Gamma Knife radiosurgery for Trigeminal schwannoma

see also Trigeminal schwannoma treatment

Systematic review and meta-analysis

Yang et al. performed a systematic review and meta-analysis to analyze the clinical outcomes of patients with trigeminal schwannomas treated primarily or adjunctly with GKRS. They searched two databases, Pubmed and Embase, for studies published before January 1, 2021, using GKRS for trigeminal schwannomas. Studies reporting treatment of other schwannomas, or other forms of SRS such as linear accelerator and Cyberknife were excluded to reduce its heterogeneity.

The search achieved 351 studies, of which 35 were assessed for full-text eligibility. 19 studies were included in the meta-analysis. 456 of 504 patients (0.94, 95% CI 0.91-0.96, I2 = 3.02%, p < 0.01) from 18 studies had local control, and 278 of 489 patients (0.63, 95%CI 0.48-0.78, I2 = 88.75%, p < 0.01) from 16 studies experienced tumor regression or disappearance. 231 of 499 patients (0.50, 95% CI 0.37-0.62; I2 = 83.89%, P < 0.01) from 17 studies had clinical symptoms improved. There was no significant difference in tumor control between those treated with GKRS as either primary treatment or adjuvant to surgery(p = 0.390).

GKRS is an efficacious primary and adjuvant method of treating trigeminal schwannomas, with reliable tumor control rates. Randomized controlled trials are needed to further and comprehensively evaluate the benefit-to-risk ratio of gamma knife radiosurgery [1)].

Case series

A retrospective analysis was performed on 32 patients with TS who underwent GKRS between May 1994 and December 2016. Clinical charts, radiographic results, and surgical records were reviewed. To evaluate whether symptoms improved after GKRS, patient demographics, GKRS profile, radiological tumor size change, and tumor location were analyzed.

Results: Tumor control after GKRS for symptomatic TS was 87%. The improvement rates for facial pain at 6, 12, and 24 months after GKRS were 46%, 72%, and 86%, respectively. For the same time intervals, facial hypesthesia improved by 12%, 46%, and 52%, respectively. Of the patients with diplopia, 17% had improved symptoms 12 months after GKRS, and 50% of the patients improved after 24 months.

GKRS can be an effective treatment modality for TS tumor control and shows favorable results in improving TS-related symptom, especially facial pain [2)].

Shin et al. aimed to evaluate the radiographic and clinical outcomes after gamma knife radiosurgery (GKRS) for trigeminal schwannomas (TSs). A total of 87 patients who underwent GKRS for TSs

between 1990 and 2020 were enrolled. The mean tumor volume was 4.3 cm3. The median prescribed dose for the margins of the tumor was 13 Gy. The median follow-up duration was 64.3 months (range 12.0-311.5 months). The overall local tumor control rate was 90%, and the symptom response rate was 93%. The response rate for each symptom was 88% for facial pain, 97% for facial sensory change, and 86% for cranial nerve deficits. Nineteen (22%) patients showed transient swelling, which had regressed at the time of the last follow-up. Cystic tumors were associated with transient swelling ($p = 0.04$). A tumor volume of < 2.7 cm3 was associated with local tumor control in univariable analysis. Transient swelling was associated with symptom control failure in both univariable and multivariable analyses ($p = 0.04$, odds ratio 14.538). GKRS is an effective treatment for TSs, both for local control and symptom control [3)]

2018

Thirty-two patients with TS who underwent GKRS between January 1994 and January 2013 with at least 2 years of follow-up were enrolled in the study. Clinical charts and surgical records were retrospectively reviewed to evaluate factors affecting TCR and symptomatic outcomes. The median patient age was 57.5 years (max = 81, interquartile range [IQR] = 51-67), and the median tumor volume was 3.55 cm3 (max = 25.2 cm3, IQR = 2.0-6.2 cm3). The median marginal and maximum doses were 13.0 Gy (max = 18.0 Gy, IQR = 12.5-15 Gy) and 23.8 Gy (max = 35 Gy, IQR = 21.7-25.0 Gy), respectively.

