

# CARBON ION THERAPY FOR UNRESECTABLE RETROPERITONEAL SARCOMAS

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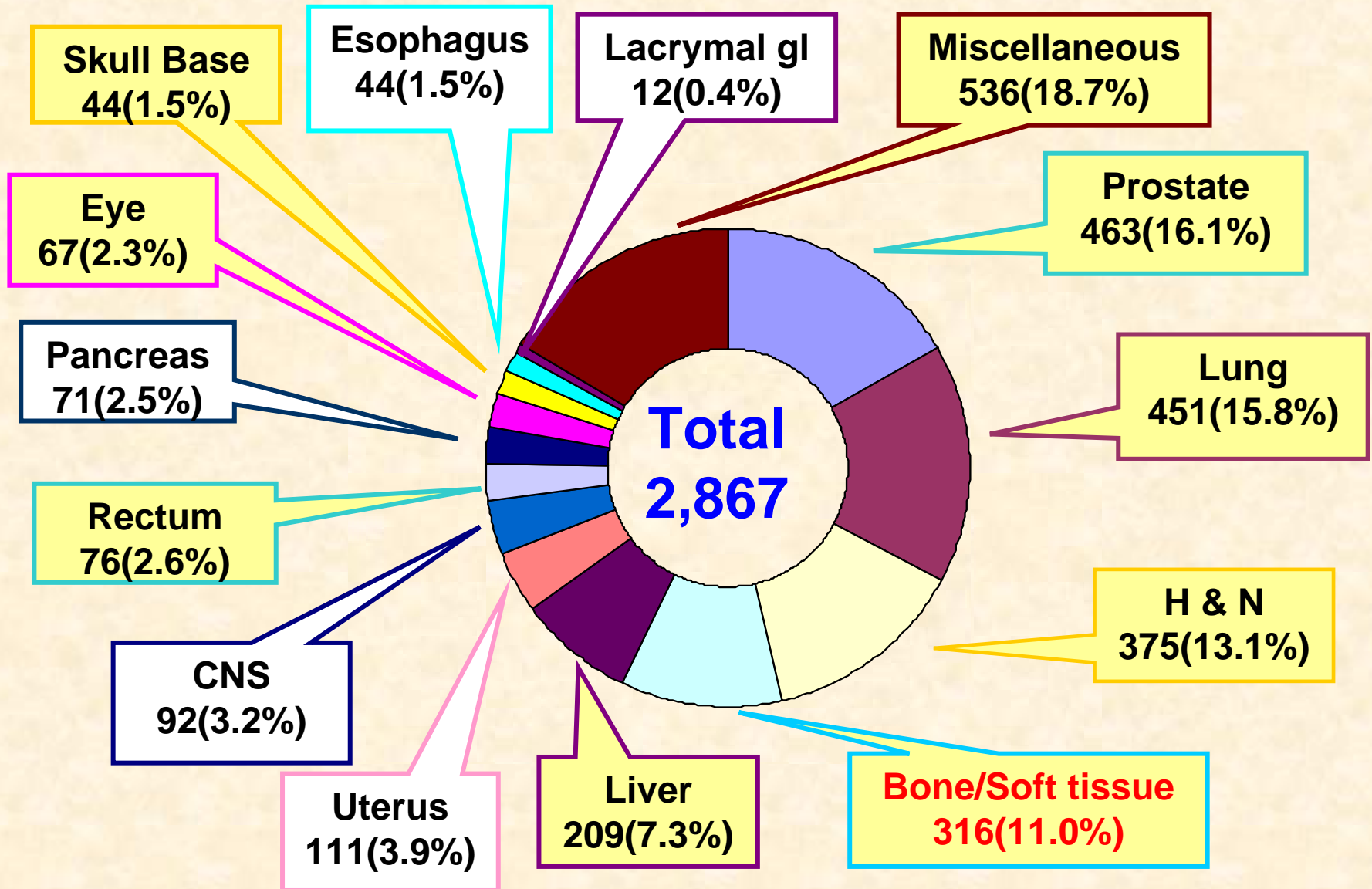
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# Purpose

