Abstract

Background: Stereotactic radiosurgery (SRS) with Gamma Knife (GK) is an alternative to conventional surgery for treatment of trigeminal neuralgia. It has been well recognized as an effective treatment but the functional outcomes have not been closely studied.

Objectives: The current study evaluated the quality of life, short and long term outcome, changes in smoking and dental care in patients with idiopathic TN who underwent GK surgery at Penn State Hershey Medical Center.

Methods: Seventy consecutive patients with proven medically refractory idiopathic TN were included in this study. Of these patients, fifty nine (35 female and 24 male) were reviewed retrospectively. Of these, fourteen patients were also evaluated preoperatively. Mean 67.6 years (range 39-97 years). All patients underwent SRS with prescribed maximal dose radiation dose of 80 Gy to the 100% isodose level with a 4mm isocenter. The follow up period was 2 to 58 months (mean 21.2 months). Phone interview and survey evaluation was carried out on these patients to investigate their functional improvements. An SF-12 form was used to evaluate quality of life. Detailed smoking history and dental history were evaluated using the University of Minnesota Long Term Follow-up Study Questionnaire.

Results: Fifty two patients (88.1%) had complete resolution or decrease in frequency/intensity of their symptoms at follow up. Preoperatively, 8 patients (13.6%) reported having unnecessary tooth extraction as a treatment for facial pain prior to GKS. None of the patients had abnormal tooth development to explain these extractions. Thirty eight of these patients had their teeth cleaned by a dentist within 6 months after the GKS procedure. 13 patients (34.2%) reported being anxious about undergoing the dental procedure. One patient had reactivation of pain which resolved in one week. There was no relationship between tobacco use and intensity of pain. The mental component summary (MCS) was used as a marker of mental health, and was improved in patients that had complete pain resolution when compared to those with decreased pain, whereas the physical component summary (PCS), which was used as a marker of physical health remained comparable between these two groups. In the patient group that had pre and postoperative evaluations there was no difference between the PCS and MCS scores, but they were both improved post operatively.

Conclusions: Stereotactic radiosurgery for trigeminal neuralgia is an effective treatment option which results in improvement in dental care and mental health related quality of life in patients obtaining pain relief.

ABBREVIATIONS

GKS: Gamma Knife Surgery; TN: Trigeminal neuralgia; SRS: Stereotactic radiosurgery; MR: Magnetic resonance; TSE: Turbo spin echo; SF-12: Short form-12; PCS: Physical component summary; MCS: Mental component summary

INTRODUCTION

Trigeminal neuralgia is a debilitating disease with an incidence rate of approximately 3-5 cases per year per 100,000 persons [1-3]. First-line treatment is with medical therapy. Due to serious side effects, tachyphylaxis or failure of medical regimen, approximately 25% of these patients undergo a surgical procedure [1].

Stereotactic radiosurgery has become an accepted procedure for use in patients with medically refractory idiopathic trigeminal neuralgia since its first introduction by Leksell in 1951 [4,5]. Many patients with TN are elderly and may have medical conditions that may contraindicate invasive surgery. Radiosurgery appeals to these patients due its low-risk of complications such as from general anesthesia. Most GKS procedures are performed on an outpatient basis. An increasing number of studies have appeared in the literature reporting on outcomes in patients undergoing GKS for TN, focusing on pain control and complications. There are few reports describing quality of life of these patients. Postoperative dental care in this population has not been previously evaluated, though this is a commonly described area of fear and discomfort that is expressed by these patients. The high prevalence of orofacial pain of dental origin and the dramatic similarities between TN and odontogenic pain frequently lead to incorrect diagnoses and sometimes invasive dental treatments that may be irreversible [6]. Smoking in chronic pain syndromes...
is a common problem and attempts to quit have previously been correlated to increased pain intensity [7]. It is unknown if TN pain and its treatment affects tobacco use in this population. Finally, overall quality of life outcomes in this population have not been previously reported.

The purpose of this study was to evaluate the pain outcome, changes in dental care, changes in smoking habits and changes in quality of life in TN patients treated with GKS.

MATERIALS AND METHODS

Patient characteristics

This was a retrospective chart review, phone survey and prospective study of patients with TN treated with GKS between August 2003 and March 2008 at Penn State Hershey Medical Center. All patients had failed maximum medical management, developed unacceptable side effects from medication or had not benefited from prior surgical intervention. All patients with an established diagnosis of typical idiopathic TN were included in the study. Seventy patients were available for evaluation. Fifty nine patients (35 female and 24 male) with at least one postoperative follow up were included in the study. Chart review was performed to obtain the patient medical history, procedure details, short-term complications, pain control and time to resolution of pain. Fifty nine patients were available for contact and underwent phone surveys at follow up to determine long-term outcomes. Fourteen of these patients had evaluations at the time of their preoperative visit in clinic in addition to the postoperative evaluation.