Results: At a median follow-up of 90.5 months (max = 281 months, IQR = 49-139.75 months), the actuarial 3-, 5-, and 10-year TCR were 93.8, 86.2, and 80.8%, respectively. Our data and multivariate analysis indicated that the target volume was the only significant factor determining TCR and that larger tumors (> 5 cm3) were more likely to progress ($p = 0.011$). Cystic tumors had a higher incidence of transient enlargement and temporary symptom change compared to those in solid tumors. An unfavorable outcome of symptoms was observed in five patients (15.6%). Complications were observed in two patients (6.25%), including hydrocephalus and radio-induced trigeminal neuropathy, respectively.

Conclusions: GKRS can be a safe and effective treatment modality for TS with long-term follow-up, especially for small tumors. An extended period of follow-up observation is required to conclude the clinical response to GKRS [4)]

2016

From February 2002 to November 2011, 50 patients (11 males, 39 females) underwent GKS for intracranial lesions accompanied by TN. Pathological diagnoses included meningioma in 30 patients, vestibular schwannoma in 11, trigeminal schwannoma in 7, epidermoid cyst in 1, and arteriovenous malformation in 1. Twenty-two (44%) had a lesion dominantly located in the middle fossa and 26 patients (52%) in the posterior fossa. Twenty-five (50%) patients complained of type I pain, and 18 patients (36%) suffered from type II pain. The other 7 patients (14%) presented with facial pain that could not be determined. Pain was assessed retrospectively by subjective descriptions and with the Barrow Neurological Institute pain intensity score before and after GKS.

Results: Tumor control was evaluated with magnetic resonance imaging in 44 (95.7%) of 46 patients over a median follow-up period of 54.8 months (range, 13-142 months). Initial improvement in pain

after GKS was observed in 46 (92%) patients. The percentage of patients with improved Barrow Neurological Institute score was 73.5% at 1 year, 70.7% at 2 years, and 76.5% at 3 years. Complete pain relief at the final follow-up was achieved in 18 patients (36%). Pain recurred in 13 patients (28.3%) after initial improvement. Pathological diagnosis, location of the lesion, and type of facial pain did not influence the initial pain response after GKS. Pain recurred more frequently in patients with meningioma than in those with schwannoma (P = .045). Type II pain showed better response to the treatment (P = .006).

Conclusion: The majority of patients with facial pain secondary to a benign intracranial lesion showed improvement after GKS. However, a substantial proportion of the patients experienced incomplete pain relief and recurrence. GKS needs to be combined with an additional modality or the technique must be modified to achieve complete and durable pain control [5)]

2013

The records of 52 patients who underwent stereotactic radiosurgery (SRS) for trigeminal schwannoma were reviewed using a retrospective study. The median patient age was 47.1 years (range, 18-77); 20 patients (38.5%) had undergone prior tumor resection and 32 (61.5%) underwent radiosurgery on the basis of imaging diagnosis only. The most frequent presenting symptoms were facial numbness (29 patients), jaw weakness (11 patients), facial pain (10 patients) and diplopia (4 patients). Fifty-two cases with solid tumors were mainly solid in 44 cases (84.6%), mostly cystic in 2 cases (3.8%), and cystic and solid mixed in 6 cases (11.5%). Two cases of mostly cystic tumor first underwent stereotactic cystic fluid aspiration and intracavitary irradiation, and then had MRI localization scan again for gamma knife treatment. The mean tumor volume was 7.2 ml (range, 0.5-38.2). The mean prescription radiation dose was 13.9 Gy (range, 11-17), and the mean prescription isodose configuration was 47.9%.

