
15 YEARS OF PROTON THERAPY IN SOUTH AFRICA

Clinicians involved in the program

E. Mills

V. Levin

F Vernimmen

J. Wilson

C. Stannard

J. Harris

J. Parkes

S. de Canha

PROTON BEAM HAS MAINLY BEEN USED FOR RADIOSURGERY PURPOSES

- limited treatment days per week
- small field (10 cm circle), passively scattered beam
- stereotactic positioning chair

200 MeV Fixed Horizontal Beam in Proton Vault

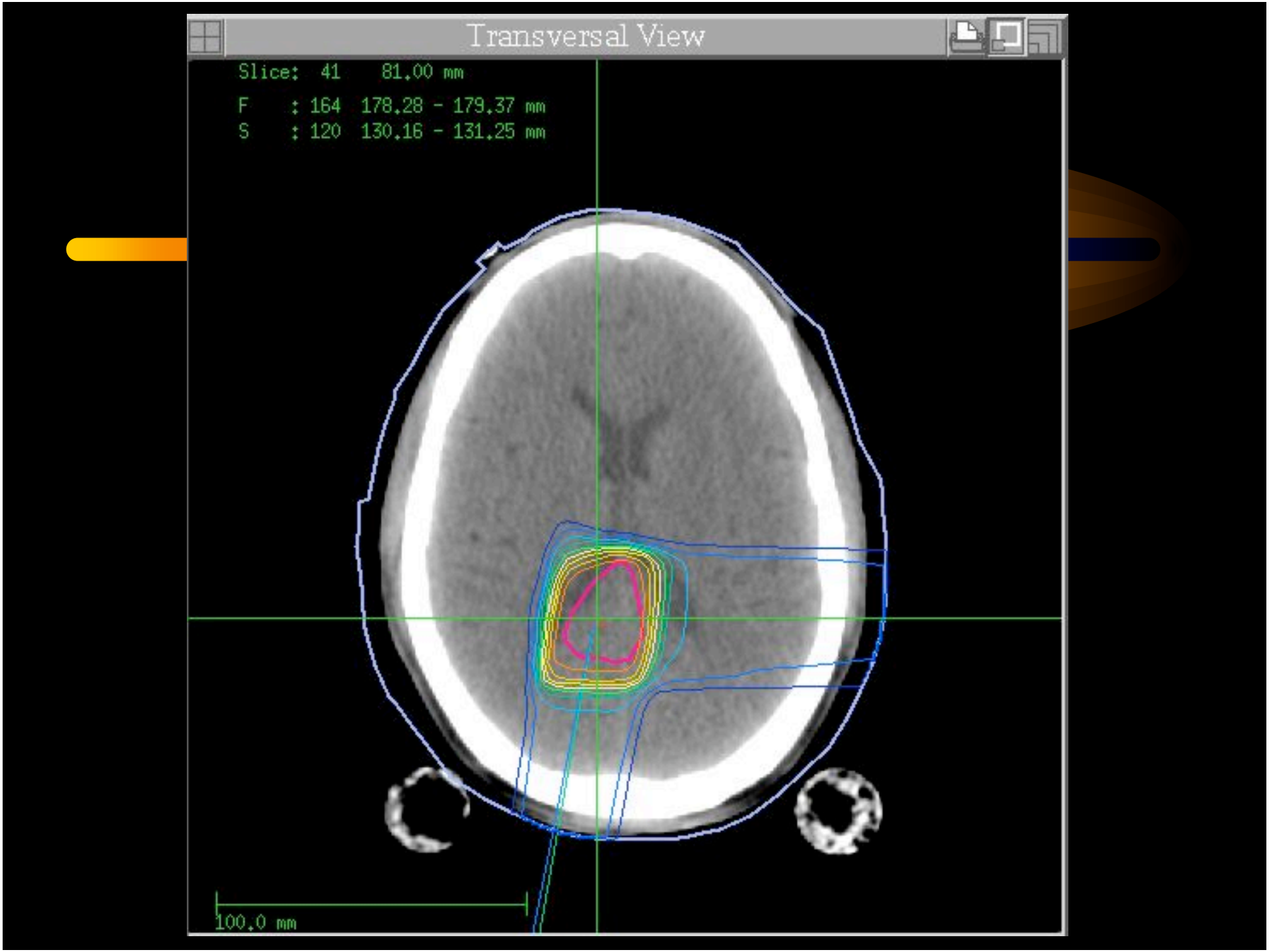
PROTON THERAPY TREATMENTS

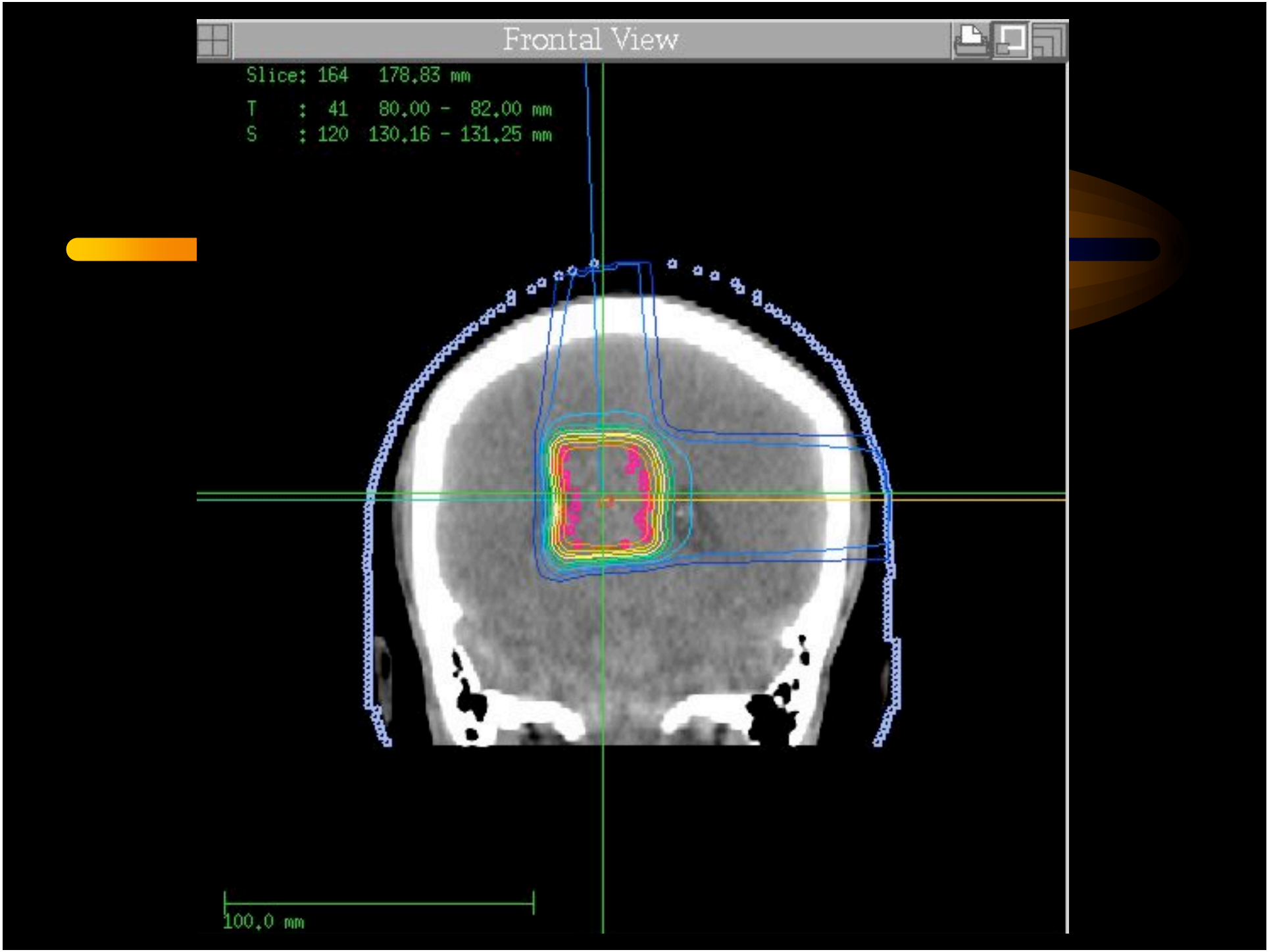
DIAGNOSIS	NUMBER OF PATIENTS (10 Sep 1993 – 31 March 2008)
Acoustic neuroma	64
Angioma	15
Arteriovenous malformation	81
Brain tumor	60
Craniopharyngioma	14
Eye and orbit tumor	33
Head and neck carcinoma	11
Meningioma	41
Metastasis	33
Paranasal sinus carcinoma	23
Pituitary adenoma	62
Prostate carcinoma	4
Skull base tumor	28
Sundry	31
	500

ARTERIOVENOUS MALFORMATIONS

PATIENT CHARACTERISTICS

- Median age = 34 years
- Median volume = 15.6 cc (1.7 – 110.6)
- Median ICRU reference dose = 20.1 SFE CGyE (18 CGyE => 90%)
- Median FU time = 4.8 years
- Overall obliteration = 52%
  - volumes < 14 cc = 75%
  - volumes > 14 cc = 46%
- Clinical outcome
  - good 53%
  - stable 34%

