The largest prospective, single-institution, homogenous series of trigeminal neuralgia patients treated with the CyberKnife® System was recently published in the journal Neurosurgery. This study provides robust clinical data supporting the safety and efficacy of the CyberKnife System for this neurological condition. CyberKnife frameless radiosurgery offers a precise, non-invasive technique with clinical outcomes comparable to Gamma Knife frame-based radiosurgery. The following table summarizes the findings.

<table>
<thead>
<tr>
<th><strong>Study Title</strong></th>
<th>Image-guided Robotic Radiosurgery for Trigeminal Neuralgia</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Principal Investigator</strong></td>
<td>Dr. Pantaleo Romanelli, Neurosurgeon, Centro Diagnostico Italiano, Milan, Italy</td>
</tr>
<tr>
<td><strong>Design</strong></td>
<td>Single-institution, homogenous and prospectively followed cohort</td>
</tr>
<tr>
<td><strong>Number of Patients Analyzed</strong></td>
<td>138 patients</td>
</tr>
<tr>
<td><strong>Time Period</strong></td>
<td>Between November 2010 and March 2014</td>
</tr>
<tr>
<td><strong>Follow-up</strong></td>
<td>Minimum and median follow-up was 36 and 52.4 months respectively</td>
</tr>
<tr>
<td><strong>Dose Prescription</strong></td>
<td>Single-fraction dose of 60 Gy delivered to a 6-mm long segment of the nerve</td>
</tr>
</tbody>
</table>

**Efficacy**
Pain relief was achieved in 93.5% of patients after a median delay of 3 weeks after treatment. This is comparable to the 91.0% after a median delay of 10 days reported in the largest Gamma Knife frame-based radiosurgery study.

**Recurrence**
Pain recurred in 18.6% of patients within 3 years of the treatment. This is favorably comparable to the 34.4% reported in the largest Gamma Knife frame-based radiosurgery study.

**Toxicity**
An overall rate of 18.1% of patients developed sensory disturbances. This is comparable to the 20.4% sensory disturbances reported with Gamma Knife frame-based radiosurgery.

**Open Access Link**
https://doi.org/10.1093/neuros/nyx571

The 93.5% of patients who achieved pain relief were able to decrease the dose of the medication intended to control the pain throughout follow-up and finally cease the pain medication. Nine patients (6.5%) who did not experience pain relief after 6 months, and 24 patients (18.6%) whose pain recurred within 3 years of treatment, underwent a second treatment with CyberKnife. All 33 patients attained pain relief after the second treatment.

**Sub-millimeter precision and accuracy**
Monthly quality assurance tests at the Centro Diagnostico Italiano demonstrated a median total treatment error of 0.30±0.12 mm. The system delivered the sub-millimeter precision and accuracy necessary for treatment of trigeminal neuralgia.

Trigeminal Neuralgia

Trigeminal neuralgia is a chronic pain condition affecting a craniofacial nerve that is primarily responsible for transmitting sensations from the face to the brain. This severe pain, quoted by patients as the most atrocious human beings can suffer, requires long-term medical treatment. The treatment usually starts with medications to lessen or block the pain signals sent to the brain. Over time, some patients stop responding to medications or suffer from unpleasant side effects. For those patients, ablative treatments such as glycerol injections, radiofrequency lesioning, balloon compression, surgery, or radiosurgery lesioning are alternative treatments.

Radiosurgery

Lars Leksell pioneered radiosurgery with the Gamma Knife System (Elekta AB, Stockholm, Sweden) in 1951. This radiosurgery system directs focused beams of radiation to the nerve, damaging the nerve and reducing or eliminating the pain. Sub-millimeter precision and accuracy is required for this treatment. This has been achieved with the Gamma Knife System using an invasive stereotactic frame fixed to the patient’s skull.

CyberKnife® Radiosurgery

The CyberKnife® System (Accuray Incorporated, Sunnyvale, California) is also used for the treatment of trigeminal neuralgia. Its image guidance technology enables sub-millimeter precision and accuracy without an invasive stereotactic frame. This eases the treatment for patients and gives the physician the option to fractionate the treatment in multiple sessions. While trigeminal neuralgia patients are treated in single session, other neurological indications close to sensitive structures such as the spine or optic apparatus may benefit from multisession radiosurgery.

A custom-fitted thermoplastic mask secures the patient in treatment position. X-ray images are continually acquired throughout treatment to track any shift and gradual drift. The CyberKnife 6-axis robotic arm then aims each beam of radiation taking into account any translational and rotational changes. All displacements are automatically corrected, regardless of how small, maintaining sub-millimeter accuracy, preserving conformal dose distribution, and sparing the surrounding critical structures and normal tissues.

Important Safety Information

Most side effects of radiotherapy, including radiotherapy delivered with Accuray systems, are mild and temporary, often involving fatigue, nausea, and skin irritation. Side effects can be severe, however, leading to pain, alterations in normal body functions (for example, urinary or salivary function), deterioration of quality of life, permanent injury, and even death. Side effects can occur during or shortly after radiation treatment or in the months and years following radiation. The nature and severity of side effects depend on many factors, including the size and location of the treated tumor, the treatment technique (for example, the radiation dose), and the patient’s general medical condition, to name a few. For more details about the side effects of your radiation therapy, and to see if treatment with an Accuray product is right for you, ask your doctor.

© 2018 Accuray Incorporated. All Rights Reserved. The styled Accuray logo, CyberKnife, Max, Precise®RT, Precise®RTX, Accuray Precision, IDS, Iris, Xchange, RoboTouch, InView, MultiPlan, Insight, Synchrony, InTema, InView, PlanTouch, and QuickPlan are trademarks or registered trademarks of Accuray Incorporated, in the United States and other countries and may not be used or distributed without written authorization from Accuray Incorporated. Use of Accuray Incorporated’s trademarks requires written authorization from Accuray Incorporated. Other trademarks used and identified herein are the property of their respective owners. MKT-CK-0118-0347