Stereotactic Fractionated Radiotherapy for Trigeminal Neuralgia: A Preliminary Report

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Background. Stereotactic fractionated radiotherapy for treatment of trigeminal neuralgia is a new method.

Methods. In our study, 20 patients with medically intractable trigeminal neuralgia underwent stereotactic fractionated radiotherapy with X-ray. The preliminary results are promising and follow-up with a mean of 1 year has been undertaken.

Results. The results show that 40% of the patients are pain free, and that 50% of the patients have experienced a 50% to 90% reduction in pain levels. All in all, 90% of the patients improved after the treatment while only 10% reported no improvement. The mean reduction in pain intensity was a score of 72.3%. Forty percent of the patients reported discontinuing Tegretol with no extra pain while 30% of patients had pain reduction with reductive Tegretol doses. The time frame for pain relief after the fractionated radiotherapy with x-ray treatment ranged from 1 week to 6 months with a mean of 2.5 months. There appeared to be no major complications except for one patient with high blood pressure which needed to be controlled during the radiation course.

Conclusions. It seems that fractionated radiotherapy with X-ray for treatment of trigeminal neualgia offers an alternative method. This type of treatment has been shown to be effective, less costly, and less invasive, especially in patients who are older, have recurring neuralgia or are reluctant to undergo invasive operations. **(Mid Taiwan J Med 2000;5:221-7)**

Key words

stereotactic fractionated radiotherapy, trigeminal neuralgia

INTRODUCTION

For treatment of trigeminal neuralgia, the common methods are microvascular decompression (MVD), percutaneous retrogasserian radiofrequency rhizotomy (PRRR), and percutaneous retrogasserian glycerol rhizotomy (PRGR). The efficacy of these treatments have been ascertained within the past 20 years [1,2]. MVD has been shown to be a popular treatment with an 85% long term success rate [3]. Unfortunately, MVD is an invasive technique and poses some surgical risks for elderly patients and patients with poor medical conditions. Literature reports that there is about a 1% mortality rate and a 27% surgical complication rate associated with MVD [4]. PRRR and PRGR are much less invasive than MVD; yet they are less effective and often create more complications than MVD, especially in those involving PRRR procedures [2]. In long-term follow-up, the recurrence rates after PRRR and PRGR treatments are around 18% and have been

Received : March 16, 2000. Revised : June 28, 2000.
Accepted : September 1, 2000.
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reported to be as high as 65% [2,5,6]. Other common complications include a 20.3% occurrence of corneal reflex impairment with or without keratitis, a 10.5% rate of masseter weakness, a 5.2% rate of paresthesia, a 1.5% rate of painful anesthesia, and a 0.5% rate of ocular palsy and diplopia [5]. In 1971, Leksell was the first to report treatment of trigeminal neuralgia with X-ray in the middle cranial fossa. The results from his study were promising as two patients reported no pain even at follow-up 18 years later [7]. Since 1992, the Gamma Knife has been used for the treatment of trigeminal neuralgia at the entry zone of the trigeminal nerve [8-10]. The results obtained from these reports are very encouraging as there were no reported mortalities. Also, patients had a 94% rate of improvement and less than 6% suffered from complications in the Kondziolka series [11]. A similar method, using photon beams from X-ray at the root entry zone of the trigeminal nerve, could pose the same efficacy, rate, however, the safety of the trigeminal nerve has yet to be reported . Our attempt to find the solution to this problem led to this study.

MATERIALS AND METHODS

From September 1997 to December 1998, 20 patients with medically intractable trigeminal neuralgia underwent fractionated radiotherapy with X-ray at China Medical College Hospital. During the procedure, a stereotactic ring (Fisher) was fastened to the head under local anesthesia with 2% xylocain. The localization of the trigeminal nerve was performed using magnetic resonance imaging (MRI). The target point was calculated by a personal computer with a Fisher formula package. This target point was set at the root entry zone of the affected trigeminal nerve approximately 1 cm from the proximal end of the trigeminal root. The localization of the target point was then matched with the central point of the isocenter of a linear accelerator. The procedure was corrected by laser beam alignment after application of the stereotactic frame.