The mean age was 67.6 years (range from 39 to 97 years). Mean symptom duration prior to presentation for evaluation for GKS was 104.1 months (range 1 to 576 months). Twenty patients (33.9%) had undergone other surgical procedures prior to GKS, of these 11 patients presented with facial numbness prior to GKS. The left side was involved in 47% of the patients and the right side in 53%. The preoperative work up in these patients included a, a history and physical exam, a full neurological exam and MR imaging. All patients with atypical facial pain, evidence of mass lesion or vascular compression on MR imaging were excluded.

Our patient population reflected the general population of this age group: Thirty one patients (52.5%) were high school graduates, 14 patients (23.8%) did not graduate high school, 10 patients (16.9%) graduated college and 4 patients had postgraduate training (6.8%). 30 patients were married (50.8%), 19 patients (32.2%) were widowed, 7 patients (11.9%) were divorced and three patient was single (5.1%). Finally, 39 patients (66%) were retired, 6 patients were working full-time (10.2%), 4 patients were (6.8%) caring for family, 6 patients (10.2%) were working part-time and four patient (6.8%) was disabled.

Radiosurgery technique

All patients were treated at Hershey Medical Center or Lancaster General Hospital with a Leksell Gamma Knife unit (model C; Elekta Instruments AB, Stockholm, Sweden) by a team consisting of a neurosurgeon, a radiation oncologist and a medical physicist. All procedures were performed on an outpatient basis. Patients were given moderate intravenous sedation with 1 to 2mg of midazolam and 2mg of morphine. A Leksell stereotactic frame was then applied with local anesthesia. Contrast enhanced T1 weighted MR imaging and TSE sequence optimized for the trigeminal nerve was used for planning. Treatment planning was performed using GammaPlan (Elekta Instruments AB).

All patients underwent SRS with prescribed maximal dose radiation dose of 80 Gy to the 100% isodose level. This was performed with a single 4mm collimator. The radiation dose was placed on the trigeminal nerve with the 50% isodose line lying outside the brainstem. A sample plan is shown in Figure 1. Retreatment was carried out with a dose of 60Gy to the 100% isodose level.

Follow-up Evaluation

The follow up period ranged from 2 to 58 months (mean 21.2 months). All patients had attended at least one outpatient follow up with the Gamma Knife team. Usual follow-up visits were performed at 1, 3, 6 and every 6 months thereafter. Pain control, time to pain resolution and facial numbness were assessed at each follow up. Facial pain outcomes were classified as complete pain resolution, partial pain resolution (decrease in number of episodes and/or intensity of pain by at least 80%) or continued pain.

We attempted to contact all seventy patients. An IRB approved follow up phone interview was carried out on fifty nine patients able to be contacted. The remaining 11 patients were not available for follow-up because one patient was deceased and 10 were lost to follow-up due to out of date contact information.

Following brief phone consent the following information was obtained from the patients: demographic background, pain control (using 1-10 rating of pain), long-term complications, detailed dental history, smoking history and general health-related quality of life using the SF-12 questionnaire.

Detailed dental history and tobacco use history was obtained using the University of Minnesota Long Term Follow Up Study Questionnaire. The SF-12 questionnaire was used to calculate the physical and mental component summary scores to evaluate the physical and mental health related quality of life preoperatively and at time of follow up.

RESULTS

Pain distribution

The most common distribution of pain was in the second and third division of the trigeminal nerve in 38% patients and least...
common was in the first division. The results are displayed in Figure 2. Left side was affected in 28 patients (47%) and right side in 31 patients (53%).

**Pain outcome**

Fifty one patients (86.4%) had complete or partial pain resolution at follow-up: 45 patients (76.3%) had complete pain resolution and 6 patients (10.1%) had partial resolution of pain with decrease in intensity and episodes by at least 80%. Eight patients (13.6%) had no resolution of pain. Five of these 8 patients had had prior surgical intervention for the pain without resolution of symptoms. Twenty four of the 45 patients with complete or partial pain resolution (53.3%) were pain free within 10 days following GKS and 38 patients (84.4%) by 3 months. Figure 3 shows the progression to pain alleviation or resolution in the patient group.

