

1.

Year: 2006

Patient number: 10

Author: Lee, Kuan J.; Barber, David C.; Walton, Lee

Reference: Medical physics, 33, 7, 2532-40, 2006

Title: Automated gamma knife radiosurgery treatment planning with image registration, data-mining, and Nelder-Mead simplex optimization

Abstract: Gamma knife treatments are usually planned manually, requiring much expertise and time. We describe a new, fully automatic method of treatment planning. The treatment volume to be planned is first compared with a database of past treatments to find volumes closely matching in size and shape. The treatment parameters of the closest matches are used as starting points for the new treatment plan. Further optimization is performed with the Nelder-Mead simplex method: the coordinates and weight of the isocenters are allowed to vary until a maximally conformal plan specific to the new treatment volume is found. The method was tested on a randomly selected set of 10 acoustic neuromas and 10 meningiomas. Typically, matching a new volume took under 30 seconds. The time for simplex optimization, on a 3 GHz Xeon processor, ranged from under a minute for small volumes (<1000 cubic mm, 2-3 isocenters), to several tens of hours for large volumes (>30,000 cubic mm, >20 isocenters). In 8/10 acoustic neuromas and 8/10 meningiomas, the automatic method found plans with conformation number equal or better than that of the manual plan. In 4/10 acoustic neuromas and 5/10 meningiomas, both overtreatment and undertreatment ratios were equal or better in automated plans. In conclusion, data-mining of past treatments can be used to derive starting parameters for treatment planning. These parameters can then be computer optimized to give good plans automatically.

2.

Year: 2006

Patient number: 12

Author: Park, Chul Kee; Jung, Hee Won; Kim, Jeong Eun; Paek, Sun Ha; Kim, Dong Gyu

Reference: Surgical neurology, 66, 2, 160-5, 2006

Title: The selection of the optimal therapeutic strategy for petroclival meningiomas

Abstract: BACKGROUND: Broad experience with the management of petroclival meningiomas was analyzed to optimize therapeutic strategy. METHODS: The records of 75 patients with petroclival meningioma were reviewed. The population was divided into a microsurgery group (n = 49), a radiosurgery group (n = 12), a radiation therapy group (n = 5), and an observation group (n = 9) according to the modality of primary treatment. In the microsurgery group, the tumor was completely resected in 10 patients. Eleven of the 39 patients with incomplete resections sequentially underwent adjuvant radiation therapy or radiosurgery. The median follow-up period was 86 months (range, 48-210 months). The median follow-up period of the radiosurgery, the radiation therapy, and the observation group was 52 months (range, 48-71 months), 56 months (range, 51-72 months), and 63 months (range, 53-68 months), respectively. Management outcomes were evaluated with

respect to tumor control rate, neurological deficit, and functional status assessed by the Karnofsky Performance Score. **RESULTS:** In the microsurgery group, 11 (22.4%) patients eventually showed tumor progression. However, there was only one recurrence if adjuvant therapy was used after incomplete removal. The incidence of favorable outcomes for cranial neuropathies was better in the incomplete resection group (69.2%) than for patients in the complete resection group (20%, $P = .032$). Moreover, a favorable functional outcome predominated in the incomplete resection group (76.9%) compared with the complete resection group (30%, $P = .049$). The disease was stable in both the radiation therapy and the radiosurgery groups during the follow-up period, with functional status and cranial nerve function perfectly preserved in these patients. No predictive factor other than short symptom duration was found to be significant. **CONCLUSIONS:** Because the growth rate of petroclival meningioma is low and good functional status can be guaranteed, intended incomplete resection should be considered as an acceptable treatment option. Adjuvant treatment after surgery is useful in the control of residual tumors. Radiosurgery may be appropriate as the primary treatment in asymptomatic patients with small tumor; however, more aggressive treatment is needed in young patients or patients with short symptom durations.

3.

Year: 2006

Patient number: 36

Author: Zachenhofer, Iris; Wolfsberger, Stefan; Aichholzer, Martin; Bertalanffy, Alexander; Roessler, Karl; Kitz, Klaus; Knosp, Engelbert

Reference: Neurosurgery, 58, 1, 28-36, 2006

Title: Gamma-knife radiosurgery for cranial base meningiomas: experience of tumor control, clinical course, and morbidity in a follow-up of more than 8 years

Abstract: **OBJECTIVE:** Surgical resection of cranial base meningiomas is often limited owing to involvement of crucial neural structures. Within the last 2 decades Gamma Knife radiosurgery (GKRS) has gained increasing importance as an adjunct treatment after incomplete resection and as an alternative treatment to open surgery. However, reports of long-term results are still sparse. We therefore performed this study to analyze the long-term results of GKRS treatment of cranial base meningiomas, following our previously published early follow-up experience. **METHODS:** A retrospective analysis of the medical files for Gamma Knife and surgical treatments, clinicoradiological findings, and outcome was carried out focusing on tumor control, clinical course, and morbidity. **RESULTS:** Between 1992 and 1995, we treated 36 patients with cranial base meningiomas using GKRS (male:female ratio, 1:5; mean age, 59 yr; range, 44-89 yr). Twenty-five patients were treated with GKRS after open surgery, and 11 patients received GKRS alone. Tumor control, neurological outcomes, and adverse effects were analyzed after a long-term follow-up period (mean, 103 mo; range, 70-133 mo) and compared with our previous results after an early follow-up period (mean, 48 mo; range, 36-76 mo). Control of tumor growth was achieved in 94% of patients. Compared with the early follow-up period, the late neuroradiological effects of GKRS on cranial base meningiomas were continuing tumor shrinkage in 11 patients (33%), stable tumor size in

20 patients (64%) and tumor progression in two meningiomas (6%). The neurological status improved in 16 patients (44%), remained stable in 19 patients (52%), and deteriorated in one patient (4%). Adverse side effects of GKRS were found only during the early follow-up period. **CONCLUSION:** Our data confirm that GKRS is not only a safe and effective treatment modality for cranial base meningiomas in short-term observation, but also in a mean long-term follow-up period of more than 8 years. Tumor shrinkage and clinical improvement also continued during the longer follow-up period.

4.

Year: 2005

Patient number: 127

Author: Feigl, Guenther C.; Bundschuh, Otto; Gharabaghi, Alireza; Samii, Madjid; Horstmann, Gerhard A.

Reference: Journal of neurosurgery, 102, 189-94, 2005

Title: Volume reduction in meningiomas after gamma knife surgery

Abstract:OBJECT: The purpose of this study was to evaluate the volume-reducing effects of gamma knife surgery (GKS) of meningiomas with and without previous surgical treatment. METHODS: A group of 127 patients with a mean age of 57.1 years (range 9-81 years) with 142 meningiomas (128 World Health Organization Grade I and 14 Grade II) were included in this study. The management strategy reduces tumor volume with surgery when necessary (81 patients). Stereotactic GKS with a Gamma Knife model C was performed in all tumors of suitable size. Magnetic resonance imaging follow-up examinations with volumetric tumor analysis was performed 6 months after treatment and annually thereafter. The mean tumor volume was 5.9 cm³ (range < 5 to > 40 cm³). The mean follow-up time after GKS was 29.3 months (range 11-61 months). The mean prescription dose was 13.8 Gy (range 10-18 Gy). A reduction in volume occurred in 117 (82.4%) of all tumors, and in 20 tumors (14.1%) growth ceased. The overall tumor control rate of 96.4%. The mean volume reduction achieved with GKS was more than 46.1%. Only five tumors (3.5%) showed a volume increase. **CONCLUSIONS:** Gamma knife surgery was effective in reducing meningioma volume at short-term follow up. Further studies are needed to examine the development of these findings over a longer period.

5.

Year: 2005

Patient number: 15

Author: Huffmann, Beate C.; Reinacher, Peter C.; Gilsbach, Joachim M.

Reference: Journal of neurosurgery, 102, 283-6, 2005

Title: Gamma knife surgery for atypical meningiomas

Abstract:OBJECT: Complete resection is the optimal treatment for atypical meningiomas (AMs) but its feasibility depends on the tumor site. The object of this study was to assess the effect of gamma knife surgery (GKS) on AM. METHODS: In 15 patients 21 AMs were treated by GKS. Four patients had residual lesions and 10 patients had recurrent tumors

after one or more microsurgical interventions. Three patients were treated twice with GKS because of tumor tissue outside the treatment volume, either at the margin or at a distant location. The median clinical and neuroimaging follow-up period was 35 months (range 21-67 months). Ten tumors shrank 6 to 12 months after GKS, 10 remained stable, and one grew. Between 18 and 36 months after GKS, four patients had a distant recurrence, and two had a margin recurrence. In one of these cases, an additional local recurrence was demonstrated 1 year later, and the patient underwent standard radiotherapy. No patient suffered persistent adverse effects after radiosurgery. **CONCLUSIONS:** After early tumor shrinkage, high recurrence rates were demonstrated both at the treatment margin and at distant locations in cases treated for AM. There was only one recurrence within the GKS radiation field. For small- and medium-sized AMs GKS may be a safe adjunct to other treatment modalities.

6.

Year: 2005

Patient number: 19

Author: Jensen, Ashley W.; Brown, Paul D.; Pollock, Bruce E.; Stafford, Scott L.; Link, Michael J.; Garces, Yolanda I.; Foote, Robert L.; Gorman, Deborah A.; Schomberg, Paula J.

Reference: International journal of radiation oncology biology physics, 62, 1, 32-7, 2005

Title: Gamma knife radiosurgery of radiation-induced intracranial tumors: local control, outcomes, and complications

Abstract: **PURPOSE:** To determine local control (LC) and complication rates for patients who underwent radiosurgery for radiation-induced intracranial tumors. **METHODS AND MATERIALS:** Review of a prospectively maintained database (2,714 patients) identified 16 patients (20 tumors) with radiation-induced tumors treated with radiosurgery between 1990 and 2004. Tumor types included typical meningioma (n=17), atypical meningioma (n=2), and schwannoma (n=1). Median patient age at radiosurgery was 47.5 years (range, 27-70 years). The median tumor margin dose was 16 Gy (range, 12-20 Gy). Median follow-up was 40.2 months (range, 10.8-146.2 months). Time-to-event outcomes were calculated with Kaplan-Meier estimates. **RESULTS:** Three-year and 5-year

7.

Year: 2005

Patient number: 23

Author: Kim, Dong Gyu; Kim, Ch Heon; Chung, Hyun Tai; Paek, Sun Ha; Jeong, Sang Soon; Han, Dae Hee; Jung, Hee Won

Reference: Journal of neurosurgery, 102, 255-8, 2005

Title: Gamma knife surgery of superficially located meningioma

Abstract: **OBJECT:** The authors analyzed tumor control rates and complications in patients with superficially located meningiomas after gamma knife surgery (GKS). **METHODS:** Between 1998 and 2003, GKS was performed in 23 patients with 26 lesions

in whom follow-up imaging for 1 year or more was available. The male/female ratio was 1:22. The mean age was 59 years. The median tumor volume was 4.7 cm³, and the mean margin dose was 16 Gy at the 50% isodose line. Peritumoral edema was revealed on magnetic resonance (MR) imaging in four patients before GKS. Magnetic resonance imaging and clinical examinations were performed every 6 months after GKS. The mean follow-up duration was 32 months. The tumor shrank in eight cases, was stable in 17, and enlarged in one; thus 25 (95%) of 26 tumors were controlled. A peritumoral high signal on T2-weighted MR images was found in eight lesions and preexisting edema was aggravated in three lesions after GKS. Ten of these 11 patients complained of severe headache, and three patients experienced neurological deficits at the same time after a mean latency of 3 months; however, high signal was not demonstrated on imaging before 6 months on average. Steroid agents, when required, gave relief to all patients. The complication rate was 43% (10 of 23 cases). High signal disappeared in nine patients and decreased in the remaining two. High signal was associated with a high integral dose and a large tumor volume. Tumor shrinkage at the last follow-up examination was more prominent in the patients with symptomatic high signal ($p = 0.03$). **CONCLUSIONS:** There was a good tumor control rate with a high complication rate. Longer follow up of more patients is needed. Adjusting the dose-volume relationship should be considered to reduce complications.

8.

Year: 2005

Patient number: 200

Author: Kreil, W.; Luggin, J.; Fuchs, I.; Weigl, V.; Eustacchio, S.; Papaefthymiou, G.

Reference: Journal of neurology neurosurgery and psychiatry, 76, 10, 1425-30, 2005

Title: Long term experience of gamma knife radiosurgery for benign skull base meningiomas

Abstract: **OBJECTIVES:** As most reports on the gamma knife have related only to short or mid-term results, we decided to evaluate the effectiveness and toxicity of radiosurgical treatment for benign skull base meningiomas in 200 patients with a follow up of 5-12 years to define the role of gamma knife radiosurgery (GKRS) for basal meningiomas and to provide further data for comparison with other treatment options. **METHODS:** In total, 99 patients were treated with a combination of microsurgical resection and GKRS. In 101 patients, GKRS was performed as the sole treatment option. Tumour volumes ranged from 0.38 to 89.8 cm³ (median 6.5 cm³), and doses of 7-25 Gy (median 12 Gy) were given to the tumour borders at covering isodose volume curves (range 20-80%, median 45%). **RESULTS:** The actuarial progression free survival rate was 98.5% at 5 years and 97.2% at 10 years. Passing radiation induced oedema occurred in two patients (1%). The neurological status improved in 83 cases (41.5%), remained unaltered in 108 (54%), and deteriorated in 9 (4.5%). Worsening was transient in seven patients (3.5%) and unrelated to tumour or treatment in one (0.5%). Repeated microsurgical resection was performed in five patients following GKRS (2.5%). **CONCLUSIONS:** GKRS has proved to be an effective alternative to microsurgical resection, radiotherapy, and Linac based radiosurgery for adjunctive and primary treatment of selected patients with basal

meningiomas. Because of the excellent long term tumour control rate and low morbidity associated with GKRS, this treatment option should be used more frequently in the therapeutic management of benign skull base meningiomas.

9.

Year: 2005

Patient number: 38

Author: Linskey, Mark E.; Davis, Stephen A.; Ratanatharathorn, Vaneerat

Reference: Journal of neurosurgery, 102, 59-70, 2005

Title: Relative roles of microsurgery and stereotactic radiosurgery for the treatment of patients with cranial meningiomas: a single-surgeon 4- year integrated experience with both modalities

Abstract:OBJECT: The authors sought to assess the respective roles of microsurgery and gamma knife surgery (GKS) in the treatment of patients with meningiomas.

METHODS: The authors culled from a 4-year prospective database data on 74 cases of meningiomas. Thirty-eight were treated with GKS and 35 with microsurgery. Simpson Grade 1 or 2 resection was achieved in 86.1 % of patients who underwent microsurgery. Patients who underwent GKS received a mean margin dose of 16.4 Gy (range 14-20 Gy). The mean tumor coverage was 94.7%, and the mean conformity index was 1.76.

Significant differences between the two treatment groups (GKS compared with microsurgery) included age (mean 60 compared with 50.7 years), volume (mean 7.85 cm³ compared with 44.4 cm³), treatment history (55.3% compared with 14.3%), and tumor location (cavernous sinus/pteroclival, 14 compared with three). The median follow up was 21.5 months (range 1.5-50 months). In patients with benign meningiomas GKS tumor control was 96.8% with one recurrence at the margin. The recurrence rate was zero of 27 for Simpson Grade 1 or 2 resection and three of four for higher grades in those patients who underwent microsurgery. There was no procedure- related mortality or permanent major neurological morbidity. The mean Karnofsky Performance Scale score was maintained for both forms of treatment. Symptoms improved in 48.4% of patients undergoing microsurgery and 16.7% of those who underwent GKS. Transient and permanent cranial nerve morbidity was 7.9 compared with 2.9%, and 5.3 compared with 8.5% for GKS and microsurgery, respectively. In a patient satisfaction survey 93.1% of microsurgery patients and 91.2% of GKS patients were highly satisfied. CONCLUSIONS: Both GKS and microsurgery serve important roles in the overall management of patients with meningiomas. Both are safe and effective and provide high degrees of satisfaction when used for differentially selected patients.

10.

Year: 2005

Patient number: 309

Author: Malik, I.; Rowe, J. G.; Walton, L.; Radatz, M. W. R.; Kemeny, A. A.

Reference: British Journal of Neurosurgery, 19, 1, 13-20, 2005

Title: The use of stereotactic radiosurgery in the management of meningiomas

Abstract: This is a systematic review of a consecutive series of 309 meningiomas treated with gamma knife stereotactic radiosurgery between 1994 and 2000. There was an extreme selection bias towards lesions unfavourable for surgery, determined by the patients referred for treatment: 70% of tumours involved the skull base, 47% specifically the cavernous sinus: 15% of patients had multiple meningiomas or type 2 neurofibromatosis. Tumour histology was the main determinant of growth control ($p < 0.001$), the 5-year actuarial control rates being 87% for typical meningiomas, 49% for atypical tumours and 0% for malignant lesions. Complications from radiosurgery were rare, occurring in 3% of tumours, and were most frequently trigeminal and eye movement disturbances treating cavernous sinus meningiomas. Given the problems inherent in managing these tumours, radiosurgery is a valuable strategy and adjuvant treatment for these meningiomas. © The Neurosurgical Foundation.

11.

Year: 2005

Patient number: 36

Author: Metellus, Philippe; Regis, Jean; Muracciole, Xavier; Fuentes, Stephane; Dufour, Henry; Nanni, Isabelle; Chinot, Oliver; Martin, Pierre Marie; Grisoli, Francois

Reference: Neurosurgery, 57, 5, 873-86, 2005

Title: Evaluation of fractionated radiotherapy and gamma knife radiosurgery in cavernous sinus meningiomas: treatment strategy

Abstract: **OBJECTIVE:** To investigate the respective role of fractionated radiotherapy (FR) and gamma knife stereotactic (GKS) radiosurgery in cavernous sinus meningioma (CSM) treatment. **METHODS:** The authors report the long-term follow-up of two populations of patients harboring CSMs treated either by FR (Group I, 38 patients) or GKS radiosurgery (Group II, 36 patients). There were 31 females with a mean age of 53 years in Group I and 29 females with a mean age of 51.2 years in Group II. In 20 patients (Group I) and 13 patients (Group II), FR and GKS radiosurgery were performed as an adjuvant treatment. In 18 patients (Group I) and in 23 patients (Group II), FR and GKS radiosurgery were performed as first line treatment. In our early experience with GKS radiosurgery (1992, date of gamma knife availability in the department), patients with tumors greater than 3 cm, showing close relationship with the optic apparatus (< 3 mm) or skull base dural spreading, were treated by FR. Secondly, with the advent of new devices and our growing experience, these criteria have evolved. **RESULTS:** The median follow-up period was 88.6 months (range, 42-168 mo) for Group I and 63.6 months (range, 48-92 mo) for Group II. According to Sekhar's classification, 26 (68.4%) patients were Grade III to IV in Group I and 10 (27.8%) patients in Group II ($P < 0.05$); 23 (60.5%) patients had extensive lesions in Group I and 7 (19.4%) patients in Group II ($P < 0.05$). Mean tumor volume was 13.5 cm in Group I and 5.2 cm in Group II ($P < 0.05$). Actuarial progression-free survival was 94.7% and 94.4% in Group I and II, respectively. Clinically, improvement was seen for 24 (63.2%) patients in Group I and for 21 (53.8%) patients in Group II ($P > 0.05$). Radiologically, 11 (29%, Group I) patients and 19 (Group II, 52.7%) patients showed tumor shrinkage ($P = 0.04$). Transient morbidity was 10.5% in Group I

and 2.8% in Group II. Permanent morbidity was 2.6% in Group I and 0% in Group II. CONCLUSION: FR and GKS radiosurgery are safe and efficient techniques in treatment of CSMs, affording comparable satisfactory long-term tumor control. However, GKS radiosurgery provides better radiological response, is far more convenient, and fits into most patients lives much better than FR. Therefore, in the authors' opinion, GKS radiosurgery should be advocated in first intention for patients with CSMs, whereas conventional radiotherapy should be reserved for cases that are not amenable to this technique, thus making these two therapeutic modalities not alternative but complementary tools in CS meningioma treatment strategy.

12.

Year: 2005

Patient number: 20

Author: Nicolato, A.; Giorgetti, P.; Foroni, R.; Grigolato, D.; Pasquin, I. P.; Zuffante, M.; Soda, C.; Tomassini, A.; Gerosa, M.

Reference: Acta neurochirurgica, 147, 4, 367-75, 2005

Title: Gamma knife radiosurgery in skull base meningiomas: a possible relationship between somatostatin receptor decrease and early neurological improvement without tumour shrinkage at short-term imaging follow-up

Abstract:Background. This study investigates a possible relationship between the effects of gamma knife (GK) on meningioma somatostatin receptors (SRs) and the high rate of early neurological improvement without tumour reduction at short-term imaging follow-up.Methods. From December 1997 to December 2002, somatostatin receptor scintigraphy (SRS) using an (111)Indium-labelled somatostatin analogue, Octreotide, was performed both before and 7-12 months after radiosurgery in 20 patients with intracranial meningiomas. Semiquantitative data were calculated as an SRS index.Findings. The pre-GK SRS index was always >1 , averaging 4.44 ± 3.20 . There were no statistically significant differences between the pre-GK average values of primary (4.80 ± 3.65) and residual (3.75 ± 1.93) meningiomas. At the first clinical/MRI follow-up, the neurological examination had improved in 15/20 (75%) and had not changed in 5/20 patients. A corresponding slight tumour shrinkage on high-resolution MRI was documented in 3/20 cases only. The post-GK average SRS index was lower than pre-GK values both in primary (3.87 ± 3.19) and in adjuvant (2.52 ± 1.14) treatments, but the differences were not significant. However, the subgroup of patients with early neurological improvement showed a higher pre-GK average SRS index (5.21 ± 3.33) and a more substantial post-GK average SRS index decrease (3.86 ± 3.00) than the patients whose clinical condition remained stable (2.10 ± 0.59 and 1.99 ± 0.55 , respectively). The difference between the two subgroups of patients proved to be statistically significant ($P < 0.05$).Conclusions. Our preliminary findings suggest a possible relationship between a decrease in the concentration of SRs on meningioma cells at short-term functional imaging follow-up after radiosurgery and early neurological improvement.

