Gamma Knife Radiosurgery for Chordomas

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Case Reports › Neurosurgery. 1991 Jul;29(1):38-45; discussion 45-6.
doi: 10.1097/00006123-199107000-00007.

The role of radiosurgery in the management of chordoma and chondrosarcoma of the cranial base

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Affiliations + expand

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● *Clinical Investigation*

STEREOTACTIC RADIOSURGERY FOR CHORDOMA AND CHONDROSARCOMA: FURTHER EXPERIENCES

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1998

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JNS JOURNAL OF NEUROSURGERY
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1989

Fractionated proton radiation therapy of chordoma and low-grade chondrosarcoma of the base of the skull

View Less

Mary Austin-Seymour M.D.[1], John Munzenrider M.D.[1], Michael Goitein Ph.D.[1], Lynn Verhey Ph.D.[1], Marcia Urie Ph.D.[1], Richard Gentry M.S.[1], Steven Birnbaum B.S.[1], Donna Ruotolo B.S.[1], Patricia McManus R.N.[1], Steven Skates Ph.D.[1], Robert G. Ojemann M.D.[1], Andrew Rosenberg M.D.[1], Alan Schiller M.D.[1], Andreas Koehler B.A.[1], and Herman D. Suit M.D.[1]

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› Int J Part Ther. 2021 Jun 25;8(1):179-188. doi: 10.14338/IJPT-20-00066.1. eCollection 2021 Summer.

Clinical Outcomes Following Dose-Escalated Proton Therapy for Skull-Base Chordoma

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2021

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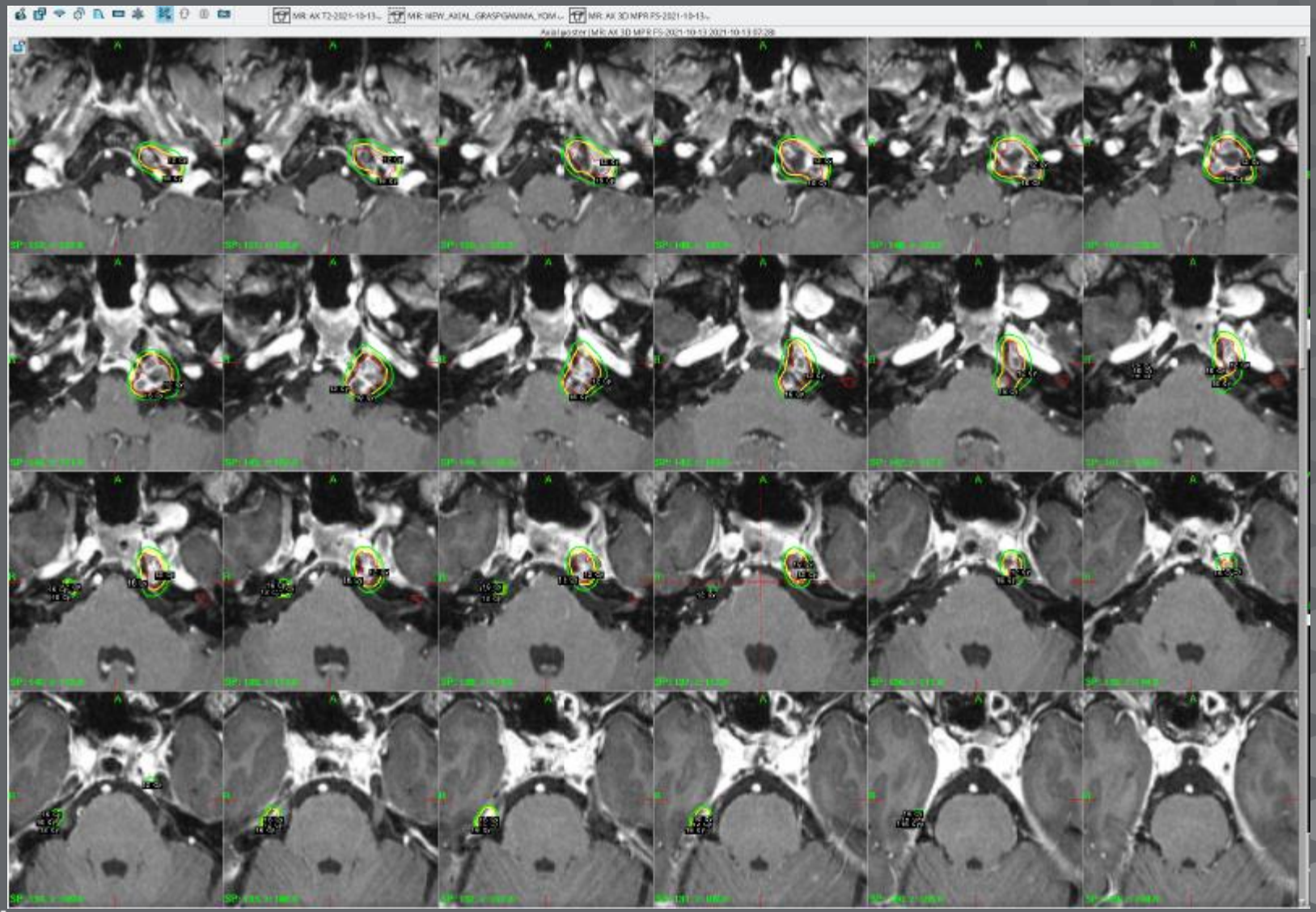
69 y/o woman with recurrent multiple chordoma sites after prior endonasal resection, proton RT and further a second resection after progression



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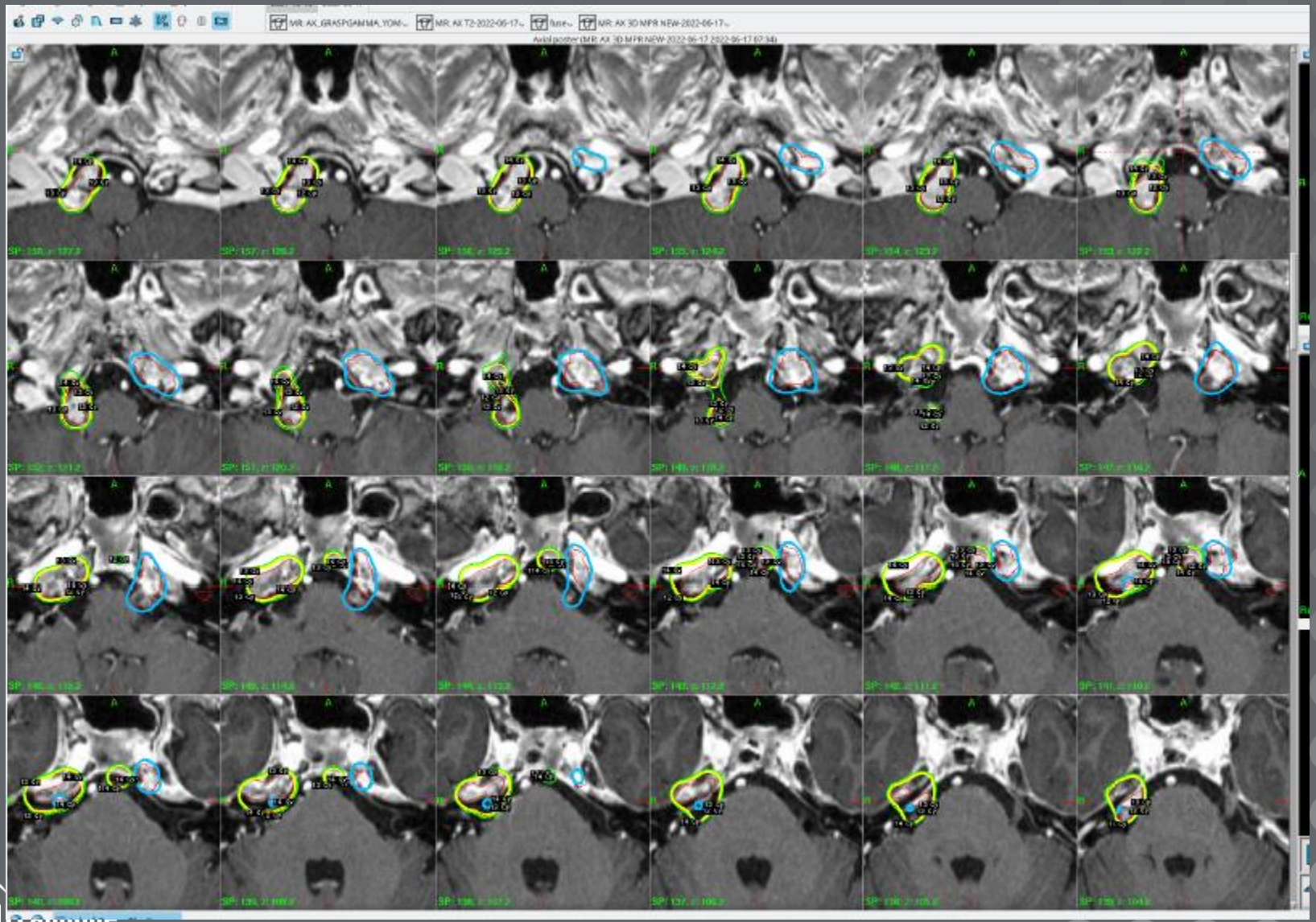

