

# *Tumors of the Inferior Vena Cava*

Daniel Azoulay

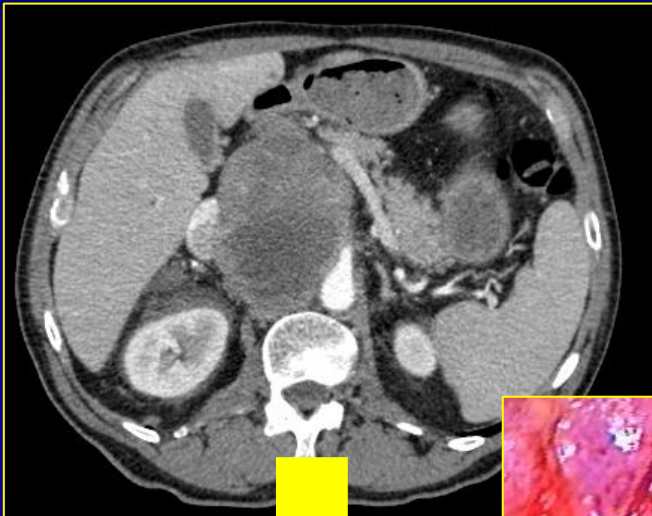
*Hôpital Henri Mondor, Créteil*

# *Surgery of the Inferior Vena Cava*

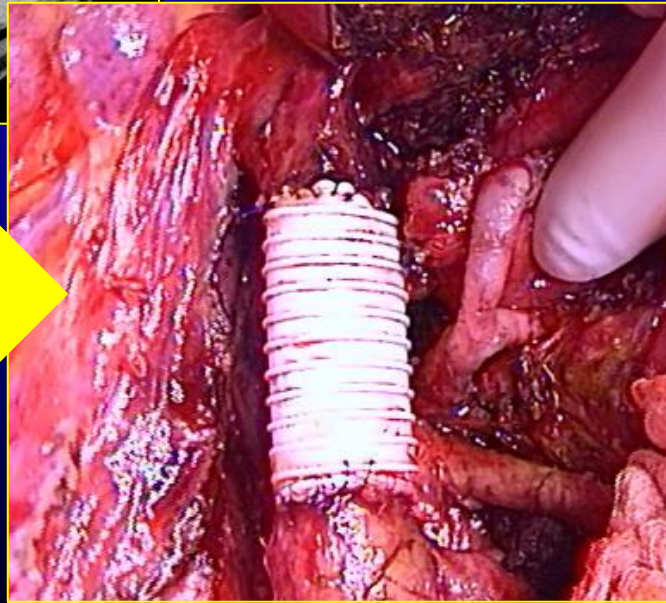
1. Indications
2. Surgical strategy
3. Types of IVC reconstruction
4. Liver surgery combined to IVC surgery
5. Minimally invasive surgery of IVC

# *Surgery of the Inferior Vena Cava*

## 1. Indications: Primary malignant tumor of the IVC



## **Leiomyosarcoma**

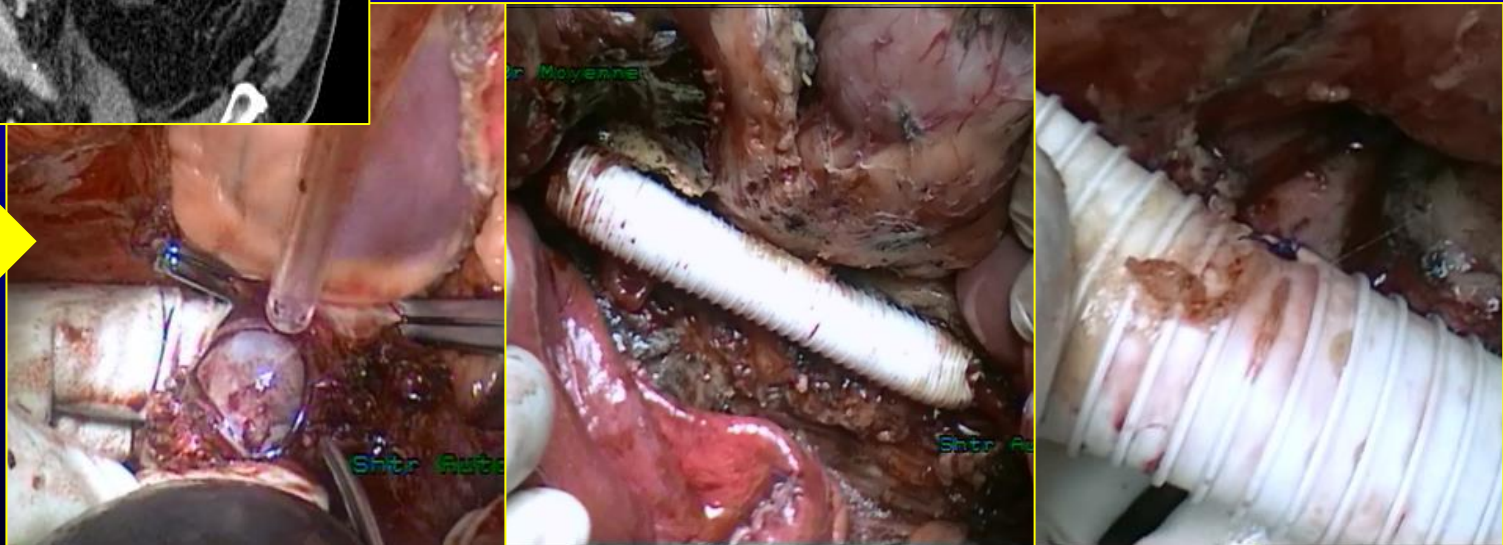
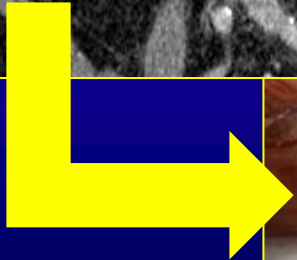


