Outcome of Gamma Knife Radiosurgery for Trigeminal Neuralgia

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= Abstract =

The surgical methods for medically intractable trigeminal neuralgia are microvascular decompression (MVD) and/or percutaneous RFG or glycerol rhizotomy. But now radiosurgery is used as another method to this condition. Since the first radiosurgical treatment of trigeminal neuralgia which was performed by Leksell in the early 1950s1-3, the target was changed from trigeminal ganglion to the root entry zone of trigeminal nerve1-3. And the dosages of stereotactic irradiation to target are variable now7. In our study, we report our long-term experience in typical trigeminal neuralgia who had gamma knife radiosurgery.

Introduction

The surgical methods for medically intractable trigeminal neuralgia are microvascular decompression (MVD) and/or percutaneous RFG or glycerol rhizotomy. But now radiosurgery is used as another method to this condition. Since the first radiosurgical treatment of trigeminal neuralgia which was performed by Leksell in the early 1950s1,2, the target was changed from trigeminal ganglion to the root entry zone of trigeminal nerve1,2,10. And the dosages of stereotactic irradiation to target are variable now7. In our study, we report our long-term experience in typical trigeminal neuralgia who had gamma knife radiosurgery.

Methods and Material

The mean age of patients was 51 years (range, 24-71). Eight patients had undergone prior surgical treatment. Among them, one patient had 2 procedures such as microvascular decompression (MVD) after glycerol injection at trigeminal ganglion. There were 4 males and 7 females. No
one had underlying neurological disease.

All patients had Gamma Knife radiosurgery (GKR) using the Leksell Unit. By the magnetic resonance image (MRI) we identified the trigeminal nerve in its course from the pons to Meckel’s cave. Stereotactic coordinates were calculated for a single 4mm isocenter, just 1- 6mm lateral side from the junction of the trigeminal nerve and pons.

At the first 3 cases, we targeted the junction between the nerve and the pons(Fig. 1). In these cases, the pons was irradiated above 56 gray. In the later cases, The isocenter is positioned more lateral side so that the brain stem surface usually received less than the 20% isodose( Table 1 ) (Fig. 2).

A range of maximum radiosurgical doses were selected between 67 and 85 gray( Table 1 ). All patients were discharged within 24 hours. Patients were evaluated by follow-up studies through outpatient department or telephone interview with regard to the severity and frequency of pain compared to preradiosurgical status. The patient him/herself made the classification of the pain relief using the percentile scale\textsuperscript{13}.

### Results

The mean follow-up duration was 25 months(range 13-50). The effects of GKR for pain have begun early. In 7 cases, the effects developed within 1 month(3 cases within 1 week) and in others at postoperative second, third, fifth month respectively.

In 3 patients, pain were relieved completely at the last follow up and in 3 patients, markedly improved(80- 90%).

Another 4 patients showed significant improvement(30-50%)( Table 1 ). There was recurrence in only one case and she complained same amount of pain at the last follow-up. There was no side effect related to GKR in all cases. Only 3 patients(case 3, 9, 11) showed gradual decrease of symptom. Most patients(case 1, 2, 4, 5, 6, 7, 8, 10) showed fluctuation of symptom during follow-up.

One patient(case 1) complained hypesthesia in tongue 8 months after GKR but it was tolerable. Before GKR, all patients had been taking medication(carbamazepine or carbamazepine with diphenyl hydantoin), but at the last follow-up, 6 patients(55%) were taking medication and especially only one among the patients who were pain-free.