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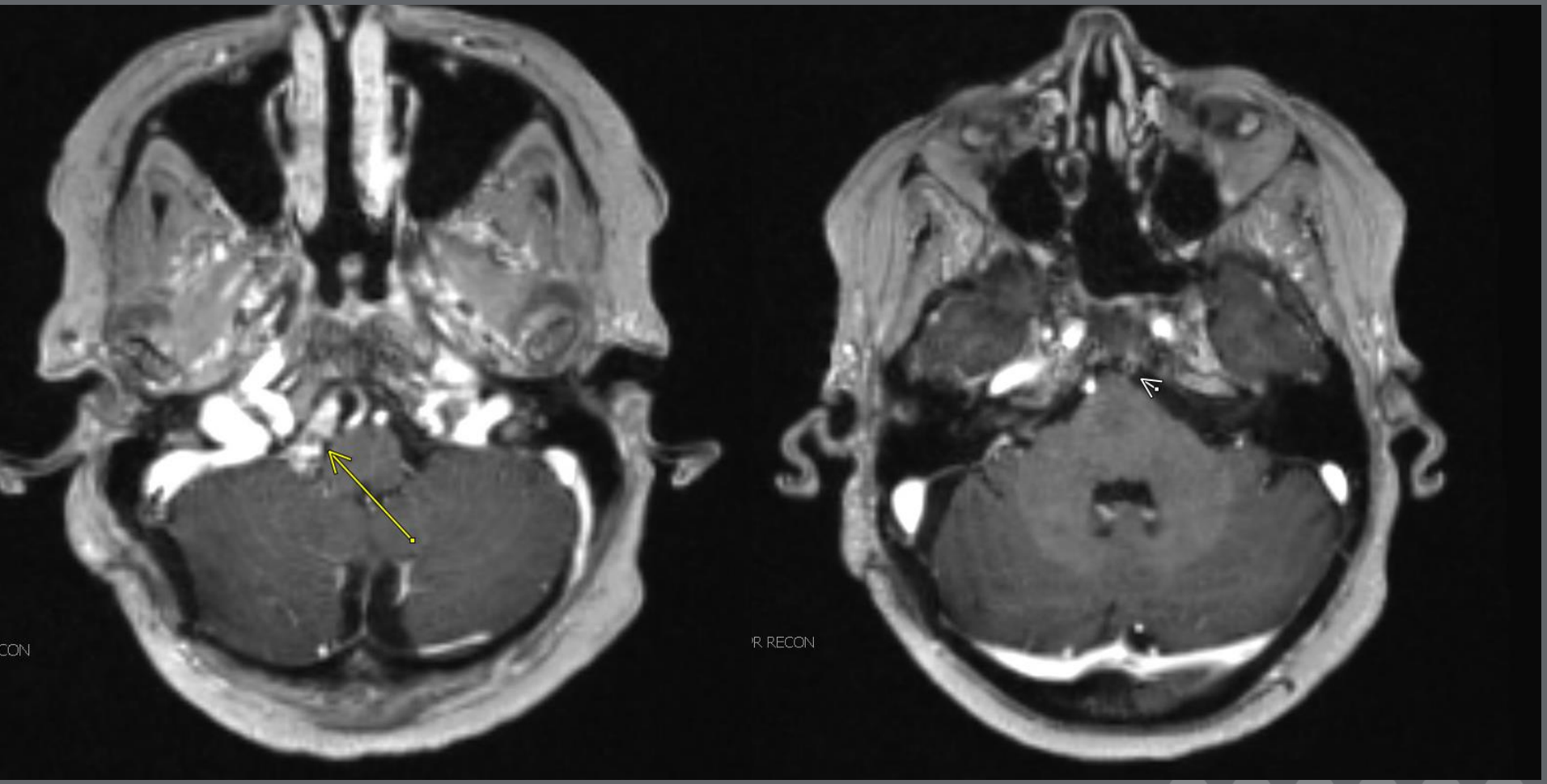

2 and 10 months after gamma knife radiosurgery with tumor regression

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Stereotactic Radiosurgery for Chordoma: A Report From the North American Gamma Knife Consortium

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BACKGROUND: Although considered slow-growing, low-grade malignancies, chordomas are locally aggressive and destructive tumors with high recurrence rates.

OBJECTIVE: To assess patient survival, tumor control, complications, and selected variables that predict outcome in patients who underwent Gamma Knife stereotactic radiosurgery (SRS) as primary, adjuvant, or salvage management for chordomas of the skull base.

METHODS: Six participating centers of the North American Gamma Knife Consortium identified 71 patients who underwent SRS for chordoma. The median patient age was 45 years (range, 7-80 years). The median SRS target volume was 7.1 cm^3 (range, 0.9-109 cm^3), and median margin dose was 15.0 Gy (range, 9-25 Gy).

RESULTS: At a median follow-up of 5 years (range, 0.6-14 years) after SRS, 23 patients died of tumor progression. The 5-year actuarial overall survival after SRS was 80% for the entire group, 93% for the no prior fractionated radiation therapy (RT) group (n = 50), and 43% for the prior RT group (n = 21). Younger age, longer interval between initial diagnosis and SRS, no prior RT, < 2 cranial nerve deficits, and smaller total tumor volume were significantly associated with longer patient survival. The 5-year treated tumor control rate after SRS was 66% for the entire group, 69% for the no prior RT group, and 62% for the prior RT group. Older age, recurrent group, prior RT, and larger tumor volume were significantly associated with worse tumor control.

CONCLUSION: Stereotactic radiosurgery is a potent treatment option for small sized chordomas, especially in younger patients and as part of a multipronged attack that includes surgical resection when possible.