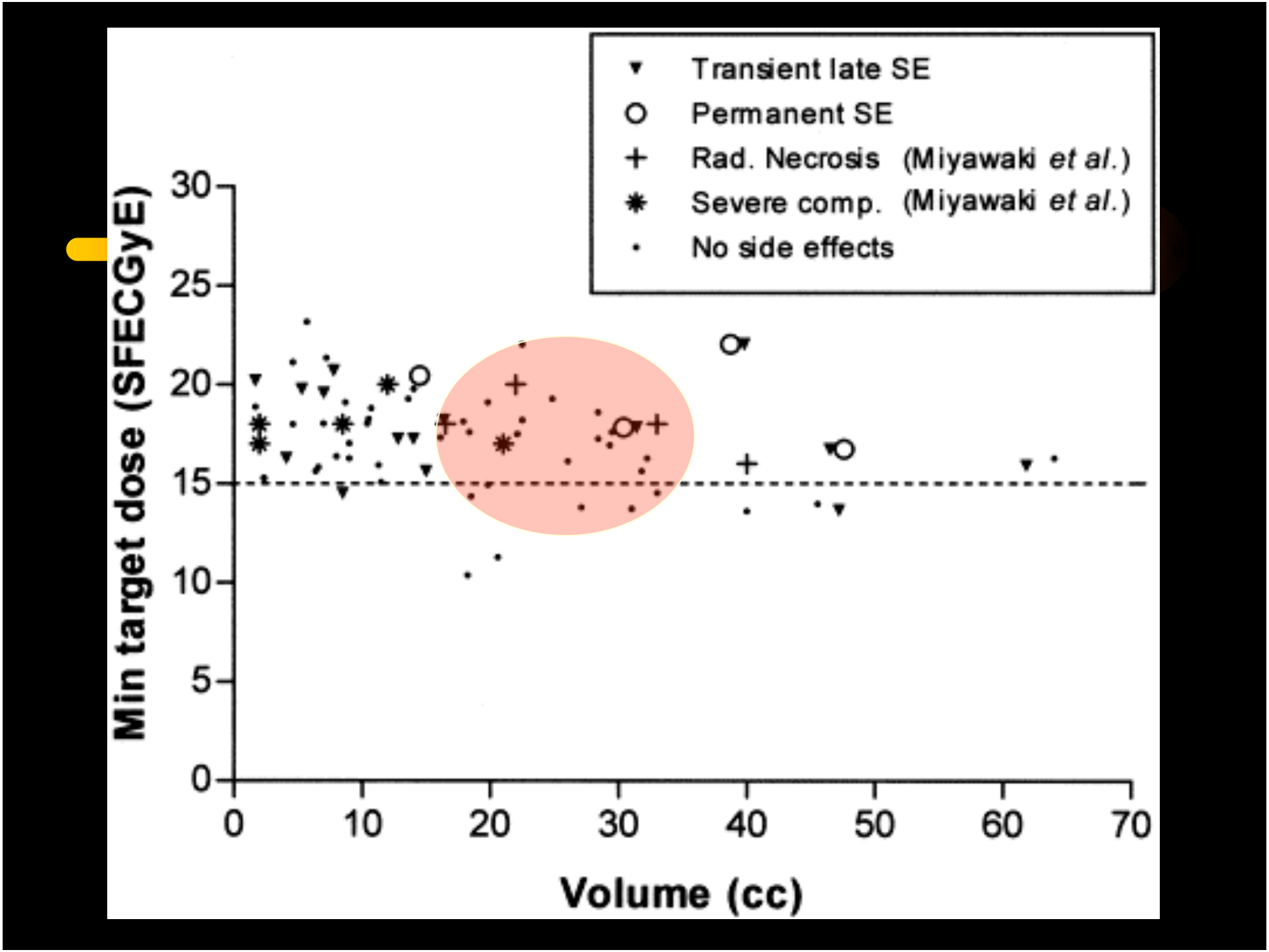

Transversal View
Slice: 41 81.00 mm
F : 164 178.28 - 179.37 mm
S : 120 130.16 - 131.25 mm
100.0 mm


Frontal View
Slice: 164 178.83 mm
T : 41 80.00 - 82.00 mm
S : 120 130.16 - 131.25 mm
100.0 mm

OBLITERATION RATES FOR LARGE ARTERIOVENOUS MALFORMATIONS

Study	<4 cc	4-13.9 cc	≥14 cc	<10 cc	>10 cc
Miyawake	67%	58%	23%		
Pan			25% (>15 cc)		31%
Fabrikant	90%-95%	90%-95%	60%-70%		
Friedman	81%	89% (4-10 cc)			69%
Schlienger	70%	51% (4->14 cc)			
Nataf					39%
Engenhart	83%	75% (<33.5 cc)	50% (>33.5 cc)		
iThemba LABS	75% (<4, 4-13.9 cc)		46%	64%	48%
Hadjipanayis				76%	25%
Lindvall				56%	50%