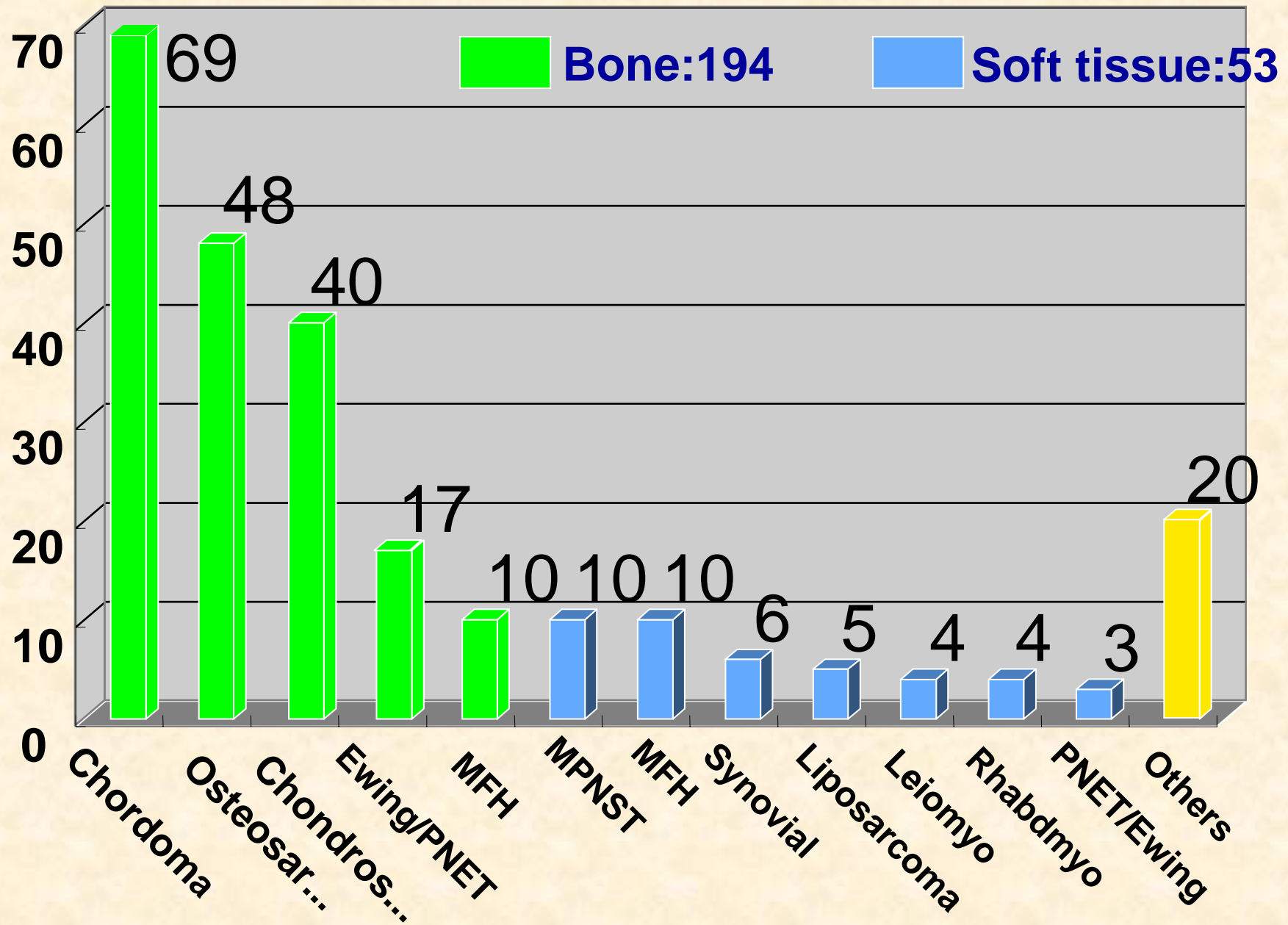
- To evaluate the effectiveness and safety of carbon ion RT in patients with unresectable retroperitoneal STS.
- To compare the results of carbon ion RT with those of surgical series in the literatures.

# *Tumor Sites in C-ion Radiotherapy*

*(6.1994~8.2006)*



# Bone & Soft Tissue Sarcoma by Histology



# Backgrounds

- Surgery is currently the mainstay of treatment for retroperitoneal soft tissue sarcomas (STS)
- Macroscopic total resection is done in 50-70% of patients.
- The 5-year local control and overall survival rates obtained by surgery with/without adjuvant RT are reported to be 50% and 50%, respectively.
- Due to high-LET components and the Bragg peak property, carbon ion RT is expected to be more effective and safe in treatment of sarcomas than x-rays.

# Materials

- Between 1996 and 2004, 17 pats with unresectable retroperitoneal STS were treated in phase I/II and phase II study with carbon ion RT.
- 10 males and 7 females
- Median age 53 years (16 - 64).
- 8 patients with previously untreated and 9 patients with recurrent tumor
- Phase I/II Study(Dose escalation) 4
- Phase II Study(Fixed dose) 13

# Tumor Characteristics

• Histological type	MFH*	5
	Liposarcoma	3
	MPNST**	3
	Other	6
• Tumor Grade	Low	2
	High	15
• Maximum Tumor Diameter	4~15cm (Median : 10)	
• Clinical Tumor Volume	57~1034cc (Median : 416)	
• Tumor Localization	Abdomen	10
	Pelvis	7