KEY WORDS: Chordoma, Gamma Knife, North American Gamma Knife Consortium, Proton beam radiation therapy, Radiation therapy, Stereotactic radiosurgery

Neurosurgery 68:379–389, 2011 DOI: 10.1227/NEU.0b013e3181ff9a12 www.neurosurgery-online.com

Fractionated Radiation Therapy: background

Photon radiotherapy (10 studies)

- # patients =191
- Median dose = 52.7Gy
- 5-year OAS=53.5%
- 5-year PFS=36%
- Adverse radiation effect (ARE) rate=0-5%

Proton radiation therapy (5 studies)

- # patients =416
- Mean dose: 66-83 cGE
- 5-year OAS=79.8% (range, 66.7-80.5%)
- 5-year PFS=69.2% (range, 46-73%)
- ARE rate=5-17%

Amichetti et al. Proton therapy in chordoma of the base of the skull: a systemic review. Neurosurg Rev. 2009

Objective

To assess patient survival, tumor control, the risk of complications, and variables that predict outcomes in chordoma patients who underwent Gamma knife stereotactic radiosurgery as primary or adjuvant management.

Participating Institutions

Institution	No. of pts	Median tumor volume (cc)	Median margin dose (Gy)
University of Pittsburgh	19	3.7	16
University of Sherbrooke	4	14.2	16
Mayo Clinic	23	17.4	15
University of Virginia	15	6.0	15.5
CINN	2	27.5	13.4
UCSF	8	6.2	14
Total (follow-up patients)	71	6.6	15.5

Patient characteristics (N=71)

characteristics		valuable
male		43
female		28
No. Operations	= 0 (biopsy)	13
	= 1	36
	= 2	12
	= 3	4
	= 4	3
	= 5	1
	= 6	1
	= 7	1
Prior fractionated radiation therapy		20
SRS for tumor progression		16
SRS for residual tumor		51
SRS as initial treatment		4

Patient and GK SRS Characteristics

Characteristics	median	range
Age	45.9	7.0-80.8
Symptom duration (months)	6.5	0-297
Interval Dx prior to GK (months)	14.6	0.5-297
Follow-up after Dx (months)	99.1	7.9-317
Follow-up after GK (months)	62.3	3.9-168.9
Median Tumor volume (cc)	7.1	0.9-108.6
Median Margin dose (Gy)	15.0	9-25
Median Max dose (Gy)	32.0	18-50
Number of Isocenters	7	1-30

GK SRS for Chordomas

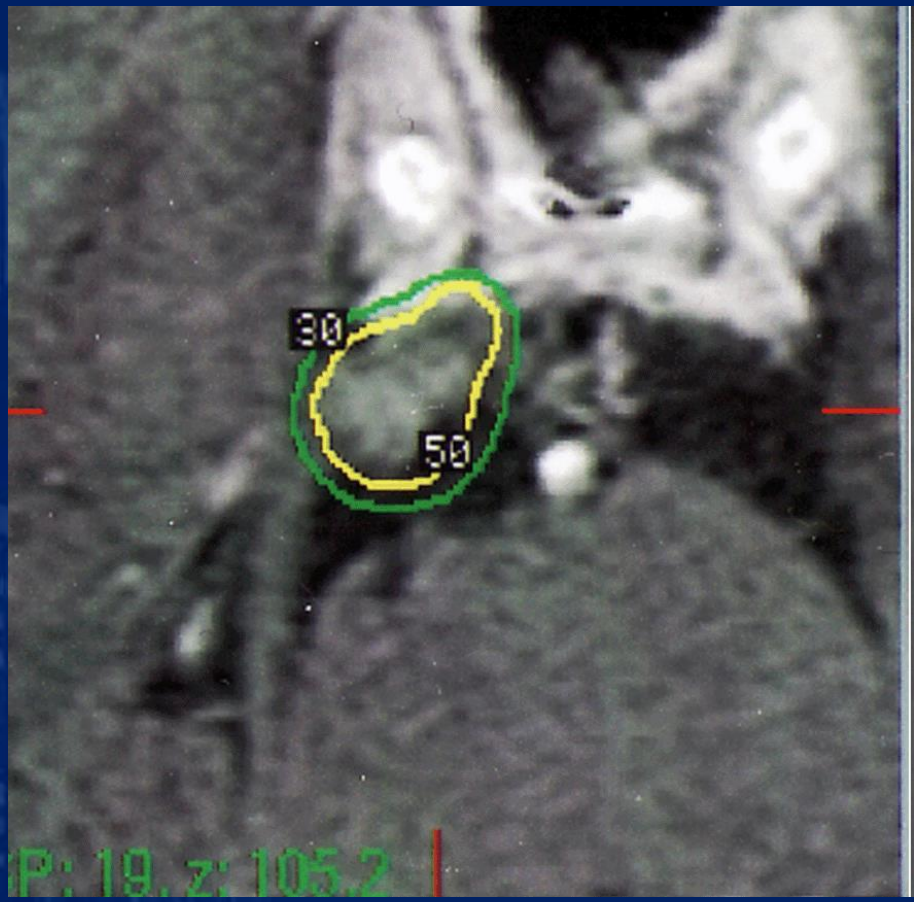
	Treated Tumor response				
	CR	PR	SD	PD	(Total)
No.Patients	**2**	**22**	**24**	**23**	**(71)**
%	**2.8%**	**31.0%**	**33.8%**	**32.4%**	**(100%)**

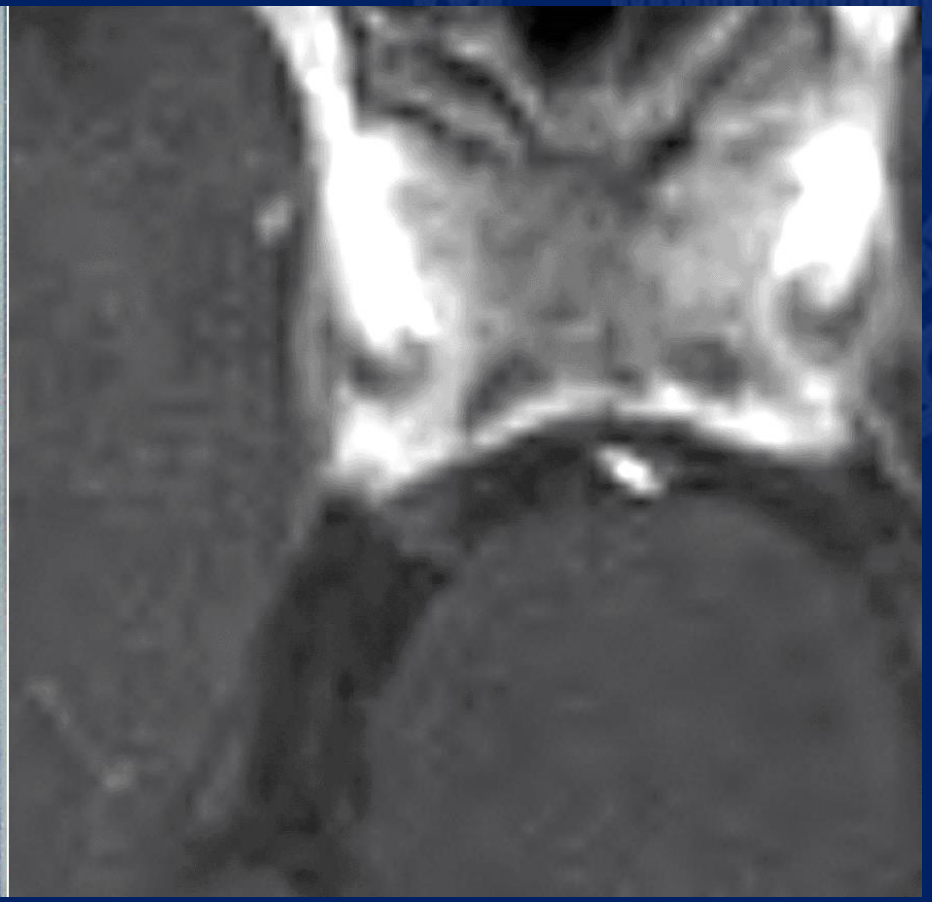
CR=complete response; PR=partial response (> 25% decrease);
SD=stable disease (± 25 % change); PD=progressive disease (> 25% increase)