### Discussions

In 1971, Lars Leksell discussed results from two patients who underwent radiosurgery for trigeminal neuralgia in 1953\textsuperscript{8).} Both patients had irradiation of the trigeminal ganglion using stereotactic guidance. The first patient who had been treated with 16.5Gy complained no trigeminal neuralgia during 18 years. And the second, 22Gy-treated patient also experienced no trigeminal neuralgia. In 1991, Lindquist, et al., reported 22 cases of patients who had gasserian ganglion radiosurgery by target localization aided by stereotactic cisternography. But the results were not good. Thirteen of the 22 patients were pain free after 6 months but only 4 remained so after 2.5 years\textsuperscript{9).} Kondziolka, et al. reported that they concluded that gasserian ganglion was probably not appropriate as the primary radiosurgery target and radiosurgery to root entry zone had

### Table 1. Patient characteristics who irradiated to the REZ and follow-up results

<table>
<thead>
<tr>
<th>No.</th>
<th>Age/ Sex</th>
<th>Location</th>
<th>Previous treatment</th>
<th>Maximum dose(Gy)</th>
<th>Dose to pons (isodose % line)</th>
<th>Medication before GKR</th>
<th>Medication after GKR</th>
<th>GKR pain &amp; Residual Onset of F/U duration</th>
<th>Onset of effect</th>
<th>F/U duration (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>53/F</td>
<td>R1 V2, 3</td>
<td>MVD* Gi\textsuperscript{1}</td>
<td>67</td>
<td>60(90%)</td>
<td>carbamazepine</td>
<td>carbamazepine</td>
<td>20%</td>
<td>free</td>
<td>1m 50</td>
</tr>
<tr>
<td>3-4</td>
<td>60/F</td>
<td>Lt V2, 3</td>
<td>Gi</td>
<td>67</td>
<td>60(90%)</td>
<td>carbamazepine</td>
<td>none</td>
<td>50%</td>
<td>7d\textsuperscript{9}</td>
<td>16</td>
</tr>
<tr>
<td>5-6</td>
<td>71/F</td>
<td>R1 V2</td>
<td>Ai\textsuperscript{8}</td>
<td>80</td>
<td>56(70%)</td>
<td>carbamazepine</td>
<td>none</td>
<td>free</td>
<td>1m</td>
<td>48</td>
</tr>
<tr>
<td>7-8</td>
<td>42/F</td>
<td>R1 V2, 3</td>
<td>MVD</td>
<td>70</td>
<td>35(50%)</td>
<td>carbamazepine</td>
<td>carbamazepine</td>
<td>100%</td>
<td>9d</td>
<td>26</td>
</tr>
<tr>
<td>9-10</td>
<td>45/M</td>
<td>R1 V3</td>
<td>RFL\textsuperscript{4}</td>
<td>80</td>
<td>16(20%)</td>
<td>carbamazepine</td>
<td>none</td>
<td>free</td>
<td>15d</td>
<td>27</td>
</tr>
<tr>
<td>11-12</td>
<td>50/M</td>
<td>R1 V2</td>
<td>MVD</td>
<td>80</td>
<td>16(20%)</td>
<td>carbamazepine</td>
<td>carbamazepine</td>
<td>50%</td>
<td>3d</td>
<td>22</td>
</tr>
<tr>
<td>13-14</td>
<td>65/M</td>
<td>R1 V2</td>
<td>none</td>
<td>80</td>
<td>16(20%)</td>
<td>carbamazepine</td>
<td>none</td>
<td>10%</td>
<td>2m</td>
<td>20</td>
</tr>
<tr>
<td>15-16</td>
<td>24/F</td>
<td>R1 V2</td>
<td>none</td>
<td>80</td>
<td>16(20%)</td>
<td>carbamazepine</td>
<td>none</td>
<td>70%</td>
<td>5m</td>
<td>24</td>
</tr>
<tr>
<td>17-18</td>
<td>39/F</td>
<td>Lt V3</td>
<td>none</td>
<td>85</td>
<td>17(20%)</td>
<td>carbamazepine</td>
<td>carbamazepine</td>
<td>50%</td>
<td>2m</td>
<td>18</td>
</tr>
<tr>
<td>19-20</td>
<td>55/F</td>
<td>R1 V2</td>
<td>RFL* x 2</td>
<td>80</td>
<td>16(20%)</td>
<td>carbamazepine</td>
<td>carbamazepine</td>
<td>10%</td>
<td>9d</td>
<td>16</td>
</tr>
<tr>
<td>21-22</td>
<td>62/M</td>
<td>Lt V2</td>
<td>MVD</td>
<td>80</td>
<td>16(20%)</td>
<td>carbamazepine</td>
<td>carbamazepine</td>
<td>30%</td>
<td>free</td>
<td>3d 13</td>
</tr>
</tbody>
</table>