At a mean follow-up of 61 months (range, 12-156), neurological symptoms or signs improved in 35 patients (67.3%), 14 patients (26.9%) had a stable lesion, and worsening of the disease occurred in 2 patients (3.8%). On imaging, the schwannomas almost disappeared in 8 (15.4%), shrank in 32 (61.5%), remained stable in 5 (9.6%), and increased in size in 7 patients (13.5%). Tumor growth control was achieved in 45 (86.5%) of the 52 patients.

SRS is an effective and minimally invasive management option for patients with residual or newly diagnosed trigeminal schwannomas. The use of SRS to treat trigeminal schwannomas resulted in good tumor control and functional improvement [6)].

2009

The records of 33 consecutive patients with trigeminal schwannoma treated via Gamma knife radiosurgery were retrospectively reviewed. The median patient age was 49.5 years (range 15.1-82.5 years). Eleven patients had undergone prior tumor resection. Two patients had neurofibromatosis Type 2. Lesions were classified as root type (6 tumors), ganglion type (17 tumors), and dumbbell type (10 tumors) based on their location. The median radiosurgery target volume was 4.2 cm3 (range 0.5-18.0 cm3), and the median dose to the tumor margin was 15.0 Gy (range 12-20 Gy).

At an average of 6 years (range 7.2-147.9 months), the rate of progression-free survival (PFS) at 1, 5, and 10 years after SRS was 97.0, 82.0, and 82.0%, respectively. Factors associated with improved PFS included female sex, smaller tumor volume, and a root or ganglion tumor type. Neurological

symptoms or signs improved in 11 (33.3%) of 33 patients and were unchanged in 19 (57.6%). Three patients (9.1%) had symptomatic disease progression. Patients who had not undergone a prior tumor resection were significantly more likely to show improvement in neurological symptoms or signs.

Stereotactic radiosurgery is an effective and minimally invasive management option in patients with residual or newly diagnosed trigeminal schwannomas. Predictors of a better treatment response included female sex, smaller tumor volume, root or ganglion tumor type, and the application of SRS as the primary treatment [7].

2007

Phi et al. reviewed the clinical records and radiological data in 22 consecutive patients who received GKS for a trigeminal schwannoma. The median tumor volume was 4.1 ml (0.2-12.0 ml), and the mean tumor margin dose was 13.3 +/- 1.3 Gy at an isodose line of 49.9 +/- 0.6% (mean +/- standard deviation). The median clinical follow-up period was 46 months (range 24-89 months), and the median length of imaging follow-up was 37 months (range 24-79 months).

Tumor growth control was achieved in 21 (95%) of the 22 patients. Facial pain responded best to radiosurgery, with two thirds of patients showing improvement. However, only one third of patients with facial hypesthesia improved. Six patients (27%) experienced new or worsening cranial neuropathies after GKS. Ten patients (46%) showed tumor expansion after radiosurgery, and nine of these also showed central enhancement loss. Loss of central enhancement, tumor expansion, and a tumor in a cavernous sinus were found to be significantly related to the emergence of cranial neuropathies.

The use of GKS to treat trigeminal schwannoma resulted in a high rate of tumor control and functional improvement. Cranial neuropathies are bothersome complications of radiosurgery, and tumor expansion in a cavernous sinus after radiosurgery appears to be the proximate cause of the complication. Loss of central enhancement could be used as a warning sign of cranial neuropathies, and for this vigilant patient monitoring is required [8].

Twenty-six patients with trigeminal schwannomas underwent GKS at the University of Virginia Lars Leksell Gamma Knife Center between 1989 and 2005. Five of these patients had neurofibromatosis and one patient was lost to follow up. The median tumor volume was 3.96 cm(3), and the mean follow-up period was 48.5 months. The median prescription radiation dose was 15 Gy, and the median prescription isodose configuration was 50%. There was clinical improvement in 18 patients (72%), a stable lesion in four patients (16%), and worsening of the disease in three patients (12%). On imaging, the schwannomas shrank in 12 patients (48%), remained stable in 10 patients (40%), and increased in size in three patients (12%). These results were comparable for primary and adjuvant GKSs. No tumor growth following GKS was observed in the patients with neurofibromatosis.