PD with adjacent tumor recurrence: N=10/23
PD with remote tumor recurrence: N=3/23

Adjacent tumor recurrence (AR) alone: N=4
Remote tumor recurrence (RR) alone: N=4

Chordoma Radiosurgery



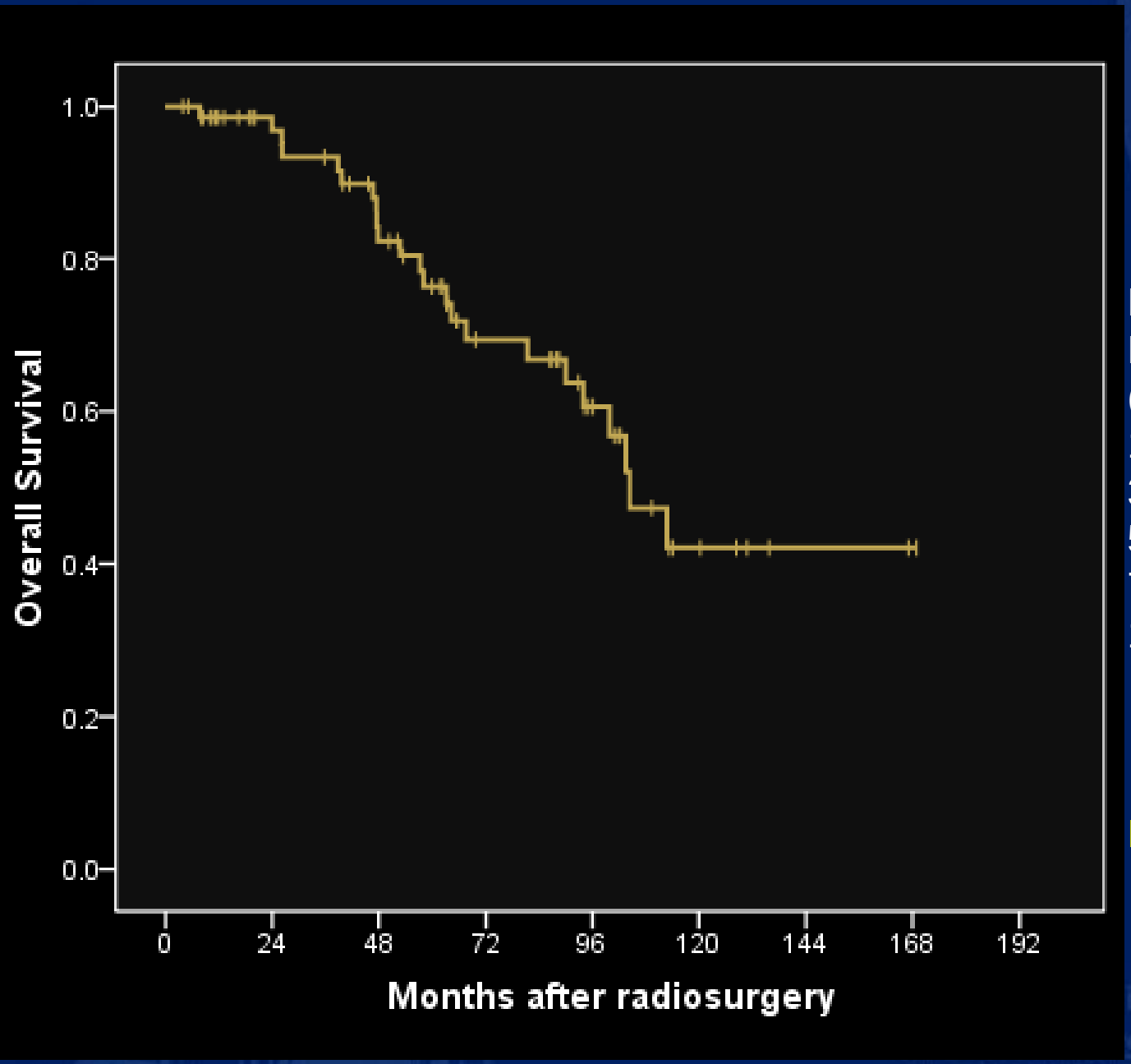


SRS

9 years after SRS

A 37-year-old man with a chordoma of the clivus and right cavernous sinus underwent an endoscopic endonasal removal of the tumor 2 months before SRS.