# *Surgery of the Inferior Vena Cava*

## 1. Indications: Abdominal tumors invading the IVC



## **Right renal cancer**





# *Surgery of the Inferior Vena Cava*

1<sup>bis</sup> Indications: Abdominal tumors invading the IVC

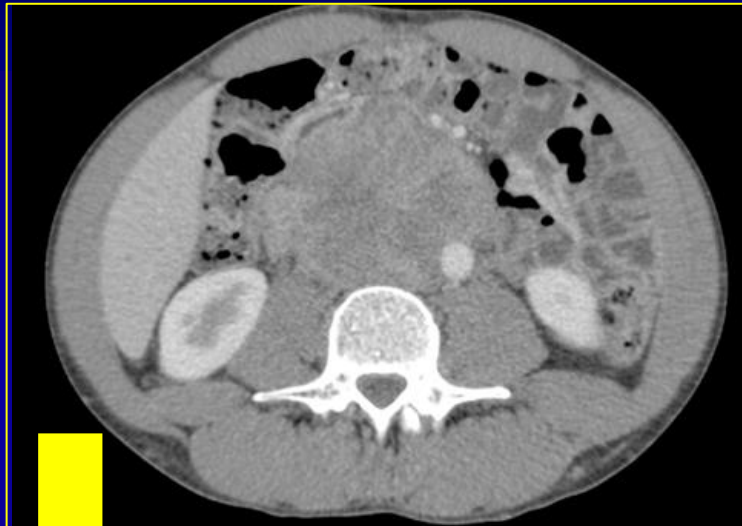


**Left renal cancer**

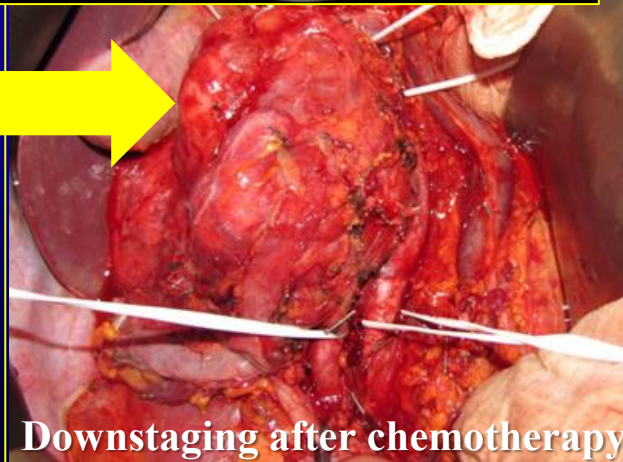


# *Surgery of the Inferior Vena Cava*

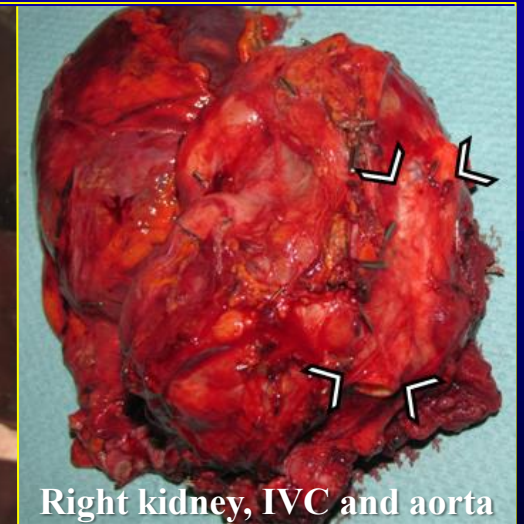
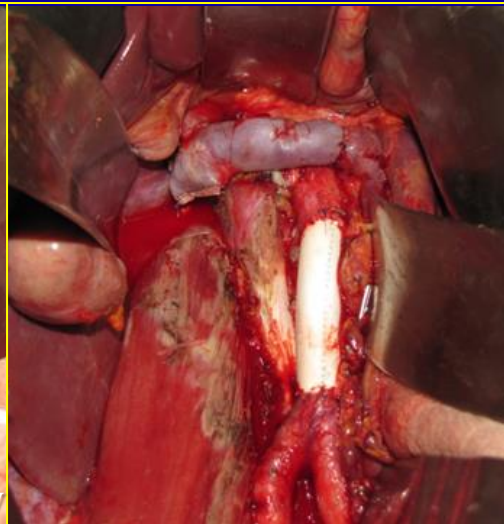
## 1<sup>ter</sup> Indications: Others