13.

Year: 2005

Patient number: 26

Author: Pamir, M. Necmettin; Kiliç, Türker; Bayrakli, Fatih; Peker, Selçuk

Reference: Surgical neurology, 64, Suppl 2, S58-66, 2005

Title: Changing treatment strategy of cavernous sinus meningiomas: experience of a single institution

Abstract:BACKGROUND: Oncological treatment of a neoplasm is more than surgical removal of the tumor. Probably, this truth is the reason for the ongoing discussion on cavernous sinus meningiomas in the last decade. Debate on optimal management of cavernous sinus meningiomas aims to compare the different treatment strategies: (a) radical surgical resection and (b) conservative surgical resection complemented with radiosurgical treatment. MATERIALS AND METHODS: Natural history of the change in the management strategy of cavernous sinus meningiomas in our department before and after GK facility became available in 1997 allowed us to compare the 2 aforementioned strategies. Before installation of a Leksell GK unit at the hospital in 1997, the neurosurgical team at Marmara University Institute of Neurological Sciences and Faculty of Medicine (Istanbul, Turkey) treated patients with cavernous sinus meningioma using radical resection (radical strategy, group A, 10 patients). After 1997, the same neurosurgical team used understanding of surgical removal of the extracavernous sinus tumor component with GK irradiation of the intracavernous part (conservative strategy, group B, 12 patients). Another group of patients, who were treated with GK as a first-step treatment, was analyzed (GK group, group C, 26 patients). RESULTS: At the end of the third year, more stable tumor volume control was achieved in groups B and C; after the second year, an incline in the tumor volume-time graph was detected. Group B resulted in less cranial nerve-related complications; a certain degree of improvement in cranial nerve deficits was observed. CONCLUSION: Comparing 2 different management strategies for cavernous sinus meningiomas in the same hospital setting using the same neurosurgical group, we conclude that extracavernous resection followed by GK is as effective as radical surgery. Considering cranial nerve complications and third-year tumor volume control achievement, conservative approach yielded better results. Longer follow-up with larger series is necessary.

14.

Year: 2005

Patient number: 49

Author: Pollock, B. E.; Stafford, S. L.

Reference: International Journal of Radiation Oncology Biology Physics, 62, 5, 1427-1431, 2005

Title: Results of stereotactic radiosurgery for patients with imaging defined cavernous sinus meningiomas

Abstract:Introduction: The purpose of this study was to evaluate the efficacy and safety of stereotactic radiosurgery as primary management for patients with imaging defined cavernous sinus meningiomas. Methods: Between 1992 and 2001, 49 patients had

radiosurgery for dural-based masses of the cavernous sinus presumed to be meningiomas. The mean patient age was 55.5 years. The mean tumor volume was 10.2 mL; the mean tumor margin dose was 15.9 Gy. The mean follow-up was 58 months (range, 16-144 months). Results: No tumor enlarged after radiosurgery. Twelve of 38 patients (26%) with preexisting diplopia or facial numbness/pain had improvement in cranial nerve function. Five patients (10%) had new (n = 3) or worsened (n = 2) trigeminal dysfunction; 2 of these patients (4%) underwent surgery at 20 and 25 months after radiosurgery despite no evidence of tumor progression. Neither patient improved after partial tumor resection. One patient (2%) developed an oculomotor nerve injury. One patient (2%) had an ischemic stroke related to occlusion of the cavernous segment of the internal carotid artery. Event-free survival was 98%, 85%, and 80% at 1, 3, and 7 years after radiosurgery, respectively. Univariate analysis of patient and dosimetric factors found no analyzed factor correlated with postradiosurgical morbidity. Conclusions: Radiosurgery was an effective primary management strategy for patients with an imaging defined cavernous sinus meningioma. Except in situations of symptomatic mass effect, unusual clinical presentation, or atypical imaging features, surgery to confirm the histologic diagnosis is unlikely to provide clinical benefit. © 2005 Elsevier Inc.

15.

Year: 2005

Patient number: 160

Author: Shuto, Takashi; Inomori, Shigeo; Fujino, Hideyo; Nagano, Hisato; Hasegawa, Naoki; Kakuta, Yukio

Reference: Journal of neurosurgery, 102, 134-9, 2005

Title: Cyst formation following gamma knife surgery for intracranial meningioma

Abstract: OBJECT: The authors conducted a study to evaluate the clinical significance of cyst formation or enlargement after gamma knife surgery (GKS) for intracranial benign meningiomas. METHODS: The medical records of 160 patients with 184 tumors were examined for those with follow-up data of more than 2 years among 270 patients who underwent GKS for intracranial meningiomas between February 1992 and November 2001. Cyst formation or enlargement following GKS was observed in five patients, one man and four women (mean age 61.2 years). The tumor location was the sphenoid ridge in one case, petroclival in two, tentorium in one, and parasagittal region in one. All patients underwent surgery before GKS. The mean tumor volume was 10.5 cm³, the mean margin dose was 13.4 Gy (median 14 Gy), and the mean maximum dose was 27.5 Gy (median 24.1 Gy). At the time of GKS three tumors were associated with cyst, of which two enlarged after radiosurgery. Three cysts developed de novo after GKS. Three of the five patients needed surgery to treat the cyst formation or enlargement. Histological examination demonstrated various findings such as tumor necrosis, proliferation of small vessels, vascular obliteration, and hemosiderin deposits. CONCLUSIONS: New cyst formation following GKS for benign intracranial meningioma is relatively rare; however, both preexisting and newly developed cysts tend to enlarge after GKS and often require surgery.

16.

Year: 2004

Patient number: 137

Author: DiBiase, Steven J.; Kwok, Young; Yovino, Susannah; Arena, Cristan; Naqvi, Shahid; Temple, Richard; Regine, William F.; Amin, Pradip; Guo, Chuanfa; Chin, Lawrence S.

Reference: International journal of radiation oncology biology physics, 60, 5, 1515-9, 2004

Title: Factors predicting local tumor control after gamma knife stereotactic radiosurgery for benign intracranial meningiomas

Abstract:**PURPOSE:** To determine the long-term outcomes and prognostic factors in benign intracranial meningiomas treated with gamma knife stereotactic radiosurgery (GK-SRS). **METHODS AND MATERIALS:** Between 1992 and 2000, 162 patients with benign meningiomas were treated with GK-SRS at the University of Maryland Medical Center. Complete follow-up was available in 137 patients. All patients underwent magnetic resonance imaging (MRI)-based treatment planning. Serial MRIs and clinical exams were performed to assess tumor response. GK-SRS was the primary treatment in 85 patients (62%), whereas 52 patients (48%) had prior surgical resections. The median prescribed dose was 14 Gy (range, 4-25 Gy) to the 50% isodose line. The median tumor volume, treatment volume, and conformity index were 4.5 cc (range, 0.32-80.0 cc), 6.3 cc (range, 1.0-75.2 cc), and 1.34 (range, 0.65-3.16), respectively. The median follow-up for the entire cohort was 4.5 years (range, 0.33-10.5 years). The following factors were included in the statistical analysis for disease-free survival (DFS) and overall survival (OS): sex, age, dose, gross tumor volume (GTV), conformity index (CI), and dural tail coverage. **RESULTS:** Serial MRI analysis was available in 121 patients (88.3%). Decrease in tumor size was observed in 34 patients (28.1%), whereas there was no change in 77 patients (63.6%), for a crude radiographic control rate of 91.7%. Increase in tumor size was seen in 10 patients (8.3%). New neurologic deficits attributed to the treatment developed in 10 patients (8.3%). The mean DFS and OS for the entire cohort are 4.6 years and 5.0 years, respectively. The 5-year actuarial DFS and OS were 86.2% and 91.0%, respectively. Univariate analysis revealed GTV, sex, CI, and dural tail treatment to be significant prognostic factors. Patients with GTV \leq 10 cc also had longer survivals, with the 5-years DFS and OS of 91.9% vs. 68.0% ($p = 0.038$) and 100% vs. 59.7% ($p = 0.0001$), respectively. The 5-years actuarial DFS and OS for females vs. males were 90.2% vs. 74.2% ($p = 0.0094$) and 91.6% vs. 89.1% ($p = 0.016$), respectively. Patients with

17.

Year: 2004

Patient number: 28

Author: Iwai, Yoshiyasu; Yamanaka, Kazuhiro; Morikawa, Toshie

Reference: Journal of clinical neuroscience : official journal of the Neurosurgical Society of Australasia, 11, 7, 715-8, 2004

Title: Adjuvant gamma knife radiosurgery after meningioma resection

Abstract: We evaluated the usefulness of adjuvant treatment with gamma knife radiosurgery following meningioma surgery. During the past 8 years, we operated on 78 patients with meningiomas. Among these, 28 patients (36%) received gamma knife radiosurgery postoperatively. The indications for radiosurgery were as follows: residual tumour after surgery in 13 patients (46.4%), regrowth of residual tumour during the follow-up period in 7 patients (25%), recurrence after total removal (Simpson grade 1 or 2) in 7 patients (25%), and another intracranial meningioma in one patient (3.6%). The tumour diameter at the time of radiosurgery ranged from 5.2 to 48.1 mm (median 21.6 mm). Larger tumours with a mean diameter above 40 mm in two patients were treated with two-staged radiosurgery. The tumor marginal dose ranged from 8 to 23 Gy (median 12 Gy). The follow-up period was 3-84 months (median 30 months) after radiosurgery. The tumour size decreased in 17 patients (60.7%), remained unchanged in 9 patients (32.1%), and increased in 2 patients (7.2%). No radiation injury was experienced. Adjuvant therapy using gamma knife radiosurgery for meningiomas can achieve control of tumour growth and may improve patient outcomes. Careful surgical planning and follow-up are required to understand the usefulness and limitations of radiosurgery in this setting.

18.

Year: 2004

Patient number: 57

Author: Kuo, John S.; Chen, Joseph C. T.; Yu, Cheng; Zelman, Vladimir; Giannotta, Steven L.; Petrovich, Zbigniew; MacPherson, Dana; Apuzzo, Michael L. J.

Reference: Neurosurgery, 54, 6, 1385-93, 2004

Title: Gamma knife radiosurgery for benign cavernous sinus tumors: quantitative analysis of treatment outcomes

Abstract: **OBJECTIVE:** We review our 8-year experience with gamma knife radiosurgery (GKRS) for the treatment of patients with benign cavernous sinus tumors and present a quantitative analysis of factors relevant to treatment outcomes. **METHODS:** From 1994 to 2002, a total of 139 patients with benign cavernous sinus tumors were treated in 145 sessions. Their median age was 53 years, and the median follow-up was 3.5 years. The tumors included 57 meningiomas, 76 pituitary tumors (49 nonfunctional adenomas, 15 prolactinomas, 5 adrenocorticotrophic hormone-secreting tumors, 6 growth hormone-secreting tumors, and 1 plurihormone-secreting tumor), 4 schwannomas, 1 hemangioma, and 1 paraganglioma. Sekhar tumor grades were as follows: I, n = 28 (20%); II, n = 42 (30%); III, n = 42 (30%); IV, n = 19 (14%); and V, n = 8 (6%). The median tumor volume was 3.4 cm³, and the median prescribed dose was 15 Gy defined to the 50% isodose line. **RESULTS:** A total of 136 treated tumors (97.8%) were well controlled by GKRS, with low morbidity. For meningiomas, 29 tumors (51%) were unchanged and 26 (46%) were smaller at a median of 15.2 months. For pituitary tumors, 50 (66%) were unchanged and 25 (33%) were smaller at a median of 20.6 months. Improvement in cranial nerve (CN) function was seen in 19 (36.5%) of 52 patients with pre-GKRS deficits,

and 3 patients (2.2%) developed new stable CN deficits after GKRS: 1 patient developed IVth

19.

Year: 2004

Patient number: 58

Author: Kuo, John S.; Yu, Cheng; Giannotta, Steven L.; Petrovich, Zbigniew; Apuzzo, Michael L. J.

Reference: Neurosurgery, 55, 1, 168-72, 2004

Title: The Leksell gamma knife Model U versus Model C: a quantitative comparison of radiosurgical treatment parameters

Abstract:OBJECTIVE: We present a quantitative comparison of radiosurgery treatments for cavernous sinus tumors using the Leksell gamma knife Model U versus the Model C with automatic positioning system (APS) (Elekta Instruments, Norcross, GA). METHODS: At our medical center from August 1994 through May 2000, the Model U was used to treat 96 patients (37 men (39%) and 59 women (61%); median age, 54.5 yr) with benign cavernous sinus tumors: 43 meningiomas (45%), 48 pituitary tumors (50%), and 5 others (5%). From June 2000 through April 2002, the Model C with APS treated 45 patients (20 men (44%) and 25 women (56%); median age, 51.4 yr) with 15 meningiomas (33%), 29 pituitary tumors (65%), and 1 schwannoma (2%). The two groups had similar treated tumor volumes (Model U mean, 4.3 cm³; Model C mean, 4.2 cm³), equivalent tumor distances from critical structures (optic nerve, chiasm, and pons), comparable distributions in Sekhar tumor grades, and the same median prescribed dose of 15 Gy to the 50% isodose line at the tumor periphery. All planning and treatments were performed by the same radiosurgery team to minimize dosage to adjacent critical tissues and to optimize conformity index. RESULTS: Analysis of multiple treatment parameters showed that the Model C plans were superior. Model C treatments had an improved conformity index (Model U mean, 1.7; Model C mean, 1.6; P < 0.02) and a lower underdosed tumor volume (Model U mean, 0.4 cm³; Model C mean, 0.1 cm³; P < 0.004). The total treated volume and the excess treated volume were similar. The Model C group had a reduction in optic chiasm dose (Model C mean dose, 3.8 Gy; Model U mean dose, 5.3 Gy; P < 0.0001). The average number of isocenters was slightly higher for the Model C group (6.7 versus 6 for the Model U), but with a lower mean number of collimator sizes (1 versus 2 for the Model U). Model C plans required a mean of 93 fewer plugs per treatment, thus contributing to an estimated 67.6 minutes saved per treatment session. CONCLUSION: Comparison of radiosurgery treatments using the Leksell gamma knife Model U versus the Model C with APS was performed by quantitative analysis of treatment parameters on a cohort of benign cavernous sinus tumors. Treatment plans using the Model C resulted in better tumor coverage (improved conformity, less underdosed tumor volume) and decreased optic chiasm dose. An estimated average of 1 hour was saved per treatment when using the Model C with APS.

20.

Year: 2004

Patient number: 176

Author: Liscák, R.; Kollová, A.; Vladyka, V.; Simonová, G.; Novotný, J., Jr.

Reference: Acta neurochirurgica. Supplement, 91, 65-74, 2004

Title: Gamma knife radiosurgery of skull base meningiomas

Abstract: Meningiomas are the most frequent benign tumors treated by gamma knife radiosurgery and the majority of them are located on the skull base. Between 1992 and 1999, 197 skull base-located meningiomas in 192 patients were treated by gamma knife in Prague. Contact with the chiasma or optic tract was not regarded as a contraindication for gamma knife radiosurgery and such contact was observed in 32% of the skull base meningiomas treated. 176 patients were monitored during a median of 36 months, of whom 73% showed a decrease in tumor volume; no change was observed in 25% and continued growth was observed in 2%. Neurodeficit improved in 63% of patients, temporary morbidity occurred in 11% and persistent morbidity remained in 4.5%. Radiosurgery induced edema in 11%. Significantly lower edema occurrence was observed after radiosurgery in patients with no history of edema prior to radiosurgery, where the tumor was located in the posterior skull base and where the dosage to the tumor margin was lower than or equal to 14 Gy. Radiosurgery of skull base meningiomas has been proven to be safe and efficient. We consider gamma knife treatment for skull base meningiomas to be the method of choice whenever tumors are within the volume limits and there is no need for an urgent decompressive effect from the open operation.

21.

Year: 2004

Patient number: 40

Author: Maruyama, Keisuke; Shin, Masahiro; Kurita, Hiroki; Kawahara, Nobutaka; Morita, Akio; Kirino, Takaaki

Reference: Neurosurgery, 55, 5, 1068-75, 2004

Title: Proposed treatment strategy for cavernous sinus meningiomas: a prospective study

Abstract: **OBJECTIVE:** To establish a safe and effective treatment strategy for cavernous sinus (CS) meningiomas, we prospectively analyzed the outcome of a treatment protocol combining surgery and radiosurgery during the past 7 years. **METHODS:** Tumors confined to the CS and distant from the optic apparatus and the brainstem were treated with radiosurgery alone. Tumors attached to or compressing the optic apparatus and brainstem and that were larger than 3 cm in mean diameter, extended into the multiple cranial fossae, and were suspected of being malignant were treated with combined nonradical microsurgery and radiosurgery. **RESULTS:** In accordance with this treatment protocol, 40 patients aged 26 to 72 years (median, 51 yr) with primary (n = 27) or recurrent (n = 13) CS meningiomas (volume range, 0.9-39.3 cm³; median volume, 5.4 cm³) were treated with combined surgery and radiosurgery (n = 23) or radiosurgery alone (n = 17). During radiosurgery, 12 to 18 Gy (median, 16 Gy) was delivered to the tumor margin. The follow-up period ranged from 14 to 79 months (median, 47 mo). The actuarial tumor control rate was 94.1% at 5 years. The improvement of cranial nerve

function was significantly frequent in patients with primary CS meningiomas ($P < 0.05$). Permanent cranial nerve dysfunction was significantly frequent in patients with tumors compressing the brainstem or smaller than 10 cm³ ($P < 0.05$). All 36 patients with a pretreatment Karnofsky Performance Scale score of 90 or more maintained the same range after treatment. **CONCLUSION:** Proper combination of microsurgery and radiosurgery for CS meningiomas provides excellent growth control with favorable functional state. Outcomes were better when this protocol was adopted at the initial diagnosis for patients with smaller tumors that did not compress the brainstem.

22.

Year: 2004

Patient number: 81

Author: Mindermann, Thomas; de, Rougemont Olivier

Reference: Stereotactic and functional neurosurgery, {Stereotact-Funct-Neurosurg }, 2004 (epub: 18 Nov 2004), vol. 82, no. 4, p. 194-5, ISSN: 1011-6125.

Title: The significance of tumor location for Gamma Knife treatment of meningiomas

Abstract: We conducted this retrospective review to evaluate the influence of tumor location on the outcome of Gamma Knife treatment (GKT) for meningiomas. Patient charts from 1995 to 2001 of the Gamma Knife Center Zurich, Switzerland, were reviewed. Of 81 patients, 23% had parasagittal or convexity meningiomas (PCM), 62% had skull base meningiomas (SBM), and 15% had posterior fossa meningiomas (PFM). Tumor control was achieved in 95% of PCM, 92% of SBM, and 100% of PFM. Neurological deficits were present in 5% of patients with PCM before and following GKT, in 62% of patients with SBM before GKT and in 46% following GKT, and in 17% of patients with PFM before and following GKT. We conclude that tumor location has an influence on tumor control and outcome. Deep and small tumors seem to be associated with better tumor control and less complications. Neurological deficits tend to resolve in deep tumors following GKT. 2004 S. Karger AG, Basel.

23.

Year: 2004

Patient number: 12

Author: Nicolato, A.

Reference: The quarterly journal of nuclear medicine and molecular imaging, 48, 1, 26-32, 2004

Title: 111Indium-octreotide brain scintigraphy: a prognostic factor in skull base meningiomas treated with gamma knife radiosurgery

Abstract: AIM: The purpose of this study is to prospectively investigate the prognostic role of somatostatin receptor scintigraphy (SRS) using an 111Indium-labelled somatostatin analogue, Octreotide, in skull base meningiomas (SBMs) treated with gamma knife (GK) radiosurgery. METHODS: From December 1997 to March 2000, SRS was performed both before and within 1 year of radiosurgery on 12 patients. Semi-quantitative data were calculated as SRS index; the index decrease was arbitrarily considered significant above

10%. A potential correlation between the decrease in post/pre-GK SRS index and radiosurgical outcome was evaluated. RESULTS: The follow-up period was at least 30 months in the whole series (median, 43 months). In all 12 patients, the pre-GK SRS index was always >1, averaging 3.73+/-2.9. A decrease in the post-GK average SRS index (2.35+/-1.5) was observed. The difference between the pre- and post-GK average values was statistically significant ($p < 0.03$). At the 1st high-resolution magnetic resonance imaging (MRI) follow-up within 1 year of GK, there was no tumor shrinkage in any of the 12 patients of our series. A post /pre-GK SRS index decrease >10% was observed in 9 patients and <10% in 3. Delayed MRI follow-up documented tumor reduction in all 9 cases having an ^{111}In uptake decrease >10%, with stable imaging in the others ($p = 0.00024$). CONCLUSION: Our preliminary findings suggest a prognostic correlation between a decrease in concentration of somatostatin receptors on meningioma cells within 1 year of radiosurgery and delayed meningioma shrinkage.

24.

Year: 2004

Patient number: 16

Author: Pollock, Bruce E.; Link, Michael J.; Foote, Robert L.; Stafford, Scott L.; Brown, Paul D.; Schomberg, Paula J.

Reference: Stereotactic and functional neurosurgery, {Stereotact-Funct-Neurosurg }, 2004 (epub: 01 Apr 2004), vol. 82, no. 2-3, p. 98-103, ISSN: 1011-6125.