\*MFH: Malignant fibrous histiocyoma

\*\*MPNST: Malignant peripheral nerve sheath tumor

# Carbon Ion Radiotherapy

- HIMAC (Heavy Ion Medical Accelerator in Chiba)
  - Fixed vertical and horizontal beams
- Energy            290 or 350 MeV (Vertical beam)  
                         290 or 400 MeV (Horizontal beam)
- Range            15cm (290 MeV), 20cm (350 MeV),  
                         25cm (400 MeV)
- RBE (Relative Biologic Effectiveness) : 2.0~3.5  
                         3.0 at the distal part of the SOBP
- Numbers of ports
  - 2 ports                            5
  - 3 ports                            12



# Carbon Ion Radiotherapy for Unresectable Bone and STS

- Phase I/II dose escalation study
  - Dose level 1: 52.8 GyE (3.3 GyE/Fr) 1
  - Dose level 2: 57.6 GyE (3.6 GyE/Fr) 0
  - Dose level 3: 64.0 GyE (4.0 GyE/Fr) 2
  - Dose level 4: 70.4 GyE (4.4 GyE/Fr) 0
  - Dose level 5: 73.6 GyE (4.6 GyE/Fr) 1
- Phase II fixed dose study
  - 70.4 GyE (4.4 GyE/Fr) 12
  - 73.6 GyE (4.6 GyE/Fr) 1

Carbon ion RT was given in 16 fractions over 4 weeks

# Treatment Results

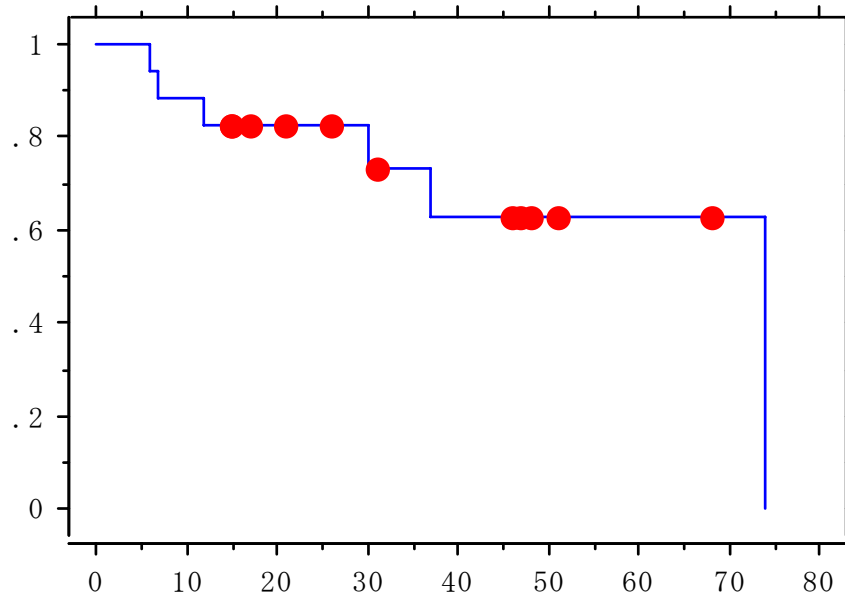
- All 17 patients completed the planned carbon ion RT.
- Follow-up: > 1 year
- Median survival time 30 moths (6-74)
- Alive or dead
  - Alive 6
  - Dead 11
- Local failure
  - Yes 4
  - No 13
- Median time to local failure 21 moths (3-35)
- Any recurrence
  - Yes 11
  - No 6

# Radiation Morbidity (RTOG/EORTC)

Acute:	Skin	Grade 0	0	0%
		Grade 1	13	76%
		Grade 2	4	24%
	Gastrointestinal	Grade 0	17	100%
Late:	Skin	Grade 0	1	6%
		Grade 1	15	88%
		Grade 2	1	6%
	Gastrointestinal	Grade 0	17	100%
	Peripheral nerve	Grade 0	12	71%
		Grade 1	0	0%
		Grade 2	5	29%