**IVC leiomyosarcoma  
invading the abdominal  
aorta.**



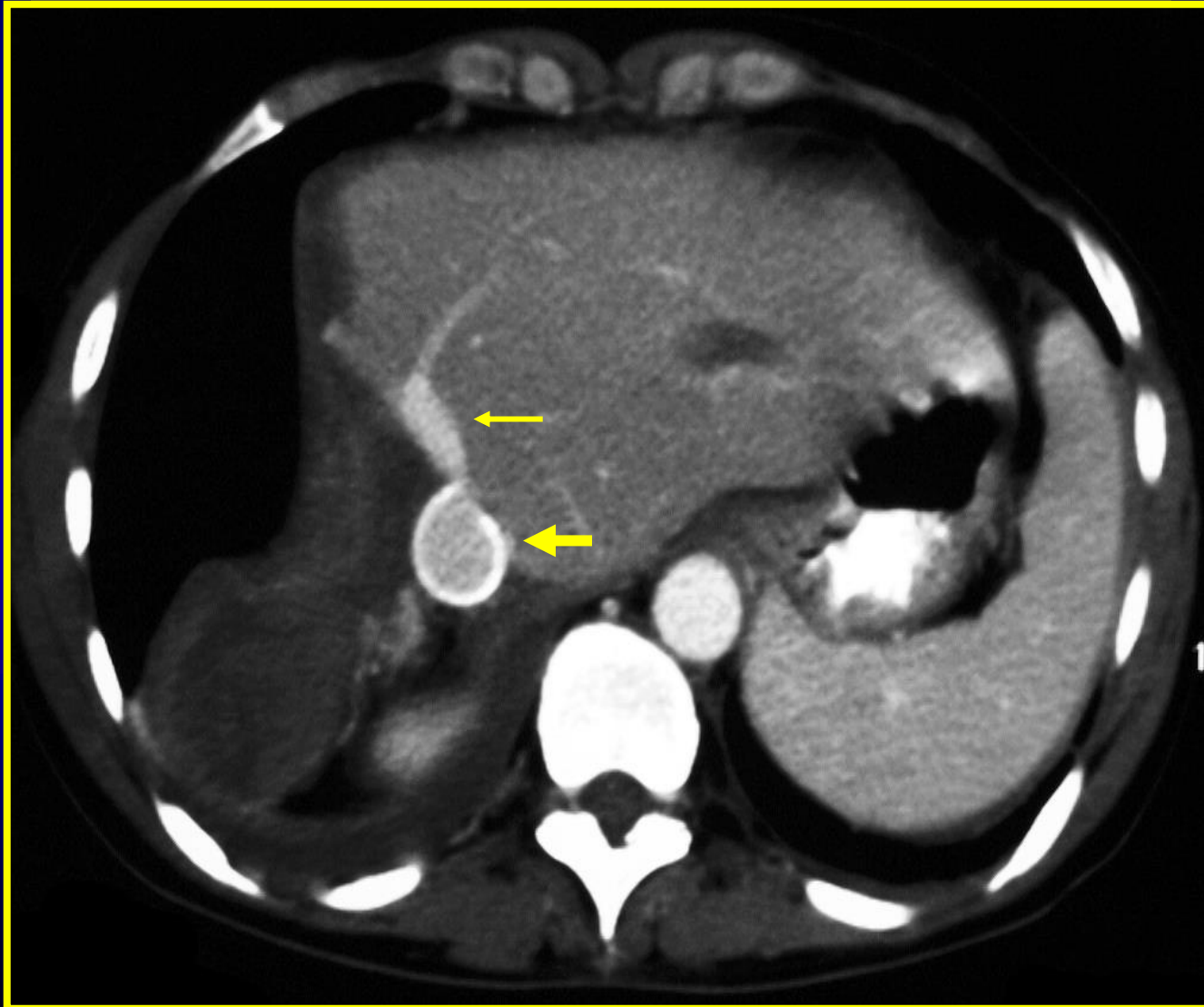
Downstaging after chemotherapy



Right kidney, IVC and aorta

# *Surgery of the Inferior Vena Cava*

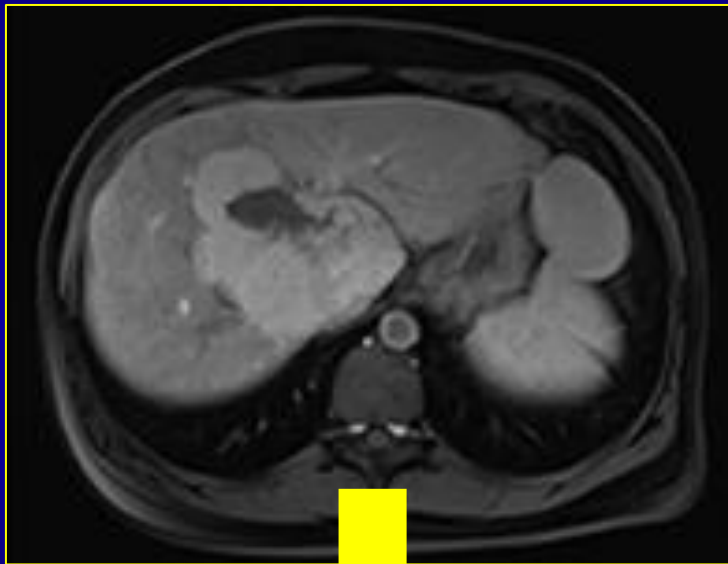
## 1. Indications: **Malignant liver tumors**



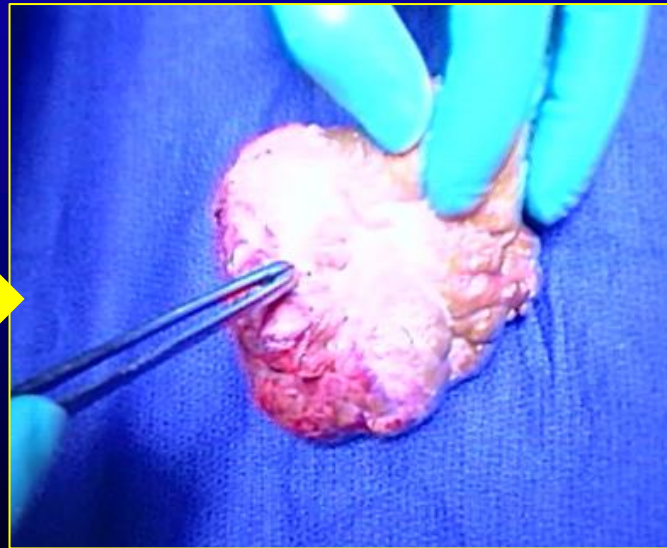


# *Surgery of the Inferior Vena Cava*

## 1. Indications: **Benign liver tumors**



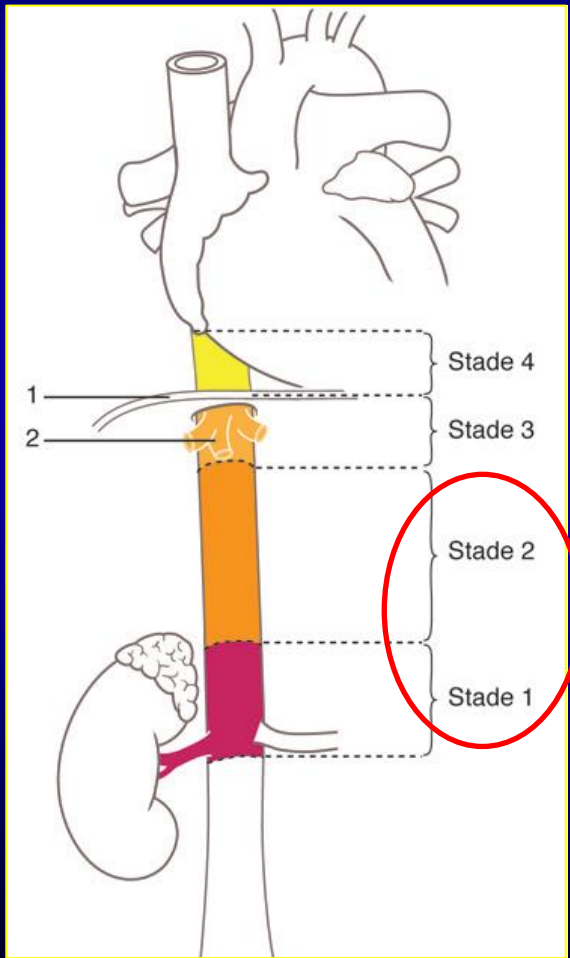
### **Focal nodular hyperplasia**





# *Surgery of the Inferior Vena Cava*

## 2. Surgical strategy



## **Classification of Neves and Zincke**



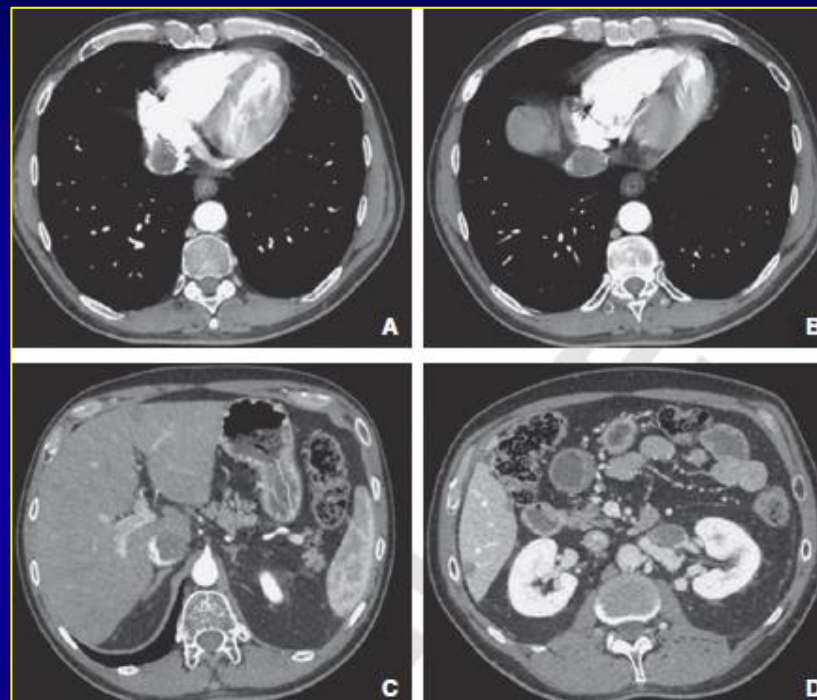
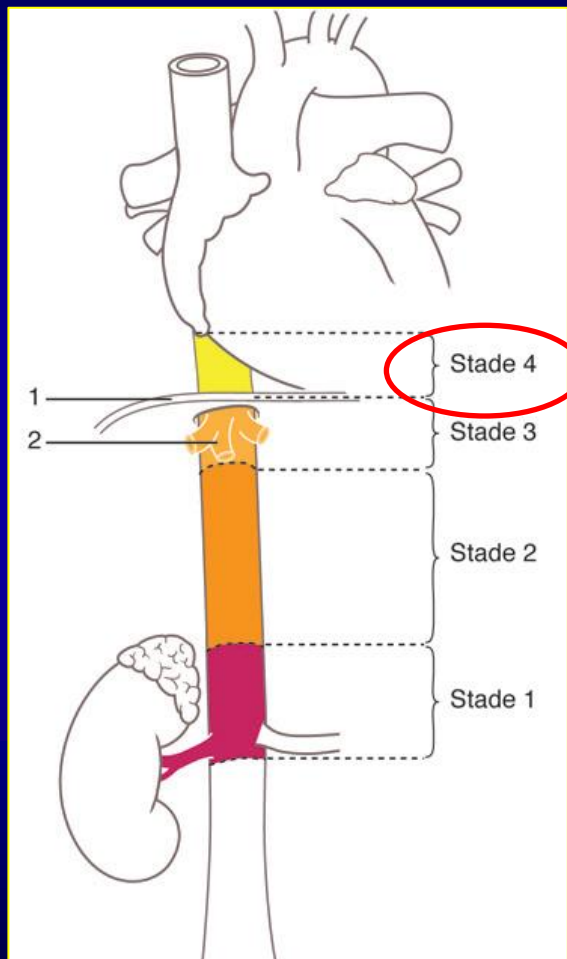
**Level I**