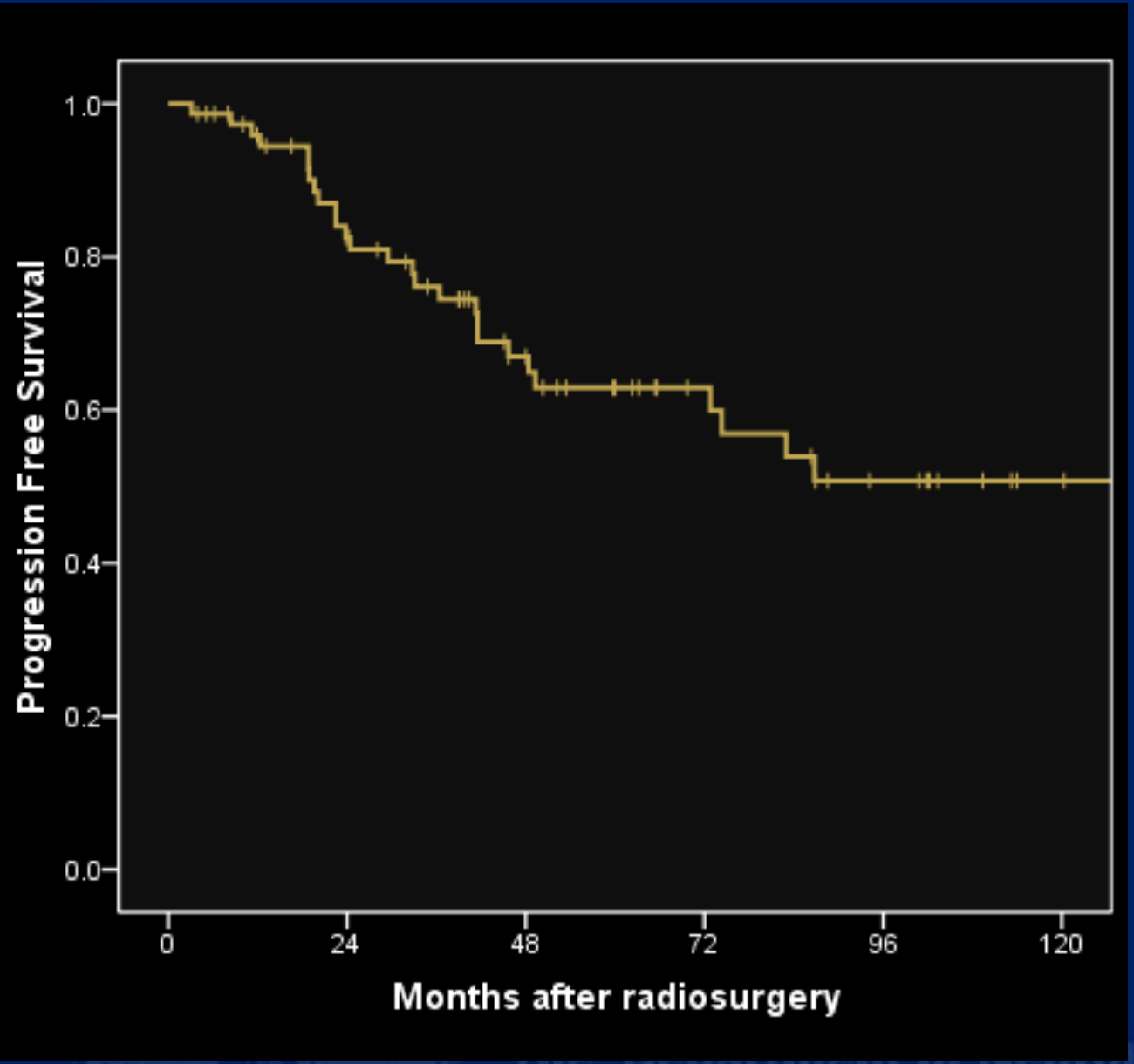
Overall survival after SRS



Died: 23/71(32%)
Median Survival=104 mo
(95% CI:89-120mo)
1yr-OAS=98.6%
3yr-OAS=93.4%
5yr-OAS=76.4%
7yr-OAS=66.8%
10-yr-OAS=42.1%

Protons: 5 year =80%

Progression free survival after SRS



1yr-PFS=95.5%
3yr-PFS=78.6%
5yr-PFS=66.1%
7yr-PFS=60.0%
10-yr-PFS=50.7%

Protons 5 year =69%

Factors that Affect Patient Survival

Univariate Analysis

Parameter	Better outcome	Significance
Age	< 45-year-old	0.010*
Dx-GK interval	< 3Y	0.014*
No. of operations	0-1	0.006*
Prior RT	No	<0.0001*
CN deficit	0-1	0.034*

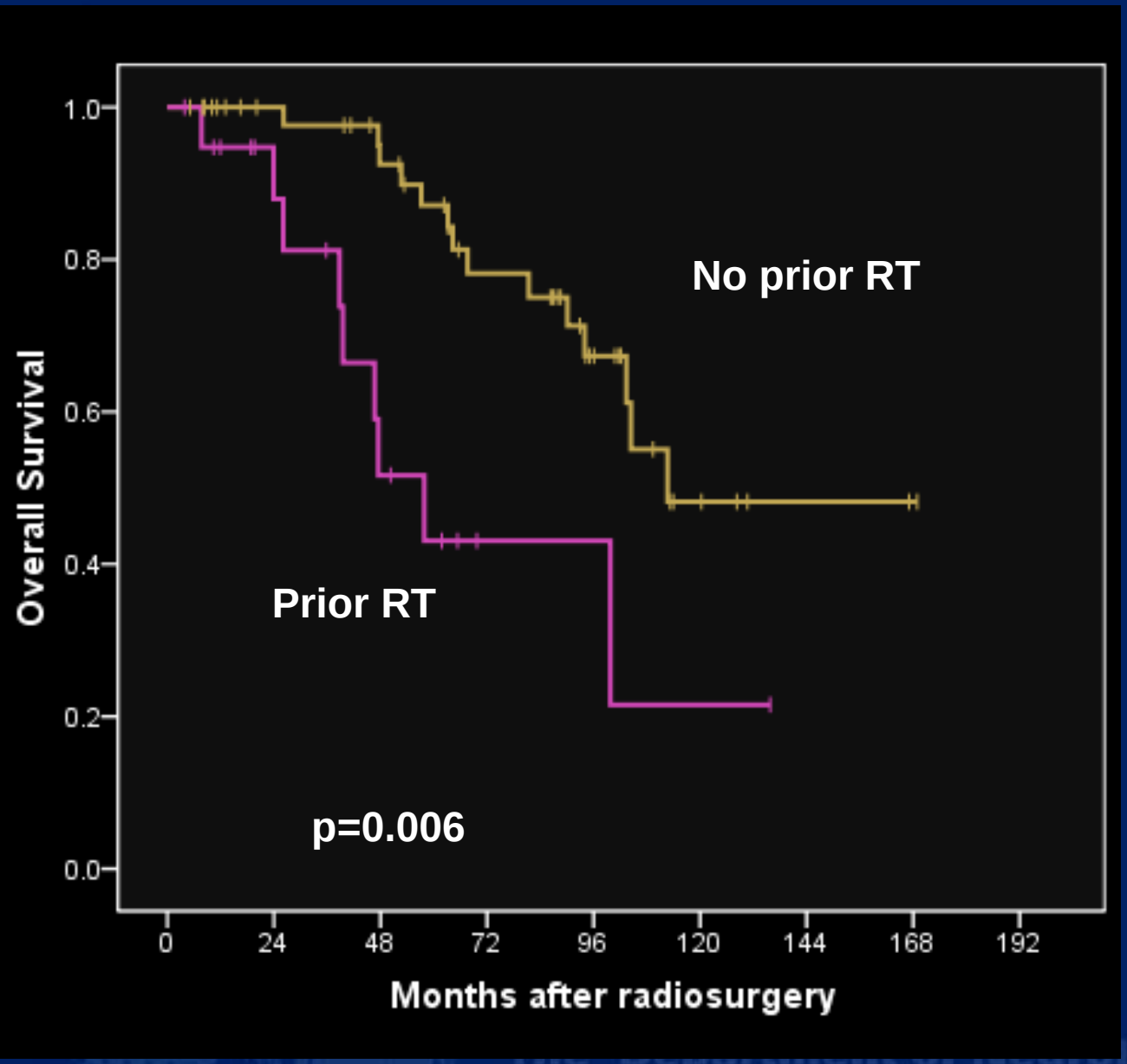
Sex, symptom interval, timing of SRS (residual vs. recurrence), tumor volume, and margin dose were not associated with patient survival (p>.05).