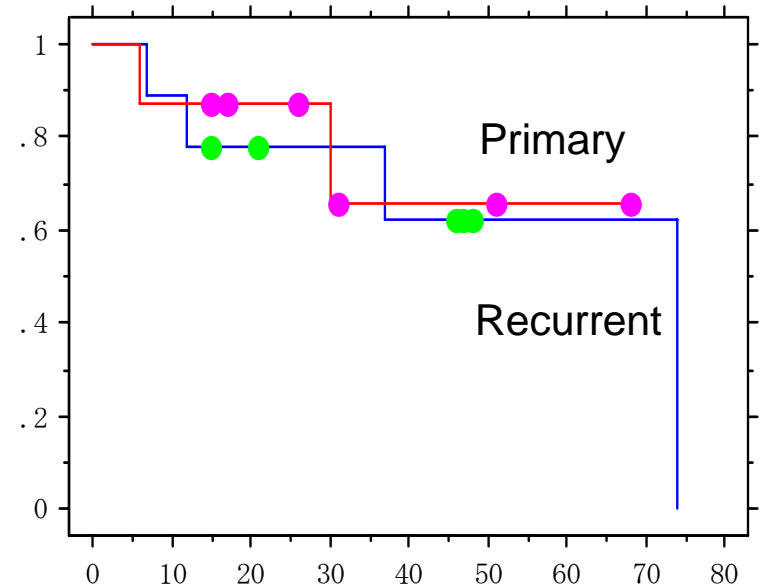
# Overall Survival

All patients (n=17)



All patients: 73% at 3 years  
63% at 5 years

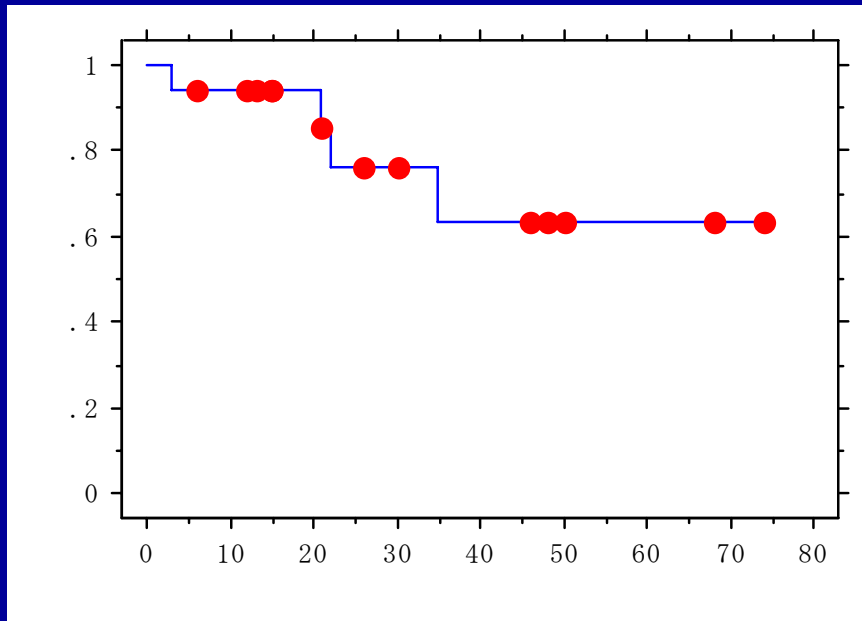
Primary tumor (n=8)  
Post-op recurrent tumor (n=9)



Primary tumor: 65% at 5 years  
Recurrent tumor: 62% at 5 years

# Local Control

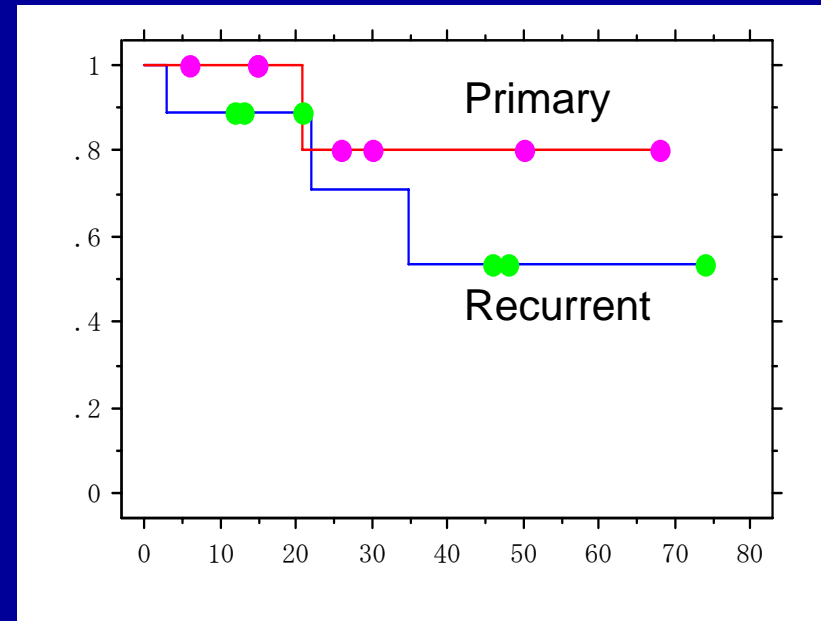
All patients (n=17)



All patients : 63% at 3 years  
63% at 5 years

Primary tumor (n=8)

Post-op recurrent tumor (n=9)