**Level II**

**Easy...usually**

# *Surgery of the Inferior Vena Cava*



**Level IV**

**Easy??**

## *Cardiopulmonary bypass and surgery of IVC*

1 <sup>st</sup> author	Year	n cases	Mortality (%)	5-yrs survival (%)
Skinner	1989	8	-	57
Novick	1990	27	7.4	32 (3-yrs survival)
Shahian	1990	10	0	5 patients alive
Stewart	1991	12	0	37
Langenburg	1994	3	0	100
Glazer	1996	18	5	56.6
Welz	1997	19	5.2	18
Yamashita	1999	12	8.3	18.8
Stahler	2000	9	44	39
Tsuji	2001	33	6	52.9
Chiappini	2002	13	0	8 patients alive
Dedeilias	2009	9	11.1	5 patients alive
Shuch	2010	63	22.2	-
Navia	2011	144	10.4	33
Fabre	2013	14	14.3	45.7
Fabiani	2013	7	0	7 patients alive at 1 year
<b>Total</b>	<b>89-13</b>	<b>401</b>	<b>Median 6%</b>	<b>&gt; spontaneous outcome</b>

## *Cardiopulmonary bypass and surgery of IVC combined to liver resection*

1 <sup>st</sup> author	n cases with/wo liver resection	Mortality (n/n)
Skinner	0/8	NA
Novick	1/27	NA
Shahian	0/10	0
Stewart	0/12	0
Langenburg	0/3	0
Glazer	0/18	0/1
Welz	0/19	0/1
Yamashita	0/12	0/1
Staehler	0/9	0/5
Tsuji	0/33	0/2
Chiappini	0/13	0/5
Dedeilias	0/9	0/1
Shuch	0/63	0/12
Navia	0/144	0/15
Fabre	2/12	0/2
Fabiani	2 /5	0
<b>Total</b>	<b>4 cases</b>	<b>reported mortality nil</b>



# *Surgery of the Inferior Vena Cava*

## 3. IVC reconstruction

**Autologous vein:** superficial femoral, internal saphenous, internal jugulaire, external iliac, left renal, gonadic, ...

**Cryopreserved Veins and arteries**

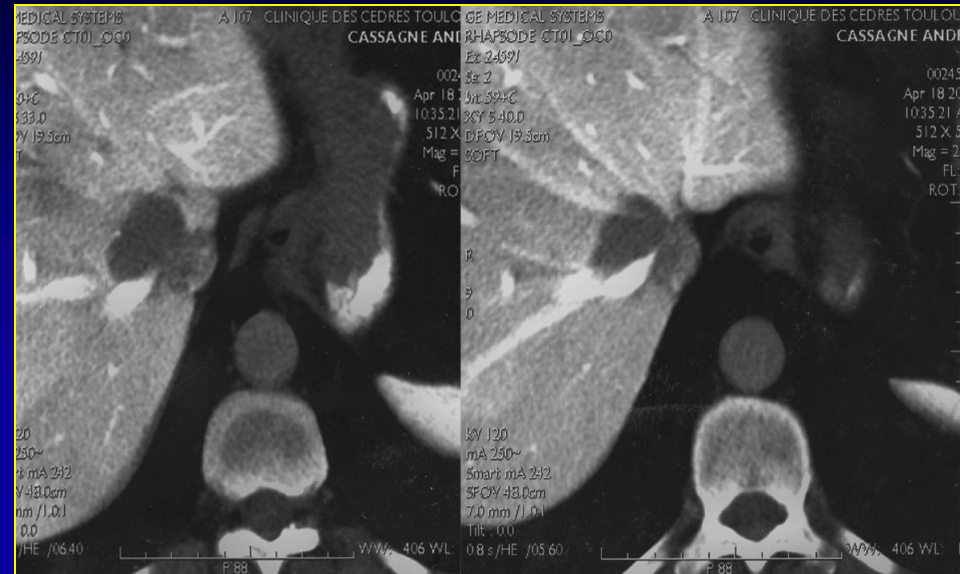
Dacron but high risk of thrombosis

**Reinforced PTFE (18-20 mm) = choice :**

- rapid endothelialization, good patency at long term,
- resistant to infection,
- resists to compression due to surrounding organs

# Hepatectomy Combined with Replacement of the IVC

## A. Prognosis



Resection = the only curative treatment of liver tumors

No treatment = median survival < 6 months

Best regimen of chemo = median survival < 12 months

T invading the IVC or hepato-caval confluence = CI

## Right Trisegmentectomy With a Synthetic Vena Cava Graft

Shunzaburo Iwatsuki, MD; Satoru Todo, MD; Thomas E. Starzl, MD, PhD

• In the course of a right trisegmentectomy of the liver, nearly the entire length of the retrohepatic vena cava was replaced with a Dacron graft. Patency of the graft was proved by a venacavogram a year later.  
(*Arch Surg* 1988;123:1021-1022)

Replacement of the vena cava during hepatic resection must be a rare occurrence. We have reported only one such case, using a vena caval allograft.<sup>1</sup> The perform-