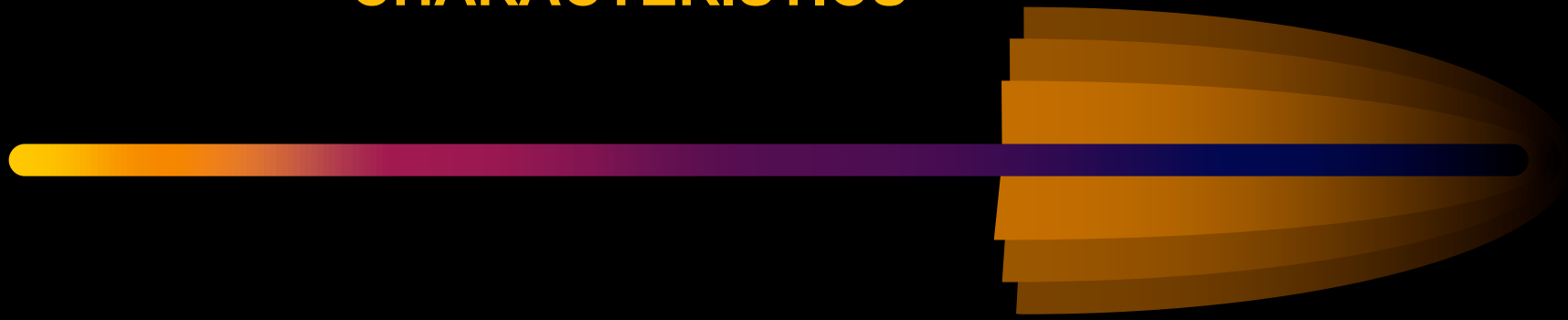
* Current data from our study


Transient late SE
Permanent SE
Rad. Necrosis (Miyawaki et al.)
Severe comp. (Miyawaki et al.)
No side effects
Min target dose (SFECGyE)
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
Volume (cc)

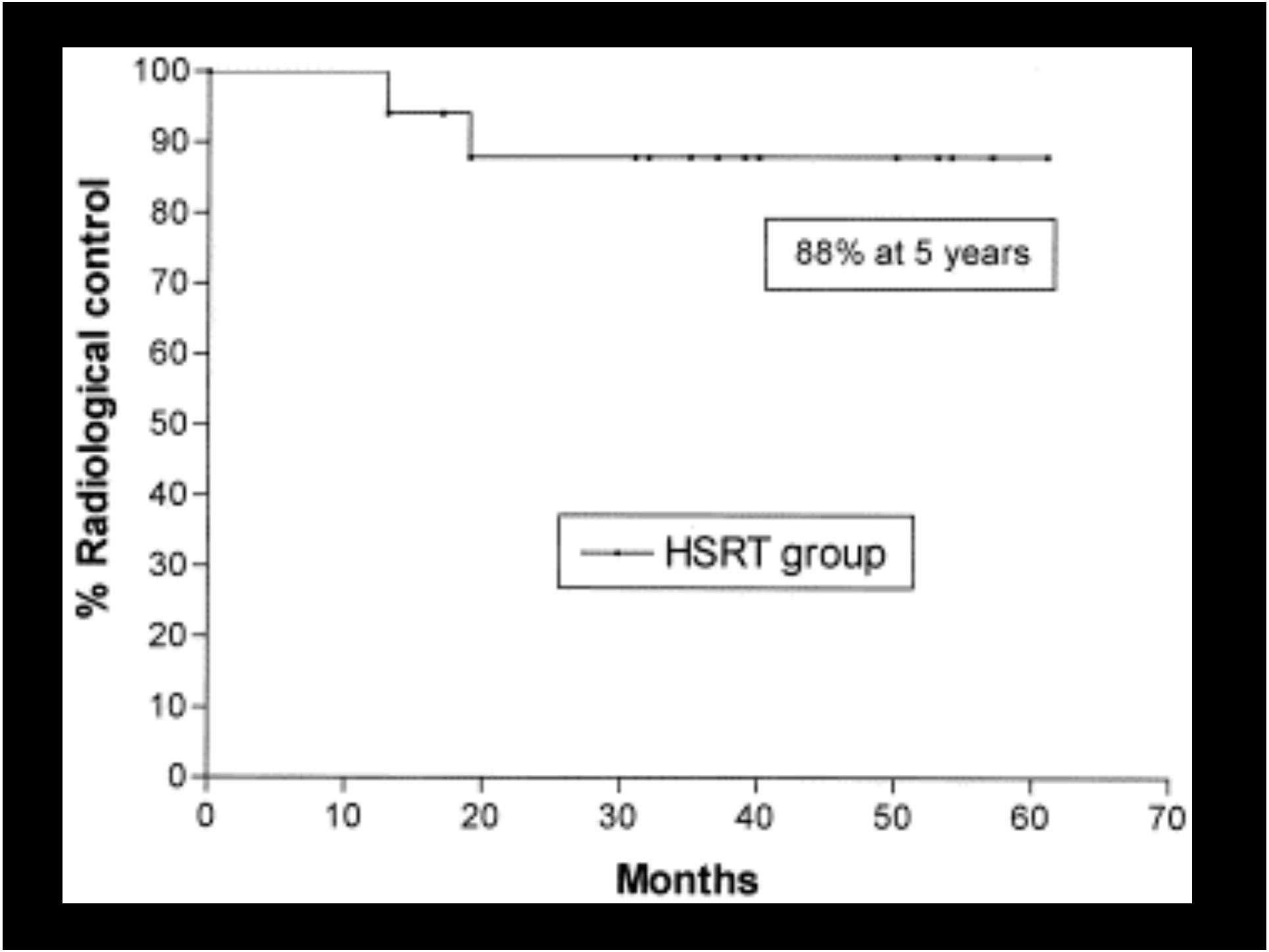
MENINGIOMA


TH0172
23-FEB-1945
11:03
03-JUN-1997
IMAGE 75
STUDY 5
MF 1.71
H
MAGNETOM
H-SP
RP
sel
*R
TR 500.0
TE 15.0/1
TA 03:24
AC 3
SP
SL
FoV 173*
134 *25
Cor>Sag
W 2