Title: Radiosurgery as primary management for meningiomas extending into the internal auditory canal

Abstract: Stereotactic radiosurgery is increasingly utilized as primary management for patients with skull base meningiomas. This study reviews the results of stereotactic radiosurgery for patients with meningiomas extending into the internal auditory canal (IAC) to determine the risk of facial weakness or hearing loss. From 1990 to 2002, 16 patients had radiosurgery for meningiomas extending into the IAC. The median patient age was 63 years. Ten patients had symptoms of vestibulocochlear nerve dysfunction before radiosurgery. The median tumor volume was 5.1 cm³; the median tumor extension into the IAC was 7 mm (range, 3-12). The median tumor margin dose was 15 Gy. The median follow-up was 36 months. Ten meningiomas (63%) decreased in size, and 6 tumors were unchanged. No patient developed facial weakness. One patient (6%) had worsened facial sensation. Three of 14 patients (21%) with either normal hearing clinically ($n = 5$) or documented Gardner- Robertson class 1-2 before radiosurgery ($n = 9$) had decreased hearing after radiosurgery. The 1-, 2- and 5-year actuarial incidences of hearing preservation were 93, 84 and 42%, respectively. Three patients (19%) had improved hearing after radiosurgery. One patient with class 2 hearing improved to class 1; 2 patients with no speech discrimination before radiosurgery (class 5) improved to a class 3 status following the procedure. The risk of facial weakness or hearing loss is low after radiosurgery for patients with meningiomas extending into the IAC. Radiosurgery is an excellent alternative to surgical excision for meningiomas in this location, especially if a subtotal resection is likely or a hearing-sacrificing operation such as a translabyrinthine approach is contemplated. Copyright 2004 S. Karger AG, Basel.

25.

Year: 2003

Patient number: 179

Author: Chang, J. H.; Chang, J. W.; Choi, J. Y.; Park, Y. G.; Chung, S. S.

Reference: Journal of neurology neurosurgery and psychiatry, 74, 2, 226-30, 2003

Title: Complications after gamma knife radiosurgery for benign meningiomas

Abstract:OBJECTIVES: To analyse the results of gamma knife radiosurgery (GKS) for the treatment of intracranial meningiomas and to assess possible factors related to the outcome and complications of such treatment. METHODS: The authors retrospectively reviewed the clinical and radiological data of 179 patients (194 lesions) treated with GKS for meningiomas between May 1992 and October 2000. The mean follow up duration was 37.3 months (range 6.4 to 86.3 months). The study determined the correlation between radiosurgical outcome including imaging changes after GKS and multiple factors such as tumour location and size, patient characteristics, venous sinus status, pre-GKS degree of oedema, other treatment modalities, and radiosurgical parameters. RESULTS: The radiological control rate was 97.1%. Magnetic resonance imaging (MRI) showed complications after GKS in 35 lesions (25.0%) among the 140 lesions followed up with MRI. Complications were divided into peritumorous imaging changes (33 lesions; 23.6%) and transient cranial nerve dysfunction (two lesions; 1.4%). Radiation induced imaging changes were seen mostly in convexity, parasagittal, and falx meningiomas that were deeply embedded in the cortex. About 60% of these were asymptomatic and the overall rate of symptomatic imaging changes was 9.3%. Neurological deficit related to imaging changes developed in only three patients, and all the symptoms were transient. CONCLUSION: GKS for intracranial meningiomas seems to be a safe and effective treatment. However, meningiomas of the convexity, parasagittal region, or falx cerebri have a higher incidence of peritumorous imaging changes after GKS than those of the skull base. Therefore, the use of GKS needs to be considered very cautiously in cerebral hemispheric meningiomas, taking into consideration patient age and general condition, tumour size and location, pattern of cortical embedding, relation between the tumour and venous sinuses, presenting symptoms, and patient preference.

26.

Year: 2003

Patient number: 219

Author: Flickinger, John C.; Kondziolka, Douglas; Maitz, Ann H.; Lunsford, L. Dade

Reference: International journal of radiation oncology biology physics, 56, 3, 801-6, 2003

Title: Gamma knife radiosurgery of imaging-diagnosed intracranial meningioma

Abstract:PURPOSE: To evaluate tumor control and outcome from radiosurgery of meningiomas diagnosed by imaging without pathologic verification. METHODS AND MATERIALS: A total of 219 meningiomas diagnosed by imaging criteria underwent gamma knife radiosurgery to a median marginal tumor dose of 14 Gy (range 8.9-20), a median treatment volume of 5.0 cm³ (range 0.47-56.5), and a median maximal dose of

28 Gy (range 22-50). The median follow-up was 29 months (range 2-164). **RESULTS:** Tumor progression developed in 7 cases, 2 of which turned out to be different tumors (metastatic nasopharyngeal adenoid cystic carcinoma and chondrosarcoma). One tumor was controlled, but the development of other brain metastases suggested a different diagnosis. The actuarial tumor control rate was 93.2% +/- 2.7% at 5 and 10 years. The actuarial rate of identifying a diagnosis other than meningioma was 2.3% +/- 1.4% at 5 and 10 years. The actuarial rate of developing any postradiosurgical injury reaction was 8.8% +/- 3.0% at 5 and 10 years. No pretreatment variables correlated with tumor control in univariate or multivariate analysis. The risk of postradiosurgery sequelae was lower (5.3% +/- 2.3%) in patients treated after 1991 (with stereotactic MRI and lower doses; $p = 0.0104$) and tended to increase with treatment volume ($p = 0.0537$). **CONCLUSION:** Radiosurgery of meningioma diagnosed by imaging without tissue confirmation is associated with a high rate of tumor control and acceptable morbidity but carries a small risk (2.3%) of an incorrect diagnosis.

27.

Year: 2003

Patient number: 30

Author: Harris, Anthony E.; Lee, John Y. K.; Omalu, Bennett; Flickinger, John C.; Kondziolka, Douglas; Lunsford, L. Dade

Reference: Surgical neurology, 60, 4, 298-305, 2003

Title: The effect of radiosurgery during management of aggressive meningiomas

Abstract: **BACKGROUND:** Aggressive (atypical or malignant) meningiomas are difficult tumors to manage. We review the local control and survival rates of patients with aggressive meningiomas after multi-modality therapy that included stereotactic radiosurgery (SRS). **METHODS:** Thirty patients had SRS for treatment of malignant ($n = 12$) or atypical ($n = 18$) meningiomas. There were 17 (57%) males and 13 (43%) females with an average age of 58 years. The mean number of prior surgical resections was two. The median imaging follow-up was 2.3 (0.1-11.4) years; median clinical follow-up was 3.8 (0.25-11.5) years. **RESULTS:** After SRS, the overall median time until progression of neurologic signs was 48.0 (+/-6.51) months. Median time to neurologic progression was significantly worse for patients treated late after recurrence versus early after craniotomy. Atypical meningiomas had 5- and 10-year overall actuarial survival rates of 59% (+/-13), while malignant meningiomas had 5- and 10-year overall actuarial survival rates of 59% (+/-16) and 0%. These curves were not significantly different from one another. Atypical meningiomas had a 5-year progression-free survival (PFS) of 83% (+/-7%), while malignant meningiomas had a 5-year PFS of 72% (+/-10) ($p = 0.018$). On multivariate analysis, early SRS and smaller tumor volumes were associated with better PFS, while younger age was associated with better survival. One patient had an adverse radiation effect after SRS. **CONCLUSIONS:** Stereotactic radiosurgery is an important adjuvant management strategy for residual tumors identified early after craniotomy and partial resection. Aggressive use of early boost radiosurgery following craniotomy and radiation therapy is recommended for patients with malignant meningiomas.

28.

Year: 2003

Patient number: 11

Author: Hart, D. J.; Giannotta, S. L.

Reference: Techniques in Neurosurgery, 9, 2, 86-92, 2003

Title: Complex cranial base meningioma: Combined management

Abstract: The management of giant cranial base meningiomas is challenging. The optimal treatment paradigm for such lesions remains poorly defined. Based on earlier studies, the authors have evaluated treatment outcomes for these complex lesions comparing attempted gross total resection in a single sitting (9 patients) versus staged surgical resection (6 patients) versus staged surgery plus gamma knife stereotactic radiosurgery (11 patients). Cranial nerve deficits were found in 33%, 16%, and 27% in the respective groups, whereas major neurologic deficits occurred in 22%, 0%, and 0% respectively. Mortality was 11%, 0%, and 0% in the single surgery, staged surgery, and surgery plus gamma knife groups, whereas hospital stay dropped from 15.5 days for single surgery to 9.3 days for staged surgery and 7.6 days for surgery plus gamma knife. Tumor control was excellent, with long-term tumor control in 24 of 26 patients (92%) over a mean 69.8-month follow-up. The authors conclude that although every patient should be evaluated on an individual basis, single-stage surgical resection may present increased risk of morbidity and a longer hospital stay. The long-term safety and efficacy of gamma knife treatment of these lesions remains unclear, but may play an important role in a combined surgical and radiosurgical treatment paradigm. © 2003 Lippincott Williams & Wilkins, Inc.

29.

Year: 2003

Patient number: 42

Author: Iwai, Yoshiyasu; Yamanaka, Kazuhiro; Ishiguro, Tomoya

Reference: Neurosurgery, 52, 3, 517-24, 2003

Title: Gamma knife radiosurgery for the treatment of cavernous sinus meningiomas

Abstract: **OBJECTIVE:** We report on the efficacy of gamma knife radiosurgery for cavernous sinus meningiomas. **METHODS:** Between January 1994 and December 1999, we used gamma knife radiosurgery for the treatment of 43 patients with cavernous sinus meningiomas. Forty-two patients were followed up for a mean of 49.4 months (range, 18-84 mo). The patients' average age was 55 years (range, 18-81 yr). Twenty-two patients (52%) underwent operations before radiosurgery, and 20 patients (48%) underwent radiosurgery after the diagnosis was made by magnetic resonance imaging. The tumor volumes ranged from 1.2 to 101.5 cm³ (mean, 14.7 cm³). The tumors either compressed or were attached to the optic apparatus in 17 patients (40.5%). The marginal radiation dose was 8 to 15 Gy (mean, 11 Gy), and the optic apparatus was irradiated with 2 to 12 Gy (mean, 6.2 Gy). Three patients with a mean tumor diameter greater than 4 cm were treated by two-stage radiosurgery. **RESULTS:** Thirty-eight patients (90.5%)

demonstrated tumor growth control during the follow-up period after radiosurgery. Tumor regression was observed in 25 patients (59.5%), and growth was unchanged in 13 patients (31%). Regrowth or recurrence occurred in four patients (9.5%). The actual tumor growth control rate at 5 years was 92%. Only one patient (2.4%) experienced regrowth within the treatment field; in other patients, regrowth occurred at sites peripheral to or outside the treatment field. Twelve patients (28.6%) had improved clinically by the time of the follow-up examination. None of the patients experienced optic neuropathy caused by radiation injury or any new neurological deficits after radiosurgery.

CONCLUSION: Gamma knife radiosurgery may be a useful option for the treatment of cavernous sinus meningiomas not only as an adjuvant to surgery but also as an alternative to surgical removal. We have shown it to be safe and effective even in tumors that adhere to or are in close proximity to the optic apparatus.

30.

Year: 2003

Patient number: 11

Author: Iwai, Yoshiyasu; Yamanaka, Kazuhiro; Morikawa, Toshie; Ishiguro, Tomoya; Honda, Yuji; Matsuzaka, Yasuhiro; Komiyama, Masaki; Yasui, Toshihiro

Reference: No shinkei geka, 31, 6, 649-55, 2003

Title: The surgical treatment strategy and results of parasellar meningiomas in the era of radiosurgery

Abstract: We evaluated the surgical treatment results of parasellar meningiomas in the era of radiosurgery. We treated 24 patients of parasellar meningiomas surgically. The median age was 60 yrs (ranging from 29 to 82 yrs). The most common tumor location was the sphenoid ridge in 12 patients and the tuberculum sellae in 7 patients. The pterional approach using fronto-temporal craniotomy was performed for all patients. The residual or recurrent tumors were treated by gamma knife radiosurgery (GKS). We are able to follow up these cases for a median of 3.8 yrs (ranging from 1 to 8 yrs) after the operations. The radicality of tumor resection was Simpson grade II in 13 patients (54%), grade III in 3 patients (13%) and grade IV in 7 patients (33%). Clinical improvement was achieved in 81% of the patients. Of the patients who had visual disturbance preoperatively, 8 patients (73%) showed improvement, but 3 patients suffered deterioration postoperatively. None of the patients died. One patient suffered transient memory disturbance and one patient suffered mild facial numbness postoperatively. Boost radiosurgery for the residual tumors was performed for six patients and tumor growth control was able to be achieved in all patients, with a median of 3.1 years follow-up period (ranging from 0.5 to 6 yrs). Five patients with tumor regrowth or recurrence were treated by GKS. We recommend fronto-temporal craniotomy with nonradical resection for parasellar meningiomas and radiosurgery for residual and recurrent tumors. This strategy will achieve good functional outcome with long-term tumor growth control.

31.

Year: 2003

Patient number: 106

Author: Kobayashi, T.; Kida, Y.; Mori, Y.; Hattori, T.; Yoshimoto, M.; Hasegawa, J.; Fujitani, S.

Reference: Japanese Journal of Neurosurgery, 12, 5, 370-377, 2003

Title: Long-term results of gamma radiosurgery for skull base meningiomas

Abstract: The effects of gamma radiosurgery on 106 out of 150 cases of skull base meningiomas which had been treated by gamma knife and followed-up for more than 3 years (mean of 48.2 months) have been evaluated. Overall results showed that partial response (PR) was found in 44 cases, minor response (MR) in 9, no change (NC) in 42 and progression (PG) in 11. Another words, response rate was 41.5%, control rate was 89.6% and progression rate was 10.4%. There found differences of the response among different locations; the response rate of C-P angle and CS-parasellar meningiomas showed higher than others, but control rate was higher in C-P angle and tentorial meningioma. Progression was found only in CS-parasellar and petroclival meningioma. The progression rate has changed from 0% at less than 3 years of follow-up, 10.4% at more than 3 years and 18.2% at more than 5 years. The factors related to the progression are the tumor size, the radiation dosis, the locations and the tumor pathology. Side effects were found in 4 cases (4.6%)-that is radiation induced edema in one, hearing deterioration in two and visual deterioration in one case within 2 years of treatment.

32.

Year: 2003

Patient number: 85

Author: Kondziolka, D.; Nathoo, N.; Flickinger, J. C.; Niranjan, A.; Maitz, A. H.; Lunsford, L. D.; Piepmeier, J. M.; Berger, M. S.; Loeffler, J. S.; Gutin, P. H.

Reference: Neurosurgery, 53, 4, 815-822, 2003

Title: Long-term results after radiosurgery for benign intracranial tumors

Abstract: BACKGROUND: Stereotactic radiosurgery is the principal therapeutic alternative to resecting benign intracranial tumors. The goals of radiosurgery are the long-term prevention of tumor growth, the maintenance of patient function, and the prevention of new neurological deficits or adverse radiation effects. Evaluation of long-term outcomes more than 10 years after radiosurgery is needed. METHODS: We evaluated 285 consecutive patients who underwent radiosurgery for benign intracranial tumors between 1987 and 1992. Serial imaging studies were obtained, and clinical evaluations were performed. Our series included 157 patients with vestibular schwannomas, 85 patients with meningiomas, 28 patients with pituitary adenomas, 10 patients with other cranial nerve schwannomas, and 5 patients with craniopharyngiomas. Prior surgical resection had been performed in 44% of these patients, and prior radiotherapy had been administered in 5%. The median follow-up period was 10 years. RESULTS: Overall, 95% of the 285 patients in this series had imaging-defined local tumor control (63% had tumor regression, and 32% had no further tumor growth). The actuarial tumor control rate at 15 years was 93.7%. In 5% of the patients, delayed tumor growth was identified. Resection was performed after radiosurgery in 13 patients (5%). No

patient developed a radiation-induced tumor. Eighty-one percent of the patients were still alive at the time of this analysis. Normal facial nerve function was maintained in 95% of patients who had normal function before undergoing treatment for acoustic neuromas. **CONCLUSION:** Stereotactic radiosurgery provided high rates of tumor growth control, often with tumor regression, and low morbidity rates in patients with benign intracranial tumors when evaluated over the long term. This study supports radiosurgery as a reliable alternative to surgical resection for selected patients with benign intracranial tumors.

33.

Year: 2003

Patient number: 186

Author: Lee, J. Y. K.; Kondziolka, D.; Flickinger, J. C.; Lunsford, L. D.

Reference: Techniques in Neurosurgery, 9, 3, 136-142, 2003

Title: Cavernous sinus meningioma radiosurgery

Abstract: Although cavernous sinus meningiomas are histologically benign, the intimate association of these tumors to critical neurovascular structures makes their surgical resection difficult. Given the complexities and morbidity associated with open surgical approaches to the cavernous sinus, surgeons have created a viable alternative and important adjunct. Stereotactic radiosurgery provides effective tumor control with minimal morbidity. In a recent series of 186 patients with cavernous sinus meningiomas treated at the University of Pittsburgh, the authors observed a 5-year tumor control rate of 93% for typical meningiomas. Using marginal tumor doses to the 50% isodose line of 13 Gy and by keeping the optic nerve dose less than 8 Gy, the authors have kept the risk of adverse radiation effects to 6.7%. Gamma Knife radiosurgery provides long-term tumor control and preserves neurologic function in most patients. It is both an adjunct to open craniotomy as well as a primary treatment for cavernous sinus meningiomas. © 2003 Lippincott Williams & Wilkins, Inc.

34.

Year: 2003

Patient number: 186

Author: Lee, J. Y. K.; Kondziolka, D.; Flickinger, J. C.; Lunsford, L. D.

Reference: Techniques in Neurosurgery, 8, 4, 251-260, 2003

Title: Radiosurgical treatment of cavernous sinus neoplasms: Indications and results

Abstract: Although most pathologic tumors that involve the cavernous sinus are benign, the intimate association of these tumors to critical neurovascular structures makes their surgical resection difficult. Stereotactic radiosurgery provides effective tumor control with minimal morbidity. Its success with respect to meningiomas of the cavernous sinus is measured by its long-term tumor control rate and safety, and its success with respect to pituitary adenomas is measured by both endocrinologic control in addition to arrest of tumor growth. In a recent series of 186 patients with cavernous sinus meningiomas treated at the University of Pittsburgh, the authors observed a 5-year tumor control rate of

93% for typical meningiomas. Using marginal tumor doses of 13 Gy, the authors achieved long-term growth control and preserved neurologic function in most patients. By keeping the optic nerve dose less than 8 Gy and by using a marginal tumor dose of 13 Gy, they kept the risk of adverse radiation effects to 6.7%. The role of radiosurgery for pituitary adenomas requires careful analysis of the patient's visual, hormonal, and medical condition. The authors currently consider radiosurgery a viable alternative to microsurgery for patients with nonhormone-producing pituitary adenomas with cavernous sinus extension as long as they do not suffer from visual compromise from tumor compression of the optic apparatus. For patients with hormone-producing pituitary adenomas extending into the cavernous sinus, the authors favor microsurgery as the primary management modality and use radiosurgery for persistent/recurrent tumors or for patients who are not considered good candidates for surgical resection. © 2003 Lippincott Williams & Wilkins, Inc.

35.

Year: 2003

Patient number: 97

Author: Levivier, Marc; Lorenzoni, Jose; Massager, Nicolas; Ruiz, Salvador; Devriendt, Daniel; Brotchi, Jacques

Reference: Neurosurgical focus, {Neurosurg-Focus}, 15 May 2003 (epub), vol. 14, no. 5, p. e8, ISSN: 1092-0684.

Title: Use of the Leksell gamma knife C with automatic positioning system for the treatment of meningioma and vestibular schwannoma

Abstract: OBJECT: The authors report their experience using the Leksell gamma knife C (GK-C) for the treatment of meningioma and vestibular schwannoma (VS). METHODS: In December 1999, the first commercially available clinical GK-C was installed at the Université Libre de Bruxelles (Erasme Hospital, Brussels, Belgium). In January 2000, the system was upgraded and equipped with the automatic positioning system (APS). Between February 2000 and February 2003, the APS-equipped GK-C was used to perform 532 radiosurgical treatments, including those in 97 meningiomas and 101 VSs. Meningioma and VS represent 18 and 19%, respectively, of lesions in patients treated with GK-C at the authors' center. The mean number of isocenters per lesion was 9.5 (range 1-36): 18.1 (range 1-36) for meningioma and 12.8 (range 1-27) for VS. In 77.6% of the cases, the authors used a single helmet of collimators (55.5% in meningioma and 74.3% in VS). The most frequently used collimator size was 4 mm (46.7%). Whereas it was 4 mm in cases of VS (64.3%), it was 8 mm in cases of meningioma (41.6%). The APS could be used in 86% of the cases, either alone (79%) or in combination with trunnions (7%). There was a difference in the APS-based treatment success rate in meningiomas (85%) and VSs (94%). A significant difference was also noted in the conformity of the radiosurgical treatments between the two lesions. CONCLUSIONS: The APS-equipped GK-C represents an evolutionary step in radiosurgery. It requires adjustments by the treating team for its specific limitations, which vary among indications, as exemplified by the differences inherent between meningioma and VS in this series.

36.

Year: 2003

Patient number: 278

Author: Pollock, B. E.

