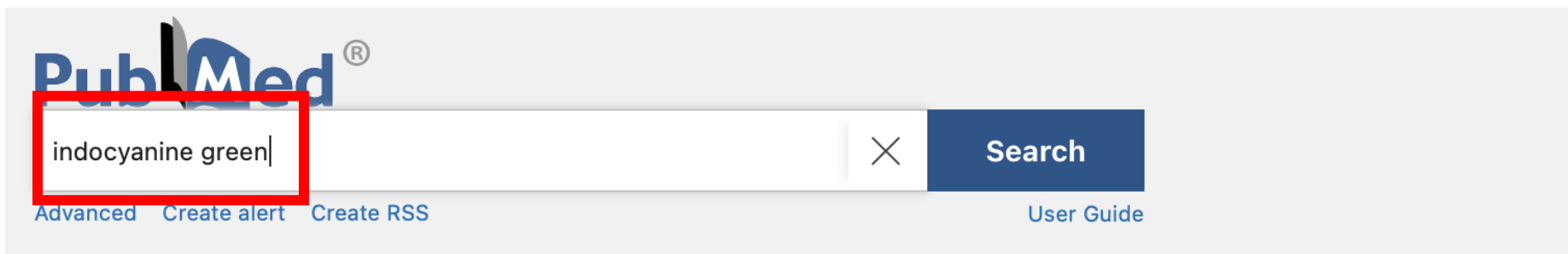


¿POR QUÉ HABLAR DE ICG?

¿POR QUÉ HABLAR DE ICG?



¿POR QUÉ HABLAR DE ICG?



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indocyanine green

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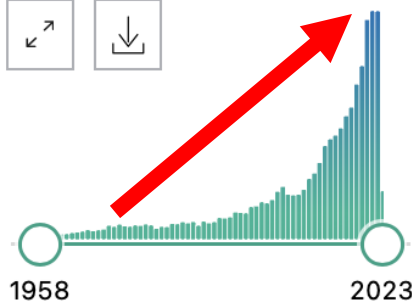
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15,957 results

Page 1 of 1,596

RESULTS BY YEAR



Indocyanine Green: Historical Context, Current Applications, and Future Considerations.

1 Reinhart MB, Huntington CR, Blair LJ, Heniford BT, Augenstein VA.

Cite Surg Innov. 2016 Apr;23(2):166-75. doi: 10.1177/1553350615604053. Epub 2015 Sep 10.

Share PMID: 26359355 Review.

BACKGROUND: **Indocyanine green** (ICG) is a dye used in medicine since the mid-1950s for a variety of applications in in cardiology, ophthalmology, and neurosurgery; however, its

fluorescent properties have subsequently been used in the intraoperative evaluation of

¿POR QUÉ HABLAR DE ICG?

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Page 1 of 12

RESULTS BY YEAR



- [Navigated liver surgery: State of the art and future perspectives.](#)
1 Gavriilidis P, Edwin B, Pelanis E, Hidalgo E, de'Angelis N, Memeo R, Aldrighetti L, Sutcliffe RP.
Cite Hepatobiliary Pancreat Dis Int. 2022 Jun;21(3):226-233. doi: 10.1016/j.hbpd.2021.09.002.
Share Epub 2021 Sep 8.
PMID: 34544668 Review.

Uso en cirugía pediátrica

Route of administration	Mode of detection	Examples	ICG Dosing (alternative) ^a
Intravenous	Immediate organ perfusion	Angiography, bowel perfusion, flap perfusion	2.5 mg IV immediately before assessment (0.05–0.1 mg/kg)
	Hepatic clearance	Cholangiography	2.5 mg IV 1 h before assessment (0.1 mg/kg)
		Hepatoblastoma/HCC metastasectomy	0.5 mg/kg IV 24 h before surgery
Enhanced tumor permeability and retention		Primary hepatic tumor resection	0.5 mg/kg IV 72–96 h before surgery
		Sarcoma resection & pulmonary metastasectomy	4–5 mg/kg IV 24 h before surgery

Evolving applications of fluorescence guided surgery in pediatric surgical oncology: A practical guide for surgeons

Seth D Goldstein¹, Todd E Heaton², Alexander Bondoc³, Roshni Dasgupta³, Abdelhafeez Abdelhafeez⁴, Andrew M Davidoff⁴, Timothy B Lautz⁵

Affiliations + expand

PMID: 33189300 DOI: 10.1016/j.jpedsurg.2020.10.013

Route of administration	Mode of detection	Examples	ICG Dosing (alternative) ^a
Interstitial/lymphatic injection	Lymph node	SLNB, retroperitoneal lymph node biopsy	2–4 mL peritumoral 20–40 min before assessment
	Lymphatic channel	Thoracic duct imaging	0.5 mg/kg into inguinal lymph node
Inhaled	Pulmonary imaging	Bronchial tree visualization	TBD
Direct renal pelvis injection	Urinary	Ureter identification	TBD
Intraparenchymal (imaging guided)	Lesion directed	Pulmonary nodule	0.1–0.2 mL of 20 × dilution (0.125 mg/mL)

Abbreviations: HCC, hepatocellular carcinoma; ICG, indocyanine green; IV, intravenous; SLNB, sentinel lymph node biopsy; TBD, to be determined.

Uso en cirugía pediátrica

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Evolving applications of fluorescence guided surgery in pediatric surgical oncology: A practical guide for surgeons

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Angiografía - Perfusión tisular

Administración intravenosa intraoperatoria

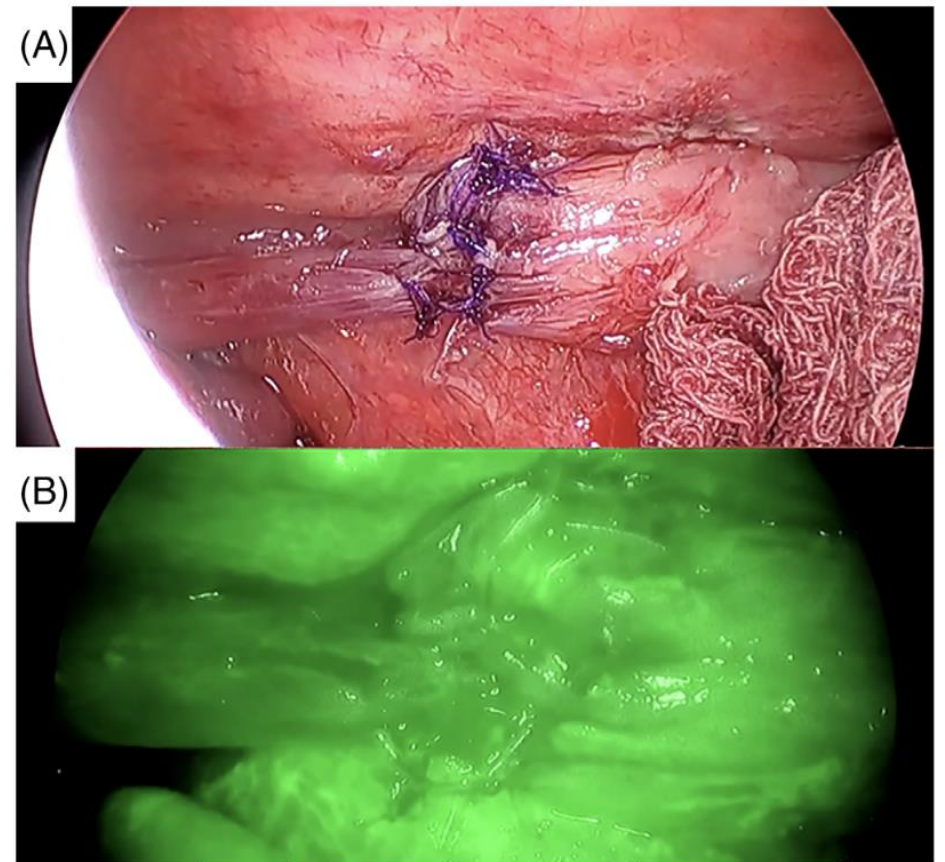
> Asian J Endosc Surg. 2022 Oct;15(4):877-881. doi: 10.1111/ases.13098. Epub 2022 Jun 17.

Feasibility of delayed anastomosis for long gap esophageal atresia in the neonatal period using internal traction and indocyanine green-guided near-infrared fluorescence

Shun Onishi ¹, Mitsuru Muto ¹, Koji Yamada ¹, Masakazu Murakami ¹, Chihiro Kedoin ¹, Ayaka Nagano ¹, Mayu Matsui ¹, Koshiro Sugita ¹, Keisuke Yano ¹, Toshio Harumatsu ¹, Waka Yamada ^{1 2}, Ryuta Masuya ³, Takafumi Kawano ¹, Satoshi Ieiri ¹

Affiliations + expand

PMID: 35715943 DOI: [10.1111/ases.13098](https://doi.org/10.1111/ases.13098)



> Eur J Pediatr Surg. 2020 Dec;30(6):505-511. doi: 10.1055/s-0039-1700548.
Epub 2019 Dec 13.

Preliminary Use of Indocyanine Green Fluorescence Angiography and Value in Predicting the Vascular Supply of Tissues Needed to Perform Cloacal, Anorectal Malformation, and Hirschsprung Reconstructions

Rebecca Maria Rentea ^{1 2}, Devin R Halleran ², Hira Ahmad ²,
Alejandra Vilanova Sanchez ^{2 3}, Alessandra C Gasior ², Katherine McCracken ²,
Geri D Hewitt ², Victoria Alexander ², Caitlin Smith ², Laura Weaver ², Richard J Wood ²,
Marc A Levitt ²

Affiliations + expand

PMID: 31858494 DOI: 10.1055/s-0039-1700548

Clinical Trial > J Pediatr Surg. 2023 Jan;58(1):82-88.