PATIENT CHARACTERISTICS



- Median age = 53 years (3/1 F/M)
- Median volume = 8.4 cc (2.6 - 63)
- Median ICRU reference dose = 21.5 SFE CGyE
  (19 CGyE => 90%)
- Median FU time = 6.8 years
- Radiological control = 89%
- Clinical improvement = 60%

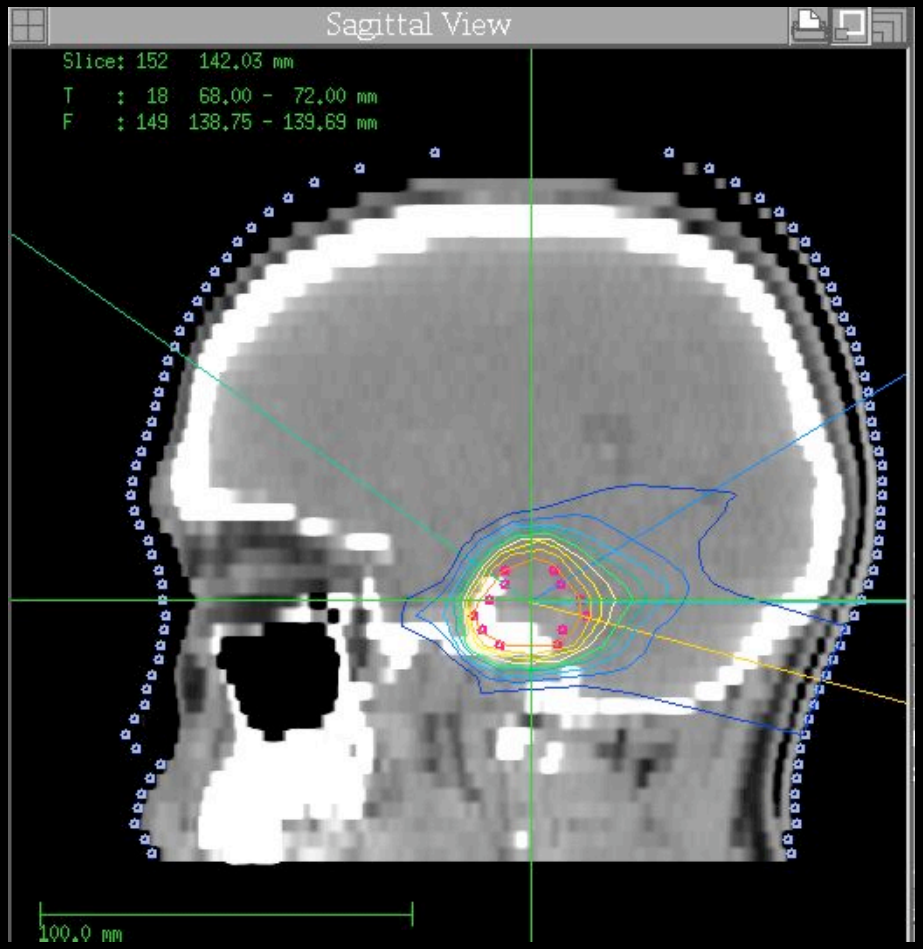

% Radiological control
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
Months
88% at 5 years
HSRT group