Reference: Neurosurgery Quarterly, 13, 2, 77-86, 2003

Title: Radiosurgery for intracranial meningiomas

Abstract: The purpose of this study was to review the results of stereotactic radiosurgery for intracranial meningiomas. A prospective computer database was queried for patient characteristics, radiosurgical parameters, tumor control, and complications of 310 patients having radiosurgery for 335 meningiomas at our center between January 1990 and October 2002. One hundred thirty-one patients (42%) had recurrent/residual tumors after prior surgical resection; 179 patients (58%) had radiosurgery as primary treatment. The majority of patients (69%) had skull-based tumors. The median tumor volume was 7.5 cc (range: 0.5-50.5 cc). The median tumor margin dose was 16 Gy (range: 12-20 Gy). Two hundred ninety-seven tumors (278 patients) had clinical and imaging follow-up at a mean of 43 months (range: 2-138 months) after radiosurgery. Two hundred seventy-nine tumors (94%) remained stable or decreased in size; 18 tumors progressed. Factors associated with progression were tumor histology and prior surgery. Treatment-related complications occurred in 26 patients (9%) and included cranial neuropathies, symptomatic edema, cyst formation, and stenosis of the internal carotid artery. Radiosurgery is safe and effective for many meningioma patients and has become the primary treatment of patients with small tumors in critical locations such as the cavernous sinus. Patients with atypical or malignant tumors have a high recurrence rate despite the use of radiosurgery. Further study is needed to determine the tumor control and complication rates 10 or more years after meningioma radiosurgery.

37.

Year: 2003

Patient number: 278

Author: Pollock, Bruce E.

Reference: Neurosurgical focus, {Neurosurg-Focus}, 15 May 2003 (epub), vol. 14, no. 5, p. e4, ISSN: 1092-0684.

Title: Stereotactic radiosurgery for intracranial meningiomas: indications and results

Abstract: OBJECT: Stereotactic radiosurgery (SRS) has become an important treatment option for patients with intracranial meningiomas. The author reviews the 12-year experience at a single institution and discusses the relative strengths and weakness of this management approach. METHODS: Between January 1990 and December 2002, 330 patients (with 356 tumors) underwent radiosurgery for intracranial meningiomas. One hundred thirty-eight patients (42%) harbored recurrent/residual tumors after having already undergone resection; 192 patients (58%) underwent radiosurgery as primary treatment. The majority of patients (70%) harbored skull base tumors. The median tumor volume was 7.3 cm³ (range 0.5-50.5 cm³). The median tumor margin dose was 16 Gy (range 12-20 Gy). In 278 patients with 297 lesions the mean clinical and imaging

follow-up period was 43 months (range 2-138 months). Two hundred seventy-eight tumors (94%) remained stable or decreased in size, and 19 tumors progressed in size. Factors associated with progression were tumor histological type and prior surgery. Treatment-related complications occurred in 8% of the patients and included cranial neuropathies, symptomatic edema, cyst formation, and stenosis of the internal carotid artery. In three patients (1%) tumor dedifferentiation was noted after SRS. CONCLUSIONS: Radiosurgical treatment of meningioma is safe and it has become the primary treatment for patients with small skull base tumors. Further study is needed to determine the long-term tumor control rates after such treatment, especially for patients treated with doses of 14 Gy or less.

38.

Year: 2003

Patient number: 62

Author: Pollock, Bruce E.; Stafford, Scott L.; Utter, Andrew; Giannini, Caterina; Schreiner, Shawn A.

Reference: International journal of radiation oncology biology physics, 55, 4, 1000-5, 2003

Title: Stereotactic radiosurgery provides equivalent tumor control to Simpson Grade 1 resection for patients with small- to medium-size meningiomas

Abstract: PURPOSE: To compare tumor control rates after surgical resection or stereotactic radiosurgery for patients with small- to medium-size intracranial meningiomas. MATERIALS AND METHODS: Between 1990 and 1997, 198 adult meningioma patients treated at our center underwent either surgical resection (n = 136) or radiosurgery (n = 62) as primary management for benign meningiomas <35 mm in average diameter. Tumor recurrence or progression rates were calculated by the Kaplan-Meier method according to an independent radiographic review. The mean follow-up was 64 months. RESULTS: The tumor resections were Simpson Grade 1 in 57 (42%), Grade 2 in 57 (42%), and Grade 3-4 in 22 (16%). The mean margin and maximal radiation dose at radiosurgery was 17.7 Gy and 34.9 Gy, respectively. Tumor recurrence/progression was more frequent in the surgical resection group (12%) than in the radiosurgical group (2%; p = 0.04). No statistically significant difference was detected in the 3- and 7-year actuarial progression-free survival (PFS) rate between patients with Simpson Grade 1 resections (100% and 96%, respectively) and patients who underwent radiosurgery (100% and 95%, respectively; p = 0.94). Radiosurgery provided a higher PFS rate compared with patients with Simpson Grade 2 (3- and 7-year PFS rate, 91% and 82%, respectively; p <0.05) and Grade 3-4 (3- and 7-year PFS rate, 68% and 34%, respectively; p <0.001) resections. Subsequent tumor treatments were more common after surgical resection (15% vs. 3%, p = 0.02). Complications occurred in 10% of patients after radiosurgery compared with 22% of patients after surgical resection (p = 0.06). CONCLUSIONS: The PFS rate after radiosurgery was equivalent to that after resection of a Simpson Grade 1 tumor and was superior to Grade 2 and 3-4 resections in our study. If long-term follow-up confirms the high tumor control rate and low morbidity of radiosurgery, this technique will likely become the preferred treatment for most patients with small- to moderate-size meningiomas without symptomatic mass effect.

39.

Year: 2003

Patient number: 32

Author: Roche, P. H.; Pellet, W.; Fuentes, S.; Thomassin, J. M.; Régis, J.

Reference: Acta neurochirurgica, 145, 10, 883-8, 2003

Title: Gamma knife radiosurgical management of petroclival meningiomas results and indications

Abstract:BACKGROUND: Surgical treatment of petroclival meningiomas remains challenging. In order to refine indications for the use of stereotactic radiosurgery in the treatment of these tumours, we retrospectively evaluated our experience in this field. METHODS: Thirty-two patients harboring a petroclival meningioma were treated consecutively using a Gamma knife between December 92 and June 1998. Eight patients underwent radiosurgery after one or more attempted surgical removals and 24 had radiosurgery as the primary treatment. The main symptoms before radiosurgery were cranial nerve palsies, including a sixth nerve deficit in 10 patients and a trigeminal nerve disturbance in 9. All patients underwent a conformal multi-isocentric treatment (mean isocenter's number 8.8) and the dose delivered at the tumour margin ranged from 10 to 15 Gy (mean dose 13 Gy). FINDINGS: The duration of follow-up varied from 24 to 118 months (mean clinical follow-up 56 months, mean radiological follow-up 52.6 months). All 32 patients survived. The tumour volume remained unchanged in 28 patients and decreased slightly in 4. Neurological status worsened permanently in 2 patients with a delayed hemiparesis due to focal pontine infarction. These complications were associated with large meningiomas with vascular involvement and ventral brainstem compression, and occurred at the very early stage of our experience. At last follow-up, preoperative fifth or sixth cranial nerve deficits had improved or recovered in 13 out of 19 patients and any delayed worsening or new cranial nerve deficits were not observed after radiosurgery. CONCLUSIONS: Stereotactic radiosurgery with a Gamma knife provides effective management of small to middle sized petroclival meningiomas and is an alternative to microsurgery. Careful selection of patients and use of major technical refinements should improve the safety of this treatment.

40.

Year: 2003

Patient number: 122

Author: Stafford, Scott L.; Pollock, Bruce E.; Leavitt, Jacqueline A.; Foote, Robert L.; Brown, Paul D.; Link, Michael J.; Gorman, Deborah A.; Schomberg, Paula J.

Reference: International journal of radiation oncology biology physics, 55, 5, 1177-81, 2003

Title: A study on the radiation tolerance of the optic nerves and chiasm after stereotactic radiosurgery

Abstract:PURPOSE: To evaluate the risk of clinically significant radiation optic

neuropathy (RON) for patients having stereotactic radiosurgery of benign tumors adjacent to the optic apparatus. **METHODS AND MATERIALS:** We reviewed the dose plans and clinical outcomes of 218 gamma knife procedures (215 patients) for tumors of the sellar and parasellar region (meningiomas, n = 122; pituitary adenomas, n = 89; craniopharyngiomas, n = 7 patients). Previous surgery or radiation therapy was performed in 156 (66%) and 24 (11%) patients, respectively. Median follow-up was 40 months (range 4-115). **RESULTS:** The median maximum radiation dose to the optic nerve was 10 Gy (range 0.4-16.0). Four patients (1.9%) developed RON at a median of 48 months after radiosurgery. All had prior surgery, and 3 of 4 had external beam radiotherapy (EBRT) in their management either before (n = 2) or adjuvantly (n = 1). The risk of developing a clinically significant RON was 1.1% for patients receiving 12 Gy or less. Patients receiving prior or concurrent EBRT had a greater risk of developing RON after radiosurgery (p = 0.004). **CONCLUSION:** RON occurred in less than 2% of our patients, despite the majority (73%) receiving more than 8 Gy to a short segment of the optic apparatus. Knowledge of the dose tolerance of these structures permits physicians to be more aggressive in treating patients with sellar or parasellar tumors, especially those with hormone-producing pituitary adenomas that appear to require higher doses to achieve biochemical remission.

41.

Year: 2003

Patient number: NA abstract

Author: Zhong, Qiang; Yu, Xin; Liu, Zong hui; Qi, Shu bin; Zhou, Dong xue; Li, Bing; Zhang, Wei

Reference: Zhonghua wai ke za zhi (Chinese journal of surgery), 41, 7, 513-5, 2003

Title: Complications following gamma knife radiosurgery

Abstract: **OBJECTIVE:** To investigate complication features following gamma knife radiosurgery (GKR), and to assess factors causing complications. **METHODS:** A retrospective analysis was conducted for 253 patients with intracranial arteriovenous malformation (AVMs), meningiomas, glial neoplasms, germinomas and metastatic cancer, respectively, which were treated with GKR. The incidences of acute, subacute and late complications following GKR were evaluated. Meanwhile, risk factors inducing subacute complications, such as the cell proliferative population of target tissues and location of target in AVM and meningioma, were evaluated, respectively. **RESULTS:** The subacute complications are the prominent reactions in all the five diseases. There is a significant difference in the incidence rate of subacute complications between early responding tissues and slow responding tissues, central and peripheral AVM, basal and nonbasal meningioma. **CONCLUSIONS:** Subacute complications are the prominent reactions after GKR, and the reactions are almost always reversible. The risk of subacute complications following GKR treatment is correlated to the proliferative cell population in the target tissues and the target location (AVM, meningioma).

42.

Year: 2002

Patient number: 121

Author: Eustacchio, S.; Trummer, M.; Fuchs, I.; Schröttner, O.; Sutter, B.; Pendl, G.

Reference: Acta neurochirurgica. Supplement, 84, 71-6, 2002

Title: Preservation of cranial nerve function following Gamma Knife radiosurgery for benign skull base meningiomas: experience in 121 patients with follow-up of 5 to 9.8 years

Abstract:INTRODUCTION: Microsurgical excision with preservation of juxtaposed neurovascular structures is considered the treatment of choice for skull base meningiomas, but there exists a great controversy regarding surgical resectability, potential risk for subsequent postoperative Cranial Nerve Deficit (CND) and the role of adjuvant or adjunctive treatment options. In this study we evaluated the effect of Gamma Knife Radiosurgery (GKRS) in 121 patients with benign basal meningiomas after a follow-up of 5 to 9.8 years. METHODS: Sixty patients had undergone open resections prior to radiosurgical treatment and 61 patients were treated by GKRS alone. Tumour volumes of 0.5 to 89.9 ccm (median 6.8 ccm) received a median marginal dose of 13 Gy (range 7-25 Gy) at the covering 25% to 80% isodose volume curves (median 45%). RESULTS: Neuroradiological controls demonstrated decreased tumour size in 73 patients (60.3%), stable meningioma volume in 47 cases (38.9%) and tumour enlargement in one patient (0.8%). Clinically, 54 patients (44.6%) improved and 61 cases (50.4%) remained unchanged. Four patients (3.3%) showed temporary and two patients (1.7%) permanent neurological deterioration (unrelated to tumour or treatment in one patient). Two patients (1.7%) developed radiation induced new or aggravated pre-existent CND (1 transient, 1 permanent) and two patients (1.7%) required further surgical resection. CONCLUSION: In our long-term experience, GKRS proved to be an attractive additional and save alternative primary treatment option in selected patients with basal meningiomas. The tumour control rate of 98.3% associated with excellent clinical outcome and low incidence for treatment related CND (1.7%) compares favourably with the reported microsurgical series.

43.

Year: 2002

Patient number: 159

Author: Lee, John Y. K.; Niranjan, Ajay; McInerney, James; Kondziolka, Douglas; Flickinger, John C.; Lunsford, L. Dade

Reference: Journal of neurosurgery, 97, 1, 65-72, 2002

Title: Stereotactic radiosurgery providing long-term tumor control of cavernous sinus meningiomas

Abstract:OBJECT: To evaluate long-term outcomes of patients who have undergone stereotactic radiosurgery for cavernous sinus meningiomas, the authors retrospectively reviewed their 14-year experience with these cases. METHODS: One hundred seventy-six patients harbored meningiomas centered within the cavernous sinus. Seventeen patients were lost to follow-up review, leaving 159 analyzable patients, in

whom 164 procedures were performed. Seventy-six patients (48%) underwent adjuvant radiosurgery after one or more attempts at surgical resection. Eighty-three patients (52%) underwent primary radiosurgery. Two patients (1%) had previously received fractionated external-beam radiation therapy. Four patients (2%) harbored histologically verified atypical or malignant meningiomas. Conformal multiple isocenter gamma knife surgery was performed. The median dose applied to the tumor margin was 13 Gy. Neurological status improved in 46 patients (29%), remained stable in 99 (62%), and eventually worsened in 14 (9%). Adverse effects of radiation occurred after 11 procedures (6.7%). Tumor volumes decreased in 54 patients (34%), remained stable in 96 (60%), and increased in nine (6%). The actuarial tumor control rate for patients with typical meningiomas was 93.1 +/- 3.3% at both 5 and 10 years. For the 83 patients who underwent radiosurgery as their sole treatment, the actuarial tumor control rate at 5 years was 96.9 +/- 3%. **CONCLUSIONS:** Stereotactic radiosurgery provided safe and effective management of cavernous sinus meningiomas. We believe it is the preferred management strategy for tumors of suitable volume (average tumor diameter < or = 3 cm or volume < or = 15 cm³).

44.

Year: 2002

Patient number: 50

Author: Mori, Y.; Kobayashi, T.; Kida, Y.

Reference: Japanese Journal of Neurosurgery, 11, 3, 230-236, 2002

Title: Stereotactic radiosurgery for petroclival meningioma

Abstract: We evaluated the results of Gamma Knife radiosurgery for petroclival meningioma in 50 patients (11 males and 39 females). The mean of the patients' age was 55.5 (range: 15 to 79) years old. Stereotactic radiosurgery was performed as a primary treatment in 29 patients. Twenty-one patients had undergone one to five prior resections. Tumors were located at the clivus in 2 patients. In the other 48 cases, tumors were located around the petrous apex or spread over the petro-clival region. Seventeen of the 48 tumors extended into the cavernous sinus. The mean tumor volume was 14.9 (range: 0.7 to 75) ml. The mean maximum dose was 27.2 (range: 18 to 35.7) Gy and the mean tumor margin dose was 13.6 (range: 8.1 to 25) Gy. In a median follow-up period of 36 (range: 6 to 112) months, 20 tumors (40%) decreased in size and 27 tumors (54%) remained unchanged. Only 3 tumors (6%) had radiographic evidence of progression in the treated part of the tumor. Surgical resection was performed in 3 patients after radiosurgery. In 1 patient, a second radiosurgery and then surgical resection was done. A second radiosurgery was also performed in 4 other patients. In 2 of these 4 patients, the second radiosurgery was done for tumor relapse outside the treatment field. The overall tumor control rate was 94%. Cranial nerve deficits without the evidence of tumor growth developed in only 3 patients (6%). Stereotactic radiosurgery was safe and effective in the management of patients with petroclival meningiomas, despite of the proximity of the tumors to critical neural and vascular structures.

45.

Year: 2002

Patient number: 156

Author: Nicolato, Antonio; Foroni, Roberto; Alessandrini, Franco; Bricolo, Albino; Gerosa, Massimo

Reference: Neurosurgery, 51, 5, 1153-9, 2002

Title: Radiosurgical treatment of cavernous sinus meningiomas: experience with 122 treated patients

Abstract:OBJECTIVE: To evaluate the efficacy of gamma knife (GK) radiosurgery, in terms of neurological improvement and tumor growth control (TGC), for a large series of patients with cavernous sinus meningiomas. METHODS: Between February 1993 and January 2002, 156 patients with cavernous sinus meningiomas (35 male and 121 female patients; mean age, 56.1 yr) were treated with GK radiosurgery in our department. GK radiosurgery was used as a first-choice treatment for 75 of 156 patients and as postoperative adjuvant therapy for 81 of 156 patients (all with Grade I meningiomas). Eligibility criteria for radiosurgery were as follows: symptomatic meningiomas and/or documented tumor progression on magnetic resonance imaging scans, conditions of high operative risk, patient refusal of microsurgery or reoperation, tumor volume of <20 cm³, and location no less than 2 mm from the optic pathways. RESULTS: Follow-up data for at least 12 months were available for 122 patients (median follow-up period, 48.9 mo). Clinical conditions were improved or stable for 118 of 122 patients (97%). Neurological recovery was observed for 78.5% of patients treated with GK radiosurgery alone and for 60.5% of patients treated with adjuvant therapy (P < 0.05). Adequate TGC was documented for 119 of 122 tumors (97.5%), with shrinkage/disappearance in 75 of 122 cases (61.5%) and no variation in volume in 44 of 122 cases (36%); the overall actuarial progression-free survival rate at 5 years was 96.5%. Tumor size regression was observed for 80% of patients with follow-up periods of more than 30 months, compared with 43.5% of patients with follow-up periods of less than 30 months (P < 0.0002). Radiosurgical sequelae were transient in 4 of 122 cases (3.0%) and permanent in 1 case (1%). CONCLUSION: For the follow-up periods in our series (median, >4 yr), GK radiosurgery seems to be both safe (permanent morbidity rate, 1%) and effective (97% neurological improvement /stability, 97.5% overall TGC, and 96.5% actuarial TGC at 5 yr). GK radiosurgery might be considered a first-choice treatment for selected patients with cavernous sinus meningiomas.

46.

Year: 2002

Patient number: 138

Author: Nicolato, Antonio; Foroni, Roberto; Alessandrini, Franco; Maluta, Sergio; Bricolo, Albino; Gerosa, Massimo

Reference: International journal of radiation oncology biology physics, 53, 4, 992-1000, 2002

Title: The role of Gamma Knife radiosurgery in the management of cavernous sinus

meningiomas

Abstract: PURPOSE: To evaluate the efficacy of Gamma Knife (GK) radiosurgery in terms of neurologic improvement and tumor growth control (TGC) in a large series of patients with cavernous sinus meningioma (CSM). METHODS AND MATERIALS: One hundred thirty-eight patients with CSM (28 males, 110 females; mean age: 56.2 years) were treated with GK between February 1993 and February 2001. GK was used as a first-choice treatment in 68/138 patients and as postoperative adjuvant therapy in 70/138. In 32 patients, it was possible to compare the size of the planned treatment volume to tumor volume using the conformity index (CI); optimal CI values were taken to be $<$ or $=1.5$ (range: 0.94-2.24). RESULTS: A follow-up (FU) period of at least 12 months was available for 111 patients (median: 48.2 months, range: 12.1-84.5 months). Clinical conditions were improved or stable in 107/111 patients (96.5%). Neurologic recovery was observed in 76% of cases treated by

47.

Year: 2001

Patient number: 35

Author: Chen, J. C.; Giannotta, S. L.; Yu, C.; Petrovich, Z.; Levy, M. L.; Apuzzo, M. L.

Reference: Neurosurgery, 48, 5, 1022-30, 2001

Title: Radiosurgical management of benign cavernous sinus tumors: dose profiles and acute complications

Abstract: OBJECTIVE: Radiosurgery has emerged as an alternative treatment modality for cranial base tumors in patients deemed not suited for primary surgical extirpation, patients with recurrent or residual tumor after open surgery, or patients who refuse surgical treatment. We review our short-term experience with radiosurgical management of cavernous sinus region tumors with the Leksell gamma knife. METHODS: From August 1994 to February 1999, 69 patients with cavernous sinus lesions were treated in 72 separate treatment sessions. The tumor type distribution was 29 pituitary adenomas, 35 meningiomas, 4 schwannomas, and 1 paraganglioma. The median follow-up was 122 weeks. Lesions were stratified according to a five-level surgical grade. The grade distribution of the tumors was as follows: Grade I, 13; Grade II, 21; Grade III, 19; Grade IV, 12; Grade V, 4. Median tumor volume was 4.7 cm³. The median radiation dose was 15 Gy to the 50% isodose line. Median maximal radiation dose was 30 Gy. RESULTS: Analysis of tumor characteristics and radiation dose to optic nerve and pontine structures revealed a significant correlation between distance and dose. Much lower correlation coefficients were found between tumor volume and dose. One lesion in this series had evidence of transient progression and later regression on follow-up radiographic studies. No other lesions in this series were demonstrated to have exhibited progression. Complications after radiosurgical treatment were uncommon. Two patients had cranial nerve deficits after treatment. One patient with a surgical Grade III pituitary adenoma had VIth cranial nerve palsy 25 months after radiosurgical treatment that spontaneously resolved 10 months later. A patient with a bilateral pituitary adenoma experienced bilateral VIth cranial nerve palsy 3 months after treatment that had not resolved at 35 months after treatment. Six patients with preoperative cranial nerve deficits experienced

resolution or improvement of their deficits after treatment. One patient with a prolactin-secreting adenoma experienced normalization of endocrine function with return of menses. **CONCLUSION:** Radiosurgical treatment represents an important advance in the management of cavernous sinus tumors, with low risk of neurological deficit in comparison with open surgical treatment, even in patients with high surgical grades.