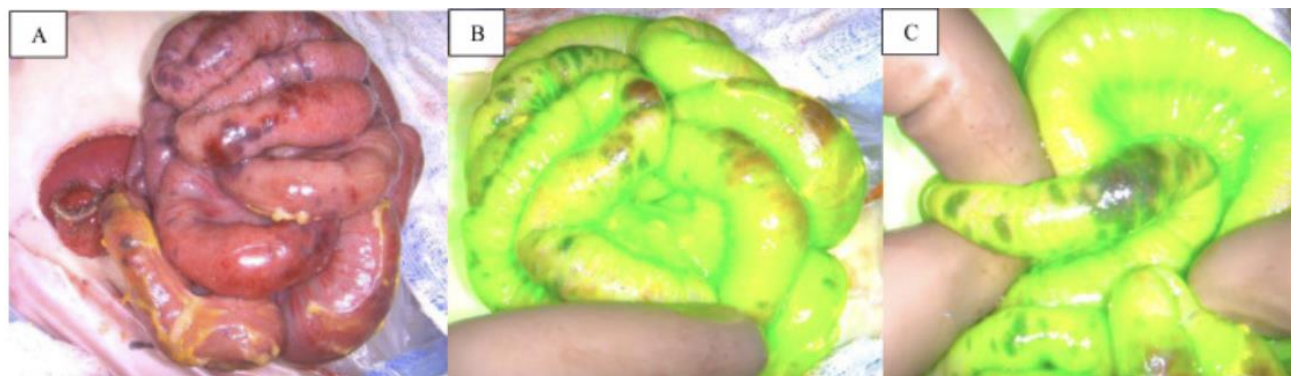
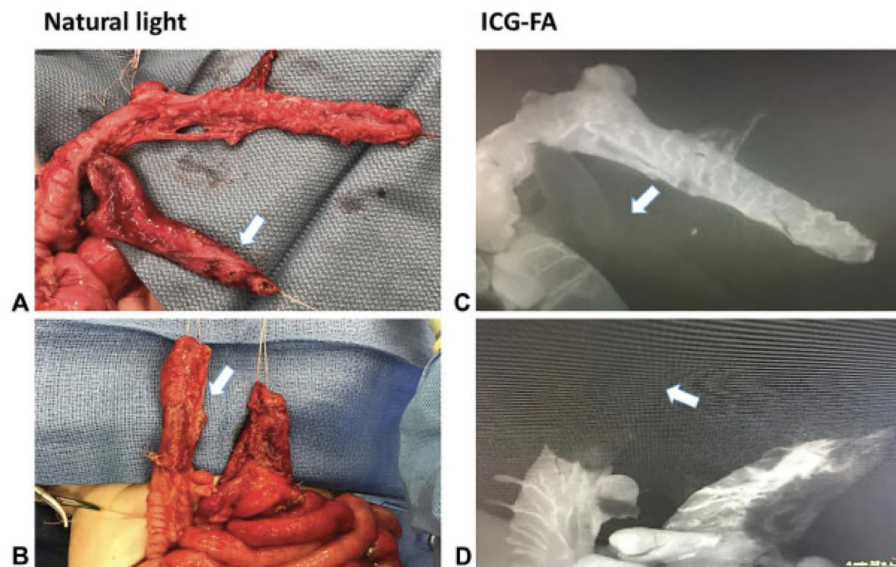
doi: 10.1016/j.jpedsurg.2022.09.020. Epub 2022 Oct 14.

Indocyanine green fluorescence angiography in pediatric intestinal resections: A first prospective mixed methods clinical trial

Annie Le-Nguyen ¹, Claude Julie Bourque ², Maeve O'Neill Trudeau ³, Thierry Ducruet ⁴,
Christophe Faure ⁵, Nelson Piché ⁶

Affiliations + expand

PMID: 36357227 DOI: 10.1016/j.jpedsurg.2022.09.020



Colangiografía - Visualización vía biliar

Administración intravenosa preoperatoria

> Surg Endosc. 2022 Jun;36(6):4369-4375. doi: 10.1007/s00464-021-08784-5.
Epub 2021 Nov 3.

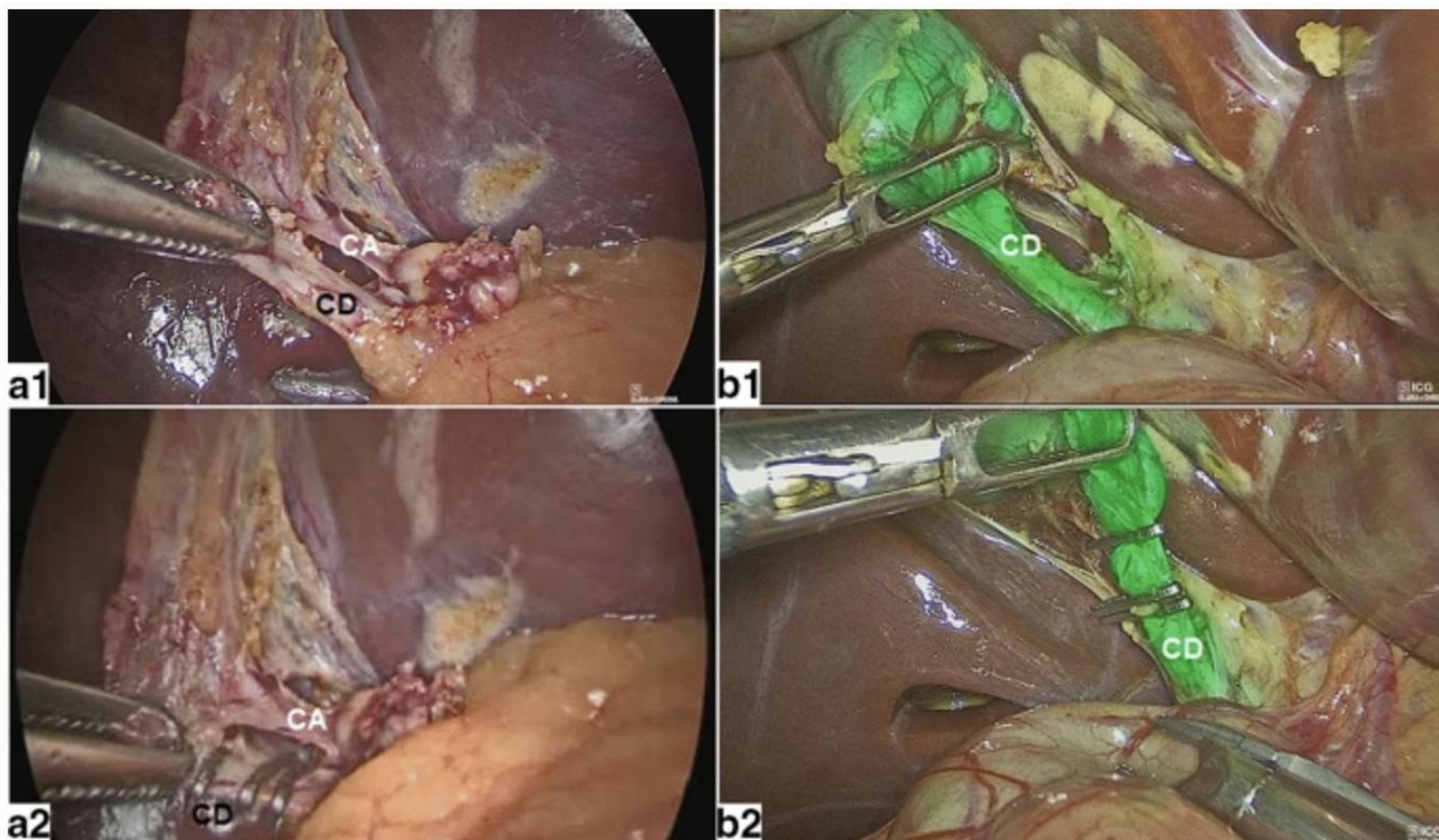
Efficacy of indocyanine green (ICG) fluorescent cholangiography to improve intra-operative visualization during laparoscopic cholecystectomy in pediatric patients: a comparative study between ICG-guided fluorescence and standard technique

Ciro Esposito ¹, Alessandro Settimi ², Mariapina Cerulo ², Maria Escolino ²

Affiliations + expand

PMID: 34734300 DOI: 10.1007/s00464-021-08784-5

Dosis: 0,35mg/kg (dilución 5mg/ml)
Tiempo administración: media 15.5h



Drenaje linfático

Administración loco regional intraoperatoria

Varicocele

Ganglio centinela

Quilotórax

Varicocele

Administración intra-testicular
Dosis: 2ml

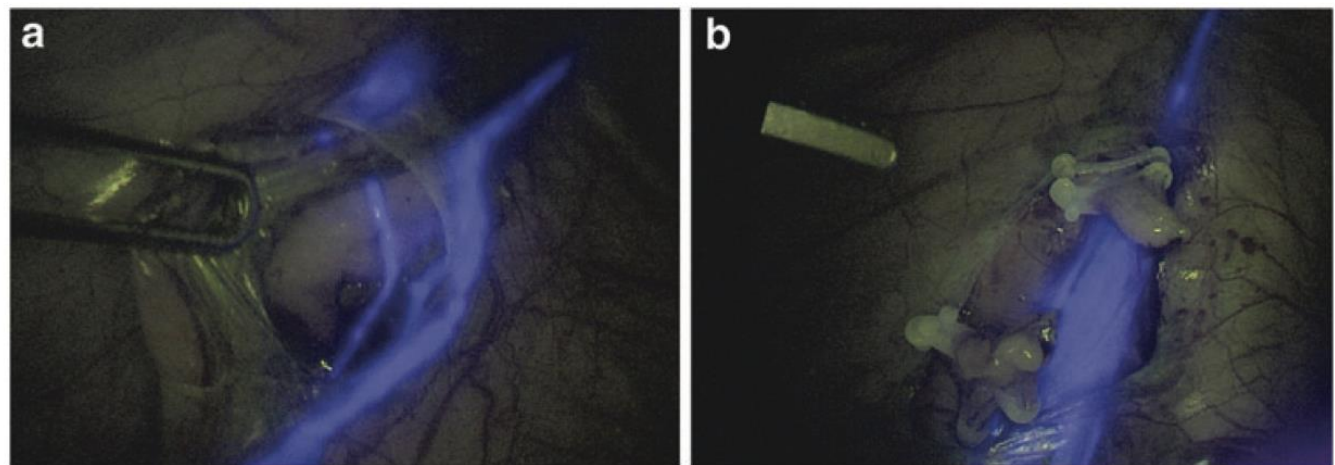
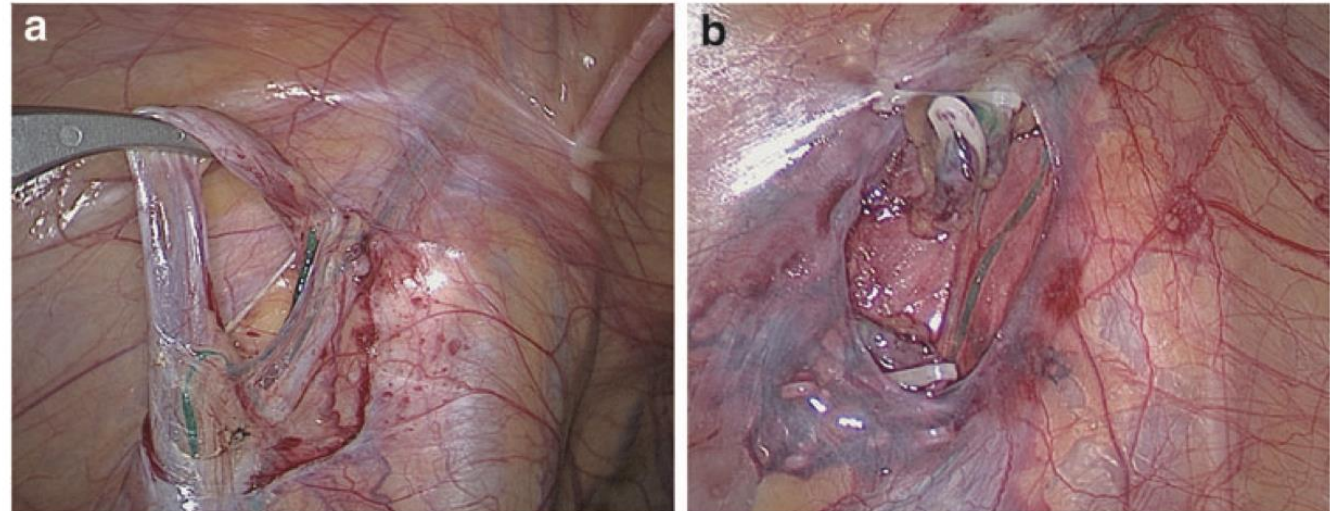
> J Laparoendosc Adv Surg Tech A. 2019 Apr;29(4):564-567. doi: 10.1089/lap.2018.0624.
Epub 2019 Jan 24.