Multivariate Analysis

		Significance	
Parameter	Better outcome	P value	HR
Age	Younger age	0.003*	1.057
Prior RT	No	<0.0005*	8.086
No. of CN deficits	Smaller number	0.008*	1.515

Dx-GK interval and No. of operations were not associated with patient survival (p>.05). HR= Hazard Ratio

Patient survival after SRS



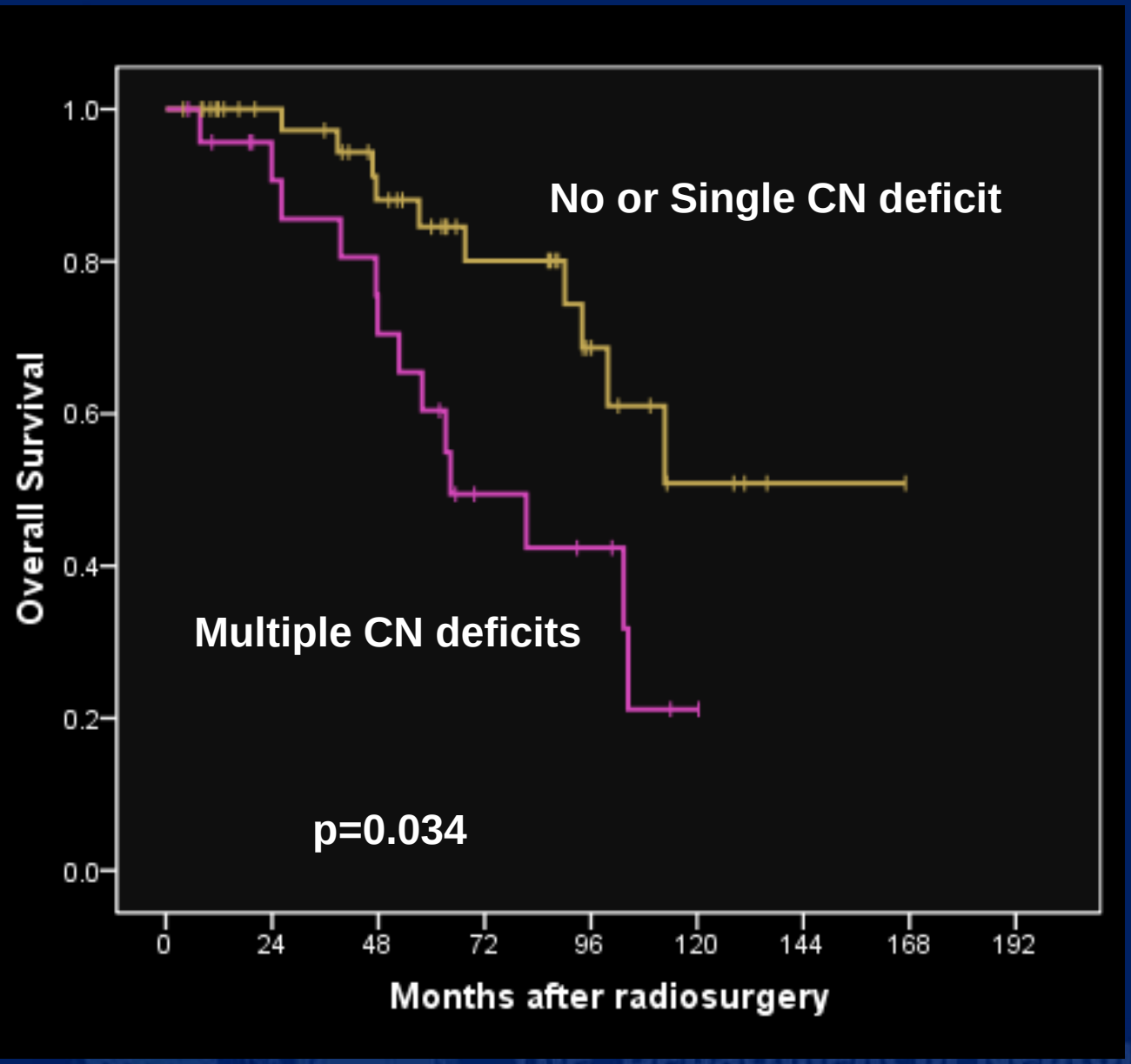
Prior RT

	No RT	RT
MST	112.7M	57.9M
3yr OAS	97.6%	81.2%
5yr OAS	87.1%	43.1%
10yr OAS	48.2%	21.5%

MST: Median Survival Time

OAS: Overall Survival Time

Patient survival after SRS



Multiple CN deficit

	0-1	≥2
MST	NR	64.3M
3yr OAS	97.2%	85.6%
5yr OAS	84.5%	60.4%
10yr OAS	50.9%	21.2%

Factors that Affect Treated Tumor Control

Univariate Analysis

Factor	Better outcome	Significance
Age	< 45-years	0.015*
Tumor volume	< 7cc	0.029*
Margin dose	≥ 16 Gy	0.028*

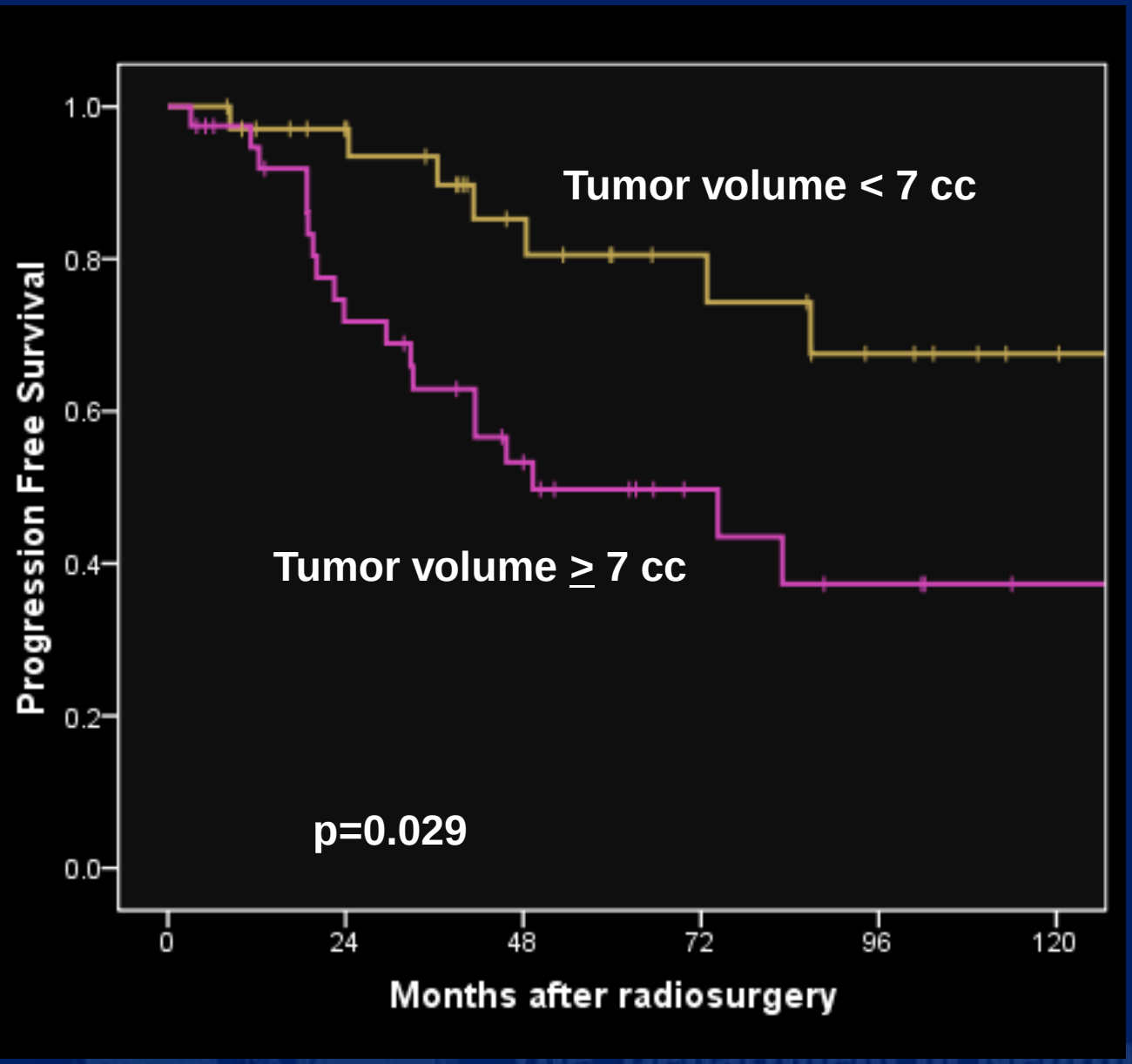
Sex, duration of symptoms, timing of SRS (early vs. late), Dx-GK interval, No. of operations, prior RT, and No. of CN deficits were not associated with patient survival (p>.05)