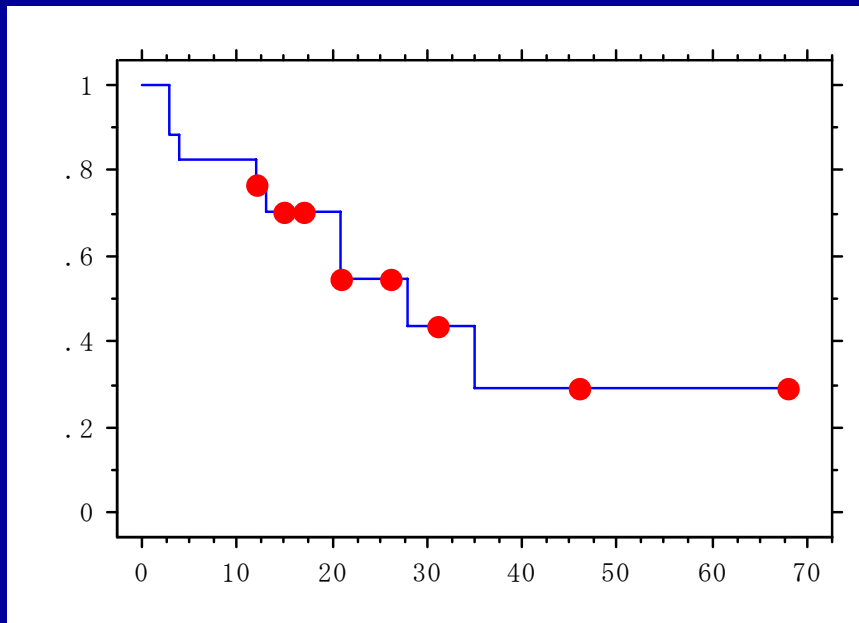


Primary tumor : 80% at 3 year  
80% at 5 years

Recurrent tumor : 53% at 3 years  
53% at 5 years

# Intra-Abdominal/Pelvic Recurrence-Free Rate

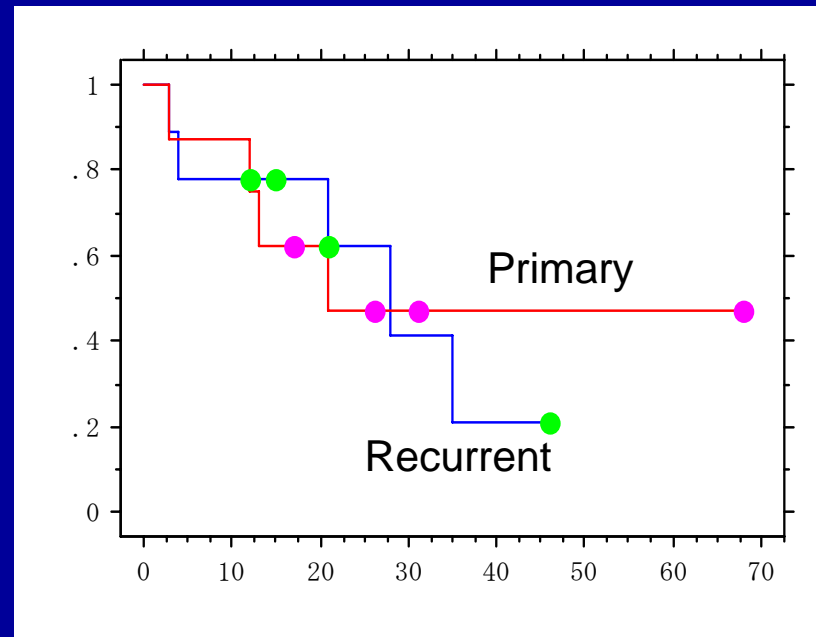
All patients (n=17)



All patients :      29% at 3 years  
                             29% at 5 years

Primary tumor (n=8)

Post-op recurrent tumor (n=9)

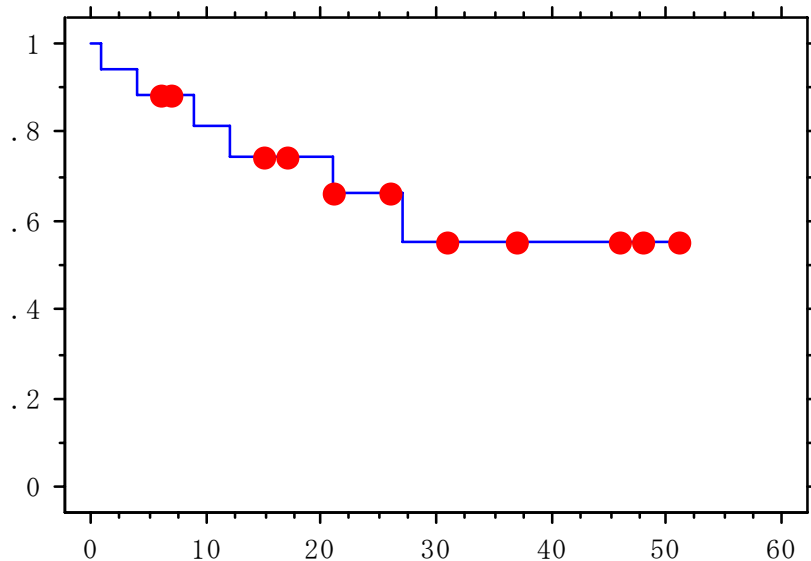


Primary tumor :      46% at 3 years  
                             46% at 5 years