Indocyanine Green Fluorescence Lymphography: A New Technique to Perform Lymphatic Sparing Laparoscopic Palomo Varicocelectomy in Children

Ciro Esposito ¹, Francesco Turrà ¹, Fulvia Del Conte ¹, Serena Izzo ¹, Francesca Gargiulo ¹,
Alessandra Farina ¹, Giovanni Severino ¹, Mariapina Cerulo ¹, Maria Escolino ¹

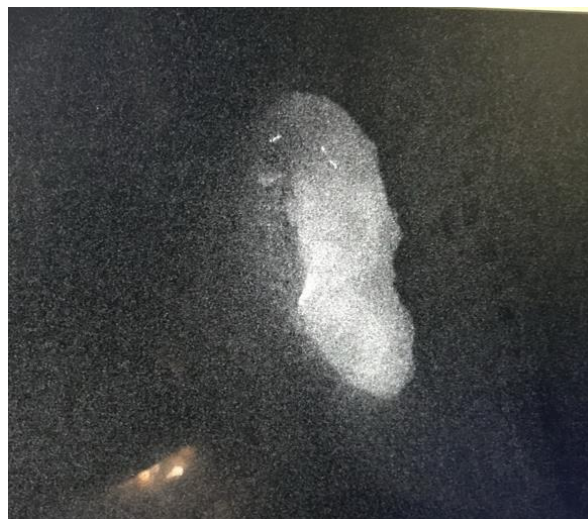
Affiliations + expand

PMID: 30676243 DOI: 10.1089/lap.2018.0624



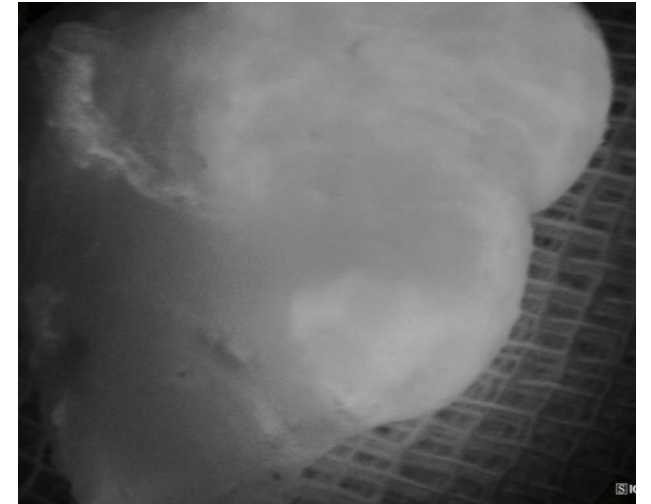
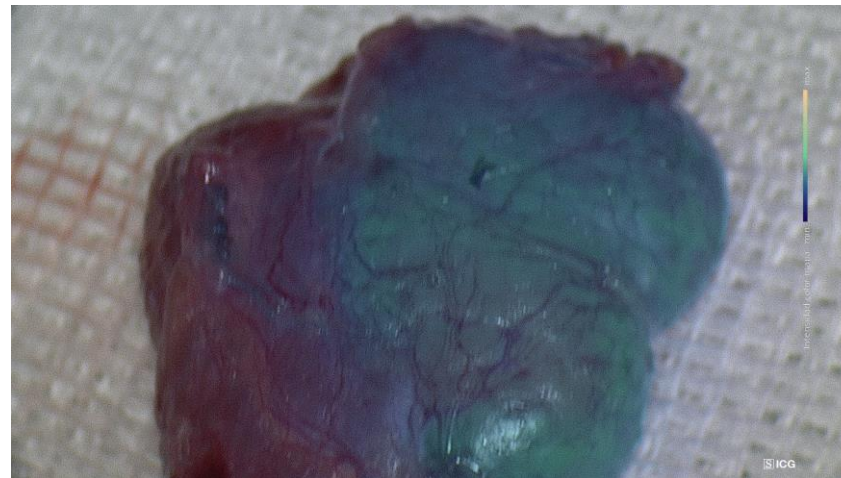
Ganglio centinela

Varón 15 años, rbdomiosarcoma fusión positiva
Administración en tejido celular subcutáneo perilesional
Dosis: 4ml



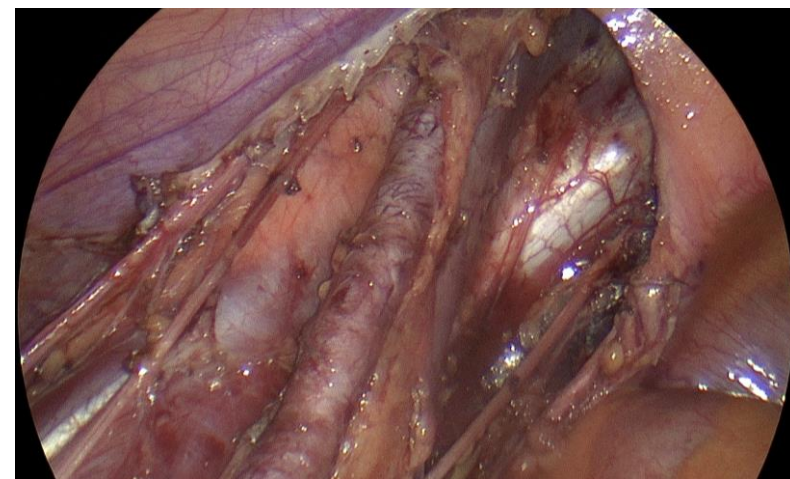
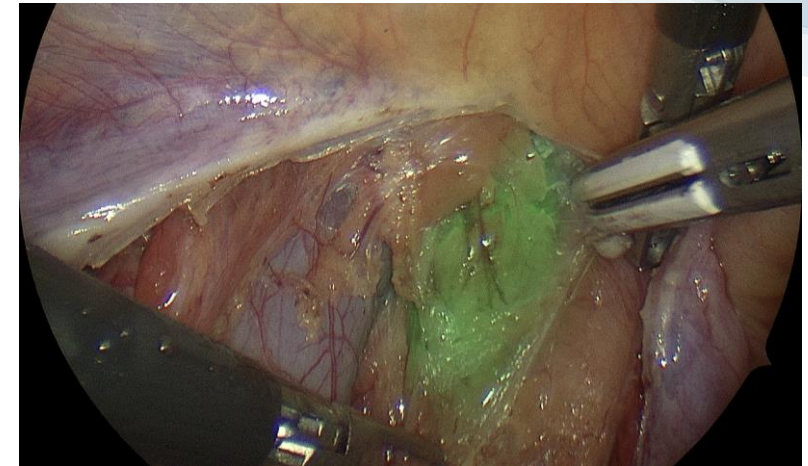
Ganglio centinela

Mujer 16 años, sarcoma células claras en muñeca
Administración subcutánea pericicatricial
Dosis: 4ml



Ganglio centinela

Varón 16 años, rabdomiosarcoma paratesticular
Administración en cordón espermático
Dosis: 4ml



Quilotórax

Administración subcutánea inguinal
Latencia mínima 20 minutos

T.I. Chang, Y.S. Chen, S.C. Huang

Intraoperative indocyanine green fluorescence lymphography to detect chylous leakage sites after congenital heart surgery