Multivariate Analysis

		Significance	
parameter	Better outcome	P value	HR
Age	Younger age	0.006*	1.044
Prior RT	No	0.032*	2.470
Margin dose	Larger dose	0.025*	0.796

No. of operations, No. of CN deficits, and tumor volume were not associated with patient survival (p>.05); HR= Hazard Ratio

Progression free survival after GK



Tumor volume

	<7cc	≥7cc
MPFST	167.1M	49.3M
3yr PFS	93.5%	62.9%
5yr PFS	80.5%	49.7%
10yr PFS	67.6%	37.3%

MPFST: Median Progression Free Survival Time

OAS: Overall Survival Time

Functional Outcomes

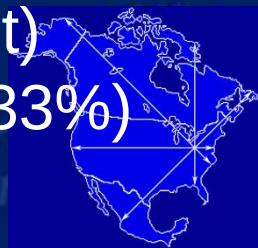
Functional outcomes after GK SRS (N=65)

Improved:	N=17 (26%)
Unchanged:	N=31 (48%)
Worse:	N=17 (26%)

Causes of delayed neurological deterioration (N=17)

treated tumor progression -8
adjacent tumor progression -3
adverse radiation effects (ARE) -4
ARE + treated tumor progression -2

Improvement of diplopia (most common presenting deficit)
CN 3: 2/9 (22%), CN IV: 3/6 (50%), CN VI: 13/40 (33%)



Adverse Radiation Effects

ARE occurred in six patients (8.5%).

Abducens neuropathy:	N=2
Facial palsy:	N=1
Trigeminal and abducens neuropathies:	N=1
Anterior pituitary dysfunction:	N=1

All patients with ARE had also undergone prior RT.

Additional Management after SRS

Treatment after SRS	Treated tumor progression	Adjacent or remote tumor progression
Resection	13	1
SRS	2	9
RT	2	3
Resection + RT	2	0
Resection + SRS	0	3
RT + chemotherapy	2	0

Summary

In this IRRF report, the predictors of better overall survival included age (< 45 years), shorter interval between diagnosis and GK SRS (<3 years), <2 prior operations, no prior RT, and no or only one cranial nerve deficit.

The predictors of better progression free survival after GK SRS included younger age, smaller tumor volume (< 7cc), and higher tumor margin dose (≥ 15Gy).

The improvement rate of pre GK cranial nerve deficits after SRS varied between 20% and 50% (preexisitng CN II, and VII neuropathies did not improve).

J Neurosurg (Suppl 2) 121:188–197, 2014

Gamma Knife surgery for intracranial chordoma and chondrosarcoma: radiosurgical perspectives and treatment outcomes

Clinical article

Ji Hee Kim, M.D.,[1] Hyun Ho Jung, M.D.,[2] Jong Hee Chang, M.D., Ph.D.,[2] Jin Woo Chang, M.D., Ph.D.,[2] Yong Gou Park, M.D., Ph.D.,[2] and Won Seok Chang, M.D.[2]

[1]Department of Neurosurgery, Hallym University Sacred Heart Hospital, Anyang, Gyeonggi-do; and [2]Division of Stereotactic and Functional Neurosurgery, Yonsei Gamma Knife Center, Department of Neurosurgery, Yonsei University College of Medicine, Seoul, Republic of Korea

Object. Intracranial chordomas and chondrosarcomas are histologically low-grade, locally invasive tumors that are reported to be similar in terms of anatomical location, clinical presentation, and radiological findings but different in terms of behavior and outcomes. The purpose of this study was to investigate and compare clinical outcomes after Gamma Knife surgery (GKS) for the treatment of intracranial chordoma and chondrosarcoma.

Methods. The authors conducted a retrospective review of the results of radiosurgical treatment of intracranial chordomas and chondrosarcomas. They enrolled patients who had undergone GKS for intracranial chordoma or chondrosarcoma at the Yonsei Gamma Knife Center, Yonsei University College of Medicine, from October 2000 through June 2007. Analyses included only patients for whom the disease was pathologically diagnosed before GKS and for whom more than 5 years of follow-up data after GKS were available. Rates of progression-free survival and overall survival were analyzed and compared according to tumor pathology. Moreover, the association between tumor control and the margin radiation dose to the tumor was analyzed, and the rate of tumor volume change after GKS was quantified.

Results. A total of 10 patients were enrolled in this study. Of these, 5 patients underwent a total of 8 sessions of GKS for chordoma, and the other 5 patients underwent a total of 7 sessions of GKS for chondrosarcoma. The 2- and 5-year progression-free survival rates for patients in the chordoma group were 70% and 35%, respectively, and rates for patients in the chondrosarcoma group were 100% and 80%, respectively (log-rank test, $p = 0.04$). The 2- and 5-year overall survival rates after GKS for patients in the chordoma group were 87.5% and 72.9%, respectively, and rates for patients in the chondrosarcoma group were 100% and 100%, respectively (log-rank test, $p = 0.03$). The mean rates of tumor volume change 2 years after radiosurgery were 79.64% and 39.91% for chordoma and chondrosarcoma, respectively ($p = 0.05$). No tumor progression was observed when margin doses greater than 16 Gy for chordoma and 14 Gy for chondrosarcoma were prescribed.

Conclusions. Outcomes after GKS were more favorable for patients with chondrosarcoma than for those with chordoma. The data also indicated that at 2 years after GKS, the rate of volume change is significantly higher for chordomas than for chondrosarcomas. The authors conclude that radiosurgery with a margin dose of more than 16 Gy for chordomas and more than 14 Gy for chondrosarcomas seems to enhance local tumor control with relatively few complications. Further studies are needed to determine the optimal dose of GKS for patients with intracranial chordoma or chondrosarcoma.

(http://thejns.org/doi/abs/10.3171/2014.7.GKS141213)

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https://doi.org/10.1007/s00701-021-04768-5

ORIGINAL ARTICLE - TUMOR - OTHER

Gamma Knife Stereotactic Radiosurgery for the treatment of chordomas and chondrosarcomas

Julian Cahill[1] · Ramez Ibrahim[1] · Geza Mezey[1] · John Yianni[1] · Debapriya Bhattacharyya[1] · Lee Walton[1] · Alison Grainger[1] · Matthias W. R. Radatz[1]

Received: 1 July 2020 / Accepted: 10 February 2021 / Published online: 19 February 2021

Abstract

Introduction Primary chordomas and chondrosarcomas of the skull base are difficult tumours to treat successfully. Despite advances in surgical techniques, a gross total resection is often impossible to achieve. In addition, some patients may be deemed unsuitable or not wish to undergo extensive surgery for these conditions. This study examines the role of Gamma Knife Stereotactic Radiosurgery (GKRS) in the treatment of these difficult cases.