48.

Year: 2001

Patient number: 87

Author: Kobayashi, T.; Kida, Y.; Mori, Y.

Reference: Surgical neurology, 55, 6, 325-31, 2001

Title: Long-term results of stereotactic gamma radiosurgery of meningiomas

Abstract:**BACKGROUND:** The early effects at a mean of 30 months and long-term results at 7 years after gamma radiosurgery for meningiomas were evaluated.

METHODS: Changes in tumor size were evaluated every 3 to 6 months after treatment using a five-point grading system, as well as changes in neurological signs and general status. **RESULTS:** Early effects in 87 cases of benign meningioma showed a minimal size reduction of 16.1% and a response rate of 8.0%, but a higher control rate of 93%. The cavernous sinus meningioma showed a size reduction of 23.2%, a response rate of 11.1%, and control of 100%. A greater size reduction of 24.8% and response rate of 33.3%, but a lower control rate of 75% were obtained in 12 cases of malignant meningioma. Side effects were found in 12 cases (13.8%): radiation-induced edema in 9, hearing disturbance in 2, and visual deterioration in 1. Long-term results for 54 of 87 patients with benign tumors showed that response increased from 8% to 42.6% but control decreased slightly due to increased disease progression. **CONCLUSION:** Gamma radiosurgery is effective and safe for meningiomas to control residual or recurrent tumors after surgery and initial tumors, with acceptable side effects and rate of tumor progression.

49.

Year: 2001

Patient number: 57

Author: Nicolato, A.; Foroni, R.; Pellegrino, M.; Ferraresi, P.; Alessandrini, F.; Gerosa, M.; Bricolo, A.

Reference: Minimally invasive neurosurgery, 44, 4, 211-7, 2001

Title: Gamma knife radiosurgery in meningiomas of the posterior fossa Experience with 62 treated lesions

Abstract:**OBJECTIVES:** This study was undertaken to assess the role of the gamma knife (GK) in the treatment of meningiomas of the posterior cranial fossa (PCF) and to statistically analyze the predictability of arbitrarily-selected prognostic factors in such treatment. **METHODS:** From February 1993 to November 1998, 57 patients underwent GK treatment for 62 meningiomas of the PCF (19 M/38 F; average age, 57.5 years,

ranging from 25 - 82 years). Tumor sites included: foramen jugular-petrous bone (26/62), petroclival (23/62), cerebellar convexity (6/62), tentorium (6/62), and foramen magnum (1/62). Single lesions were treated in 44/62 cases while meningiomatosis was treated in the remaining 18. Post-operative residual or recurrent tumor was found in 27/62 patients and, in 7/27, histology documented characteristics of biological aggressiveness (GII/III). Indications for radiosurgery included: advanced age, high operative risk, tumor volume < 20 ml, inoperable or refused for additional surgery. The prognostic factors statistically analyzed included: meningiomatosis (yes/no), radiosurgery as primary or adjuvant treatment, GI vs. GII /III histology, and tumor volume (< or = 5 ml vs. > 5 ml). **RESULTS:** The observation periods varied from 6 to 64.3 months (median 28.7 months). At the end of the study, 53/57 patients were alive and reported to be in stable or improved neurological condition. The cause of death for the remaining 4 patients included: 2 deaths associated with tumor progression, while 2 died due to causes unrelated to the disease. Neuroradiological evaluation documented the disappearance or reduction of the meningioma mass in 34/62 (55 %) cases, a stable imaging picture in 25/62 (40 %), and a progression only in 3/62 (5 %). To date, there have been no reported cases of post-GK permanent morbidity or mortality. Side effects observed were of a transient nature due to post-radiosurgical edema (6.5 %). With regard to statistical analysis, the only factor to appear to significantly influence efficacy of radiosurgery for tumor growth control (TGC) was the biological nature of the meningioma ($\chi^2 = 2.708$). The presence of meningiomatosis, SR as a primary or adjuvant treatment nor tumor volume were shown to statistically influence tumor behavior after GK. **CONCLUSIONS:** The excellent results obtained for TGC with minimal associated side effects suggest that GK is an effective therapeutic tool also for treatment of PCF meningiomas.

50.

Year: 2001

Patient number: 197

Author: Pendl, G.; Eustacchio, S.; Unger, F.

Reference: Journal of clinical neuroscience, 8, Suppl 1, 12-4, 2001

Title: Radiosurgery as alternative treatment for skull base meningiomas

Abstract: The effect of radiosurgical treatment of skull base meningiomas in 197 patients with a follow-up of at least 2 years was evaluated. Ninety-two of these patients had combined surgical and radiosurgical treatment, while Gamma Knife Radiosurgery (GKRS) was performed as primary treatment in 105 patients. Follow-up was available in 164 patients with intervals of 25-97 months (median 55 months) after GKRS. The imaging controls revealed decreased tumour size in 84 patients (51%), stable tumour volume in 76 cases (47%) and increased tumour size in 4 cases (2%). Neurological examinations showed improved neurological status in 58 cases (35%), stable clinical status in 100 patients (61%) and slight worsening in 6 cases (4%). Due to excellent tumour control rate, good clinical outcome and a low complication rate GKRS represents not only an attractive additional treatment option for basal meningiomas, but may even replace microsurgery in selected cases. Copyright 2001 Harcourt Publishers Ltd.

51.

Year: 2001

Patient number: 40

Author: Shin, M.; Kurita, H.; Sasaki, T.; Kawamoto, S.; Tago, M.; Kawahara, N.; Morita, A.; Ueki, K.; Kirino, T.

Reference: Journal of neurosurgery, 95, 3, 435-9, 2001

Title: Analysis of treatment outcome after stereotactic radiosurgery for cavernous sinus meningiomas

Abstract:OBJECT: The long-term outcome of stereotactic radiosurgery for cavernous sinus (CS) meningiomas is not fully understood. The authors retrospectively reviewed their experience with 40 CS meningiomas treated with gamma knife radiosurgery.

METHODS: Follow-up periods for the 40 patients ranged from 12 to 123 months (median 42 months), and the overall tumor control rates were 86.4% at 3 years and 82.3% at 10 years. Factors associated with tumor recurrence in univariate analysis were histological malignancy ($p < 0.0001$), partial treatment ($p < 0.0001$), suprasellar tumor extension ($p = 0.0201$), or extension in more than three directions outside the CS ($p = 0.0345$). When the tumor was completely covered with a dose to the margin that was higher than 14 Gy (Group A, 22 patients), no patient showed recurrence within the median follow-up period of 37 months. On the other hand, when a part of the tumor was treated with 10 to 12 Gy (Group B, 15 patients) or did not receive radiation therapy (Group C, three patients), the recurrence rates were 20% and 100%, respectively. Neurological deterioration was seen in nine patients, but all symptoms were transient or very mild. CONCLUSIONS: The data indicate that stereotactic radiosurgery can control tumor growth if the whole mass can be irradiated by dosages of more than 14 Gy. When optimal radiosurgical planning is not feasible because of a tumor's large size, irregular shape, or proximity to visual pathways, use of limited surgical resection before radiosurgery is the best option and should provide sufficient long-term tumor control with minimal complications.

52.

Year: 2001

Patient number: 190

Author: Stafford, S. L.; Pollock, B. E.; Foote, R. L.; Link, M. J.; Gorman, D. A.; Schomberg, P. J.; Leavitt, J. A.

Reference: Neurosurgery, 49, 5, 1029-37, 2001

Title: Meningioma radiosurgery: tumor control, outcomes, and complications among 190 consecutive patients

Abstract:OBJECTIVE: To determine local control (LC) and complication rates for patients with intracranial meningiomas who underwent radiosurgery. METHODS: One hundred ninety consecutive patients with 206 meningiomas underwent radiosurgery between 1990 and 1998. One hundred forty-seven tumors (77%) involved the cranial base. The median age at the time of radiosurgery was 58 years (range, 20-90 yr). There were 126 female patients (66%). One hundred twelve patients (59%) had undergone one

or more previous operations (median, 1; range, 1-5). Twenty-two patients (12%) had either atypical (n = 13) or malignant (n = 9) tumors. The median prescription isodose volume was 8.2 cm³ (range, 0.5-50.5 cm³), and the median tumor margin dose was 16 Gy (range, 12-36 Gy). The median imaging and clinical follow-up periods were 40 and 47 months, respectively. **RESULTS:** Overall survival rates for the entire cohort at 5 and 7 years were 82 and 82%, respectively; cause-specific survival rates at 5 and 7 years were 94 and 92%, respectively. The cause-specific survival rates at 5 years for patients with benign, atypical, and malignant tumors were 100, 76, and 0%, respectively (P < 0.0001). The 5-year LC rate was 89%, with 114 tumors (56%) decreasing in size. LC rates were correlated with tumor histological features (P < 0.0001); patients with benign tumors exhibited a 5-year LC rate of 93%, compared with 68 and 0% for patients with atypical or malignant meningiomas, respectively. No correlation was observed between radiation dose and LC rate. Twenty-four patients (13%) experienced treatment-related complications, including cranial nerve deficits (8%), symptomatic parenchymal changes (3%), internal carotid artery stenosis (1%), and symptomatic cyst formation (1%). Only six patients (3%) exhibited decreases in functional status that were directly related to radiosurgery. Tumor volume, tumor margin dose, or previous radiotherapy was not associated with the development of radiation-related complications. **CONCLUSION:** Radiosurgery is an effective management strategy for many patients with meningiomas. Patients with atypical or malignant tumors exhibit high recurrence rates despite the use of radiosurgery, and these patients continue to exhibit worse cause-specific survival rates despite aggressive treatment, including surgery, external-beam radiotherapy, and radiosurgery. Further study is needed to determine the tumor control and complication rates 10 years or more after meningioma radiosurgery.

53.

Year: 2001

Patient number: NA abstract

Author: Yuan, S. Y.; Pan, L.; Zhang, N.

Reference: Fudan University Journal of Medical Sciences, 28, 3, 227-229, 2001

Title: Relationship comparative study between prescription volume and target volume in Gamma Knife dose planning

Abstract: Purpose: To optimize the individual Gamma Knife dose planning by the comparative study between prescription volume and target volume. Methods: The target volume, prescription volume and their histogram of eight hundred and sixty patients had been compared and statistically analysed. Results: The median ratio of prescription volume and target volume had been detailed. That of meningioma ranked first. Pituitary adenoma, acoustic neurinoma and AVM ranked second and third. That of lymphoma was the lowest. Three hundred and eighty five cases had been followed up. Lesions of 154 cases regressed and disappeared, of 192 cases had partial shrinkage (>50%), of 27 cases (<50%) and of 13 cases enlarged. Conclusions: To abate the differences between prescription volume and target volume may improve the optimization of dose planning and decreased the complications after radiosurgery.

54.

Year: 2000

Patient number: 73

Author: Iwai, Y.; Yamanaka, K.; Nakajima, H.; Yasui, T.; Kishi, H.

Reference: No shinkei geka, 28, 5, 411-5, 2000

Title: Gamma knife radiosurgery for skull base meningiomas: the treatment results and patient satisfaction expressed in answers to a questionnaire

Abstract:Skull base meningiomas can be treated by radiosurgery with low morbidity. We evaluated the effectiveness of gamma knife radiosurgery for skull base meningiomas. We also evaluated patient satisfaction through answers to a questionnaire. We treated 77 patients of skull base meningiomas using gamma knife radiosurgery from January 1994 to June 1998. Among these patients, 73 patients were able to be followed up from 6 to 60 months (average 25 months). The diagnosis was made by operations on 39 patients (53%), and on magnetic resonance imagings in 34 patients (47%). 21 patients (28.7%) had residual tumors after operations and 18 patients (24.3%) had recurrence after operations. 40% of neurological deficits occurred after previous operations and 20% of the patients were asymptomatic. The locations of the tumors were mainly the cavernous sinus region in 35 patients and the petroclival region in 20 patients. The tumor sizes were 8.6 to 58.3 mm (average 24.7 mm) and five cases of tumors with a mean diameter above 40 mm were treated by two-staged radiosurgery. Treatment volume was 0.3 to 31 ml (average 9.8 ml). The treatment dose was 8 to 16 Gy (average 11.2 Gy) at the tumor margin. The tumor decreased in size in 50 patients (68%) and was unchanged in 20 patients (28%) and we were able to achieve 96% tumor growth control. The clinical symptoms improved in 22 patients (30.1%) and were unchanged in 47 patients (64.4%) and only 4 patients (5.5%) showed deterioration. 50 patients (68%) felt clinical improvement and only 3 patients (4%) sensed deterioration. 58 patients (79%) were able to continue their previous work. Gamma knife radiosurgery has a very low morbidity rate and enables good tumor control, and patients with skull base meningiomas express satisfaction with the treatment results.

55.

Year: 2000

Patient number: 22

Author: Ojemann, S. G.; Sneed, P. K.; Larson, D. A.; Gutin, P. H.; Berger, M. S.; Verhey, L.; Smith, V.; Petti, P.; Wara, W.; Park, E.; McDermott, M. W.

Reference: Journal of neurosurgery, 93, Suppl 3, 62-7, 2000

Title: Radiosurgery for malignant meningioma: results in 22 patients

Abstract:OBJECT: The initial treatment of malignant meningiomas in the past has included surgical removal followed by fractionated external-beam radiotherapy. Radiosurgery has been added to the options for treatment of primary or recurrent tumors over the last 10 years. The authors report their results of using gamma knife radiosurgery (GKS) to treat 22 patients over an 8-year period. METHODS: Twenty-two patients who

underwent GKS for malignant meningioma between December 1991 and May 1999 were evaluated. Three patients were treated with GKS as a boost to radiotherapy and 19 for recurrence following radiotherapy. Outcome factors including patient survival, freedom from progression, and complications were analyzed. In addition, in the recurrent group, variables such as patient age, sex, tumor location, target volume, margin dose, and maximum dose were also analyzed. Univariate and multivariate analyses were performed. Overall 5-year survival and progression-free survival estimates were 40% and 26%, respectively. Age ($p < \text{or} = 0.003$) and tumor volume ($p < \text{or} = 0.05$) were significant predictors of time to progression and survival in both univariate and multivariate analyses. Five patients (23%) developed radiation necrosis. Significant relationships between complications and treatment variables or patient characteristics could not be established. **CONCLUSIONS:** Tumor control following GKS is greater in patients with smaller-sized tumors ($< 8 \text{ cm}^3$) and in younger patients. Gamma knife radiosurgery can be performed to treat malignant meningioma with acceptable toxicity. The efficacy of GKS relative to other therapies for recurrent malignant meningioma as well as the value of GKS as a boost to radiotherapy will require further evaluation.

56.

Year: 2000

Patient number: 12

Author: Pendl, G.; Unger, F.; Papaefthymiou, G.; Eustacchio, S.

Reference: Journal of neurosurgery, 93, Suppl 3, 107-12, 2000

Title: Staged radiosurgical treatment for large benign cerebral lesions

Abstract:OBJECT: Large brain lesions are considered unamenable to gamma knife treatment because of possible adverse effects. The proximity of eloquent brain to a target location, including some arteriovenous malformations (AVMs), still poses a challenge to the neurosurgeon. Because meningiomas and AVMs often show a slow or absent growth rate, partial radiosurgical treatment in cases with risk of unacceptable surgery-related morbidity is an alternative. The authors evaluated the results of staged treatment.

METHODS: Since April 1992, 12 patients suffering from large benign tumors (meningiomas) and seven with AVMs considered inoperable underwent gamma knife radiosurgery in staged procedures. All patients with tumors underwent primary open surgery for partial removal of recurrent growth and subsequent radiosurgical treatment. Four men and eight women ranging in age from 26 to 73 years harbored tumors that ranged in volume from 19 to 90 cm^3 . Marginal dose ranged from 10 to 25 Gy prescribed in the 30 to 50% isodose. The time interval between the radiosurgical treatments varied from 1 to 8 months. Follow up ranged from 5 and 89 months. Three female and four male patients (age range 10-48 years) had undergone previous AVM embolization and were treated with margin doses of 18 to 22 Gy in the 40 to 50% isodose. The volume range of these AVMs was 11 to 25 cm^3 . The time interval between radiosurgical treatments ranged from 5 to 36 months. The mean follow up was 22.6 months. Neurological follow-up examinations showed clinical improvement in 11 patients (58%), whereas five (26%) remained unchanged. Among tumor patients no deterioration or further tumor growth was observed. Tumor necrosis demonstrated noticed in five patients (26%). One patient with

an AVM suffered from seizures and hemiparesis. Follow-up magnetic resonance imaging of the residual nidus disclosed no rebleeding. CONCLUSIONS: For selected patients with large benign lesions staged gamma knife radiosurgery could be an alternative, as evidenced by the authors' series in which there was no mortality and low incidence morbidity.

57.

Year: 2000

Patient number: 16

Author: Pollock, B. E.; Iuliano, B. A.; Foote, R. L.; Gorman, D. A.

Reference: Neurosurgery, 46, 3, 576-82, 2000

Title: Stereotactic radiosurgery for tumor-related trigeminal pain

Abstract: OBJECTIVE: Between 1 and 6% of patients who are diagnosed with facial pain syndromes have tumors that involve the trigeminal nerve. We report the effects of stereotactic radiosurgery on tumor-related trigeminal pain. METHODS: We reviewed results, from a prospective database, for 24 consecutive patients with cranial base tumors and either trigeminal neuralgia (n = 9) or painful trigeminal neuropathy (n = 15) who underwent stereotactic radiosurgery during an 8-year period. The tumor was the radiosurgical target for these patients (not the trigeminal nerve or ganglion). The median clinical follow-up period after radiosurgery was 45 months (range, 12-90 mo); the median neuroimaging follow-up period was 36 months (range, 5-86 mo). RESULTS: There were 20 women and 3 men, with an average age of 57 years (range, 33-79 yr). One patient had bilateral facial pain and underwent staged radiosurgery. Pathological classification indicated 16 meningiomas and 8 malignant cranial base tumors (adenoid cystic carcinoma, n = 6; squamous cell carcinoma, n = 2). Twelve of 24 patients (50%) were initially free of pain, and another 11 patients (46%) reported that they experienced significant improvements in their trigeminal pain syndromes after radiosurgery. The tumor histological type, quality of facial pain, preexisting facial numbness, and marginal and maximal radiation doses were not related to postradiosurgical facial pain outcomes. Three patients with malignant cranial base carcinomas developed recurrent facial pain, 1 to 9 months after radiosurgery, which was related to tumor progression outside the irradiated volume. One patient (4%) developed new partial V2 numbness after radiosurgery. CONCLUSION: Radiosurgery proved to be effective in improving tumor-related trigeminal pain for the majority of patients with either benign or malignant cranial base tumors. Recurrence of trigeminal pain is frequent for patients with malignant cranial base carcinomas and is related to tumor progression.

58.

Year: 2000

Patient number: 80

Author: Roche, P. H.; Régis, J.; Dufour, H.; Fournier, H. D.; Delsanti, C.; Pellet, W.; Grisoli, F.; Peragut, J. C.

Reference: Journal of neurosurgery, 93, Suppl 3, 68-73, 2000

Title: Gamma knife radiosurgery in the management of cavernous sinus meningiomas
Abstract:OBJECT: The authors sought to assess the functional tolerance and tumor control rate of cavernous sinus meningiomas treated by gamma knife radiosurgery (GKS).
METHODS: Between July 1992 and October 1998, 92 patients harboring benign cavernous sinus meningiomas underwent GKS. The present study is concerned with the first 80 consecutive patients (63 women and 17 men). Gamma knife radiosurgery was performed as an alternative to surgical removal in 50 cases and as an adjuvant to microsurgery in 30 cases. The mean patient age was 49 years (range 6-71 years). The mean tumor volume was 5.8 cm³ (range 0.9-18.6 cm³). On magnetic resonance (MR) imaging the tumor was confined in 66 cases and extensive in 14 cases. The mean prescription dose was 28 Gy (range 12-50 Gy), delivered with an average of eight isocenters (range two-18). The median peripheral isodose was 50% (range 30-70%). Patients were evaluated at 6 months, and at 1, 2, 3, 5, and 7 years after GKS. The median follow-up period was 30.5 months (range 12-79 months). Tumor stabilization after GKS was noted in 51 patients, tumor shrinkage in 25 patients, and enlargement in four patients requiring surgical removal in two cases. The 5-year actuarial progression-free survival was 92.8%. No new oculomotor deficit was observed. Among the 54 patients with oculomotor nerve deficits, 15 improved, eight recovered, and one worsened. Among the 13 patients with trigeminal neuralgia, one worsened (contemporary of tumor growing), five remained unchanged, four improved, and three recovered. In a patient with a remnant surrounding the optic nerve and preoperative low vision (3/10) the decision was to treat the lesion and deliberately sacrifice the residual visual acuity. Only one transient unexpected optic neuropathy has been observed. One case of delayed intracavernous carotid artery occlusion occurred 3 months after GKS, without permanent deficit. Another patient presented with partial complex seizures 18 months after GKS. All cases of tumor growth and neurological deficits observed after GKS occurred before the use of GammaPlan. Since the initiation of systematic use of stereotactic MR imaging and computer- assisted modern dose planning, no more side effects or cases of tumor growth have occurred. CONCLUSIONS: Gamma knife radiosurgery was found to be an effective low morbidity-related tool for the treatment of cavernous sinus meningioma. In a significant number of patients, oculomotor functional restoration was observed. The treatment appears to be an alternative to surgical removal of confined enclosed cavernous sinus meningioma and should be proposed as an adjuvant to surgery in case of extensive meningiomas.

59.