Recurrent tumor :   20% at 3 years

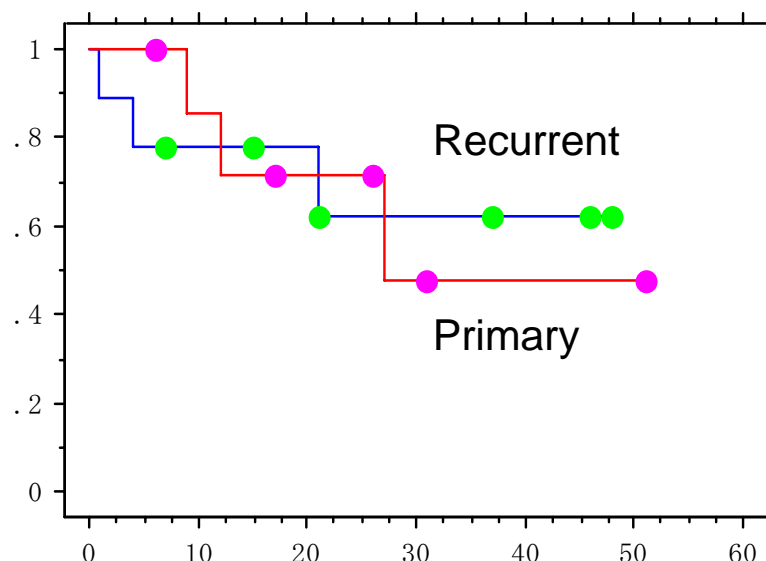
# Extra-Abdominal/Pelvic Recurrence-Free Rate

All patients (n=17)



All patients      55% at 3 years

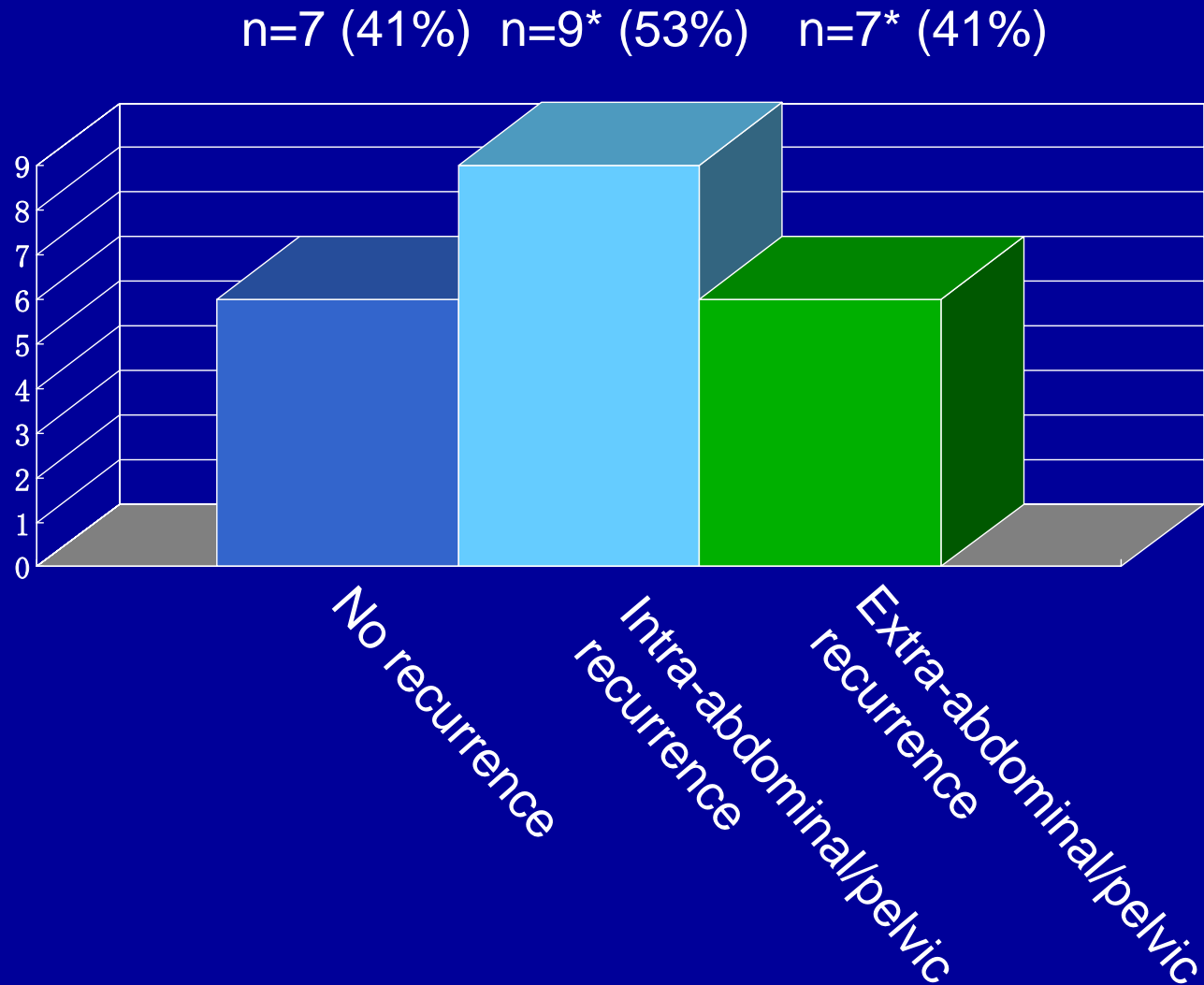
Primary tumor (n=8)  
Post-op recurrent tumor (n=9)