Gamma knife radiosurgery affords a favorable risk-to-benefit profile for patients harboring trigeminal schwannomas. Larger studies with open-ended follow-up review will be necessary to determine the long-term results and complications of GKS in the treatment of trigeminal schwannomas [9].

Forty-two patients with trigeminal schwannomas but no evidence of neurofibromatosis Type 2 were treated with GKS at Komaki City Hospital between November 1991 and December 2003. Of these, 37 patients were assessed. The mean tumor volume in these patients was 10 cm3. The mean maximum radiation dose directed to the tumor was 27.9 Gy and the mean dose directed to the tumor margin was 14.2 Gy. The mean follow-up period was 54 months. In four patients (11%) there was complete tumor remission; in 20 (54%) there was partial tumor remission; in eight (22%) the disease remained stable; and in five (14%) the tumor enlarged or uncontrollable facial pain developed with radiation-induced edema requiring resection. The actuarial 5- and 10-year tumor control rates were both 84%. With respect to functional outcomes, 40% of patients noted an improvement in their symptoms, and one patient experienced new symptoms despite good tumor control.

Conclusions: Gamma Knife surgery was a safe and effective treatment for a select group of patients harboring trigeminal schwannomas. Large tumors that compress the brainstem and cause deviation of the fourth ventricle should first be removed surgically and any remnant should be treated by GKS [10)].

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2004

The records of 23 patients who underwent radiosurgery for trigeminal schwannoma were reviewed. The most frequent presenting symptoms were facial numbness (11 patients), diplopia (6 patients), and facial pain (3 patients). One patient presented with partial complex seizures as the first symptom. Twelve patients had undergone one or more prior resections. Eleven underwent radiosurgery on the basis of imaging diagnosis only. The mean tumor volume was 4.5 mL (range 0.46-11.2 cc). Radiosurgery was performed using a median marginal dose of 15 Gy (range, 13-20 Gy).

Results: At a median imaging follow-up of 40 months (range, 12-146), 20 of 22 evaluable patients (91%) had tumor growth control (regression in 15 and no further tumor growth in 5). One 80-year-old patient died of unrelated cause 4 months after radiosurgery. Two patients with enlarged tumors were treated effectively with repeat radiosurgery. Twelve of 23 patients (52%) reported improvement and 9 (39%) had no change in their symptoms. Two patients noted new neurological complaints (transient facial weakness in 1 patient and worsening of the preradiosurgery facial numbness in another patient).

Radiosurgery is an effective minimally invasive management option for patients with residual or newly diagnosed trigeminal schwannomas [12)]

1999

reviewed the clinical presentation, management, and outcomes for 16 trigeminal schwannoma patients who underwent gamma knife stereotactic radiosurgery. Fifteen of the 16 patients presented with trigeminal sensory dysfunction. Nine patients had tumors in the region of the ganglion, six in the region of the trigeminal nerve root, and one in the region of the mandibular branch. Six patients had undergone one or more previous resections before radiosurgery. Ten underwent radiosurgery as the first procedure. The mean tumor volume was 5.3 cc (range, 1-17.8 cc). The mean tumor margin dose was 15.3 Gy (range, 12-20 Gy).

Results: During the average imaging follow-up of 44 months (range, 8-116 mo), the tumor control rate was 100% (regression in nine patients and no further tumor growth in seven patients). Five patients had improvement of clinical symptoms, and 11 remained unchanged. No new cranial nerve deficit developed in any patient.

Conclusion: As a minimally invasive alternative to microsurgery, gamma knife radiosurgery proved to be an alternative primary or adjuvant strategy that controlled tumor growth, did not cause new deficits, and often improved presenting symptoms [13)].

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