\textsuperscript{1} microvascular decompression
\textsuperscript{2} radiofrequency lesion making
\textsuperscript{3} glycerol injection at trigeminal ganglion
\textsuperscript{4} alcohol injection at trigeminal ganglion
\textsuperscript{5} months
\textsuperscript{6} days
better outcome (58% pain free).\textsuperscript{5,6,12}

The advantage of proximal nerve or root entry zone as the irradiation target came from two aspects. The first one is that in this area, the central myelin (oligodendrocyte) became peripheral (schwann cell) myelin. So a stronger radiobiological effect could occur at this portion.\textsuperscript{3,5,10,11} The second one is that the root entry zone can be identified clearly with MR images as it traverses the cerebrospinal fluid of the posterior fossa.\textsuperscript{5}

The authors identified easily the junction between pons and trigeminal nerve as well as root entry zone even in the patients after MVD. In the first 3 cases of this series, the centers of targets are located lateral margin of root at the junction to pons (Fig. 1). In the later 8 cases, we moved the target into central part and more distal side of root so that the brain stem surface usually received less than the 20%
isodose (Fig. 2). But in the case 4, the nerve root was deviated to brain stem due to previous operation (MVD), so the 50% isodose curve was put on the surface of pons. The nerve root entry zone was demarcated easily by MRI in all cases including MVD patients. The two target groups showed no differences of results at the last follow-up in effects or complications of brain stem. Only in the first case, she complained tongue hypesthesia after 8 months but it was tolerable.

The tenth case had no effect from ganglion lesion making the pain was decreased 80%. After she treated by GKR, the pain was decreased 80%.

GKR respectively, but there was no effect from MVD.

and glycerol injection 18 months and 8 months before which had been treated only by GKR which had other treatment before GKR and the group was not related with ranges of symptom fluctuation.

reased gradually without fluctuation. There were differences in fluctuation ranges but the outcome at the last follow-up showed the effects within 1 month and especially 3 cases explained tongue hypesthesia after 8 months but it was tolerable.

complications of brain stem. Only in the first case, she com-

Interestingly, many cases showed symptom fluctuation during follow-up. In only 3 cases (case 3, 9, 11), pain decreased gradually without fluctuation. There were differences in fluctuation ranges but the outcome at the last follow-up was not related with ranges of symptom fluctuation.

There was no difference of effects between the group which had other treatment before GKR and the group which had been treated only by GKR (p = 0.65, chi-square). The first case was treated by microvascular decompression and glycerol injection 18 months and 8 months before GKR respectively, but there was no effect from MVD. After she treated by GKR, the pain was decreased 80%. The tenth case had no effect from ganglion lesion making by radiofrequency generator. But GKR reduced 80% of trigeminal neuralgia in this case.

**Conclusion**

Pain relief of trigeminal neuralgia after GKR is effective during long term follow-up periods (improvement ≥ 50% 82%), and no significant complication. Although more clinical experiences are needed to evaluate the efficacy of GKR as a primary treatment modality for trigeminal neuralgia but we believe that GKR will become one of the important primary management strategies.

References

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방 법

* 11단과의 끝으로의 (nerve root entry zone)를 67~85Gy, 6mm collimator로 1~6mm을, 3mm을 56회, 60Gy로 8회로 시행하였다. 20%의 경우 두차로 하였다.

결 과

* 1233

결 론

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중심 단어