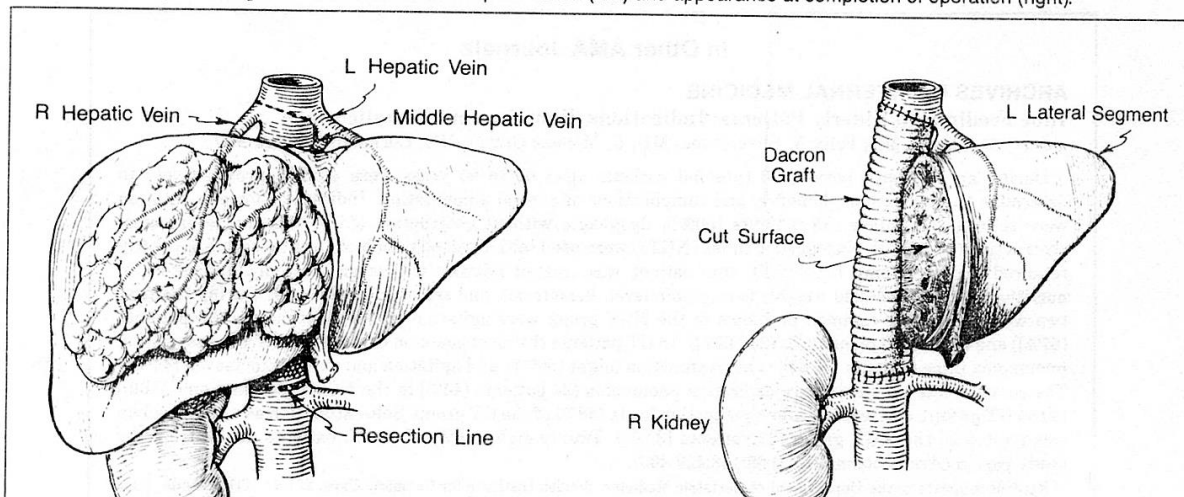
ance of grafting in this location has been notoriously poor, and it is widely believed that a prosthesis or vena caval graft cannot be expected to remain open. We report herein an unusual experience in the course of right trisegmentectomy whereby almost all of the retrohepatic vena cava was replaced with a Dacron graft, leaving only the entrance of the left hepatic vein.

### REPORT OF A CASE

A 54-year-old woman underwent exploratory surgery in another city by a competent hepatic surgeon who closed the incision when finding that a leiomyosarcoma had extensively invaded the retrohepatic vena cava (Fig 1). Three weeks later the subcostal portion of the previous thoracoabdominal incision was reopened and combined with an upper midline extension. Right hepatic trisegmentectomy was carried out including total excision of the caudate

Accepted for publication Jan 29, 1988.  
From the Department of Surgery, University Health Center of Pittsburgh, University of Pittsburgh, and the Veterans Administration Medical Center, Pittsburgh.  
Reprint requests to Department of Surgery, 3601 Fifth Ave, Falk Clinic 4 West, Pittsburgh PA 15213 (Dr Iwatsuki).

Fig 1.—Diagrammatic illustration of hepatic lesion (left) and appearance at completion of operation (right).



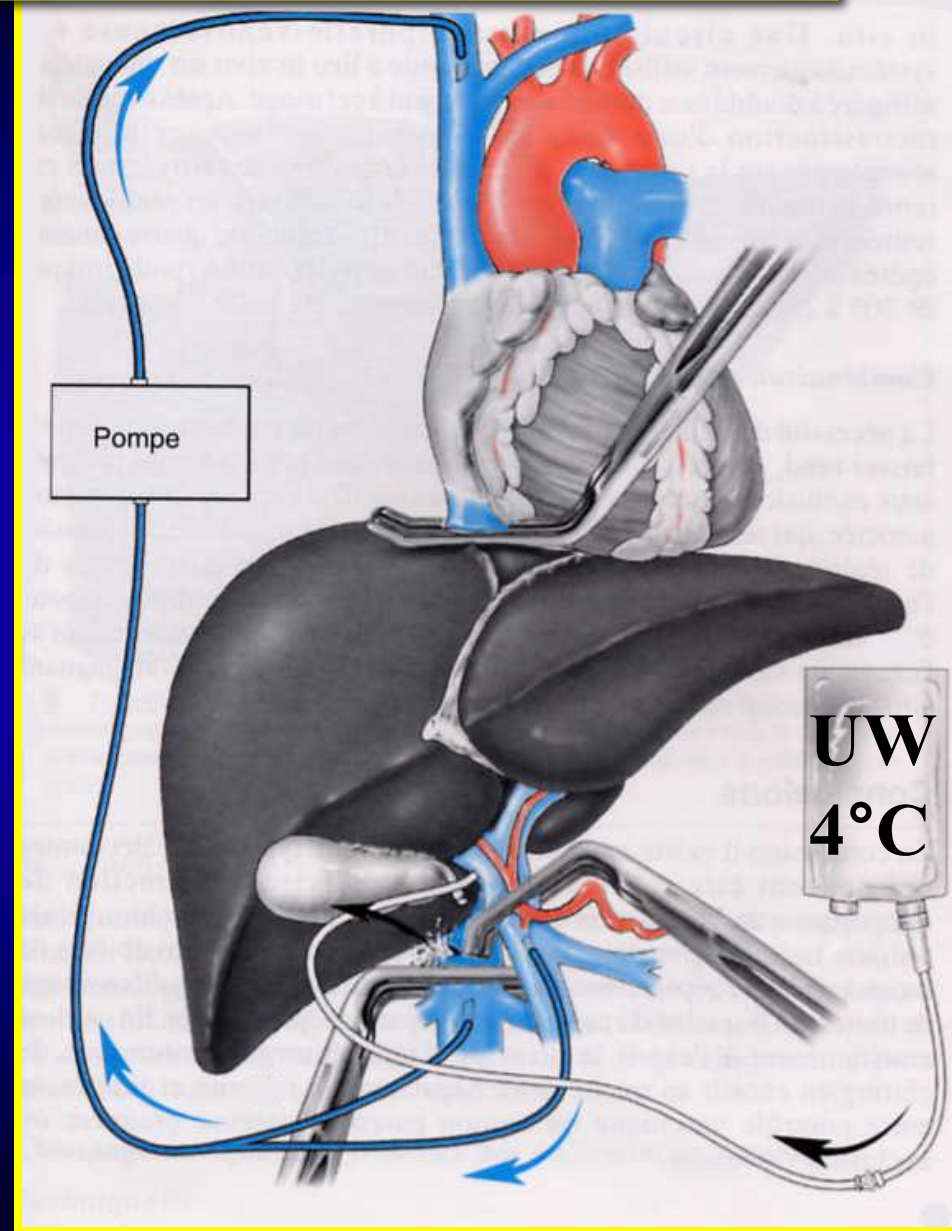
**Hepatectomy combined with Surgery of the IVC:  
Complex surgery = adaptation**

Vascular Controlle (3)

**TVE + Caval Clamping**

**+ Bypass**

**+ Hypothermic perf<sup>o</sup>**





# *Liver Surgery combined with Surgery of the Vena Cava*

## **D. Mortality**

Personnal experience 3/33 cases\* (9%)

Published reports from 1995 to 2014

Series >3 cases Hepatectomy + IVC replacement

Series from 3 to 60 cases, median = 7 cases

**Mortality = 24 / 187 cases (12.8%)**

- Liver failure = N° 1 (10 cases)
- Sepsis = N°2 (7 cases)
- Miscellaneous= N°3 (7 cases)