Year: 2000

Patient number: 77

Author: Singh, V. P.; Kansai, S.; Vaishya, S.; Julka, P. K.; Mehta, V. S.

Reference: Journal of neurosurgery, 93, Suppl 3, 57-61, 2000

Title: Early complications following gamma knife radiosurgery for intracranial meningiomas

Abstract:OBJECT: The purpose of this paper was to assess the early complications,

defined as occurring within 1 year, following gamma knife radiosurgery (GKS) for the treatment of intracranial meningiomas. **METHODS:** Seventy-seven of 306 patients undergoing GKS in the last 2.5 years harbored meningiomas. There were 35 men and 42 women with a mean age of 32.4 years (range 10-80 years). Tumor volume ranged from 0.35 to 28.6 cm³ (mean 7.9 cm³). Gamma knife radiosurgery was the primary therapy in 28 patients and followed surgery in 49 patients. There were 50 basal and 27 nonbasal meningiomas. The most common sites were parasagittal (23 patients) and cerebellopontine angle (14 patients). Ten to 15 Gy was administered to the tumor margins. Clinical and radiological follow up with a mean duration of 122 months was available in 40 patients. Seizures and increased headache were found in five and four patients, respectively. A temporary worsening of hemiparesis was seen in two patients (both with parasagittal tumors). One patient with a cavernous sinus meningioma developed a herpes labialis eruption. Perilesional edema was demonstrated in nine patients and was symptomatic in six. Six (22%) of the 27 patients with nonbasal tumors had edema (all parasagittal) and four patients were symptomatic. Only three (6%) of the 50 basal meningiomas had edema, and only one patient was symptomatic. The occurrence of edema did not correlate with tumor volume, margin or maximum dose, or with radiation received by adjacent brain. A reduction in tumor size was seen in seven patients. In one patient a new recurrent lesion developed adjacent to the previously treated tumor. **CONCLUSIONS:** Although GKS provides good results for selected patients with meningiomas, caution is required in treating patients with parasagittal tumors as the incidence of perilesional edema is considerable.

60.

Year: 2000

Patient number: 333

Author: Unger, F.; Papaefthymiou, G.; Eustacchio, S.; Trummer, M.; Pendl, G.

Reference: Acta Chirurgica Austriaca, 32, 5, 233-235, 2000

Title: Hydrocephalus - A major complication after stereotactic radiosurgical gamma knife treatment?

Abstract:Background: Hydrocephalus formation following Gamma Knife radiosurgery has been repeatedly reported in the literature. Experiences in patients treated at our own institution are presented here. Methods: 1500 patients underwent stereotactic radiosurgery with the Gamma Knife at the Department of Neurosurgery at the Karl Franzens University in Graz from April 1992 until January 1999 (age ranging from 2 to 88 years, median 51). Single dose radiosurgery was performed with use of a Gamma Unit (Modell B, 201 Cobalt-60 bears). Among those patients were 333 with meningioma, 277 with metastases, 189 had glial tumors, 186 acoustic neurinoma and 150 arteriovenous malformations. Clinical and neuroradiological follow-up examinations were performed every six months, in patients with malignant tumors at intervals of 3 months. Results: 33 patients had a preexistent hydrocephalus 20 of whom had been treated surgically with tumor resection prior to Gamma Knife treatment, in all patients ventriculoperitoneal shunts had to be inserted radiosurgery. After radiosurgery 3 patients with acoustic neurinomas and initially normal ventricular system developed hydrocephalus. Microsurgical tumor

debulking was performed in two cases. The third patient was treated by means of a ventriculoperitoneal shunt. Conclusions: Tumor-associated hydrocephalus with predictable course was observed in 2 % of all patients. By contrast, treatment-related peritumoral reaction sufficient to block the CSF circulation and requiring shunt insertion was observed only in 0.2 % of all patients and concerned less than 2 % patients with acoustic neurinomas. The aim of radiosurgery in tumor patients is growth control. In cases with preexisting aquaeductal obstruction occlusive hydrocephalus may develop especially in the phase of radiogenic perifocal edema. This fact should be discussed with patients who are not operated due to medical problems or who refuse surgery. Patients having undergone a shunting procedure already before radiosurgery are likely to remain shunt-dependent. Hydrocephalus formation is not a typical complication but is a symptom that may aggravate after radiosurgery.

61.

Year: 1999

Patient number: 14

Author: Chang, J. W.; Kim, S. H.; Huh, R.; Park, Y. G.; Chung, S. S.

Reference: Stereotactic and Functional Neurosurgery, 72, SUPPL. 1, 29-37, 1999

Title: The effects of stereotactic radiosurgery on secondary facial pain

Abstract: Twenty-seven patients with tumor-related secondary facial pain were treated by stereotactic radiosurgical procedures between November 1991 and October 1998. They had 14 meningiomas, 11 schwannomas (one trigeminal, 10 vestibular), one nasopharyngeal cancer and one chordoma. The mean maximum dose administered was 26.4 Gy (range 16 to 35 Gy) and the margin of the tumor was encompassed within the 45 to 90% isodose. The patients were analyzed based on their pain relief with a mean follow-up duration of 32.1 months. In 24 patients (85.7%), there was initial pain improvement after radiosurgery, but half had recurrent pain. A pain response was obtained in 12 cases (pain response rate = 42.9%), five were pain free and seven had pain reduction. On the follow-up MRI, a decrease in tumor volume of more than 20% of the preoperative volume occurred in 14 of 25 cases. The mean time interval to initial pain improvement (10.3 months) and pain response (5.7 months) were shorter than for a decrease in tumor volume (18.6 months). Tumor-related secondary facial pain was less responsive to stereotactic radiosurgery than idiopathic trigeminal neuralgia. It would seem that the mechanism of pain relief in radiosurgery is not only trigeminal root decompression secondary to tumor volume reduction, but also other mechanisms involving inactivation of abnormal electrical transmission may be involved.

62.

Year: 1999

Patient number: 24

Author: Iwai, Y.; Yamanaka, K.; Yasui, T.; Komiyama, M.; Nishikawa, M.; Nakajima, H.; Kishi, H.

Reference: Surgical neurology, 52, 1, 40-4, 1999

Title: Gamma knife surgery for skull base meningiomas The effectiveness of low-dose treatment

Abstract:BACKGROUND: The surgical removal of skull base meningiomas has a high morbidity rate, even by modern microsurgical standards. We evaluated the results of gamma knife surgery for skull base meningiomas using a relatively low radiation dose for the tumor margins. METHODS: We reviewed 24 cases of skull base meningiomas during a 30-month period. The locations of the tumors were the petroclival region in 11 cases, the cavernous sinus region in 9 cases, and the cerebellopontine angle region in 4 cases. Eight patients (33%) had been operated on previously and fourteen patients (67%) had been treated by neuroimaging. The marginal doses for the tumors were 8 Gy to 15 Gy (median, 10.6 Gy). A large petroclival tumor 58 mm in diameter was treated with a staged treatment protocol with a 6-month interval between treatments. RESULTS: Tumor regression was observed in 46% of the patients imaged during the follow-up period (median, 17.1 months). No patients revealed tumor growth in the follow-up period (100% tumor control rate). Eleven patients (46%) had improved clinically by the time of the follow-up examinations. Preexisting cranial nerve deficit in one patient worsened because of radiation injury. CONCLUSION: Although a longer follow-up period is required, the relatively low minimum tumor radiation dose treatment for skull base meningiomas using a gamma knife seems to be an effective treatment with low morbidity.

63.

Year: 1999

Patient number: 26

Author: Jokura, H.; Yoshimoto, T.

Reference: Japanese Journal of Neurosurgery, 8, 6, 403-412, 1999

Title: Value of gamma knife radiosurgery for tumors invading cavernous sinus

Abstract:The usefulness of radiosurgery for cavernous sinus tumors was evaluated based on our experience and recent published reports from other institutes. Twenty-six meningiomas involving the cavernous sinus were treated by radiosurgery. The length of follow-up averaged 3 years. Tumors regressed in 40% and remained stable in 56% of cases. A total of 96% of the tumors were controlled with only a few minor complications. We believe surgical resection to reduce the volume of the tumor without causing new neurological deficits, followed by radiosurgery on the tumor located in the cavernous sinus is the best choice in many cases. Twenty-five pituitary adenomas with cavernous sinus invasion were treated by a combination of trans-sphenoidal removal and radiosurgery. All the tumors are controlled in terms of volume during the follow-up (average of 34 months). There were no new neurological deficits, including visual disturbance. Hormone elevation was able to be corrected at an early stage without pituitary insufficiency more by radiosurgery than by fractionated radiation. However, to obtain good results by radiosurgery, it must be preceded by complete surgical decompression of optic nerves and chiasma from the tumor.

64.

Year: 1999

Patient number: 37

Author: Kang, C. S.; Zheng, L. G.; Xu, D. S.

Reference: Stereotactic and functional neurosurgery, 73, 1-4, 72-8, 1999

Title: Dose-volume effect in gamma knife radiosurgery of meningiomas

Abstract:OBJECTIVE: To study the relationship between dose-volume effect and complication in gamma knife radiosurgery of intracranial meningiomas. METHOD: By using an integrated logistic formula to establish mathematical models, the authors analyzed the relationship between treatment volume and logistic probability for 15 Gy, and the relationship between prescribed dose and treatment volume in 3% logistic probability. Furthermore, 37 meningiomas treated by gamma knife radiosurgery were analyzed retrospectively to investigate how the 3% isoeffect curve impacted on complication. RESULT: There was a linear relation between treatment volume and logistic probability for 15 Gy. The regression formula was $f(x) = 0.0042x + 0.0007$. The 3% isoeffect curve indicated that the prescribed dose was inversely proportional to the treatment volume. During 16.3 months follow-up on average, 18 cases below the 3% isodose curve were without complication, but in 19 cases above the 3% isodose curve, 5 cases suffered complications, the difference being statistically significant.

CONCLUSION: Dose selection in gamma knife radiosurgery is volume dependent. The 3% isodose curve may possibly be the guideline in gamma knife radiosurgery of meningiomas. Copyright 2000 S. Karger AG, Basel.

65.

Year: 1999

Patient number: 99

Author: Kondziolka, D.; Levy, E. I.; Niranjan, A.; Flickinger, J. C.; Lunsford, L. D.

Reference: Journal of neurosurgery, 91, 1, 44-50, 1999

Title: Long-term outcomes after meningioma radiosurgery: physician and patient perspectives

Abstract:OBJECT: Stereotactic radiosurgery is a primary or adjuvant management approach used to treat patients with intracranial meningiomas. The goal of radiosurgery is long-term prevention of tumor growth, maintenance of the patient's neurological function, and prevention of new neurological deficits. The object of this study is to report longer-term patient outcomes. METHODS: The authors evaluated 99 consecutive patients who underwent radiosurgery for meningioma between 1987 and 1992. Evaluation was performed using serial imaging tests, clinical evaluations, and a patient survey that was administered between 5 and 10 years after radiosurgery. Four patients underwent two radiosurgery procedures for separate meningiomas. The average tumor margin dose was 16 Gy and the median tumor volume was 4.7 ml (range 0.24-24 ml). Fifty-seven patients (57%) had undergone prior resection, of which 12 procedures were considered total. Five patients received fractionated radiation therapy before radiosurgery. Eighty-nine patients (89%) had skull base tumors. The clinical tumor control rate (no

resection required) was 93%. Sixty-one (63%) of 97 tumors became smaller, 31 (32%) remained unchanged in size, and five (5%) were enlarged. Resection was performed in seven patients (7%), six of whom had undergone prior resection. New neurological deficits developed in five patients (5%) 3 to 31 months after radiosurgery. Twenty-seven (42%) of 65 responding patients were employed at the time of radiosurgery and 20 (74%) of these remained so. Radiosurgery was believed to have been successful by 67 of 70 patients who completed an outcomes questionnaire 5 to 10 years later. At least one complication was described by nine patients (14%) and in four patients the complications resolved. **CONCLUSIONS:** Five to 10 years after radiosurgery, 96% of surveyed patients believed that radiosurgery provided a satisfactory outcome for their meningioma. Overall, 93% of patients required no other tumor surgery. Incidences of morbidity in this early experience were usually transitory and relatively mild. Radiosurgery provided long-term tumor control associated with high rates of neurological function preservation and patient satisfaction. Grant ID: K08 NS01723, Acronym: NS, Agency: NINDS.

66.

Year: 1999

Patient number: 53

Author: Liscák, R.; Simonová, G.; Vymazal, J.; Janousková, L.; Vladyka, V.

Reference: Acta neurochirurgica, 141, 5, 473-80, 1999

Title: Gamma knife radiosurgery of meningiomas in the cavernous sinus region

Abstract: For 6 years (1992-1998) we have treated 67 patients with cavernous sinus meningioma using the Leksell gamma knife in the Hospital Na Homolce, Prague. The age of the patients ranged between 19-82 years, median 57 years. Radiosurgery was the primary treatment in 64.2% of the patients, in the rest a microsurgical resection preceded. The volume of the tumour ranged from 0.9-31.4 cm³, median 7.8 cm³. The meningioma was distant from the optic tract in 58% of the cases, in 12% of the cases there was a contact with the tumour and the optic tract without its compression and in 30% of the cases there was a compression of the optic tract caused by the meningioma. The dose to the tumour margin ranged from 10-14 Gy, median 12 Gy. The follow up was available in 53 patients, in intervals of 2-60 months, median 19 months. There was no change in the tumour volume in 48% of the cases, in 52% of the cases a decrease of the tumour volume occurred. No increase of the tumour volume was observed. Clinical symptoms and signs improved in 35.8% of the patients, temporary morbidity was 3.8%. The mortality of the treatment was zero. Hitherto, the results of gamma knife radiosurgery of cavernous sinus meningioma have proved its safety and efficiency, although long term experience with a large group of patients is missing. Advances in neuroradiology and radiosurgical technique have allowed us to treat tumours with a closer contact to the optic tract and nerves compared with the past.

67.

Year: 1999

Patient number: 88

Author: Morita, A.; Coffey, R. J.; Foote, R. L.; Schiff, D.; Gorman, D.

Reference: Journal of neurosurgery, 90, 1, 42-9, 1999

Title: Risk of injury to cranial nerves after gamma knife radiosurgery for skull base meningiomas: experience in 88 patients

Abstract:OBJECT: In this study the authors sought to determine the neurological risks and potential clinical benefits of gamma knife radiosurgery for skull base meningiomas. METHODS: A consecutive series of 88 patients harboring skull base meningiomas were treated between 1990 and 1996 by using the Leksell gamma knife in a prospective clinical study that included a strict dose-volume protocol. Forty-nine patients had previously undergone surgery, and six had received external-beam radiotherapy. The median treatment volume was 10 cm³, and the median dose to the tumor margin was 16 Gy. The radiosurgical dosage to the optic nerve, the cavernous sinus, and Meckel's cave was calculated and correlated with clinical outcome. The median patient follow-up time was 35 months (range 12-83 months). Two tumors (2.3%) progressed after radiosurgery; the progression-free 5-year survival rate was 95%. At last follow-up review, 60 (68%) tumors were smaller and 26 (29.5%) remained unchanged. Clinical improvement (in vision, trigeminal pain, or other cranial nerve symptoms) occurred in 15 patients. Functioning optic nerves received a median dose of 10 Gy (range 1-16 Gy), and no treatment-induced visual loss occurred. Among nine patients with new trigeminal neuropathy, six received doses of more than 19 Gy to Meckel's cave. CONCLUSIONS: Gamma knife radiosurgery appeared to be an effective method to control the growth of most skull base meningiomas in this intermediate-term study. The risk of trigeminal neuropathy seemed to be associated with doses of more than 19 Gy, and the optic apparatus appeared to tolerate doses greater than 10 Gy. Considering the risks to cranial nerves associated with open surgery for comparable tumors, the authors believe that gamma knife radiosurgery is a useful method for the management of properly selected recurrent, residual, or newly diagnosed skull base meningiomas.

68.

Year: 1999

Patient number: 11

Author: Nakaya, K.; Hayashi, M.; Nakamura, S.; Atsuchi, S.; Sato, H.; Ochiai, T.; Yamamoto, M.; Izawa, M.; Hori, T.; Takakura, K.

Reference: Stereotactic and functional neurosurgery, 72, Suppl 1, 67-72, 1999

Title: Low-dose radiosurgery for meningiomas

Abstract:Gamma Knife radiosurgery is an effective treatment for meningiomas. However, it may be difficult to deliver what is currently considered an optimal dose, especially if the tumor is large or adjacent to critical structures. Eleven cases are presented with a follow-up of more than 12 months where the margin dose did not exceed 10 Gy. The mean age was 48.8 years. The mean follow-up period was 35.7 months (range 21 to 57 months). The mean volume of the tumors was 9.4 cm³ (range 1.6 to 28.9 cm³). The margin dose was less than 10 Gy in all 11 cases, due to a large volume in two cases. Four tumors were close to the visual pathways. Five tumors were close to the brain stem.

Imaging follow-up showed that four tumors had shrunk after radiosurgery. The remaining seven cases remained unchanged. There was no tumor growth after radiosurgery. A transient oculomotor palsy was observed in two cases after radiosurgery. It is suggested that Gamma Knife radiosurgery using lower dosage than usual is one of the options for the treatment of meningioma.

69.

Year: 1999

Patient number: NA abstract

Author: Pollock, B. E.; Gorman, D. A.; Schomberg, P. J.; Kline, R. W.

Reference: Mayo Clinic proceedings, {Mayo-Clin-Proc}, Jan 1999, vol. 74, no. 1, p. 5-13, ISSN: 0025-6196.

Title: The Mayo Clinic gamma knife experience: indications and initial results

Abstract OBJECTIVE: To review the results and expectations of contemporary stereotactic radiosurgery. MATERIAL AND METHODS: We conducted a retrospective analysis of 1,033 consecutive patients who underwent gamma knife radiosurgery at Mayo Clinic Rochester between January 1990 and January 1998. RESULTS: The number of patients undergoing radiosurgery increased from 57 in 1990 to 216 in 1997. Of 97 patients with arteriovenous malformations who underwent follow-up angiography 2 years or more after a single radiosurgical procedure, 72 (74%) had complete obliteration of the vascular malformation. Of 209 patients who underwent radiosurgery for benign tumors (schwannomas, meningiomas, or pituitary adenomas) and had radiologic studies after 2 years or more of follow-up, tumor growth control was noted in 200 (96%). Tumor growth was also controlled in 90% of brain metastatic lesions at a median of 7 months after radiosurgery. Of 20 patients with trigeminal neuralgia and follow-up for more than 2 months, 14 (70%) were free of pain after radiosurgery. CONCLUSION: Radiosurgery is a safe and effective management strategy for a wide variety of intracranial disorders. Use of radiosurgical treatment should continue to increase as more data become available on the long-term results of this procedure.

70.

Year: 1999

Patient number: 107

Author: Vermeulen, S.; Young, R.; Li, F.; Meier, R.; Rasis, J.; Klein, S.; Kohler, E.

Reference: Stereotactic and functional neurosurgery, 72, Suppl 1, 60-6, 1999

Title: A comparison of single fraction radiosurgery tumor control and toxicity in the treatment of basal and nonbasal meningiomas

Abstract: Between July 1993 and October 1997, 107 patients with 118 meningiomas were treated with Gamma Knife radiosurgery (GKRS). The most frequent site of tumor origin was the skull base (54%). The mean tumor diameter and volume were 2.5 cm and 9.4 cm³, respectively. The mean dose to the tumor periphery was 17 Gy, prescribed to a mean iso-dose of 47%. At a mean follow-up of 28 months, tumor control for basal and nonbasal meningiomas was 80%. Deteriorating peritumoral edema associated with

symptoms was observed in 1 of 49 (2%) skull-base tumors and in 4 of 39 (10%) non-basal tumors, without associated tumor growth. ($p=0.15$ and 0.234 respectively, z -test). Stereotactic radiosurgery can achieve acceptable tumor control with low morbidity in the treatment of most meningiomas. However, when the tumor is nonbasal, the potential morbidity from peritumoral edema should be recognized and other treatment options considered, such as adjuvant surgery, partial fractionated irradiation or stereotactic radiotherapy.

71.

Year: 1998

Patient number: 203

Author: Kondziolka, Douglas; Flickinger, John C.; Perez, Bernardo; Group, Gamma Knife Meningioma Study

Reference: Neurosurgery (Baltimore), 43, 3, 405-413, 1998

Title: Judicious resection and/or radiosurgery for parasagittal meningiomas: Outcomes from a multicenter review

Abstract:BACKGROUND: Parasagittal meningiomas, especially when associated with the middle or posterior third of the superior sagittal sinus, pose difficult management challenges. Initial surgical excision is associated with high morbidity and frequent tumor recurrence after subtotal resection. Neurological deficits are cumulative when multiple resections are required. No consistent management approach exists for patients with such tumors. In addition to observation, management options include resection, stereotactic radiosurgery, or fractionated radiation therapy used alone or in combination. METHODS: Sixteen centers where resection, gamma knife radiosurgery, and/or radiation therapy were available provided management data on 203 patients with histologically benign meningiomas from the time of initial diagnosis through follow-up after radiosurgery. The timing of resections, parameters of radiosurgery, rates of tumor control, morbidity, and functional patient outcomes were studied. The median follow-up duration in this study was 3.5 years (maximum, 33 yr after presentation and 6 yr after radiosurgery). RESULTS: The tumors were located in the anterior superior sagittal sinus in 52 patients, at the middle of the sinus in 91, and at the posterior portion of the sinus in 60. The mean tumor volume at the time of radiosurgery was 10 cc. In patients who underwent radiosurgery as the primary therapy ($n = 66$), the 5-year actuarial tumor control rate was $93 \pm 4\%$. No clinical failure (need for additional therapy or worsened neurological function) occurred in patients who had smaller tumors (<7.5 cc) and who had never undergone resection ($n = 41$). The 5-year control rate for patients with previous surgery was only $60 \pm 10\%$; the control rate for the radiosurgery-treated volume was 85% . Most failures resulted from remote tumor growth. Multivariate analyses identified significantly decreased tumor control with increasing tumor volume ($P = 0.002$) and previous neurological deficits ($P = 0.002$). The rate of transient, symptomatic edema after radiosurgery was 16% , was more common with larger tumors, and occurred within 2 years. Of 33 patients who were employed at the time of radiosurgery for whom a minimum of 1 year of follow-up data were available, 30 remained employed (91%). A decrease in functional status after radiosurgery was noted in only 3 of 33 (9%) employed and 7 of 77 (9%) unemployed

patients. **CONCLUSION:** In patients with smaller tumors (<3 cm in diameter) and patent sagittal sinuses, we advocate radiosurgery alone as the first surgical procedure. Patients with larger tumors and those with progressive neurological deficits resulting from brain compression should first undergo resection. Planned second-stage radiosurgery should be performed soon afterward for any residual tumor nodule or neoplastic dural remnant. Multimodality management may enhance long-term tumor control, reduce the need for multiple resections, and maintain the functional status of the patient.