J Thorac Cardiovasc Surg, 148 (2) (2014), pp. 739-740

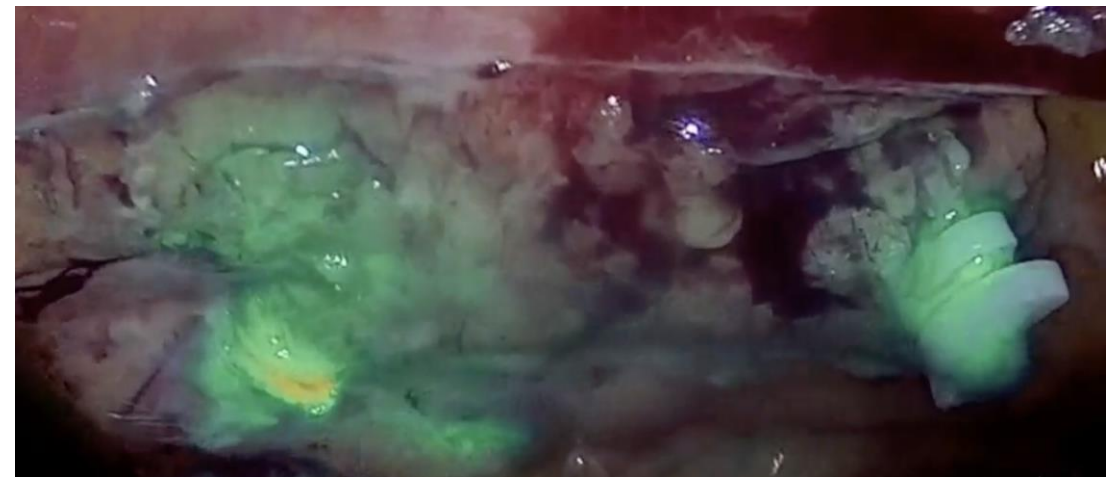
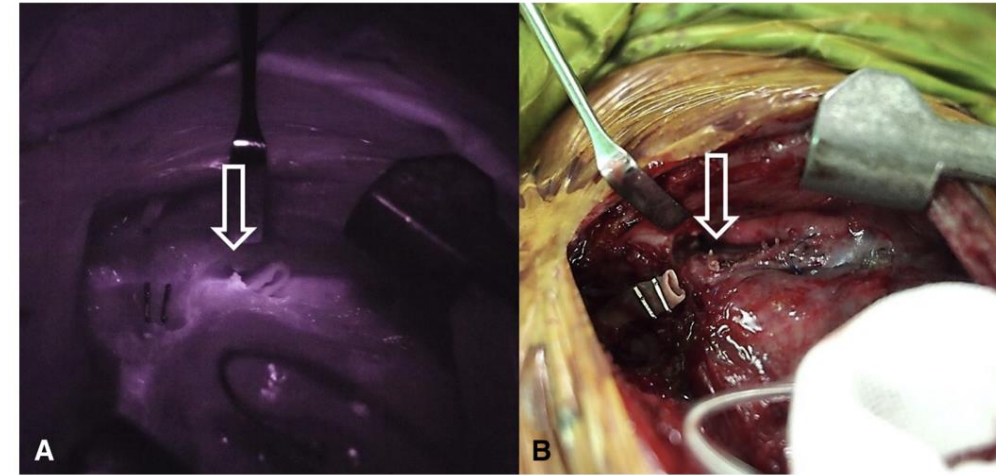
> [J Visc Surg](#). 2021 Dec;158(6):526-527. doi: 10.1016/j.jviscsurg.2021.08.006.
Epub 2021 Sep 21.

Thoracoscopy guided by intraoperative indocyanine green fluorescence lymphography for post-oesophagectomy chylothorax (with video)

R Chati ¹, E Huet ¹, J J Tuech ²

Affiliations + expand

PMID: 34561188 DOI: 10.1016/j.jviscsurg.2021.08.006



Urología

Heminefrectomía

Administración intravenosa intraoperatoria

> *Pediatr Surg Int.* 2019 Oct;35(10):1043-1050. doi: 10.1007/s00383-019-04519-9. Epub 2019 Jul 4.

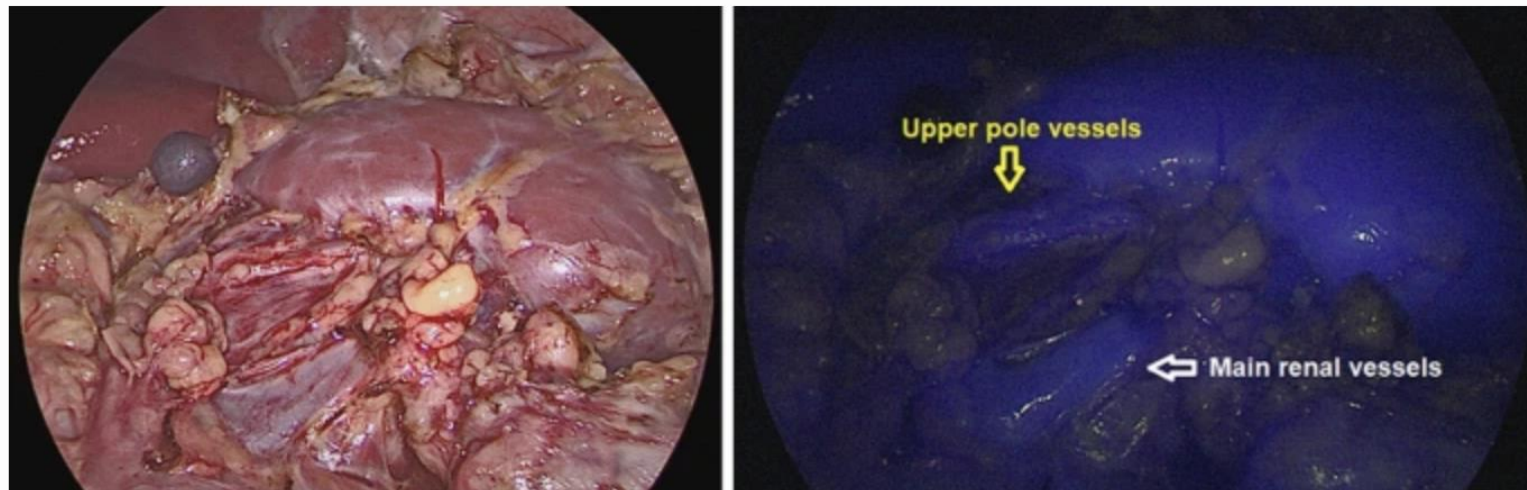
Clinical application and technical standardization of indocyanine green (ICG) fluorescence imaging in pediatric minimally invasive surgery

Ciro Esposito ¹, Fulvia Del Conte ², Mariapina Cerulo ², Francesca Gargiulo ², Serena Izzo ², Giovanni Esposito ², Maria Immacolata Spagnuolo ², Maria Escolino ²

Affiliations + expand

PMID: 31273452 DOI: 10.1007/s00383-019-04519-9

Fig. 5



ICG-enhanced fluorescence allowed an easier identification of the vascular anatomy during upper pole partial nephrectomy

Urología

Heminefrectomía

Administración intravenosa intraoperatoria

> *Pediatr Surg Int.* 2019 Oct;35(10):1043-1050. doi: 10.1007/s00383-019-04519-9. Epub 2019 Jul 4.

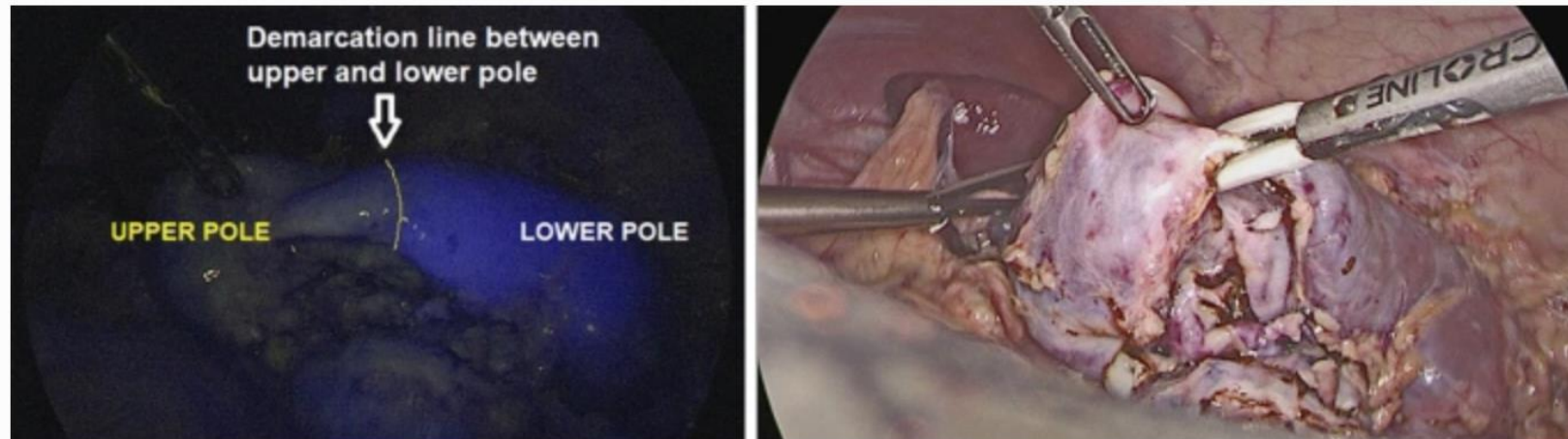
Clinical application and technical standardization of indocyanine green (ICG) fluorescence imaging in pediatric minimally invasive surgery

Ciro Esposito ¹, Fulvia Del Conte ², Mariapina Cerulo ², Francesca Gargiulo ², Serena Izzo ², Giovanni Esposito ², Maria Immacolata Spagnuolo ², Maria Escolino ²

Affiliations + expand

PMID: 31273452 DOI: 10.1007/s00383-019-04519-9

Fig. 6

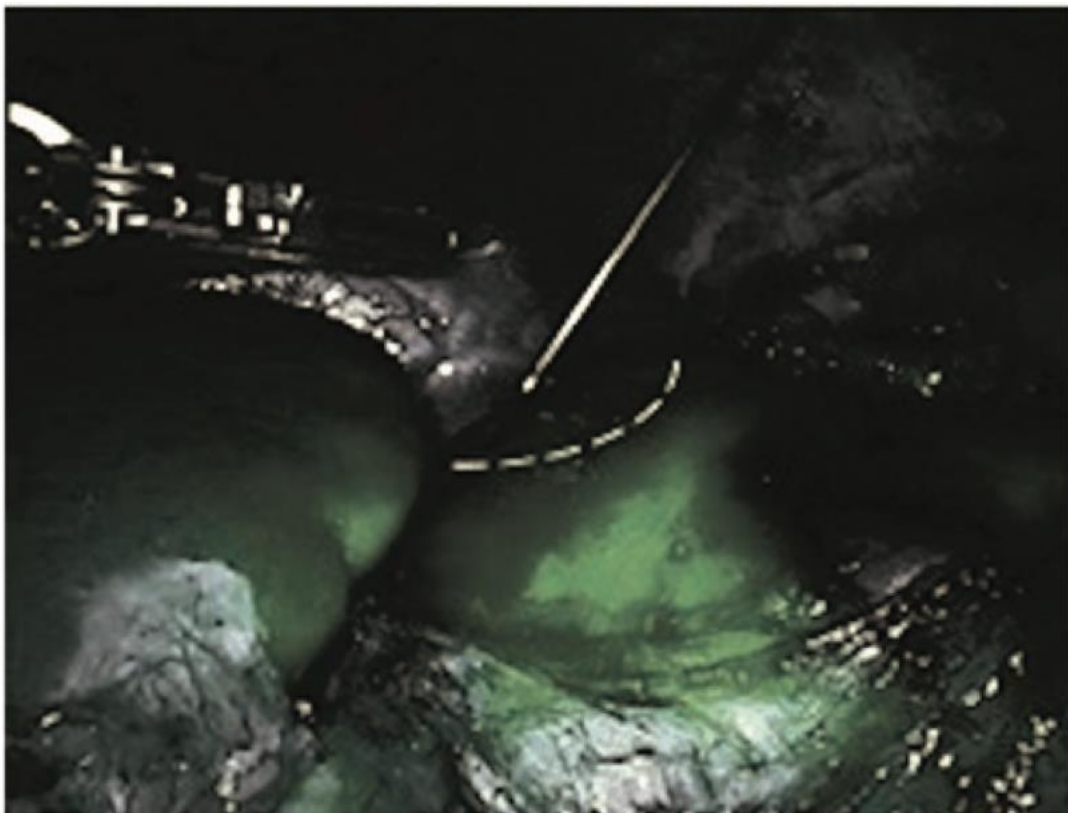


ICG-enhanced fluorescence showed a clear demarcation line between upper and lower pole during upper pole partial nephrectomy

Urología

Quistes renales

Administración intravenosa intraoperatoria



> J Laparoendosc Adv Surg Tech A. 2020 Apr;30(4):471-476. doi: 10.1089/lap.2019.0650. Epub 2020 Mar 12.