\*Azoulay, et al. Ann Surg 2006

\*Azoulay, et al. Br J Surg 2013

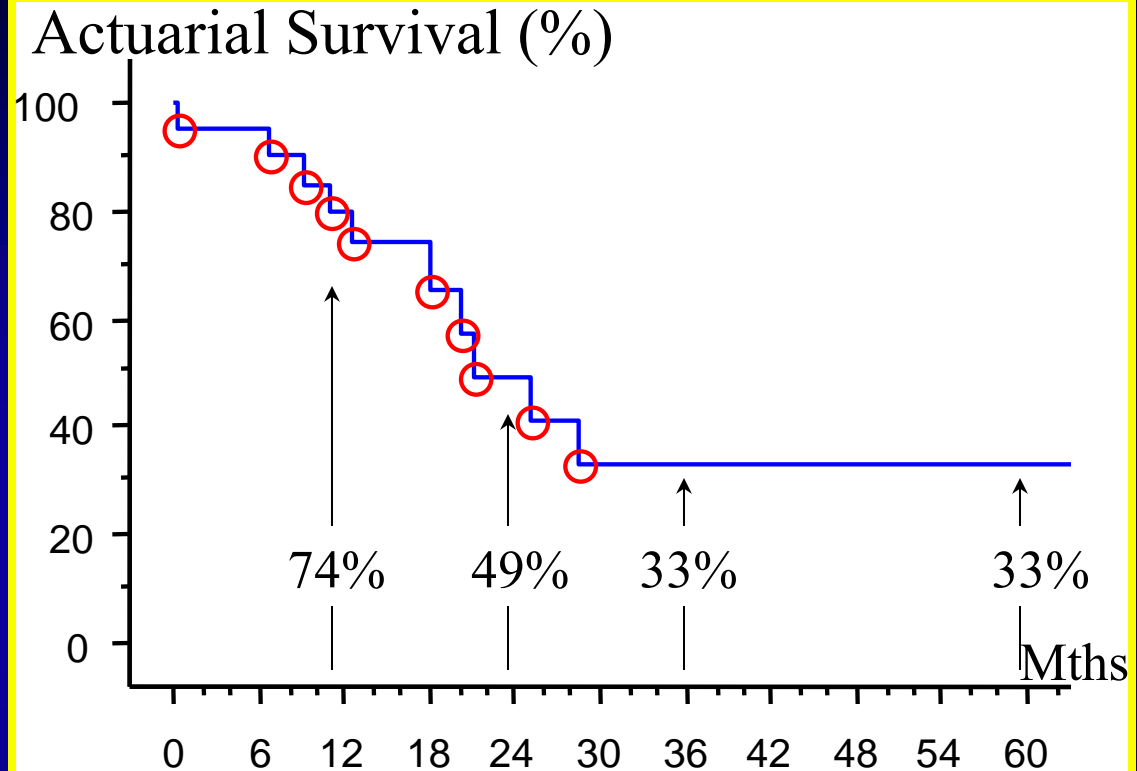
# Hepatectomy combined with Surgery of the Vena Cava :

*Experience : 22 patients Azoulay et al Ann Surg 2006*

## Results

### Actuarial Survival

1 yr	74%
2 yrs	49%
3 yrs	33%
5 yrs	33%



**Recurrence = 14 patients (64%)**

Recurrence

Liver 7 cases, Lung 4 cases,  
Brain 1 case, peritoneum 1 case  
Diffuse 1 case

## Hepatectomy combined with Surgery of the Vena Cava :

### Reported experience PTFE or Dacron (Medline 1980-2014)

15 Series  $\geq$  3 cases

Total = 173 cases excluding redundant cases

### Indications

1. Cholangiocarcinoma = 52 cases (30%)
2. Colo-rectal metastasis = 39 cases (23%)
3. Hepatocellular carcinoma = 26 cases (15%)
4. Others = 56 cases (32%)

# Relevant Reported Series of Combined Liver and IVC Reconstruction

Author	Patients	Vascular control	IVC reconstruction	R0 surgical margin	Complications Dindo > III	In hospital mortality	Overall survival
Malde et al. <sup>9</sup>	35 pt	TVE 15 In situ 14 Ex vivo 6	Graft tube 12 Direct repair 23	18 pt	14 pt	4 pt	5-years 19.6%
Nuzzo et al. <sup>6</sup>	23 pt	TVE 12 In situ 4 Other 7	Graft tube 7 Direct repair 16	23 pt	9 pt	1 pt	3-years 69%
Hashimoto et al. <sup>13</sup>	18 pt	TVE 1 Other 17	Direct 17 Graft tube 1	18 pt	–	–	5-years 46%
Azoulay et al. <sup>10</sup>	22 pt	TVE 8 In situ 9 Other 4	Graft tube 10 Direct repair 12	22 pt	14 pt	1 pt	5-yers 38.8%
Hemming et al. <sup>3</sup>	22 pt	TVE 11 In situ 1 Ex vivo 2 Other techniques 7	Graft tube 14 Direct repair 8	20 pt	10 pt	2 pt	5-yers 33%
Sarmiento et al. <sup>12</sup>	19 pt	TVE 13 Other techniques 6	Graft tube 18 Direct repair 1	16 pt	8 pt	1 pt	5-years 21%
Arii et al. <sup>5</sup>	11 pt	TVE 11	Graft tube 9 Direct repair 2	11 pt	2 pt	1 pt	5-years 25%
Miyazaki et al. <sup>14</sup>	16 pt	TVE 8 In situ 3 Side clamp 5	Graft tube 1 Direct repair 15	16 pt	4 pt	1 pt	5-years 22%



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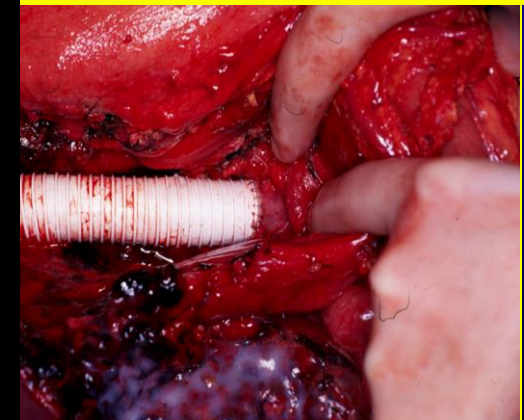
**Total 166 TVE: 66% Tube: 43% R0: 87% 61/148: 41% 11/148: 7.4%**

# Combined Liver Resection and Reconstruction of the Supra-Renal Vena Cava

*D Azoulay et al., Ann Surg 2006; 244:80-88*

*Daniel Azoulay, MD, PhD,\* Paola Andreani, MD, PhD,\* Umberto Maggi, MD,\*  
Chadi Salloum, MD,\* Fabiano Perdigao, MD,\* Mylène Sebagh, MD, PhD,†  
Antoinette Lemoine, PhD,‡ René Adam, MD, PhD,\* and Denis Castaing, MD\**

...n and reconstruction combined with liver  
performed in selected patients. The lack of  
the spontaneous poor prognosis justify  
that surgery is carried out at a center  
surgery and liver transplantation. The  
chemotherapy regimens is required to  
ults of this salvage surgery.