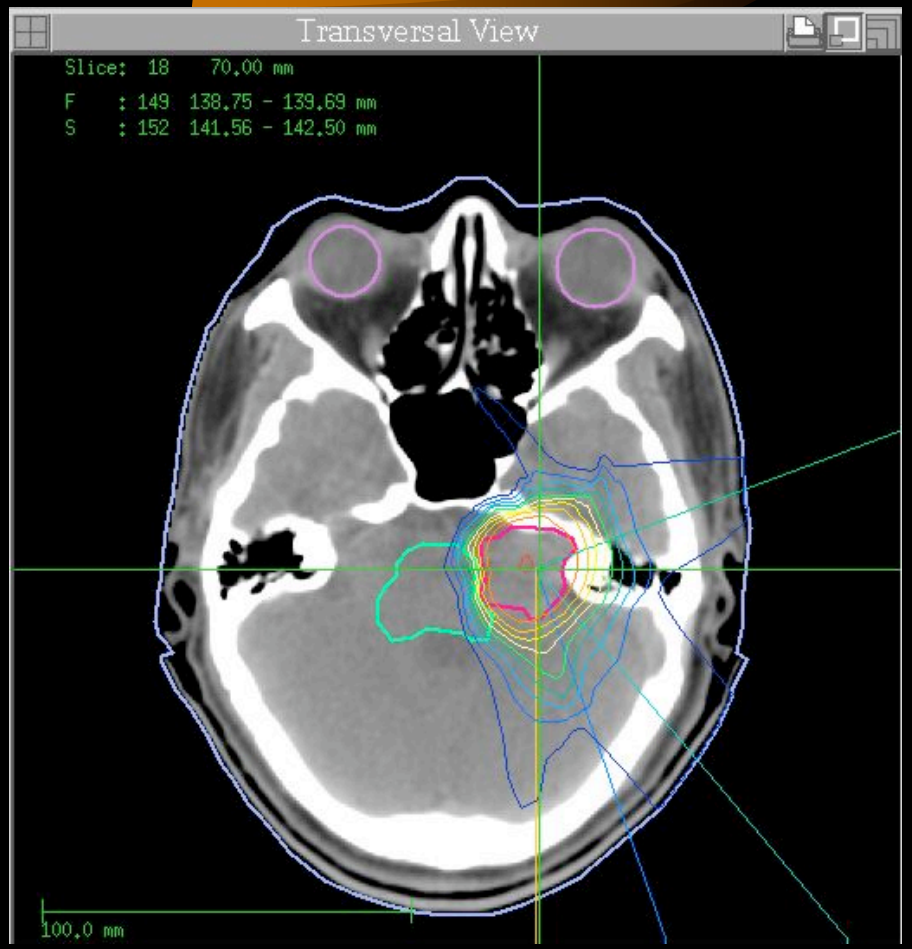
RADIOSURGERY FOR SKULL BASE MENINGIOMAS

	Morita *et al.*[14] Gamma Knife	Chang *et al.*[25] Lin Accel.	Shafron *et al.*[10] Lin Accel.	Hakim *et al.*[12] Lin Accel.	Subach *et al.*[11] Gamma Knife	NAC Proton
No of Patients	88	55	70 42% (//)	127 64% (//)	62	18
Mean vol cm^3	10	7.33	10	4.1	13.7	15.6
Range	2.3-30	0.45-27.6	0.6-28.6	0.16-51.2	0.8-56.8	2.6-63
Max dose	32 Gy	21.9 Gy	*	17.9 Gy	30 Gy	20.6 sfe/CGyE
Range	24-40 Gy	14.8-33.2 Gy	*	9.47-25 Gy	20-50 Gy	17.3-24.7 sfe/CGyE
Min dose	16 Gy	18.3 Gy	12.7 Gy	15 Gy	15 Gy	16.3 sfe/CGyE
Range	12-20 Gy	12-15 Gy	10-20 Gy	9-20 Gy	11-20 Gy	14.5-18.3 sfe/CGyE
Mean FU (months)	35	48.4	23	31	42	40
Range	12-83	17-81	2-88	1.2-79.8	12-101	13-69
Rad. stable	29.5% } **97%**	69% } **98%**	56% } **100%**	* } **84.3%**	68% } **91%**	59% } **88%**
smaller	68%	29%	44%	*	23%	29%
bigger	2.3%	2%		15.7%	8%	12%
Clin. better	21.6%	27% } **89%**	6% } **100%**	n/a	21% } **87%**	56% } **89%**
stable	-	62%	94%	n/a	66%	33%
worse	-	5%	0%	n/a	13%	11%
New cranial nerve neuropathy						
temp / permanent	13.6% / 12.5%	22% / 3.6%	*	* / 2.4%	8% / 4.8%	11% / 5.5% (†)
Late complications	0%	3.6%	4%	4.7%	1.6%	5.5% (‡)

* not stated
// % of patients with skull base lesions
† if patient with VIII nerve is excluded, see complications, the permanent neuropathy = 0%
‡ if patient with temporal lobe epilepsy is excluded, see complications, the late complications = 0%