Laparoscopic or Robotic Deroofing Guided by Indocyanine Green Fluorescence and Perirenal Fat Tissue Wadding Technique of Pediatric Simple Renal Cysts

Ciro Esposito ¹, Andrea Soria-Gondek ², Marco Castagnetti ³, Mariapina Cerulo ¹, Fulvia Del Conte ¹, Giovanni Esposito ¹, Carmine Pecoraro ⁴, Domenico Cicala ⁴, Alessandra Farina ¹, Maria Escolino ¹

Affiliations + expand

PMID: 32175803 DOI: [10.1089/lap.2019.0650](https://doi.org/10.1089/lap.2019.0650)



Urología

Quistes renales

Administración intravenosa intraoperatoria

Varón 13 años

Dosis: 1mg/kg (dilución 2,5mg/ml)



Cirugía torácica

Secuestro pulmonar

Administración intravenosa intraoperatoria

Case Reports > [Interact Cardiovasc Thorac Surg.](#) 2022 Aug 3;35(3):ivac209.

doi: 10.1093/icvts/ivac209.

Thoracoscopic resection of pulmonary sequestration with carbon dioxide insufflation and indocyanine green

Sachie Koike ^{1,2}, Masahisa Miyazawa ¹, Nobutaka Kobayashi ¹

Affiliations + expand

PMID: 35946720 PMCID: [PMC9380781](#) DOI: [10.1093/icvts/ivac209](#)

Case Reports > [J Med Case Rep.](#) 2019 Jul 27;13(1):228.

doi: 10.1186/s13256-019-2128-2.

Indocyanine green fluorescence-guided thoracoscopic pulmonary resection for intralobar pulmonary sequestration: a case report

Nozomu Motono ¹, Shun Iwai ², Aika Funasaki ², Atsushi Sekimura ², Katsuo Usuda ², Hidetaka Uramoto ²

Affiliations + expand

PMID: 31349794 PMCID: [PMC6660656](#) DOI: [10.1186/s13256-019-2128-2](#)

Case Reports > [Semin Thorac Cardiovasc Surg.](#) 2018 Spring;30(1):122-124.

doi: 10.1053/j.semtcvs.2017.05.015. Epub 2017 Jun 1.

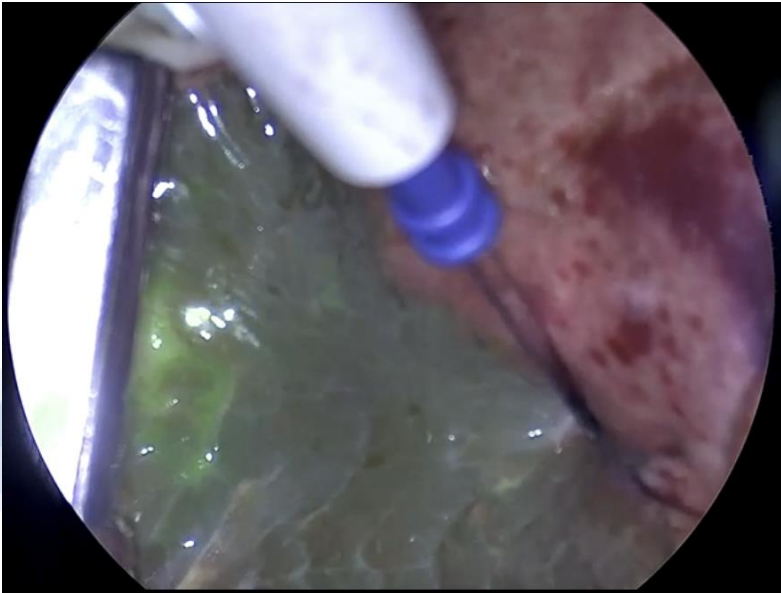
Surgery for Intralobar Pulmonary Sequestration Using Indocyanine Green Fluorescence Navigation: A Case Report

Keiji Yamanashi ¹, Norihito Okumura ², Chiaki Nakazono ¹, Tomoaki Matsuoka ¹

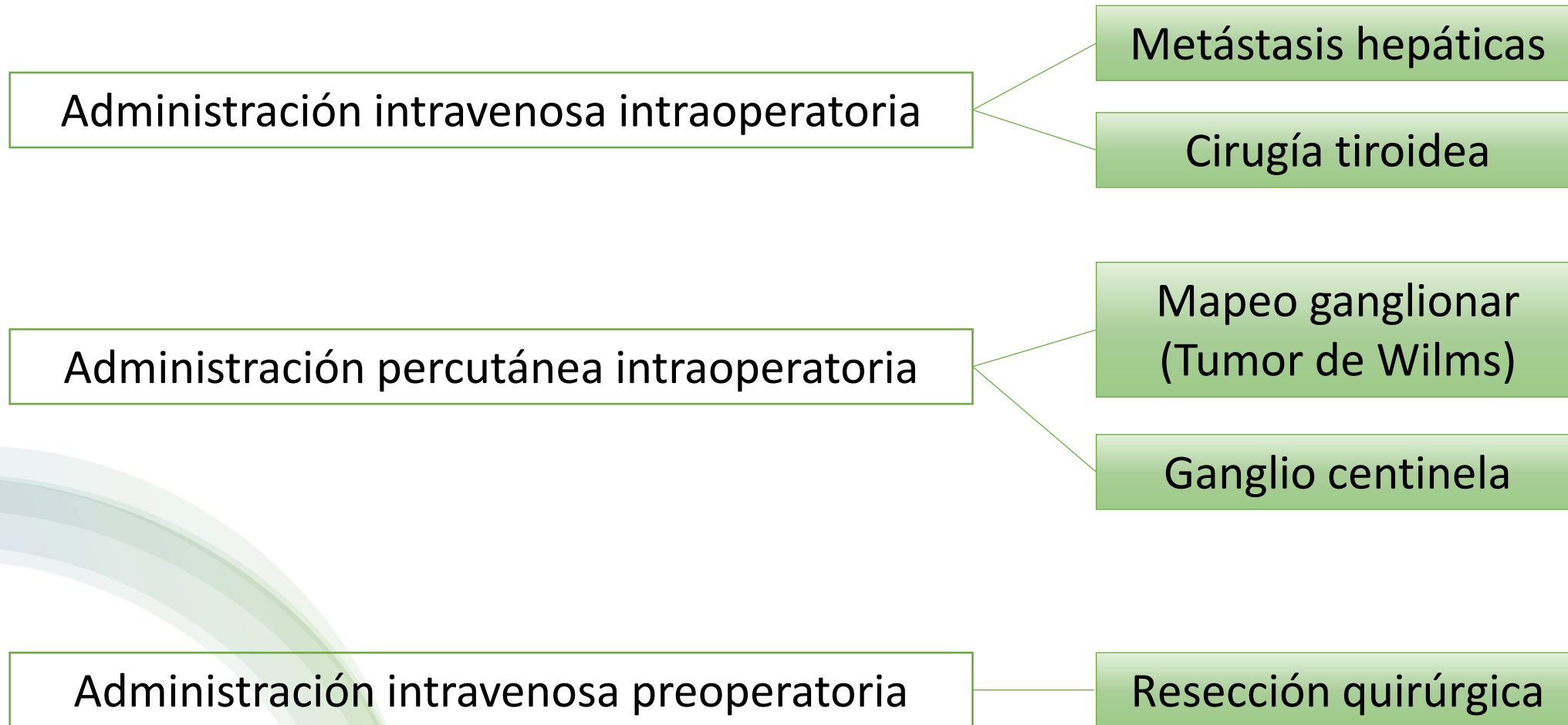
Affiliations + expand

PMID: 29747951 DOI: [10.1053/j.semtcvs.2017.05.015](#)

Secuestro pulmonar intralobar



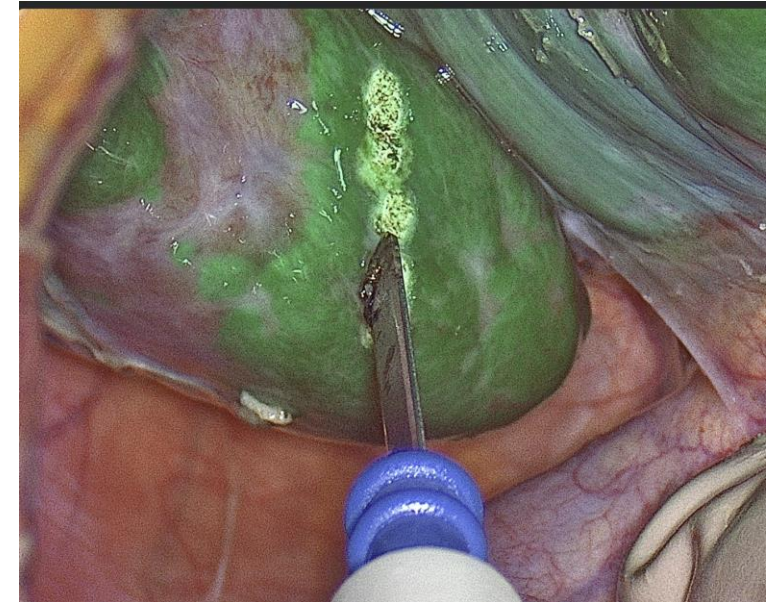
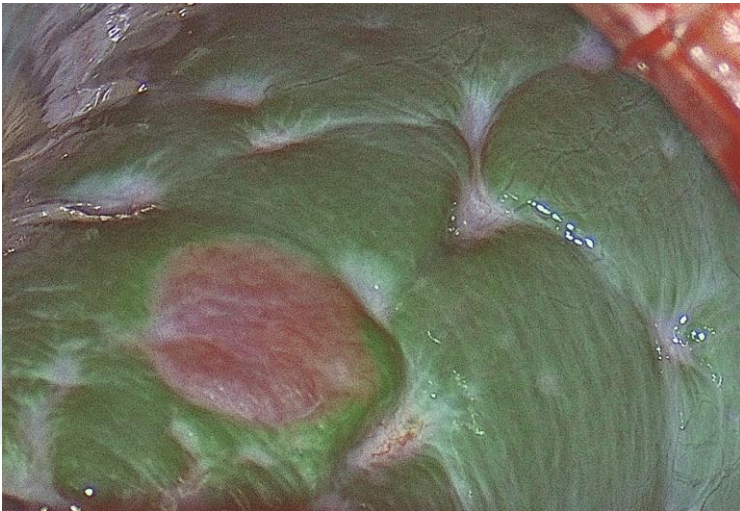
Cirugía oncológica