- 1) Feasibility is now demonstrated
- 2) Technologically « heavy » surgery
  - Bypass protects the renal function
  - Hypothermic perf protects the liver parenchyma
- 3) Preference for reinforced PTFE (Goretex)
- 4) Sepsis and thrombosis are rare
- 5) Operative Mortality  $\approx 10\%$

## Vascular reconstruction combined with liver resection for malignant tumours

D. Azoulay<sup>1,2</sup>, G. Pascal<sup>1</sup>, C. Salloum<sup>1</sup>, R. Adam<sup>1</sup>, D. Castaing<sup>1</sup> and N. Tranecol<sup>1</sup>

<sup>1</sup>Centre Hépatobiliaire, Département de Chirurgie Hépatobiliaire, Assistance Publique-Hôpitaux de Paris (AP-HP) Hôpital Paul Brousse, Villejuif, and <sup>2</sup>Service de Chirurgie Hépatobilio-Pancreatique, AP-HP Hôpital Henri Mondor, Créteil, France

Correspondence to: Professor D. Azoulay, Service Chirurgie Digestive, Hépatobilio-Pancreatique et Transplantation Hépatique, Hôpital Henri Mondor, 51 Avenue De Laune De Tassigny, 94010 Créteil, France (e-mail: daniel.azoulay@hmn.apbp.fr)

D Azoulay *et al.*, *Br J Surg* 2013

1997-2009

84 patients : 84 hepatectomies + 97 vascular reconstructions

Portal Vein : 32, **Vena Cava 33**, Hepatic Vein 23, Hepatic Artery 5

Morbidity 62%, Operative Mortality (90 ds) 14%

**Table 2** Multivariable binary logistic regression analysis of factors predictive of death

	Odds ratio	P
ICG-R15 > 10%	19.78 (1.43, 278.76)	0.031
Total bilirubin > 34 µmol/l	46.42 (1.83, 1215.04)	0.023
Duration of ischaemia	1.76 (1.09, 2.66)	0.011
Amount of blood transfused	1.15 (1.05, 1.34)	0.025
Combined major extrahepatic procedure	13.43 (1.22, 151.74)	0.042

Overall Survival at 3 years

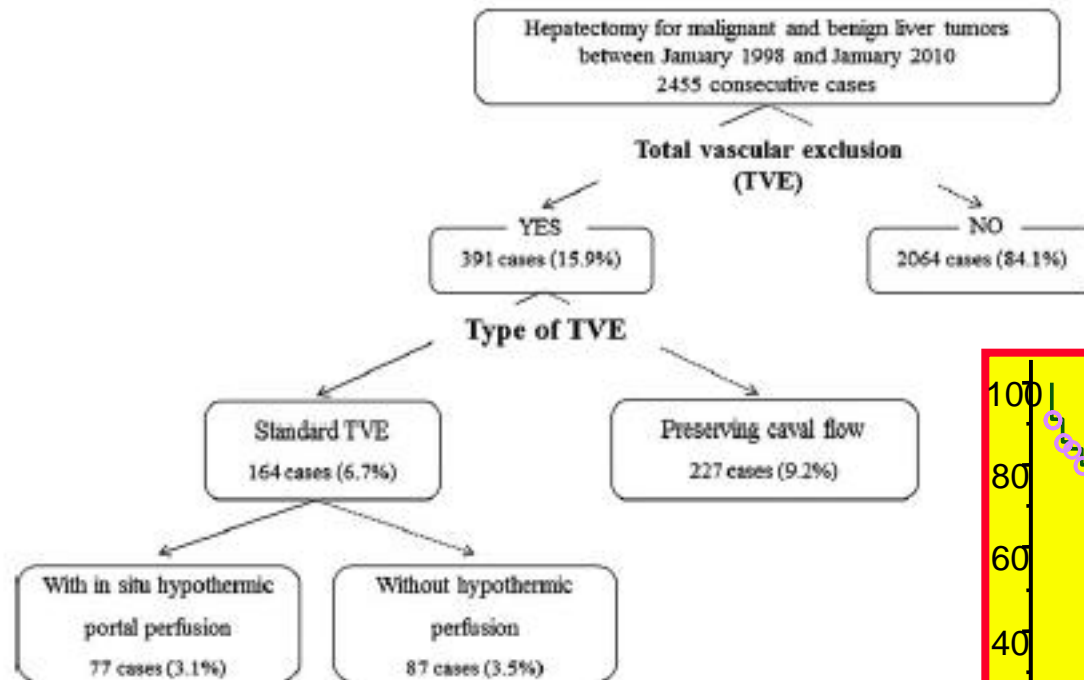
- Whole series : 44%
- LMCRC : 42%
- HCC: 27%

# Complex Liver Resection Using Standard Total Vascular Exclusion, Venovenous Bypass, and In Situ Hypothermic Portal Perfusion

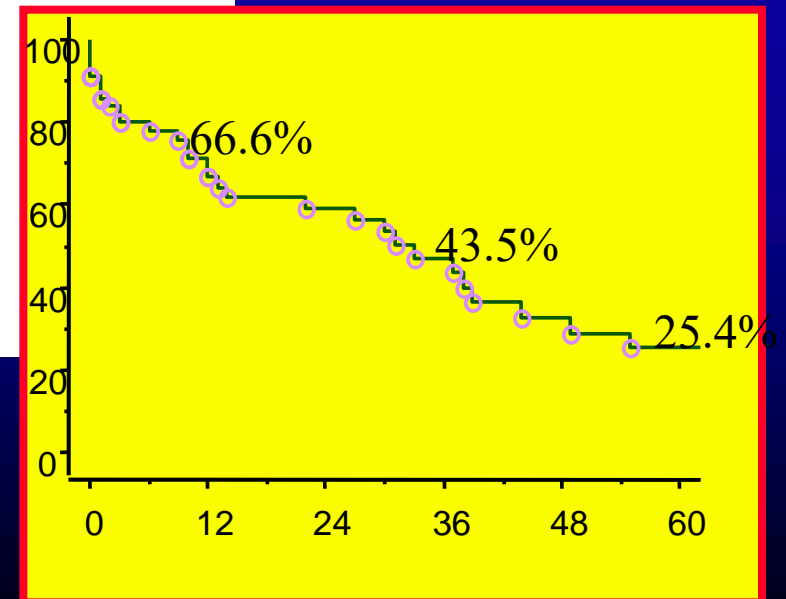
## An Audit of 77 Consecutive Cases

Daniel Azoulay, MD, PhD,\*†‡ Chetana Lim, MD,† Chady Salloum, MD,† Paola Andreani, MD, PhD,\*  
Umberto Maggi, MD,† Tonine Bartelmaos, MD,† Denis Castaing, MD,\*§ Gérard Pascal, MD,\*†  
and Feetal Fesuy, MD†