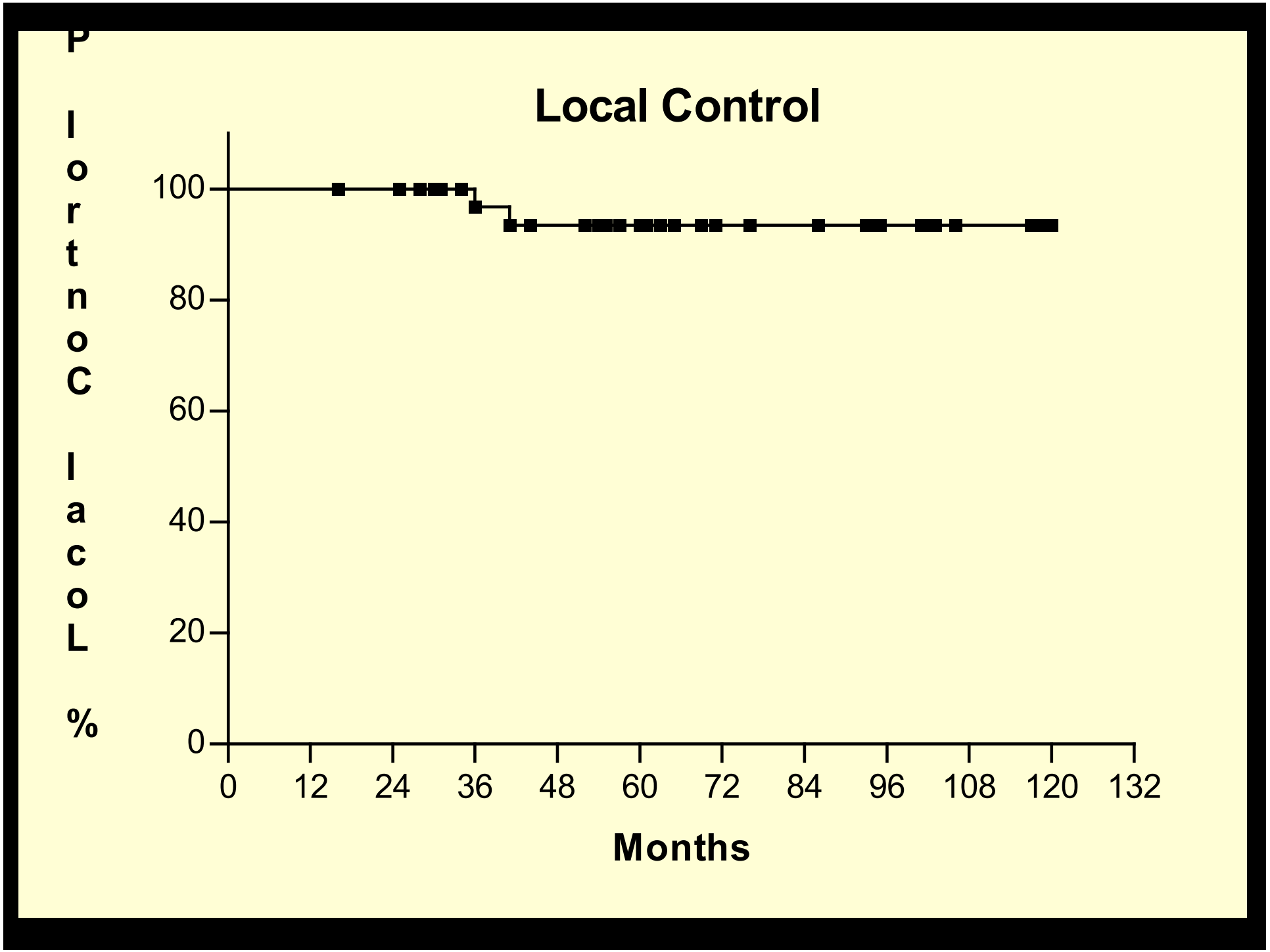
ACOUSTIC NEUROMA

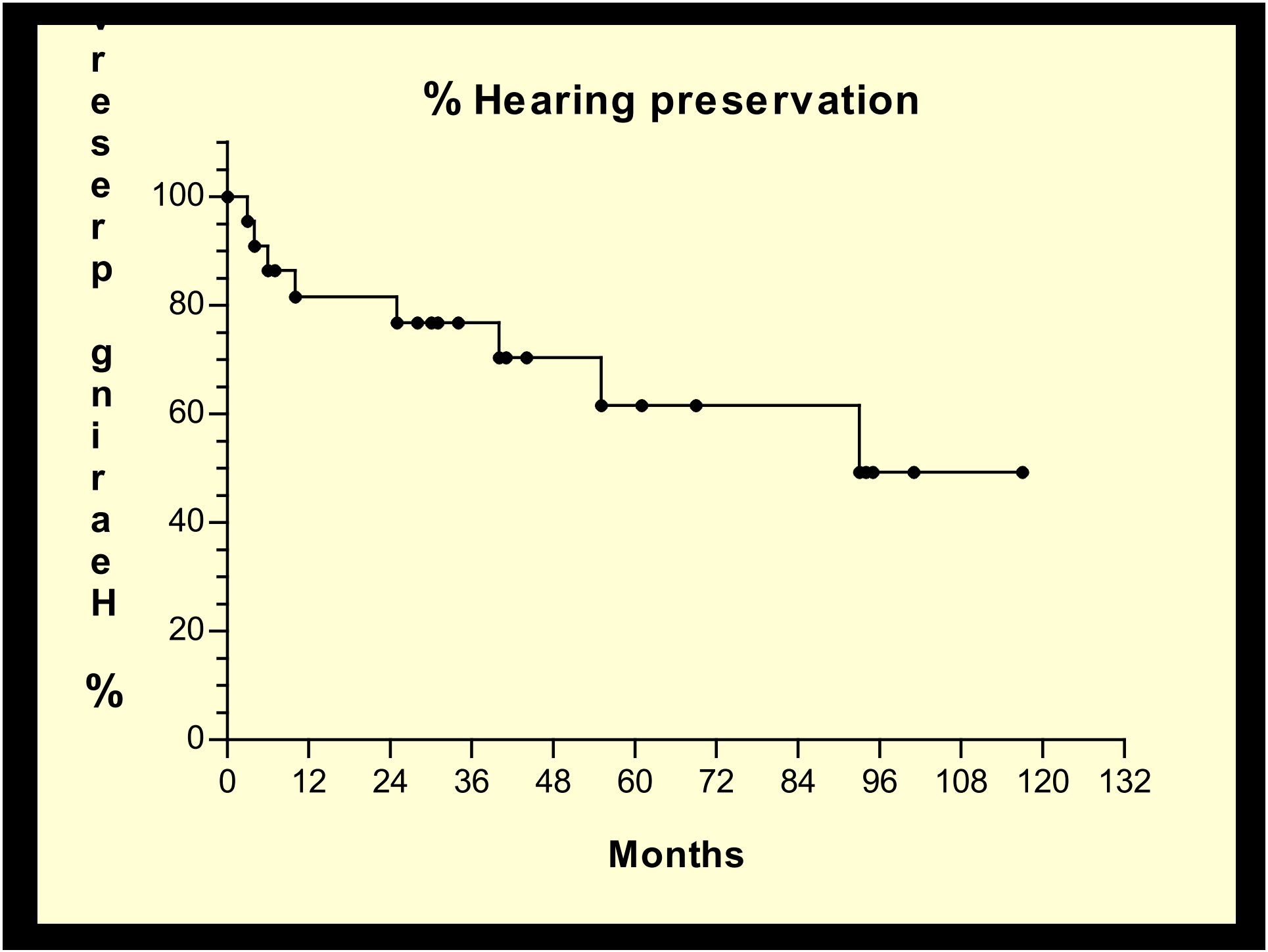




PATIENT CHARACTERISTICS

- Median age = 42 years
- Mean volume = 7 cc (1 – 45.7)
- Median ICRU reference dose = 16.3 SFE CGyE (14.7 CGyE => 90%)
- Median FU time = 5.3 years
- Radiological control = 95%
- Hearing preservation = 61%
- Facial nerve preservation = 87%


Local Control
Proportion Local %
100
80
60
40
20
0
0
12
24
36
48
60
72
84
96
108
120
132
Months


% Hearing preservation
% Hearing preservation
100
80
60
40
20
0
0
12
24
36
48
60
72
84
96
108
120
132
Months

Author	RT modality	Dose prescribed	Fractions (no of patients)	Mean tumor volume (cm^3)	Growth control (%) (years)	Nerve Preservation			Mean follow-up (months)
						Hearing (%) (years)	Facial (%) (years)	Fifth (%) (years)	
Harsh *et al.* [23]	Proton therapy	12 CGyE (margin)	Single (n = 64)	2.49	84 (5yrs)	30	95	91	44
Weber *et al.* [22]	Proton therapy	12 CGyE	Single (n = 88)	(1.4 median)	95 (5 yrs) actuarial CR	79 (2 yrs) 22 (5 yrs)	91 (5 yrs)	89 (5 yrs)	38.7 (median)
Williams [29]	Linac-based	25 Gy	5 fractions (n = 111)	1.4	100	64	100	100	21.6 (median)
		30 Gy	10 fractions (n = 14)	8.1					
Meijer *et al.* [13]	Linac-based	10- 12.5 Gy	Single (n = 49)	2.6	100 (5 yrs)	75 (5 yrs)	93 (5 years)	92 (5 yrs)	33