Metástasis hepáticas

Administración intravenosa intraoperatoria

Captación rápida por los hepatocitos, no por las células tumorales



Varón 2 años, metástasis hepáticas de neuroblastoma

Cirugía tiroidea

Administración intravenosa intraoperatoria

Fluorescencia de glándulas paratiroides

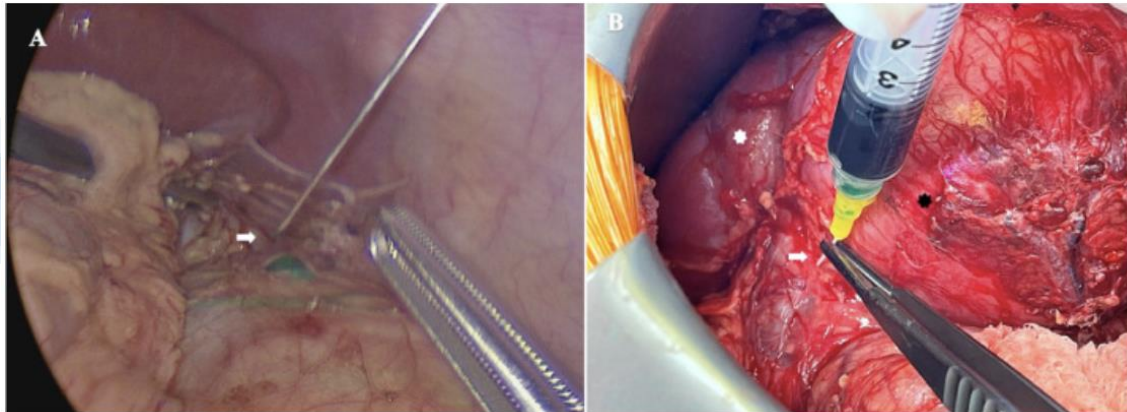


Mapeo ganglionar

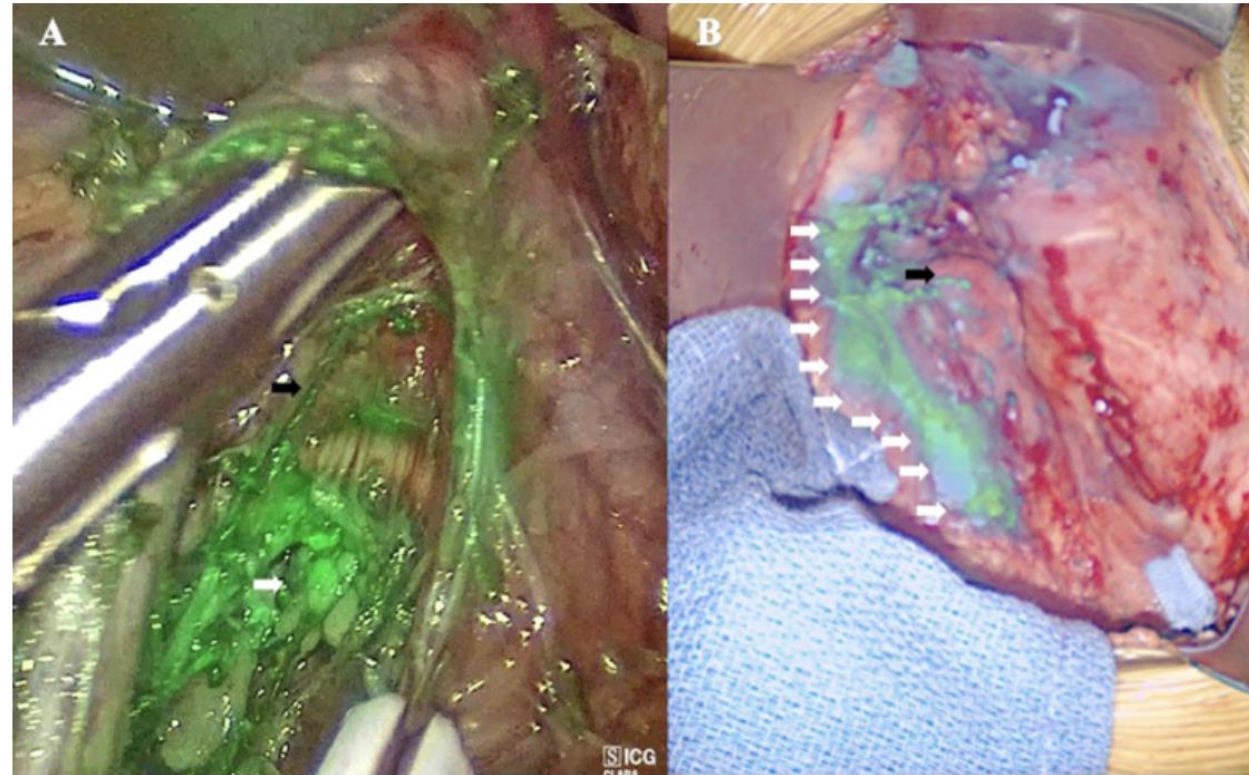
Administración percutánea renal intraoperatoria

Fluorescence-guided lymph node sampling is feasible during up-front or delayed nephrectomy for Wilms tumor

Abdelhafeez H. Abdelhafeez^{a b}  , Andrew M. Davidoff^{a b}, Andrew J. Murphy^{a b},
G Suren Arul^c, Max J. Pacht^c



Journal of Pediatric Surgery
Volume 57, Issue 12, December 2022, Pages 920-925

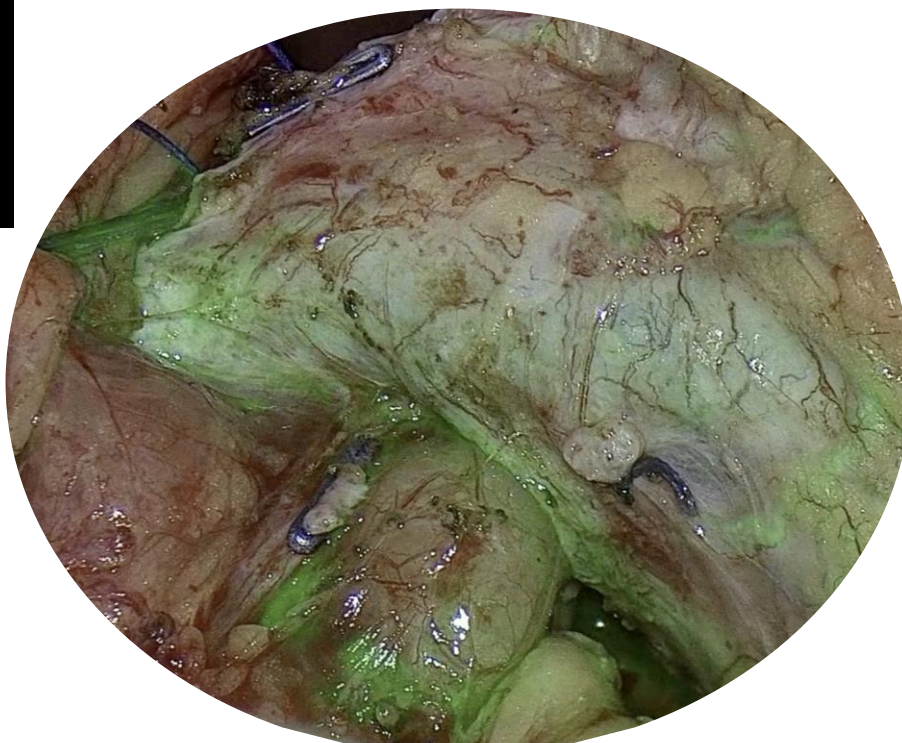
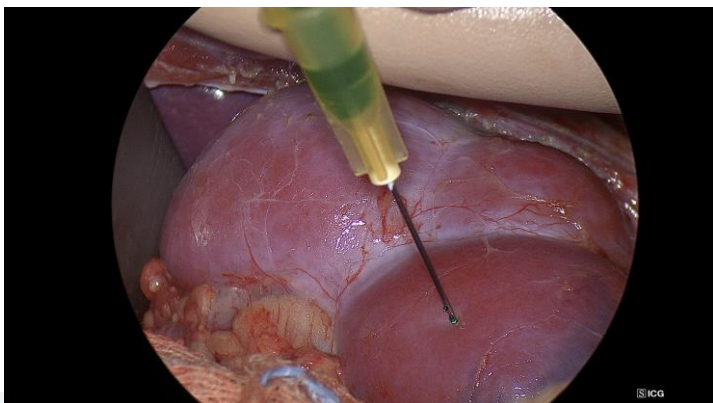


Mapeo ganglionar

Administración percutánea renal intraoperatoria

Dosis: 2 ml

Parénquima renal sano peritumoral



Resección quirúrgica

Administración intravenosa preoperatoria

Cirugía conservadora de nefronas

Review > J Pediatr Surg. 2022 Sep;57(9):174-178. doi: 10.1016/j.jpedsurg.2021.08.006.

Epub 2021 Aug 23.