Ten patients (16.9%) had numbness preoperatively, following other surgical interventions for TN and this remained unchanged at follow-up. Six of the 49 patients (10%) who did not receive any other surgical intervention for TN prior to GKS developed facial numbness following GKS. The numbness in all patients was transient and resolved within 6 months.

**Dental History and outcome**

Eight of 59 patients (13.6%) reported having unnecessary tooth extraction as a treatment for facial pain prior to GKS. None of these patients had abnormal tooth development or severe dental disease to otherwise explain the tooth extraction. All eight patients required partial dentures following the tooth extractions.

Within 6 months following GKS, thirty eight patients (64.4%) underwent teeth cleaning with a dentist. Thirteen of these patients (34.2%) expressed that they were anxious about undergoing a dental procedure. One patient had reactivation of pain following the dental procedure but this resolved within one week. Seventeen patients did not have any dental care following GKS. Of these patients, four admitted that this was due to anxiety regarding possible reactivation of pain.

**Tobacco use**

Only five patients were current smokers. Three patients reported regular use of other tobacco products. Fifteen patients had a >10 pack year history. Seven patients who successfully quit using tobacco products reported doing so prior to the incidence of pain. All these patients denied any urge to return to the use of tobacco products after development of the facial pain. All five patients that continued to smoke had complete resolution of their pain and were not interested in quitting tobacco use.

**Quality of Life outcomes**

The SF-12 data was used to obtain the MCS and PCS scores by standardized calculation methods. This data was obtained from 27 patients with complete pain resolution, 7 with partial pain resolution and one with continued pain who only had postoperative follow up. The data is shown in table 1. The normative data for the general US population of age group 65 to 74 years of age are PCS score of 44 and MCS score of 52. The scores of the TN patients with complete or partial resolution of pain at follow up are comparable to the general US population of similar age group. Of note, the PCS scores are similar in the patients with complete or partial pain resolution but the MCS score is improved only in the patients with the complete pain resolution.

SF-12 data was also obtained on 14 patients that did have pre and postoperative evaluations. The mean preoperative MCS score was 47.36 and PCS score was 39.38. The mean postoperative MCS and PCS scores were 52.62 and 44.36, respectively. These scores represented improvement from the preoperative scores of 5.26 for the MCS score and 4.99 for the PCS score (Figure 4 and Figure 5). However, using a paired t-test for the pre and postoperative scores, neither improvement was statistically significant, with the p-value for the MCS scores of 0.109 and the p-value for the PCS scores of 0.154.

**DISCUSSION**

Stereotactic radiosurgery is the least invasive surgical modality used to treatment of idiopathic medically refractory TN.
Results of radiosurgery has been widely reported in the literature in the past decade. The incidence of pain relief either complete or partial are relatively high and side effects of numbness are relatively low [8-13]. Our rates of complete and partial pain resolution are comparable to other reported studies.

In our study, there were a substantial number of patients that underwent irreversible dental procedures. The pain distribution commonly involved is the second and third division of the trigeminal nerve, as in our study, and it is possible to have TN to be misdiagnosed as odontogenic pain. There was an encouraging improvement in the number of patients that proceeded with obtaining dental care following GKS. Since there was only one patient with temporary reactivation of pain, our study suggests that patients should be encouraged to resume regular dental care following GKS.

Smoking was less prevalent in our population in comparison to the general population. It is important to note that the tobacco usage and attempts at quitting usage were not related to the intensity or continuation of pain.

Mental and physical health-related quality of life assessments were comparable to that of the general population of comparable age group. Even though the PCS scores were similar in the patients with complete or partial resolution of pain, it is interesting that the MCS scores were improved in the patients with complete resolution of pain. This indicates that the patients in the group with complete pain resolution had, upon self-reporting, indicated less depression and anxiety in assessing the limitations on their daily activities. Therefore, even if the physical burden on patient health with pain is comparable between patients with partial and complete pain resolution, there is a corresponding mental QOL improvement if complete pain relief can be achieved.

There was an improvement seen in the postoperative SF-12 results that we collected prospectively. These results did not reach statistical significance; however, only 14 patients were included in this analysis. As a result there is a high probability of insufficient power to detect a true negative effect. It is possible that these results will reach statistical significance as more patients are added to the database and this analysis.

CONCLUSIONS

Radiosurgery has been previously shown to be an effective modality for treatment of idiopathic medically intractable TN. Our data shows that radiosurgery also improves dental care and mental health-related quality of life, suggesting less anxiety and depression, in patients with complete pain resolution.

REFERENCES