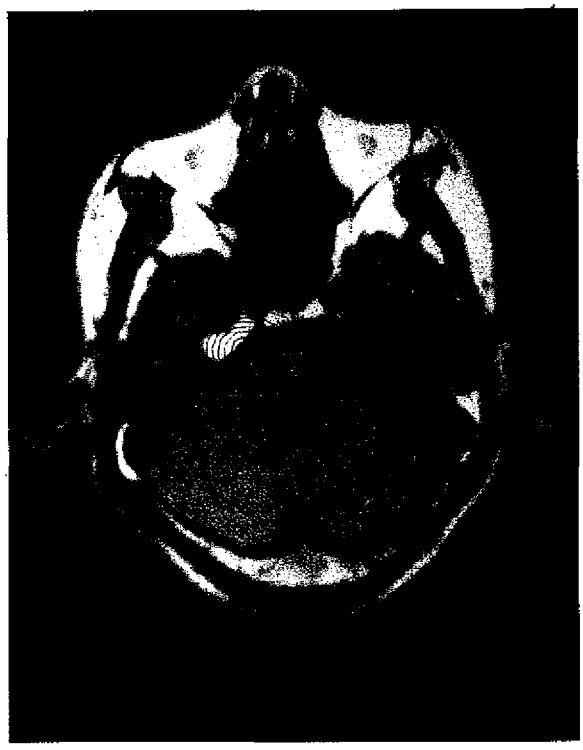

Fig. 1 Isodose distribution in a patient with 9 mm collimator to the right trigeminal nerve for treatment through multiple ports of a 2 cm × 2 cm field size with a maximum dose of 3200 cGy. Dose distribution in percentage is shown.

A 9 mm collimator was used to create a 2 cm × 2 cm radiation field. The isodose curves are shown in Fig. 1. In the figure, 100% dose refers to 800 cGy. The patients received one 800 cGy dose every other day, with a total cumulative dose of 3200 cGy. One week duration was needed to complete the course. During each irradiation, 800 cGy was delivered through six non-coplanar X-ray beams, with arch fields avoiding critical organs [12,13]. The fractionated radiation method was used to minimize possible radiation side effects. The software we used for dose-distribution was Focus Release 2.5.0 (designed by Computerized Medical System Co., St. Louise, Missouri). The target was marked on the immobilizing mask for the subsequent three doses. The accuracy of mask localization with laser beam correction was about 2 mm. A moderate dose of steroids (dexamethasone 5 mg bid for one week) was given to minimize edema on the brain stem and the trigeminal nerve.

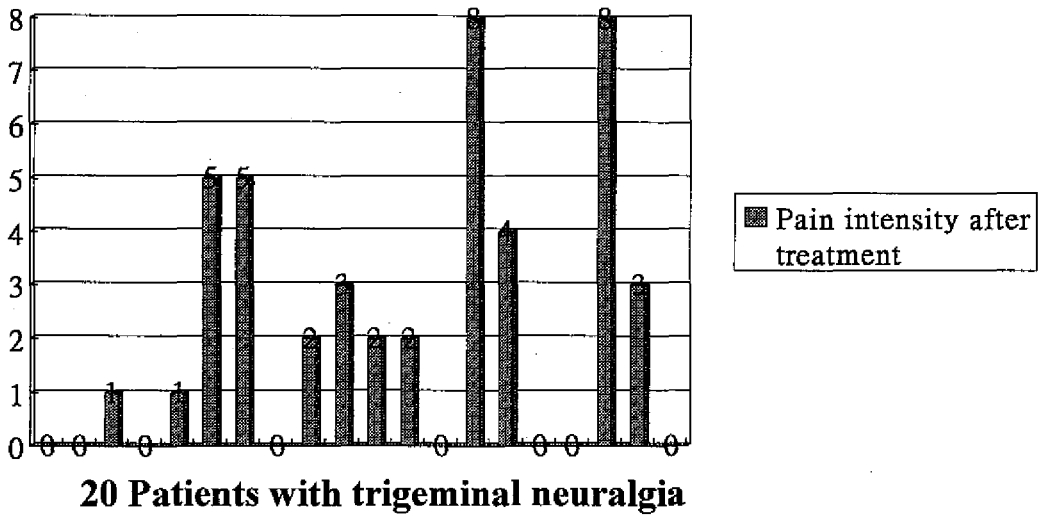

Fig. 2 Pain intensity reduction in 20 patients with trigeminal neuralgia treated by stereotactic fractionated radiotherapy with X-ray.

The patients were discharged after the one-week treatment. Carbamazepine (Tegretol) was tapered down in one month when possible. The patients were followed up at our out-patient clinics each month. The pain scale was measured and recorded by a visual analog method. A score of 0 represented no pain where a score of 10 represented pain similar to that before the treatment.

When the pain was reduced by more than 50% in intensity, the effect was considered to be a partial response and when no pain was reported, it was recorded as a complete response. The partial and complete responses were defined as an improvement in the control of pain.

RESULTS

Twenty patients with medically intractable trigeminal neuralgia were admitted to China Medical College Hospital. Their ages ranged from 55 years to 84 years with a mean age of 673 years. Of the 20 patients, 12 were females and 8 were males. The duration of pain was from one year to 15 years with a mean of 8 years. Two patients had previously undergone MVD but with recurrence of severe pain. Two patients were reported to have diabetes mellitus, two patients had hypertension and one patient had a coronary heart disease. The complete course of treatment with 3200 cGy dose was performed on the 19 patients and the one patient with hypertensive distress received only 2400 cGy. The affected branches were located on V2 in four patients, V3 in five patients, V1-2 in two patients, V2-3 in eight patients, and V1-2-3 in one patient.