Indocyanine green-guided nephron-sparing surgery for pediatric renal tumors

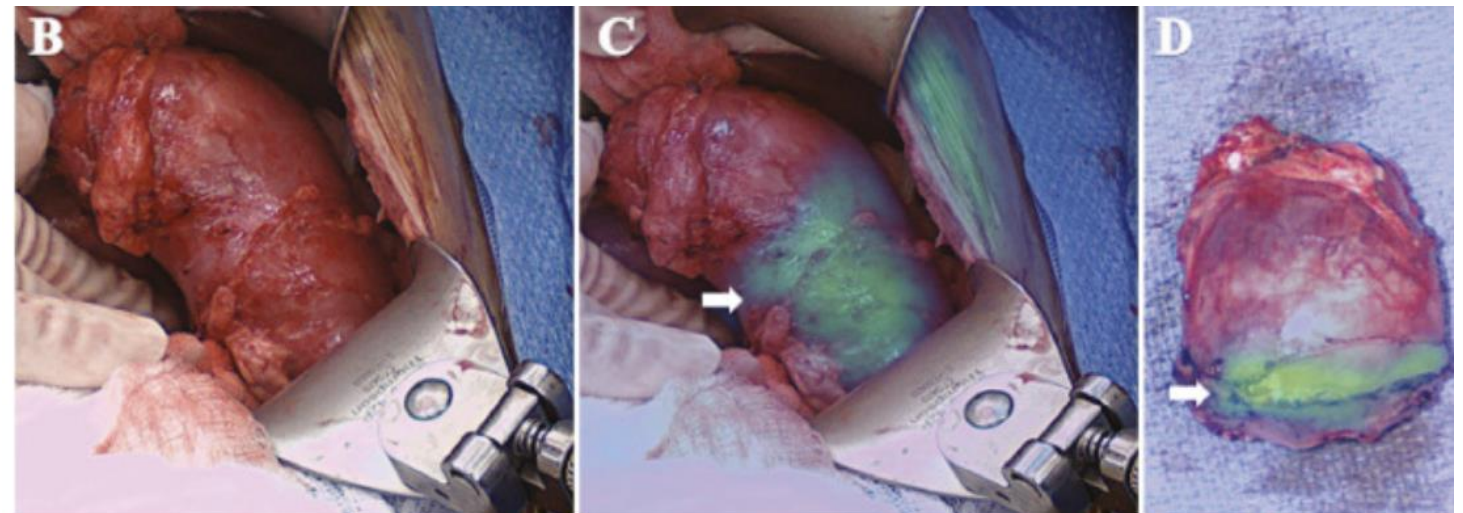
Abdelhafeez H Abdelhafeez ¹, Andrew J Murphy ², Rachel Brennan ³, Teresa C Santiago ⁴,
Zhaohua Lu ⁵, Matthew J Krasin ⁶, John J Bissler ⁷, Joseph M Gleason ⁸,
Andrew M Davidoff ²

Affiliations + expand

PMID: 34518021 DOI: 10.1016/j.jpedsurg.2021.08.006

Dosis: 1,5mg/kg
Administración: 24 previas

Mayor captación por riñón sano vs tumor



Resección quirúrgica

Administración intravenosa preoperatoria

Hepatectomía Hepatoblastoma

Dosis: variable

Administración: 48-96h previas

*Eliminación por hepatocitos sanos
pero retención en células tumorales*

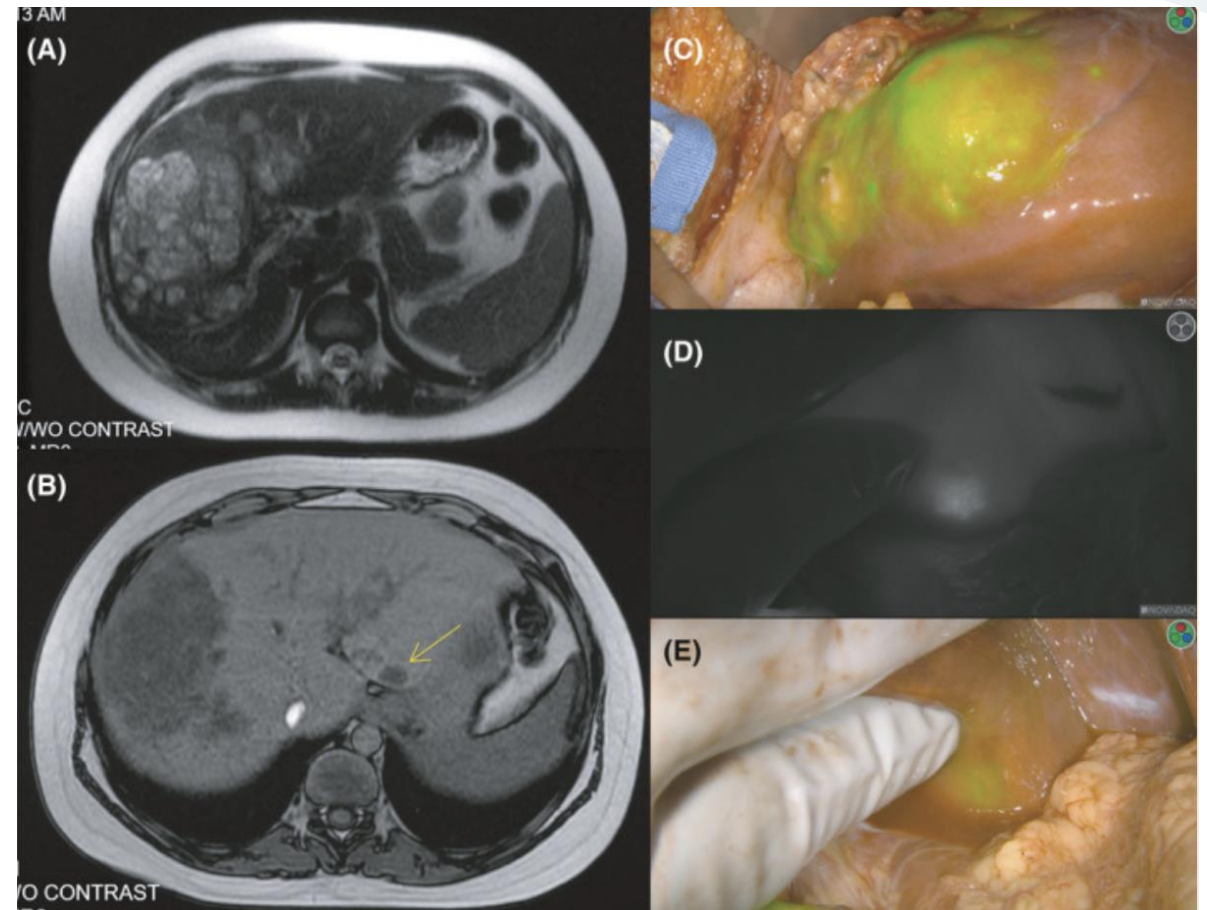
> Cancer Med. 2021 Jul;10(13):4322-4343. doi: 10.1002/cam4.3982. Epub 2021 Jun 12.

Indocyanine green is a sensitive adjunct in the identification and surgical management of local and metastatic hepatoblastoma

Charissa M Lake ¹, Alexander J Bondoc ¹, Roshni Dasgupta ¹, Todd M Jenkins ¹, Alexander J Towbin ², Ethan A Smith ², Maria H Alonso ¹, James I Geller ³, Gregory M Tiao ¹

Affiliations + expand

PMID: 34117727 PMID: PMC8267136 DOI: 10.1002/cam4.3982



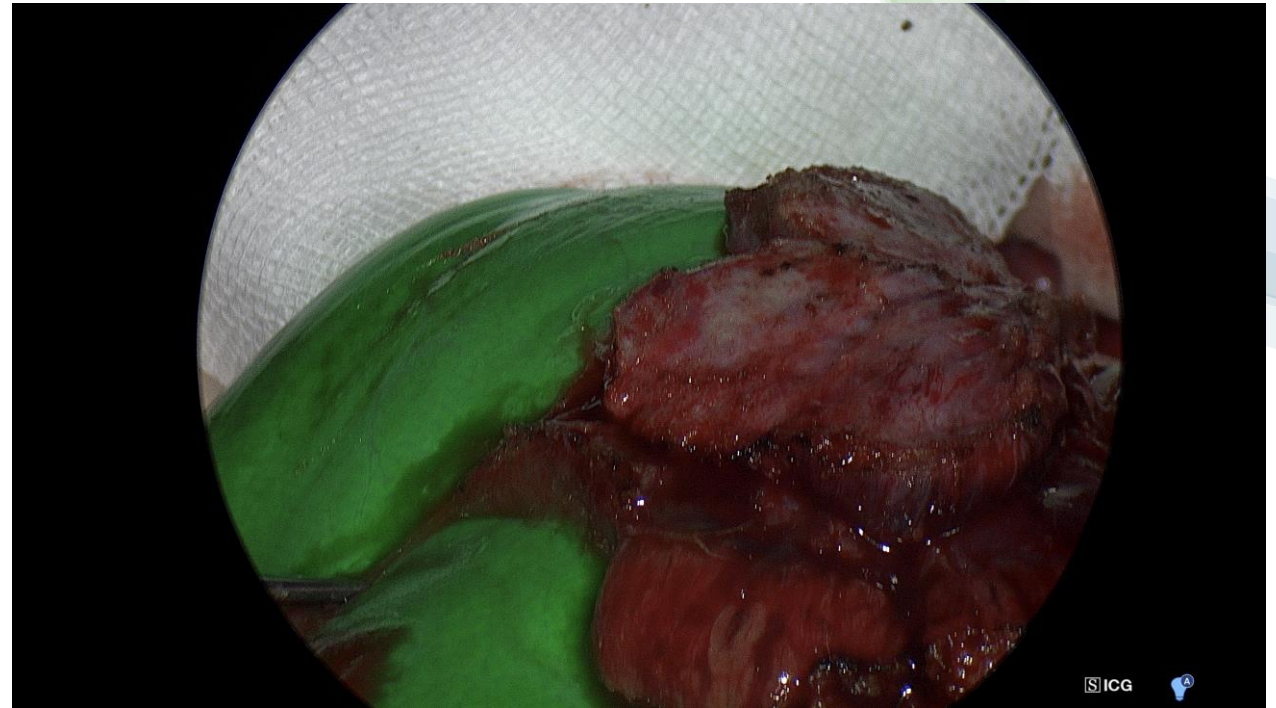
Resección quirúrgica

Hepatectomía Hepatoblastoma

Dosis: 1,5mg/kg

Administración: **intraoperatorio**

*Captación inmediata por
hepatocitos sanos pero ausencia de
captación en células tumorales*