72.

Year: 1998

Patient number: 28

Author: Ma, Z.; Tang, J.; Qiu, B.; Hou, Y.; Peng, Z.; Liu, Y.

Reference: Hunan yi ke da xue xue bao, 23, 2, 161-3, 1998

Title: Gamma knife treatment of meningiomas

Abstract: From October 1995 to July 1997, 52 cases of meningioma were treated with gamma knife radiosurgery. Twenty-eight cases were followed up by CT or MR. The follow-up period was from 2 to 22 months. Follow-up imaging evaluation showed tumor size shrinkage in 8 cases, central density decrease in 10 cases, no change in 8 cases and tumor volume increase in 2 cases. The actual 1-year tumor growth control rate was 92%. Radiation-induced edema was noted in 9 cases, including 7 cases of the nonbasal tumor and 2 cases of basal one. The indications and efficacy of gamma knife treatment of the meningioma were discussed. Our preliminary experience suggests that gamma knife is an effective and safe technique for carefully selected patients with meningiomas.

73.

Year: 1998

Patient number: 41

Author: Muthukumar, N.; Kondziolka, D.; Lunsford, L. D.; Flickinger, J. C.

Reference: Acta neurochirurgica, 140, 4, 315-20, 1998

Title: Stereotactic radiosurgery for tentorial meningiomas

Abstract: Radical microsurgical resection is the procedure of choice for tentorial meningiomas. Despite advances in microsurgery, tentorial meningiomas continue to challenge surgeons and patients. To evaluate the response of tentorial meningiomas, we evaluated 41 patients who had Gamma knife stereotactic radiosurgery during a 9 year period. Patient age varied from 32 to 79 years. Headache, trigeminal neuralgia, or facial paraesthesia were the most common presenting symptoms. Sensory deficits in the distribution of the trigeminal nerve were the most common finding. Eighteen patients (44%) had undergone between 1 and 5 (mean, 1.9) resections prior to radiosurgery; 23 had tumors diagnosed by neuroimaging. The average tumor diameter in this series was 20 mm. The maximum tumor dose varied from 24 to 40 Gy (mean, 30.5 Gy), and the tumor margin dose varied from 12 to 20 Gy (mean, 15.3 Gy). During the average follow-up interval of 3 years (range, 1-8 years), 19 patients had clinical improvement, 20

remained stable, and 2 patients deteriorated. Follow-up imaging showed a reduction in tumor size in 18 patients, no further tumor growth in 22, and an increase in tumor size in one (overall tumor control rate of 98%). Stereotactic radiosurgery using the Gamma Knife was a safe and effective primary or adjuvant treatment for patients with tentorial meningiomas.

74.

Year: 1998

Patient number: 80

Author: Pan, D. H. C.; Guo, W. Y.; Chang, Y. C.; Chung, W. Y.; Shiua, C. Y.; Wang, L. W.; Wu, S. M.

Reference: Stereotactic and Functional Neurosurgery, 70, SUPPL. 1, 19-32, 1998

Title: The effectiveness and factors related to treatment results of gamma knife radiosurgery for meningiomas

Abstract: A retrospective analysis was conducted on 80 patients with intracranial meningiomas treated with Gamma Knife radiosurgery between 1993 and 1996. The purpose was to analyze the efficacy of the treatment and to assess appropriate treatment parameters. The results were assessed by regular MR examinations, and tumor volume was measured at 6-month intervals. Mean follow-up duration was 21 months (range 6-45 months). 63 meningiomas were at the skull base and 17 were distal from the skull base. Tumor volumes < 5 ml (n = 38), 5-10 ml (n = 21), 10-15 ml (n = 14), 15-20 ml (n = 7). The patients were divided into 3 groups according to the radiation dose. The groups were high-dose (peripheral dose 17-20 Gy, n = 19), medium-dose (15-16Gy, n=33) and low-dose (12-14Gy, n=28) groups. A statistical method (Generalized Estimation Equation) was applied to compare treatment results in these groups with different doses and tumor volumes. The volume measurement at the latest follow-up showed 74% (59/80) meningiomas decreased in volume, 17% (14/80) had no tumor enlargement and 9% (7/80) had increased in volume. The increased volume was found more frequently in the patients with a short (6-12 months) follow-up period. In this series, the tumors had 32% reduction in average tumor volume at 3 years after radiosurgery. At the range of 12-20 Gy peripheral dose (PD), radiosurgery was effective to reduce tumor volume 0.7% per month ($p < 0.05$). However, higher doses had no significant difference on tumor volume reduction ($p > 0.05$). On the other hand, high-dose (PD > 17 Gy) treatment was associated with a higher risk of temporary tumor swelling and the development of adverse radiation effects (AREs). The AREs detected on MR images occurred in (25/80) 31% patients. Only 6/25 AREs were symptomatic and 2 had neurological sequelae. Peripheral doses, tumor volumes and their locations had significant impacts on the ARE ($p < 0.05$). In conclusion, a peripheral dose of 15-16 Gy may be adequate for meningiomas with small volumes (ltoreq5ml). In larger tumors (gtoreq10ml) a lower PD is preferred (12-14 Gy). To avoid initial tumor swelling and ARE, high-dose irradiation (PD > 17 Gy) is not recommended for meningiomas larger than 5 ml.

75.

Year: 1998

Patient number: 71

Author: Pan, H. C.; Chung, W. Y.; Guo, W. Y.; Chang, Y. C.; Shiao, C. Y.; Wang, L. W.; Liu, R. S.; Ngo, F. Q.; Lee, L. S.

Reference: Zhonghua yi xue za zhi, 61, 7, 397-407, 1998

Title: Effects of gamma knife radiosurgery for brain tumors: clinical evaluation

Abstract:BACKGROUND: Gamma knife radiosurgery is a safe and effective alternative to microsurgery in the management of selected intracranial lesions. In our initial three-year experience with gamma knife radiosurgery, 431 patients were treated using this method. This report presents the treatment results for three different types of brain tumors: benign meningiomas, malignant metastases and gliomas. METHODS: A retrospective study was performed to analyze a consecutive series of 71 meningiomas, 31 metastatic tumors and 21 gliomas treated by gamma knife radiosurgery between March 1993 and May 1996. The treatment results were investigated using regular magnetic resonance examinations and tumor volume measurement at six-month intervals to observe sequential changes of the tumors. Patients with meningiomas were further divided into three groups according to the peripheral radiation doses: high-dose (20-17 Gy, n = 18), medium-dose (16-15 Gy, n = 33) and low-dose (14-12 Gy, n = 20). The Generalized Estimation Equation was applied to compare treatment results in these three groups with different doses and tumor volumes. RESULTS: Volume measurements of the 71 meningiomas showed that 76% decreased in size, 16% stabilized and 8% increased in size. The volumes increased most frequently in the early stage (6-12 months) after treatment and subsequently regressed after the twelfth month. The tumor control rate for meningiomas in our three-year follow-up was over 90%. For meningiomas, the statistical analysis showed that both the radiation dose and tumor volume were significantly related to the development of adverse radiation effects ($p < 0.05$). In metastatic tumors, rapid tumor regression after radiosurgery was found in 87% of the patients. In gliomas, radiosurgery effectively inhibited tumor growth in selected patients with small, circumscribed, less infiltrative tumors. Ependymomas and low-grade astrocytomas had more favorable outcomes than other gliomas. CONCLUSIONS: Gamma knife radiosurgery is effective for controlling tumor growth in benign meningiomas for up to three years after surgery. In selected cases of malignant metastasis and gliomas, most patients appeared to benefit from the treatment with symptomatic improvement and prolonged survival. Treatment strategy and dose selection in radiosurgery should be adjusted to optimize tumor control and avoid adverse radiation effects.

76.

Year: 1998

Patient number: 41

Author: Pendl, G.; Schroettner, O.; Eustacchio, S.; Ganz, J. C.; Feichtinger, K.

Reference: Stereotactic and Functional Neurosurgery, 70, SUPPL. 1, 33-40, 1998

Title: Cavernous sinus meningiomas-what is the strategy: Upfront or adjuvant gamma

knife surgery?

Abstract: 43 patients with meningiomas of the cavernous sinus form the basis of this study. Two patients were treated with microsurgery alone, 17 patients were treated by Gamma Knife radiosurgery (GKRS) as a primary treatment modality, and 24 patients underwent a combined treatment of microsurgery followed by GKRS. Therefore, in 17 patients the diagnosis rested on clinical and radiological criteria alone. Cranial nerve disorders (CND) related to open surgical treatment were infrequent in this material (3 of 13 patients) due to deliberate strategies of partial or subtotal resection aimed at sparing cranial nerves from surgical maneuvers. In contrast, 6 of 11 patients, admitted for GKRS from other institutions suffered from considerable CND after open surgery and showed only partial improvement after GKRS. In all GKRS cases, no radiation-related complications were seen after a follow-up of 18-62 months (mean 39 months). Moreover, in all cases tumor control was obtained with a stable tumor volume in 63%, reduction of volume in 34.5% and a disappearance of tumor in 2.5%. GKRS is not only an additional treatment for meningiomas involving the cavernous sinus, but may be offered to the patient as an alternative primary treatment.

77.

Year: 1998

Patient number: 62

Author: Subach, B. R.; Lunsford, L. D.; Kondziolka, D.; Maitz, A. H.; Flickinger, J. C.

Reference: Neurosurgery, 42, 3, 437-43, 1998

Title: Management of petroclival meningiomas by stereotactic radiosurgery

Abstract: **OBJECTIVE:** To evaluate the role of stereotactic radiosurgery in the management of petroclival meningiomas, we retrospectively reviewed our experience with 62 patients managed at the University of Pittsburgh during an 8-year period. **METHODS:** All patients had cranial base meningiomas involving the region between the petrous apex and the upper two-thirds of the clivus. Some tumors extended into the cavernous sinus. Each of 39 patients (63%) had previously undergone one or more attempts at surgical resection. Seven patients (11%) had received fractionated external beam radiation therapy. Using the gamma knife, conformal multiple isocenter radiosurgery was performed with tumor margin doses of 11 to 20 Gy. **RESULTS:** During the median follow-up period of 37 months, neurological statuses improved in 13 patients (21%), remained stable in 41 patients (66%), and eventually worsened in 8 patients (13%). Tumor volumes decreased in 14 patients (23%), remained stable in 42 patients (68%), and increased in 5 patients (8%). Despite the proximity of these tumors to critical neural and vascular structures, complications resulting from radiosurgery were rare. Five patients (8%) developed new cranial nerve deficits within 24 months of radiosurgery, although none had evidence of tumor progression. These deficits resolved completely in two patients within 6 months of onset. **CONCLUSION:** Although an even longer follow-up period is desirable, we conclude that stereotactic radiosurgery provides a safe and effective management strategy for petroclival meningiomas, both as a primary procedure and as an adjunct to incomplete resection.

78.

Year: 1997

Patient number: NA abstract

Author: Hou, Y.; Tang, J.; Ma, Z.; Qiu, B.; Liu, Y.

Reference: Hunan yi ke da xue xue bao, 22, 4, 347-50, 1997

Title: Therapy for intracranial lesions by gamma knife

Abstract:The authors summarized 281 patients with intracranial lesions treated by gamma knife (GK) during Sept. 1995-Sept. 1996. The patients included 170 males and 111 females with age ranging from 5 to 85 years (average of 49.9 years). Seventy-seven patients received a follow-up 3.3-12.5 months. The average of Karnofsky Performance Status was 70.8 in pre-operation and 83.9 in post-operation; the average of tumor volume was 17.1 cm³ in pre-operation and 13.6 cm³ in post-operation; the average of lesion diameter was 2.8 cm and 2.4 cm in pre- and post- operation. respectively. GK radiosurgery has achieved the goal to improve the quality of life and to prolong the life of those patients with malignant intracranial tumors.

79.

Year: 1997

Patient number: 18

Author: Kurita, H.; Sasaki, T.; Kawamoto, S.; Taniguchi, M.; Terahara, A.; Tago, M.; Kirino, T.

Reference: Acta neurologica Scandinavica, 96, 5, 297-304, 1997

Title: Role of radiosurgery in the management of cavernous sinus meningiomas

Abstract:OBJECTIVE: To provide our early experience and philosophy in the utility of radiosurgery in the management of cavernous sinus meningiomas. METHODS: Twenty-five consecutive cases with cavernous sinus meningiomas treated between 1990 and 1995 were reviewed. Three cases were treated with gamma-knife radiosurgery, 15 with preceding surgery and gamma knife, 7 with surgery. Mean follow-up following radiosurgery and surgery were 34.8 and 25.4 months, respectively. RESULTS: The 5-year actuarial tumor control rate following radiosurgery was 85.7% and tumor remission rate was 61.4%. Permanent neurological deterioration after radiosurgery was seen in 1 case (5.9%), whereas newly developed or worsened neurological deficits permanently persisted in 59.1% of patients after surgery. There was a clear correlation between surgical radicality and postoperative morbidity rate. CONCLUSIONS: Gamma-knife radiosurgery is a valuable addition to surgical removal in the treatment of cavernous sinus meningiomas. Combination of non-radical resection and subsequent radiosurgery is recommended to improve treatment-associated morbidity.

80.

Year: 1997

Patient number: 45

Author: Park, Y. G.; Kim, E. Y.; Chang, J. W.; Chung, S. S.

Reference: Surgical neurology, 48, 5, 488-93, 1997

Title: Volume changes following gamma knife radiosurgery of intracranial tumors

Abstract:BACKGROUND: The primary goal of radiosurgery for brain tumors is the prevention of further growth. The purpose of this article is to evaluate temporal changes of tumor volume after Gamma Knife radiosurgery on intracranial tumors. METHOD: Some 137 patients with 148 intracranial tumors who were treated with Gamma Knife radiosurgery and underwent radiological follow-up were reviewed. The tumors with high radiosensitivities to conventional external radiation were excluded. RESULT: The median radiological follow-up period was 12 months (range 1.5-38 months). Volume decreased after radiosurgery in 15 of 45 meningiomas; 10 of 37 schwannomas; 6 of 21 pituitary adenomas; 4 of 15 benign gliomas, including both of 2 subependymal giant cell astrocytomas; and 2 of 8 malignant gliomas. Some 87% of meningiomas and 60% of schwannomas whose volume had decreased began to shrink within 12 months and after 12 months, respectively. Transitory increase in volume preceded shrinkage in 16.2% of schwannomas, 13.3% of benign gliomas, 4.8% of pituitary adenomas, and 2.2% of meningiomas. Marked shrinkage occurred in 17 of 19 metastatic tumors and in all 3 neurocytomas shortly after radiosurgery. Of eight malignant gliomas, five began to grow 2-14 months (median = 5 months) after radiosurgery. CONCLUSION: Several points should be considered carefully while following up on patients after radiosurgery: the possibility of transient volume increase, tumor-specific volume change patterns, and the tumor-specific goals of radiosurgery.

81.

Year: 1997

Patient number: 97

Author: Pendl, G.; Schröttner, O.; Eustacchio, S.; Feichtinger, K.; Ganz, J.

Reference: Minimally invasive neurosurgery, 40, 3, 87-90, 1997

Title: Stereotactic radiosurgery of skull base meningiomas

Abstract:Between April 1992 and February 1996, 97 patients with skull base meningiomas were treated at our department. The age of these patients ranged from 10 to 80 years. The male/female ratio was 1/2. Fifty-three of these patients had primary open surgery for partial removal or recurrent growth and subsequent radiosurgical treatment. Radiosurgery was performed as a primary treatment in 44 patients. The mean tumor volume was 13.7 cm³ (range: 0.8-82 cm³). These tumor volumes could be covered by mean isodose volumes of 45% (range: 20-70%) and were treated by a mean dose of 13.8 Gy (range: 7-25 Gy) at the tumor border. Six patients underwent radiosurgery with a staged treatment protocol with 4.6-6 months interval. In 78 patients, a total of 102 follow-up scans were available. The remaining 19 patients have not been included in the post-radiosurgical evaluation since the observation time was either too short or the patients were lost for follow-up. The mean interval between gamma knife treatment and last follow-up scan was 18.5 months, with a range from 6 to 46 months. Follow-up imaging (CT, MRI or both) revealed a decreased volume of the tumor in 31 cases (40%).

In 44 cases (56%), tumor progression was stopped, and in 3 cases (4%) increased tumor volumes could be observed. In 8 cases marked central tumor necrosis was seen. Neurological follow-up examinations in 76 patients showed a stable neurological status in 71%, ameliorated status in 24% and worsening in 5% of the patients.

82.

Year: 1997

Patient number: 79

Author: Wowra, B.; Horstmann, G. A.; Cibis, R.; Czempiel, H.

Reference: Der Radiologe, 37, 12, 1003-15, 1997

Title: Profile of ambulatory radiosurgery with the gamma knife system 2: Report of clinical experiences

Abstract: Gamma Knife radiosurgery (GKRS) was applied in 500 consecutive treatments for 445 patients within 2 years. Indications were arterio-venous malformations (93 patients), schwannomas of cranial nerves (75 patients), meningiomas (79 patients; 73 of the tumors involving the skull base), pituitary adenomas (40 patients), craniopharyngiomas (13 cases), gliomas (13 cases), rare indications (12 cases), and brain metastases (126 patients). In arterio-venous malformations two complications were observed whereas two other patients underwent surgery due to intracranial hemorrhage in the latent period after GKRS. In all cases follow-up with MRI showed evidence of an active obliteration process. Out of 24 patients with a follow-up over 1 year, angiography revealed complete obliteration in 9 patients so far. A partial obliteration was evidenced by MRI in 15 cases. In benign tumors (meningiomas and vestibular schwannomas) tumor control rates of 88% and 89% were achieved, respectively. Treatment related side effects were mild and rare; no facial palsy occurred after primary Gamma Knife treatment. GKRS was particularly effective in inoperable skull base meningiomas. Cerebral metastases were controlled in 89.5% by a single Gamma Knife treatment. The mean survival period was 11.8 months. In patients receiving a single Gamma Knife treatment the mean survival time was 9.1 months. For patients undergoing multiple (up to 5) sessions of GKRS (because of new tumors) the mean survival period was 17.2 months. MRI showed evidence of adverse radiation reactions in 10/124 patients (8.1%) which were symptomatic in 3 patients (0.8%). The results obtained in patients with cerebral metastases emphasize that GKRS alone is as effective as the combined treatment of these lesions by surgery and fractionated radiotherapy. Our results demonstrated an attractively high therapeutic gain factor of Gamma Knife treatment in key indications of radiosurgery.

83.

Year: 1996

Patient number: 34

Author: Ganz, J. C.; Schröttner, O.; Pendl, G.

Reference: Stereotactic and functional neurosurgery, 66, Suppl 1, 129-33, 1996

Title: Radiation-induced edema after Gamma Knife treatment for meningiomas

Abstract: A retrospective study was performed to analyze some parameters in a consecutive series of 35 Gamma Knife treatments in 34 patients with benign meningiomas. The minimum dose to the tumors was never less than 12 Gy. The follow-up period was from 1 to 3 years. A semiquantitative method of tumor volume assessment was used to measure the tumor response to treatment. The presence and clinical significance of postradiation edema were noted. Even in this short follow-up period, 11 of the 35 tumors were reduced in volume. No tumors increased in size. Edema developed preferentially in nonbasal tumors, especially those around the midline and sagittal sinus. In all but one case where radiation-induced edema was observed was the margin tumor dose 18 Gy or more. It is suggested that doses of 18 Gy or more should probably be avoided in the Gamma Knife treatment of meningiomas and that the greatest care should be taken in selecting non-skull base tumors for this form of treatment.

84.

Year: 1996

Patient number: 20

Author: Hodes, J. E.; Sanders, M.; Patel, P.; Patchell, R. A.

Reference: Stereotactic and Functional Neurosurgery, 66, 1-3, 15-18, 1996

Title: Radiosurgical management of meningiomas

Abstract: The management of residual, recurrent, or small skull base meningiomas is controversial. Stereotactic radiosurgery has emerged as an alternative treatment. We report our experience from September 1991 to August 1994 of treatment of 20 such patients (18 females - age 19-82 years, followed for 6-36 months (mean 15.5 months)) with the Leksell Gamma Knife registered trade mark. Nine patients were treated either with recurrent (2 patients - 2 operations each) or residual tumor. Twelve patients had skull base, 3 optic nerve, 3 parasagittal, and 1 residual torcular tumor. Mean volume/diameter was 9,172 mm³/25 mm.

85.

Year: 1996

Patient number: 100

Author: Hudgins, W. R.; Barker, J. L.; Schwartz, D. E.; Nichols, T. D.