Methods All patients harbouring either a chordoma or chondrosarcoma treated at the National Centre for Stereotactic Radiosurgery, Royal Hallamshire Hospital, Sheffield, UK, between 1985 and 2018, were reviewed with regard to their clinical presentations, pre- and post-treatment imaging, GKRS prescriptions and outcomes.

Results In total, 24 patients with a mean tumour volume of 13 cm^3 in the chordoma group (n=15) and 12 cm^3 in the chondrosarcoma group (n=9) underwent GKRS. The 5- and 10-year overall survival rates for the chordoma group were 67% and 53% respectively, while for the chondrosarcoma group, they were 78% at both time points. The tumour control rates at 5 and 10 years in the chordoma group were 67% and 49% and for the chondrosarcoma group 78% at both time points. Patients with tumour volumes of less than 7 cm^3 before GKRS treatment demonstrated a statistically significant longer overall survival rate (p=0.03).

Conclusions GKRS offers a comparable option to proton beam therapy for the treatment of these tumours. Early intervention for tumour volumes of less than 7 cm^3 gives the best long-term survival rates.

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Comparable to proton beam RT

Ogawa et al. BMC Neurology (2021) 21:207
https://doi.org/10.1186/s12883-021-02234-4

BMC Neurology

RESEARCH ARTICLE Open Access

Midterm prognosis and surgical implication for clival chordomas after extended transsphenoidal tumor removal and gamma knife radiosurgery

Yoshikazu Ogawa[1*], Hidefumi Jokura[2] and Teiji Tominaga[3]

Abstract

Background: Treating chordoma through surgery alone is often ineffective. Thus, surgery often performed with irradiation, with a reported 5-year survival rate of 60–75%. The clinical course varies, and disease rarity prevents larger number of clinical investigations.

Methods: In total, 19 patients with clival chordomas were retrospectively extracted from our institutional database. They were initially treated with maximal tumor removal using the extended transsphenoidal approach between March 2006 and January 2021. When total tumor removal was achieved, prophylactic irradiation was not performed. If tumor remnants or recurrence were confirmed, Gamma Knife (GK) radiosurgery was performed. The mean follow-up period was 106.7 months (ranged 27–224 months). The clinical course and prognostic factors were investigated.

Results: Total removal was achieved in 10 patients, whereas 4 patients suffered recurrence and required GK. GK was applied to 11 patients with a 50% isodose of 13–18 Gy (mean: 15.4 Gy), and eight patients remained progression free, whereas three patients suffered repeated local recurrence and died of tumor-related complications. The mean overall progression-free interval was 57.2 months (range: 6–169 months). One male patient died of tumor un-related lung cancer 36 months after the initial treatment, and other patients survived throughout the observational periods. The mean overall survival was 106.7 months (range: 27–224 months). Thus, the 5-year survival rate was 94.7%. Statistical analysis indicated that sex (men), > 15 Gy of 50% isodose by GK, and screening brain examinations as prophylactic medicine were significant favorable prognostic factors.

Conclusions: The favorable outcomes in this investigation suggest the importance of early detection and treatment. Surgery may enable better conditions for sufficient GK doses.

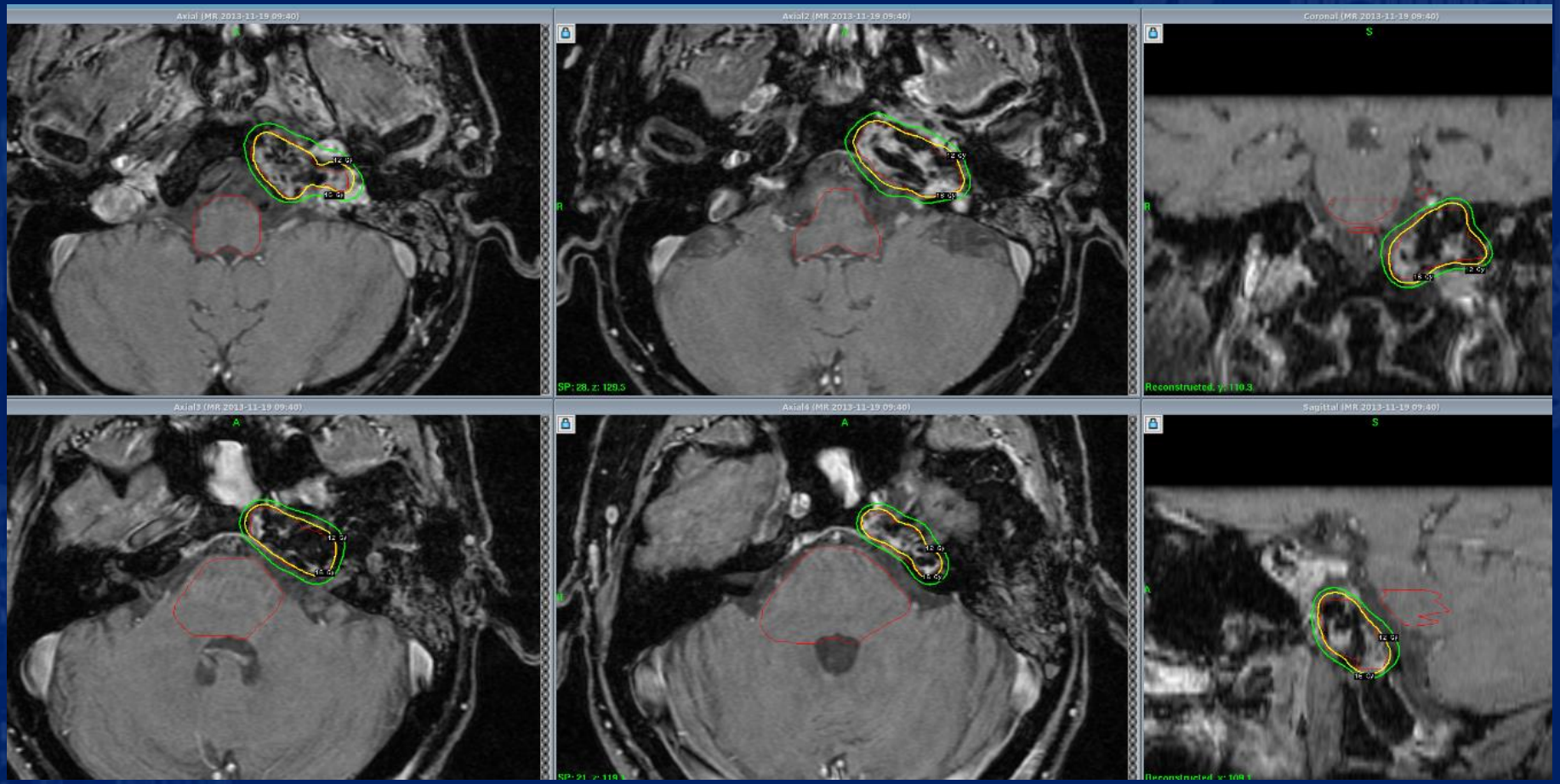
Keywords: Chordoma, Gamma knife radiosurgery, Maximal removal, Prognosis, Transsphenoidal approach

Conclusions

Multimodality management, including surgery and early SRS, provide the greatest opportunity for tumor control and cranial nerve preservation.

Repeat SRS is feasible for new adjacent or distant intracranial disease. For smaller tumors fractionated radiation therapy is not necessary in addition to SRS.

Radiosurgery appears to be as effective, more convenient, and has less morbidity than proton irradiation.



Radiosurgery for chondrosarcoma – 2013
2017- no recurrence