Primary tumor      47% at 3 years

Recurrent tumor      62% at 3 years

# Pattern of Recurrences



\*4 patients had both type of recurrence



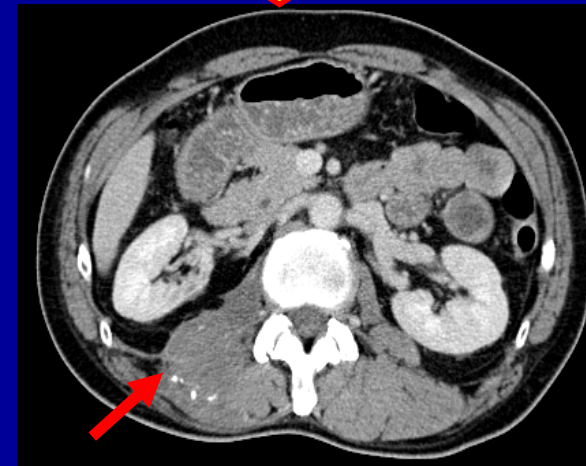
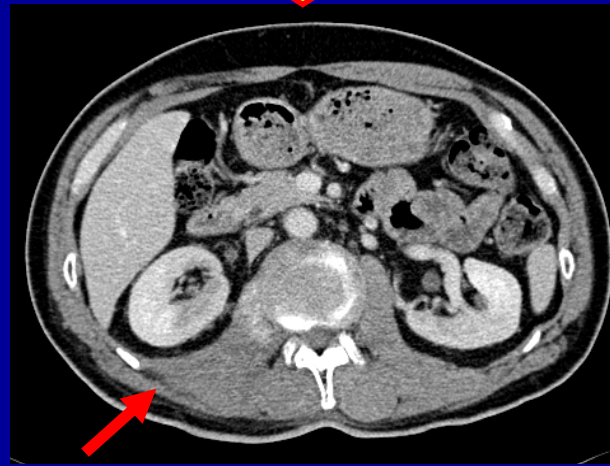
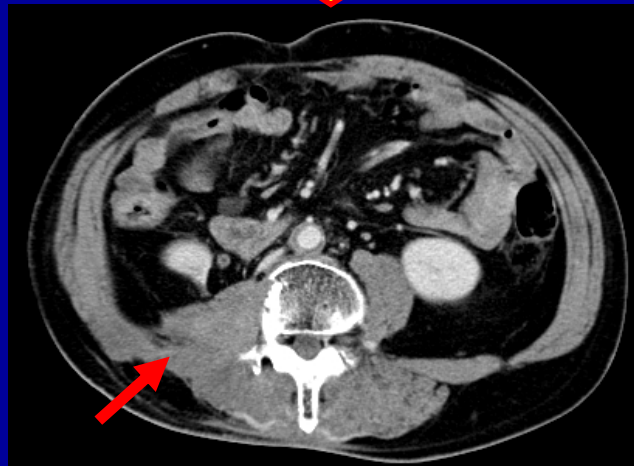
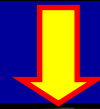
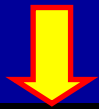
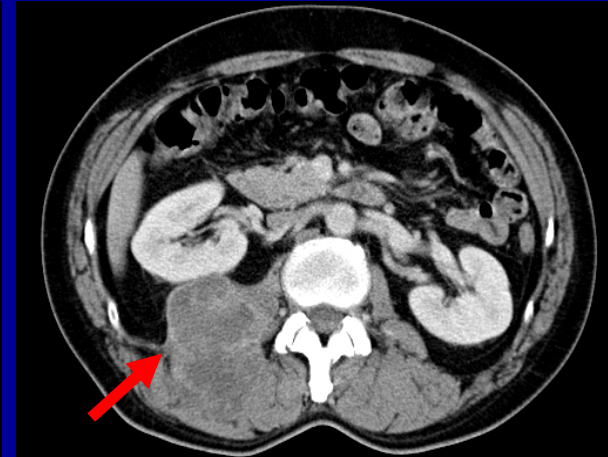
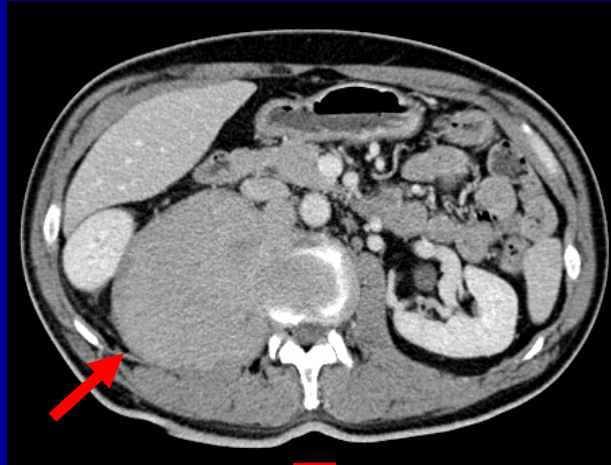
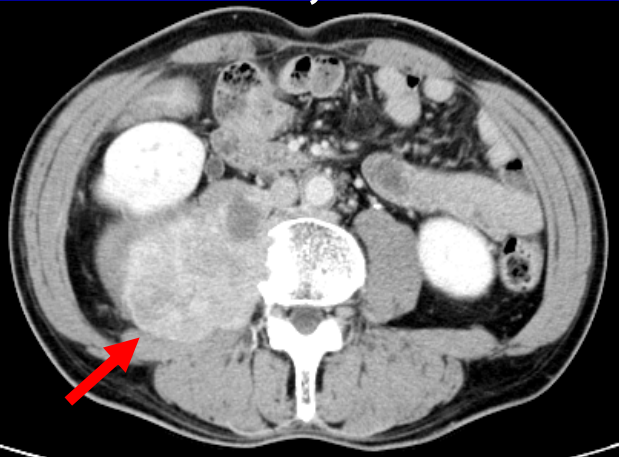
# ***Retroperitoneal Sarcoma***