Reference: Stereotactic and functional neurosurgery, 66, Suppl 1, 121-8, 1996

Title: Gamma Knife treatment of 100 consecutive meningiomas

Abstract: Clinical and imaging results of Gamma Knife treatment of 100 consecutive patients with intracranial meningiomas are reported. Only 1 patient refused follow-up imaging and her symptoms remain improved after 1 year. Mean values for the patient and treatment parameters were age 61 years, duration of symptoms 3.6 years, time since diagnosis 3 years, average tumor diameter 2.4 cm, surface radiation dose 15 Gy and number of isocenters 5. Clinical outcomes revealed that 6 were improved, 75 were unchanged and 17 had deteriorated. Of the latter, 8 were operated, 4 were treated

medically and 5 died. Imaging follow-up showed no growth in 87 patients. The size of tumors treated ranged from 0.66 to 6.8 cm average diameter. In the 77 patients with tumors with an average diameter of 3 cm or less, only 2 (3%) showed further growth, and none died of tumor-related causes.

86.

Year of Conference: 1996

Patient number:54

Author: Jiankun, Zhu; Wenwei, Dai

Reference:Conference title: XIIIth Meeting of the World Society for Stereotactic and Functional Neurosurgery, July 1-4, 1997, Lyon, France., 67, 96, 1996

Title: Preliminary report of gamma knife in the treatment of meningioma: A report of 54 cases

87.

Year: 1996

Patient number: 18

Author: Kida, Y.; Kobayashi, T.; Tanaka, T.; Oyama, H.; Niwa, M.; Maesawa, S.

Reference: No shinkei geka, 24, 6, 529-33, 1996

Title: Radiosurgery of cavernous sinus meningiomas with gamma-knife

Abstract:The treatment results of cavernous sinus meningioma with gamma-radiosurgery are reported. There were 18 cases of cavernous sinus meningioma, including 2 males and 16 females, whose age ranged from 39 to 63 with an average of 51.0 years. As prior treatments, operative tumor resection or biopsy had been carried out in 14 cases, and the pathology was verified. The other 4 cases were diagnosed clinically with radiological studies. The mean tumor diameter was 28.3mm (17.7-35.0) during the radiosurgery. The maximum dose ranged from 22 to 36Gy (mean 28.0Gy), with the marginal tumor dose ranging from 11 to 18Gy (mean 13.9Gy). Irradiation to the near-by optic nerves was less than 10Gy. Follow-up period ranged from 12 to 50 months with a mean of 25.5 months. MRI showed a minor tumor shrinkage in 9 (50.0%) and no obvious change in 8 (44.4%), and tumor progression in 1 (5.6%), which required a 2nd radiosurgery. Neurologically facial pain and facial dysesthesia were well improved (7/13). However the ophthalmoparesis was usually unchanged and only 1 out of 11 (9.1%) improved after radiosurgery. Deterioration of neurological signs was rare. Symptomatic edema presenting neurological signs was not seen. In conclusion, radiosurgery with a gamma-knife is one of the useful alternatives to operative intervention in the treatment of cavernous sinus meningiomas, not only for tumor control, but also for relief from the symptoms.

88.

Year: 1996

Patient number: 48

Author: Nakamura, S.; Hiyama, H.; Arai, K.; Nakaya, K.; Sato, H.; Hayashi, M.; Kawamata, T.; Izawa, M.; Takakura, K.

Reference: Stereotactic and functional neurosurgery, 66, Suppl 1, 142-5, 1996

Title: Gamma Knife radiosurgery for meningiomas: four cases of radiation-induced edema

Abstract: We review 48 cases of meningioma treated with Gamma Knife radiosurgery. The mean marginal dose was 15 Gy and the mean follow-up was 12 months. Follow-up computed tomography and magnetic resonance imaging showed tumor shrinkage in 19 cases, central necrosis in 1 case, loss of contrast enhancement in 1 case, and no change in 27 cases. We noted 4 cases of radiation-induced edema in supratentorial meningiomas.

89.

Year: 1996

Patient number: 50

Author: Nicolato, A.; Ferraresi, P.; Foroni, R.; Pasqualin, A.; Piovan, E.; Severi, F.; Masotto, B.; Gerosa, M.

Reference: Stereotactic and functional neurosurgery, 66, Suppl 1, 112-20, 1996

Title: Gamma Knife radiosurgery in skull base meningiomas Preliminary experience with 50 cases

Abstract: Gamma Knife radiosurgery was performed on 50 patients (10 males and 40 females) with skull base meningiomas (SBMs) between February 1993 and September 1995. The patients ranged in age from 25 to 78 years (mean age 56 years). The location of the tumors was anterior fossa (n = 4), sphenoorbital (n = 2), sellar region (n = 5), cavernous sinus (n = 26), petroclival (n = 12), and occipital foramen (n = 1). The tumor volume ranged from 0.6 to 20 cm³ (mean 8.6 cm³). The mean values for dose planning were edge isodose (EI) 46.7%, edge dose (ED) 18.0 Gy, maximum dose 39.8 Gy, average dose (AD) 25.4 Gy, and average number of isocentres 5.7. The patients were analyzed for five parameters: tumor volume (< 7.5 vs. > or = 7.5 cm³); EI (< 50 vs. > or = 50%); ED (< 18 vs. > or = 18 Gy); AD (< 25 vs. > or = 25 Gy), and primary versus residual or recurrent tumors. The overall frequency of tumor growth control (TGC) was 98%, with 1- and 2-year TGC rates of 97% and 100%, respectively. The most favorable neurological results were obtained with a tumor volume < 7.5 cm³ (p < 0.05), EI > or = 50% (NS), ED > or = 18 Gy (NS) and with primary SBMs (p < 0.01). A favorable TGC was demonstrated at follow-up imaging examinations when the tumor volume was > or = 7.5 cm³ (100% TGC rate), EI < 50% (100%), ED > or = 18 Gy (100%), AD > 25 Gy (100%), in both primary SBMs (100%) and residual or recurrent SBMs (96.5%). To date, only 3 (6%) of the 50 patients have presented signs of neurological worsening related to the Gamma Knife radiosurgery. While no early complications were noted, neuroradiological follow-up did show delayed transient imaging complications (3 edema and 1 radionecrosis; 8% of all patients). In conclusion, our preliminary results seem to confirm that Gamma Knife radiosurgery is an effective and safe adjuvant or a feasible alternative primary treatment

in controlling or preventing SBM progression.

90.

Year: 1996

Patient number: 33

Author: Tanaka, T.; Kobayashi, T.; Kida, Y.

Reference: Neurologia medico-chirurgica, 36, 1, 7-10, 1996

Title: Growth control of cranial base meningiomas by stereotactic radiosurgery with a gamma knife unit

Abstract:The effect of gamma knife radiosurgery for cranial base meningiomas was analyzed using magnetic resonance (MR) imaging in 33 patients followed up for a mean 26.5 months. There were 10 male and 23 female patients aged from 38 to 87 years (mean 54.5 yrs). Twenty-three patients had already had more than one open surgery before radiosurgery. The mean tumor volume was 16.8 cm³. The mean maximum dose was 29 Gy and the mean marginal dose was 15.1 Gy. Four patients were treated by two-stage treatment at 1- to 4-month intervals. Follow-up MR imaging revealed a decrease in tumor size in 10 patients, a small low intensity area in the tumor center in three, increase in tumor size in two, and no change in 18. After radiosurgery one patient had marked edema on MR imaging and showed cognitive deficits, and another three patients had neurological deterioration. All other patients were unchanged or improved. Growth control of cranial base meningiomas without severe neurological deficits can be achieved by radiosurgery.

91.

Year: 1995

Patient number: 29

Author: Kobayashi; Kida; Tanaka; Oyama; Iwakoshi

Reference: Dept. of Neurosurgery, Komaki City Hosp., Komaki 485, Japan. English. NOTNLM. 19950401., 1995

Title: The stereotactic radiosurgery using gamma knife on 150 cases of brain tumors (Meeting abstract)

Abstract:We have treated more than 300 cases of intracranial lesions by Leksell Gamma Unit since May 1991 at Komaki City Hospital. There are 154 cases of vascular anomaly and 150 cases of brain tumors. There were 48 cases of neurinoma (32.0%), 29 of meningioma (19.2%), 24 of gliomas (16.0%), 21 of metastatic tumors (14.0%), 6 of pituitary adenomas (4.0%), 4 of craniopharyngioma (2.7%), 3 of malignant lymphoma (2.0%) and 15 of other tumors. Dose planning and dosimetry were made on MRI images with fixation of Leksell G frame to the skull, which consist of 3-mm slices of both axial and coronal plane with gadolinium enhanced T1 images by

92.

Year: 1995

Patient number: 48

Author: Liscák, R.; Vladyka, V.; Simonová, G.; Novotný, J.

Reference: Casopis lékařu českých, 134, 17, 534-8, 1995

Title: Radiosurgical treatment of meningioma with the Leksell gamma knife

Abstract:BACKGROUND. Up to the present time radical microsurgery of the tumour was considered the most satisfactory treatment. Now an ever more important part in the treatment of these tumours is played by radiosurgery. It involves minimal surgical stress, a minimal rate of complications and minimal change of lifestyle during the postoperative period. The objective of the submitted work was to evaluate the authors' results with the use of Leksell's gamma knife. METHODS AND RESULTS. In 1992-1994 48 patients with meningiomas were indicated for treatment with a gamma knife. The group comprised 12 men (25%) and 36 women (75%) aged 18-73 years (mean age 52.8 years which did not differ significantly in the two groups). In 19 patients (39.6%) one or more neurosurgical operations were carried out previously, in 4 patients (8.3%) fractionated radiotherapy. Karnofski's score, as an indicator of the general condition, varied between 30-90%, the mean value for the whole group being 71%. The calculated volume of the meningioma was between 0.7 and 25.8 cm³, the average being 7.4 cm³. Collateral oedema in the adjacent area of the tumour was found in 6 patients (12.5%). In 19 patients (39.6%) the tumour was at the base of the skull, in 29 patients (60.4%) at other sites. The radiosurgically administered dose was within the range of 6.5-24 Gy, on average 14.2 Gy, on the isodose on average 50.7% (range 40-75%). The dose below the maximum was within the range of 13-45 Gy, on average 28.3 Gy. Only in two patients fractionated administration of the dose was used. After a 6-month interval following operation 30 patients were examined. In 7 patients (23.3%) partial wrinkling of the meningioma occurred (range 6-18 months), Karnofski's score improved by 10% in 8 (26.6%) and deteriorated in 3 patients (10%). The neurodeficit improved in 7 (23.3%) and deteriorated in 4 patients (13.3%). Collateral oedema developed in 5 patients (16.6%) 5-7 months after operation, in about half the patients it was symptom free. During the follow up period 2 patients died (8 and 5 months following surgery): in one the cause of death was not associated with the basic disease, in the second patient (where radiotherapy was the third neurosurgical operation) the radiosurgical operation could not reverse the fatal course of the disease. CONCLUSIONS. Radiosurgery of meningiomas is a safe therapeutic method with zero mortality, minimal surgical stress, a minimal rate of complications and a minimal morbidity. It is indicated in meningiomas and possibly their residues after subtotal neurosurgery up to a maximal volume of 30 cm³. It is primary treatment suitable in particular in old patients, patients with a high pre- and postoperative risk and in patients refusing open neurosurgery.

93.

Year: 1994

Patient number: 40

Author: Kida, Yoshihisa; Kobayashi, Tatsuya; Tanaka, Takayuki; Oyama, Hirofumi; Iwakoshi, Takayasu

Reference: Neurological Surgery, 22, 7, 621-626, 1994

Title: Stereotactic radiosurgery for intracranial meningiomas

Abstract: Stereotactic radiosurgery for intracranial meningiomas was attempted using a 201-source cobalt gamma knife. Forty patients bearing 42 tumors were involved in this study. Their ages ranged from 30 to 91 years, with an average of 55.1 years. The most frequent sites of origin were the parasellar and petroclival regions. The mean tumor diameter was 27.2mm and the marginal tumor dose of radiosurgery ranged from 10 to 20Gy, depending on tumor location and size. Serial imaging studies with MRI were obtained in all 40 cases, in which minor tumor shrinkage was demonstrated in 7.9%, 40.0% and 53.3% at 6, 12 and 18 months after radiosurgery respectively. Only two tumors became enlarged after the treatment. Obvious low signal intensity on MRI, indicating central tumor necrosis, was found in 32% at 12 months and 40% at 18 months. Four large tumors over 40mm in mean diameter were treated by staged radiosurgery with intervals of 1.5 to 7 months. A similar good response was able to be obtained in all 4 cases, even though they were treated with a marginal dose less than 12Gy. Symptomatic edema occurred in 5 cases (12.5%) within 12 months and required corticosteroid therapy and hyperosmotic diuresis. In conclusion stereotactic radiosurgery has proved to be an effective and relatively safe method for the treatment of intracranial meningiomas.

94.

Year: 1994

Patient number: 36

Author: Pendl, G.; Schröttner, O.; Friehs, G. M.; Legat, J.; Leber, K.; Mokry, M.; Papaefthymiou, G.; Langmann, G.

Reference: Acta neurochirurgica, 127, 3-4, 170-9, 1994

Title: Radiosurgery with the first Austrian cobalt-60 Gamma-unit A one year experience

Abstract: During the period of one year, from the 21. 4. 1992 to 21. 4. 1993, a total of 201 radiosurgical sessions on 181 patients were performed with the first Austrian Gamma-unit in Graz. 42% of radiosurgical sessions were undertaken for malignomas, 20% for meningiomas, 11.5% for vascular malformations, 9% for neurinomas, 8.5% for low grade astrocytomas and glomus jugulare tumours, 5% for sellar and suprasellar lesions, and 4% for functional disorders. Dose plan data for all the lesions treated are shown. Clinical and imaging data of the first year which are available for 120 patients (66%) are presented and discussed.

95.

Year: 1993

Patient number: 34

Author: Duma, C. M.; Lunsford, L. D.; Kondziolka, D.; Harsh, G. R. th; Flickinger, J. C.

Reference: Neurosurgery, 32, 5, 699-704, 1993

Title: Stereotactic radiosurgery of cavernous sinus meningiomas as an addition or

alternative to microsurgery

Abstract:To evaluate the response of cavernous sinus meningiomas to stereotactic radiosurgery, we reviewed our 54-month experience with 34 patients. All patients underwent radiosurgery with a 201-source cobalt-60 gamma unit. Twenty-eight patients (82%) had previous histological confirmation of a meningioma (1 to 5 cranial base craniotomies per patient); 6 (18%) were treated on the basis of neuroimaging criteria alone. The single-fraction radiation tumor margin dose (10 to 20 Gy) was designed to conform to the irregular tumor volumes in all patients. The maximum radiation dose to the optic nerve or tract was reduced to 9 Gy in 31 patients. No patient had tumor growth (100% tumor control) during the follow-up interval (median, 26 mo). Tumor regression was observed in 56% of patients imaged at an average of 18 months. Eight patients (24%) improved clinically at follow-up examinations. Four patients developed new or worsened cranial nerve deficits during the follow-up interval; two had subsequent full improvement. No patient developed an endocrinopathy or new extraocular muscle paresis. Stereotactic radiosurgery, using multiple isocenter dosimetry facilitated by the gamma unit, is an accurate, safe, and effective technique to prevent the growth of tumors involving the cavernous sinus. Despite the proximity of such tumors to adjacent cranial nerves, complications were rare. The maximum length of hospital stay was 36 hours, and all patients returned to their preoperative employment status within 3 to 5 days .(ABSTRACT TRUNCATED AT 250 WORDS).

96.

Year: 1993

Patient number: 20

Author: Ganz, J. C.; Backlund, E. O.; Thorsen, F. A.

Reference: Stereotactic and functional neurosurgery, 61, Suppl 1, 23-9, 1993

Title: The results of Gamma Knife surgery of meningiomas, related to size of tumor and dose

Abstract:In Bergen, 20 patients with meningiomas have been treated with a follow-up period in excess of 1 year. While this is too short a period to allow more than tentative conclusions to be drawn, some trends can be determined nonetheless. There has been some variation in the reporting of the results of treatment of meningiomas, with one group producing a reduction in size in 7% of patients and another in 34%. In the current material, 10 patients received 10 Gy or less to the edge of the tumor. In 4 of these 12 patients there was increase in the volume of the tumor within 1 year of treatment. Ten of the patients received 12 Gy or more to the edge of the tumor. Of these 10 patients, 4 had tumors which showed a reduction in volume. It is suggested that the difference in the reported rate of tumor volume reduction is related to differences in dose, which is discussed in relation to other treatment parameters.

97.

Year: 1991

Patient number: 50

Author: Kondziolka, D.; Lunsford, L. D.; Coffey, R. J.; Flickinger, J. C.

Reference: Stereotactic and functional neurosurgery, 57, 1-2, 11-21, 1991

Title: Gamma knife radiosurgery of meningiomas

Abstract: Fifty patients with meningiomas were treated during the initial 30 months experience using the 201 source cobalt-60 gamma knife at the University of Pittsburgh. The most frequent site of origin was the skull base. Stereotactic radiosurgery was the primary treatment modality in 16 (32%) patients with symptomatic tumors demonstrated by neuroimaging. Thirty-six patients (72%) had undergone at least one craniotomy, and 4 patients (8%) previously had fractionated external beam radiation therapy. The proximity of cranial nerves, vascular, pituitary and brainstem structures to the often convoluted tumor mass was crucial to dose selection. Follow-up imaging studies and clinical analysis of patients were performed at 6-month intervals. The actuarial 2-year tumor control rate was 96%. Only 2 patients have shown delayed tumor growth outside the radiosurgical treatment volume. To date, stereotactic radiosurgery proved to be a relatively safe and effective therapy for selected patients with symptomatic meningiomas, either as an adjuvant treatment to prior resection, or as a primary treatment alternative for patients whose advanced age, medical condition or high-risk tumor location mitigated against surgical resection.

98.

Year: 1991

Patient number: 50

Author: Kondziolka, D.; Lunsford, L. D.; Coffey, R. J.; Flickinger, J. C.

Reference: Journal of neurosurgery, 74, 4, 552-9, 1991

Title: Stereotactic radiosurgery of meningiomas

Abstract: Stereotactic radiosurgery has an expanding role in the management of selected intracranial tumors. In an initial 30-month experience using the 201-source cobalt-60 gamma knife at the University of Pittsburgh, 50 patients with meningiomas were treated. The most frequent site of origin was the skull base. Previously, 36 patients (72%) had undergone at least one craniotomy and four patients (8%) had received fractionated external beam radiation therapy. Stereotactic radiosurgery was the primary treatment modality in 16 patients (32%) with symptomatic tumors demonstrated by neuroimaging. Computer imaging-generated isodose plans (with one to five irradiation isocenters) for single-treatment irradiation gave optimal (greater than or equal to 50% isodose line) coverage in 44 patients (88%). The proximity of cranial nerves or vascular, pituitary, and brain-stem structures to the often convoluted tumor mass was crucial to dose selection. Serial imaging studies were evaluated in all 50 patients. Twenty-four patients were examined between 12 and 36 months after treatment; 13 (54%) showed a reduction in tumor volume while nine (38%) showed no change. Of 26 patients evaluated between 6 and 12 months after treatment, four showed a decrease in tumor size while 22 showed no change. Two patients (both with large tumors that received suboptimal irradiation) had delayed tumor growth outside the radiosurgical treatment volume. The actuarial 2-year tumor growth control rate was 96%. Between 3 and 12 months after radiosurgery, three

patients developed delayed neurological deficits that gradually improved, compatible with delayed radiation injury. Although extended follow-up monitoring over many years will be necessary to fully evaluate treatment, to date stereotactic radiosurgery has proved to be a relatively safe and effective therapy for selected patients with symptomatic meningiomas, including those who failed surgical resection. Radiosurgery was an effective primary treatment alternative for those patients whose advanced age, medical condition, or high-risk tumor location mitigated against surgical resection.

99.

Year: 1990

Patient number: NA abstract

Author: Sekhar, L. N.; Jannetta, P. J.; Burkhart, L. E.; Janosky, J. E.

Reference: Neurosurgery, 27, 5, 764-81, 1990

Title: Meningiomas involving the clivus: a six-year experience with 41 patients

Abstract: A series of 41 meningiomas involving the clivus operated on from July 1983 to January 1990 is reported. The presenting symptoms and signs of these patients were similar to those reported previously. All the patients were evaluated by pre- and postoperative thin-section, high-resolution computed tomography using soft tissue and bone algorithms. Most of the patients also underwent magnetic resonance imaging. The regions of the clivus involved by tumor were divided into upper, middle, or lower regions on the basis of anatomical landmarks. The diameter of the tumor was measured in three axes, and a tumor volume and a tumor equivalent diameter were computed to categorize tumors as small, medium, large, or giant types. There were 9 medium, 27 large, and 5 giant tumors in this series. Some simple and some complex operative approaches were employed to effect tumor removal. Large and giant tumors often required more than one operative approach to remove the tumor. Intraoperative technical difficulties included tumor consistency, vascularity, dissection from the brain stem, and vascular and cranial nerve encasement. Postoperative computed tomographic scans documented total excision in 32 patients (78%). Residual tumor remained in the clival or cavernous sinus areas. These patients were either being observed, or were treated with gamma knife radiosurgery. There was one operative death due to pneumonia (2%), and three patients (7%) suffered permanent major neurological changes, presumably due to vascular occlusions in the posterior circulation. In the follow-up period, which ranged from 3 to 76 months, 2 patients (6%) with tumors that had appeared to be totally excised experienced recurrence. These patients were treated by a second operation, alone or in combination with radiation therapy. Two patients who had subtotal excisions (25%) had evidence of regrowth. In 2 patients, tumor growth continued despite gamma knife radiosurgery or external beam radiotherapy.