		20- 25 Gy	5 fractions (n = 80)	2.5	94 (5 yrs)	61 (5 yrs)	97 (5 yrs)	98 (5 yrs)	33
Iwai *et al.* [25]	Gamma knife	12 Gy (margin)	Single (n = 51)	(3.6 median)	92 (5 yrs)	56 (5 yrs)	100 (5 yrs)	96 (5 yrs)	60 (median)
Unger *et al.* [26]	Gamma knife	13 Gy (margin)	Single (n = 86)	(3.4 median)	96	55	98	95	75 (median)
Bush *et al.* [19]	Proton therapy	54- 60 CGyE	30- 33 fractions (n = 30)	4.3	100	31	100	100	34
Fuss *et al.* [27]	IMRT	54 Gy	30 fractions (n = 8)	5.09 (2.48 median)	100	100	100	100	17 (18.5 median)
Lunsford *et al.* [37]	Gamma knife	13 Gy (margin)	Single (n=829}	2.5	97 (10 yrs)	50-77	99	97	120
Flickinger *et al.* [39]	Gamma knife	13 Gy (margin)	Single (n=313)	1.1	98.6 (6 yrs)	78.6 (6 yrs)	100 (6 yrs)	95.6 (6 yrs)	24 (median)
THIS SERIES	Proton therapy	21.9 CGyE (margin) (13.5 CGyE single fract. equivalent)	3 fractions (n = 42)	7.0	100 (2yrs) 93 (5yrs)	77 (2yrs) * 62 (5 yrs)*	91 (2 yrs)* 87 (5 yrs)*	97 (2 yrs) 91 (5yrs)	66 (62 median)

*** not based on the use of the Gardner-Robertson or House-Brackman scales**

CONCLUSION

- MAINLY RADIOSURGICAL CASES
- SIMILAR CLINICAL RESULTS COMPARED TO PHOTON SERIES
- DESPITE OF TREATING “LARGER” VOLUMES
- PROTON BEAM IS THEREFORE LIKELY A BETTER RADIOSURGICAL MODALITY FOR “LARGE” LESIONS
- NO CASES OF RADIATION INDUCED TUMORS WERE OBSERVED

THANK YOU