(64~70.4 GyE/16fr)

**Rhabdomyo-  
sarcoma, 52 M**

**Ewing/PNET, 53 M**

**MFH, 45 F**



**60mo**

**24mo**

**36mo**

# Results of Major Published Surgical Series

Reference	Years Studied	No. of Patients	Complete resection (%)	5-yr OS(%)	5-yr LC(%)
Catton	1975-1988	104	52	36	28
Lewis	1982-1997	278	67	54 <sup>a</sup>	29 <sup>a</sup>
Van Dalen	1989-1994	142	54	ND	32 <sup>b</sup>
Stoeckle	1980-1994	165	65	46	43 <sup>c</sup>
Gilbeau	1990-2000	45	96	60	40
Hassan	1983-1995	97	65	51 <sup>d</sup>	44 <sup>d</sup>
Gronchi	1982-2001	167	88	53	54 <sup>e</sup>
Krepien	1991-2004	67	82	58	40
<b>Current series</b>	<b>1996-2004</b>	<b>17</b>	<b>-</b>	<b>63</b>	<b>63</b>

Abbreviations: OS = overall survival; LC = local control; ND = no data available

<sup>a</sup> Outcomes for 231 patients who underwent **resection**; the survival rate is cause-specific.

<sup>b</sup> Outcomes for 114 patients who underwent **complete resection**; the local control rate is crude percentage.

<sup>c</sup> Outcomes for 94 patients who underwent **complete resection**.

<sup>d</sup> Outcomes for 63 patients who underwent **complete resection**.

<sup>e</sup> The control rate is the 5-year crude cumulative local recurrence rate.

# Conclusions

- Local control and overall survival at 5 years in patients with retroperitoneal STS treated by carbon ion RT are identical or even superior to those in reported data where the patients were treated by surgical resection with/without adjuvant RT.
- Despite the high doses delivered and the advanced nature of tumors in this series, no severe toxicities were observed.
- Carbon ion therapy is considered to be an effective and safe treatment for retroperitoneal STS.