Resección quirúrgica

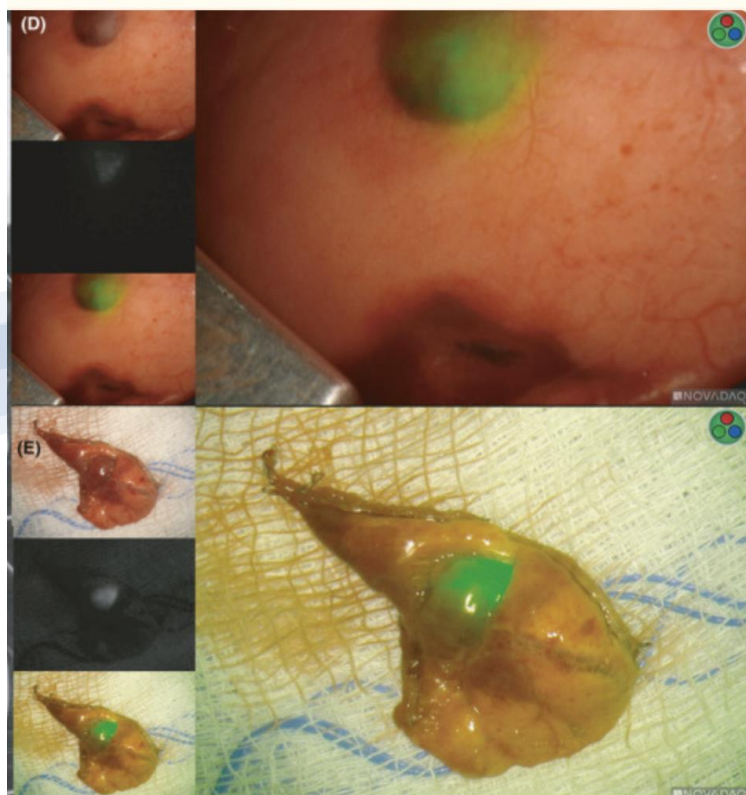
Administración intravenosa preoperatoria

Resección metástasis pulmonares (hepatoblastoma)

Dosis: variable

Administración: 24 previas

Retención en células tumorales



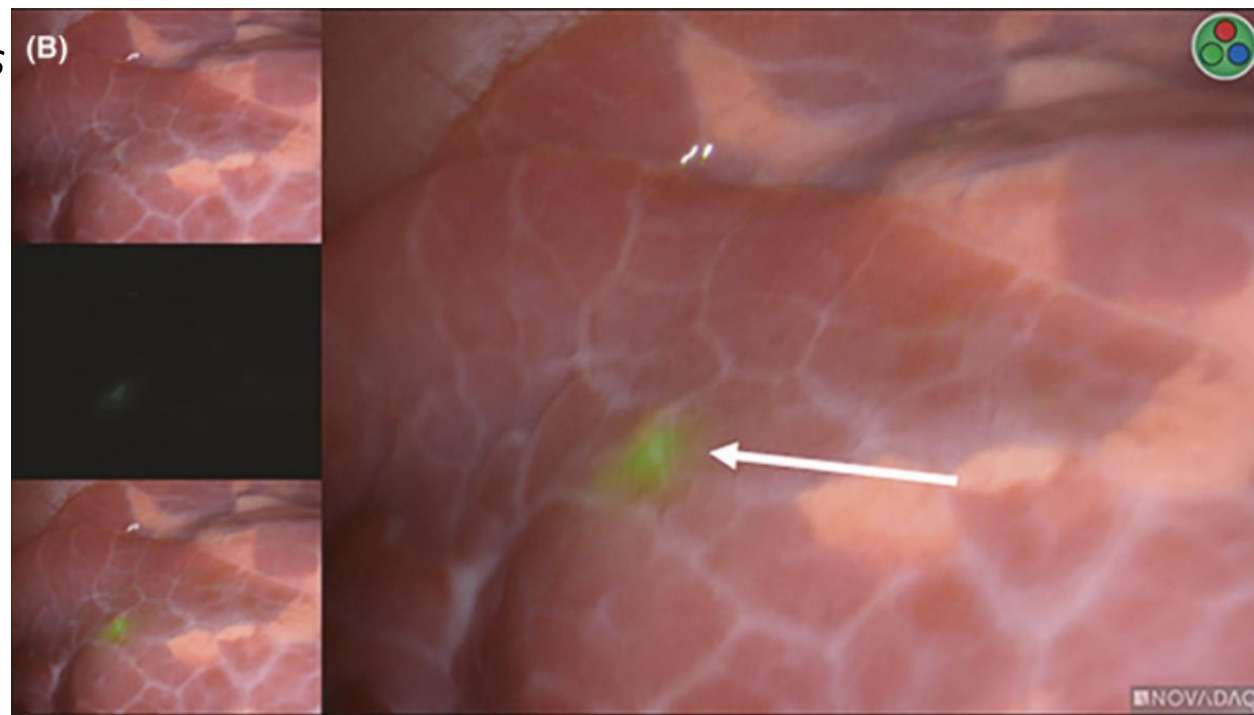
> Cancer Med. 2021 Jul;10(13):4322-4343. doi: 10.1002/cam4.3982. Epub 2021 Jun 12.

Indocyanine green is a sensitive adjunct in the identification and surgical management of local and metastatic hepatoblastoma

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Affiliations + expand

PMID: 34117727 PMCID: PMC8267136 DOI: 10.1002/cam4.3982



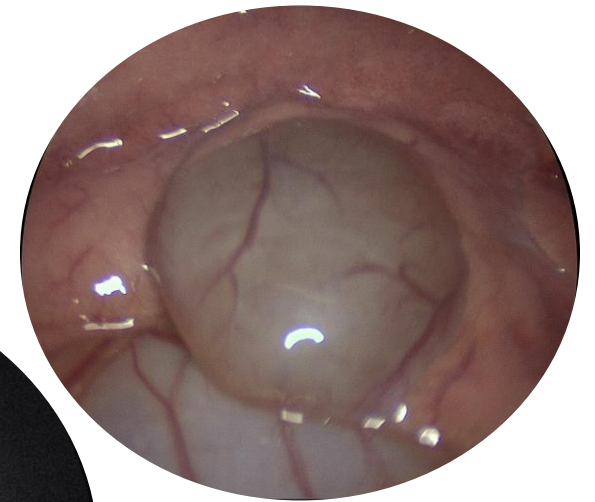
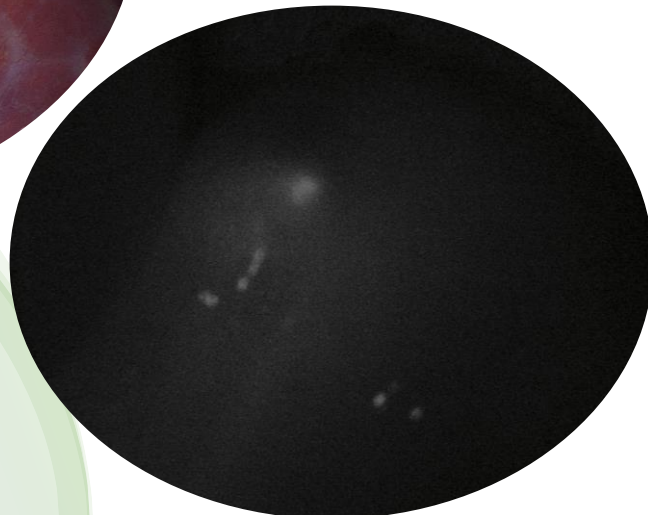
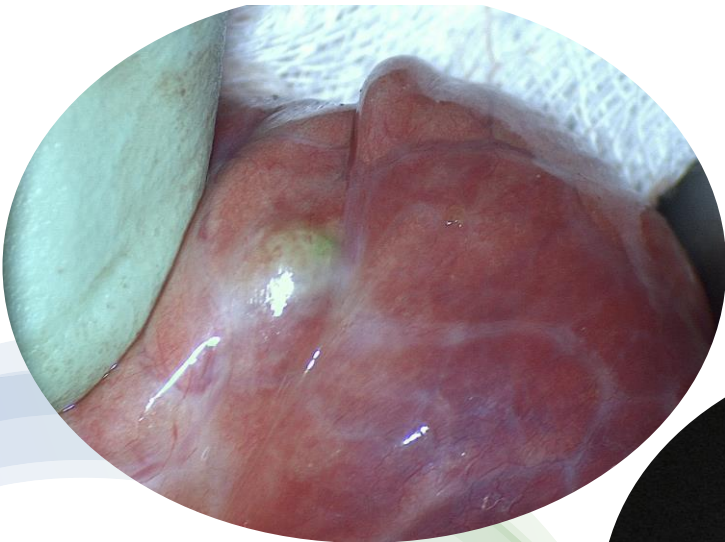
Resección quirúrgica

Administración intravenosa preoperatoria

Resección metástasis pulmonares (osteosarcoma)

Resección metástasis pulmonares (Tumor Wilms)

Dosis: 1,5mg/kg
Administración: 24 previas

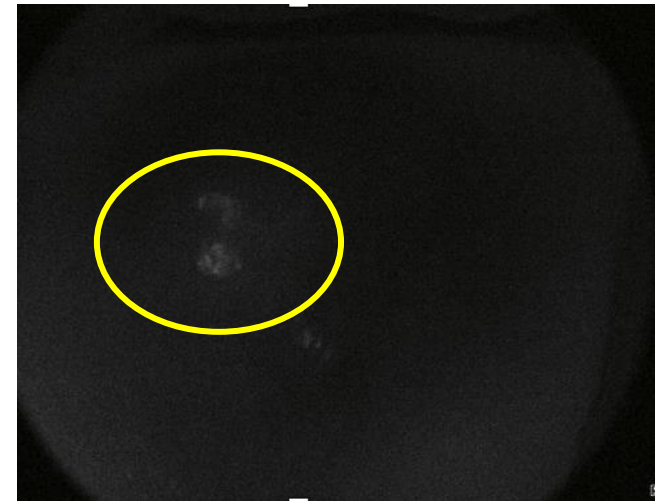


> 50 *pacientes incluidos*

Ganglioneuroma



Tumor seno endodérmico



Conclusiones

- El verde de indocianina es una herramienta de apoyo en la cirugía pediátrica.
- Su utilidad está cada vez más demostrada, pero todavía queda un largo camino para establecer protocolos y guías en las distintas indicaciones.



MUCHAS
GRACIAS