**Azoulay D, et al., Ann Surg 2014**

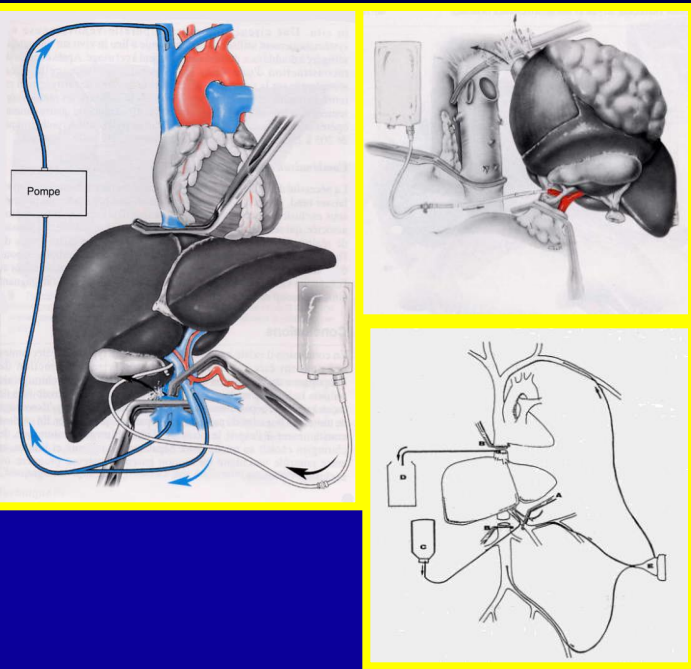


**90 D-Mortality : 19.5%**

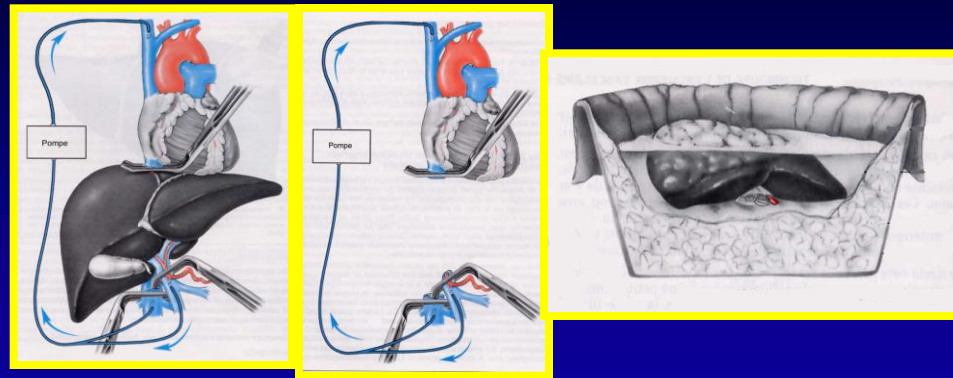


**CRM : 31 cases (40.2% of cases)**

# *In situ vs Ex situ ? review*



*vs*



## Postoperative Mortality

**12.7%**

*vs*

**27.7%**

**Including**

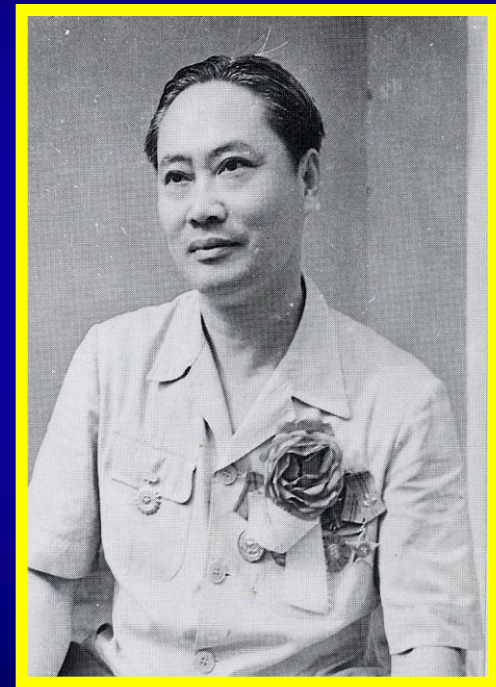
**8 cases salvage transplantation...**



# *T Heming and D Azoulay, Ann Surg 2014*

In his memoirs\* Tung related his first use of hypothermia, placing the patient in a bath tub to which were added chunks of ice until his temperature dropped to below 30<sup>0</sup> C (presumably anesthetized).

The patient was then moved to the operating table to begin the operation...

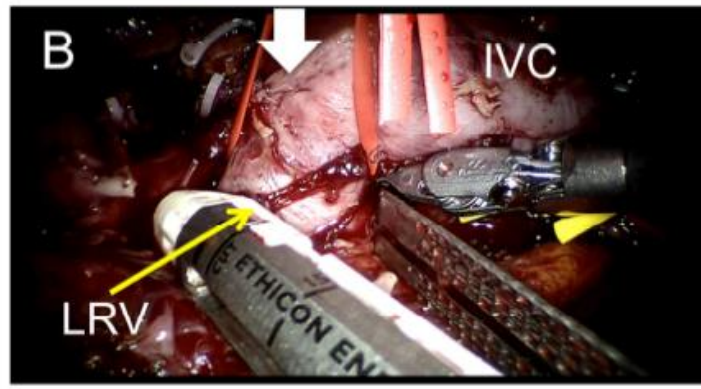
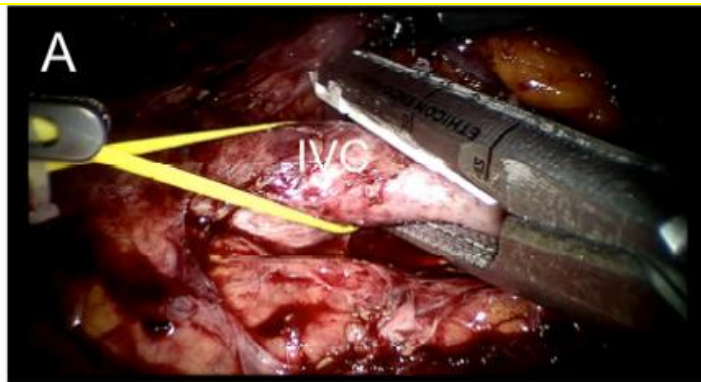
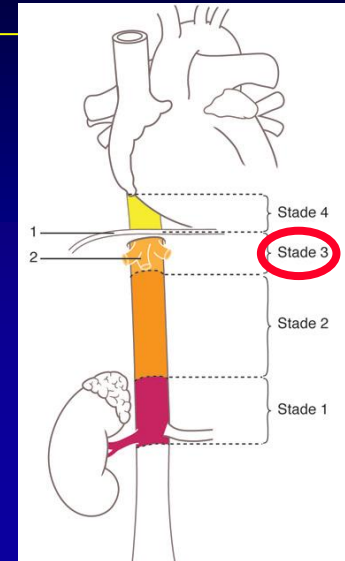


\*Tung TT. *Reminiscences of a Vietnamese Surgeon*. Red River; Foreign Languages Publishing House, Hanoi 1980. Excerpts also found in Tung, TT *Đường vào khoa học của tôi* [My Road to Science]. Youth Publishing House, Hanoi, 1993

# Minimally invasive surgery of the IVC ?

## Robotic Level III Inferior Vena Cava Tumor Thrombectomy: The initial series

Inderbir S. Gill, Charles Metcalfe, Andre Abreu, Vinay Duddalwar, Sameer Chopra, Mark Cunningham, Duraiyah Thangathurai, Osamu Ukimura, Raj Satkunasivam, Andrew Hung, Rocco Papilla, Monish Aron, Mihir Desai, Michele Gallucci



- 16 patients
- N= 7 (level II), **N= 9 (level III)**
- Median operative time : 4.9 h (4.5-6.3)
- Blood loss 375 cc (200-7000)
- No mortality**
- 1 complication (Clavien 3b)

# *Surgery of the Inferior Vena Cava*

## CONCLUSION

1. (Relatively) safe
2. Reconstruction is not always needed
3. Reinforced PTFE +++
4. Risk is higher when combined to liver resection
5. Highly multidisciplinary approach and management
6. Mini invasive surgery feasible ...but with caution