Follow-up was performed in January 1999 with a mean of 1 year after treatment. Of the total patients, 90% of the patients reported an improvement in pain. The reduction in pain levels ranged from one week to six months after treatment with a mean range of 2.5 months. Forty percent of the patients reported 100% pain relief while 50% of patients reported a 50% to 90% decrease in pain intensity. The mean decrease in pain intensity was 723%. It was reported that 40% of the patients discontinued Tegretol as they had no pain while 30% of the patients continued reductive doses of Tegretol for pain control. There were no reported complications except for one elderly patient with hypertension which could not be controlled well during the radiation course.

DISCUSSION

Leksell first reported the use of X-ray therapy on the Gasserian ganglion of the trigeminal nerve for treatment of trigeminal neuralgia in 1953 [14]. This was the first report

of trigeminal neuralgia treated by stereotactic radiotherapy. The result was shown after a follow-up 18 years later [7]. In Leksell's reports, one patient received 1650 cGy and another patient received 2200 cGy [14]. Although one of the patients developed a herpetic eruption on the lower lips four days after radiation, no other major complications were reported. Eventually the two patients in Leksell's study were cured [14]. Based on the success of this previous study, we used an X-ray-knife for treatment of trigeminal neuralgia, yet chose the target at the root entry zone of the trigeminal nerve rather than the Gassearian ganglia. In addition, the MRI is more accurate and convenient for localization than X-ray film [15]. However, the root entry zone is at the junction of the central and peripheral myelin and is believed to be more sensitive to radiation [11].

From the operative findings of microvascular decompression for treatment of trigeminal neuralgia, local pressure on the trigeminal nerve may cause interaction of the fibers and can create artificial synapses [16]. Clinical results of microvascular decompression have indirectly confirmed this theory.

When using the X-ray knife on the trigeminal neuralgia ionizing radiation on the nerve root may have a profound effect on synaptic conduction [7]. Therefore, the dosage may influence the effect of treatment. In Leksell's report, a patient given 1650 cGy showed complete relief of pain five months after radiosurgery [7]. In another patients given 2200 cGy, the pain completely subsided immediately. In a basic study, there were no histological changes due to X-knife irradiation on the frontal lobe of rats when the radiation dose was below 5000 cGy [17]. There have been reports of cases with occasional shrunken neurons with radiation doses of 7000 cGy and rare arterial wall thickening by 8000 cGy of radiation with gamma knife [18]. In clinical reports involving the gamma knife, a radiation dose has been estimated to be about 7000 rads at the central point of irradiation. In latter reports, the incidence of the numbness of the trigeminal nerve with a gamma knife was about 6% [11]. In Mehta's reports on the treatment of the cavernous sinus with radiosurgery, the radiation-induced neuropathy of the trigeminal nerve appeared to be negligible if the dosage was below 5000 cGy [19]. For the safety and efficacy of radiotheraphy on the trigeminal neuralgia, we used a medium dose of 3200 cGy for our treatment plan. However, this dose may interfere with the artificial synapse at the trigeminal nerve at entry zone. In theory, the demyelinated A-data and C-fiber are conducted together to induce pain yet this dosage will not cause permanent damage to the nerve or surrounding vessels [20]. There have been no reported cases of patients with numbness of the face in our study.

The target lesion in our study was chosen at the root entry zone of the trigeminal nerve for irradiation, as opposed to the Gasserian ganglion, on the basis of the clinical experience of MVD, where artificial synapse may occur due to the pressure of the vascular loop during microvascular decompression [21]. A medium dose of irradiation was chosen to interrupt selective conduction of small pain fibers while sparing other fibers controlling touch sensation, which are protected by myelin sheaths and not easily destroyed by a lower dosage.

The gamma knife reports for trigeminal neuralgia were also encouraging. In Kondziolka's series, 58% were pain free, 36% had good pain control, and 6% reported treatment failure [11]. After two years, 54% of the patients were pain free, and 88% had a 50% to 100% reduction of pain levels. The common period of pain relief was one month ranging from 1 day to 6.7 months after treatment. In Young's series, 74.5% of the patients reported to be completely free of pain and all medication was eventually tapered off, whereas 13.7% of the patients experienced reductions in pain from 50 to 90% [22]. Our preliminary results with stereotactic fractionated radiotherapy were similar to the results of gamma knife.

In patients with recurrent trigeminal neuralgia, a repeat operation with microvascular decompression has usually been suggested. However, reports have shown that 50% of patients had negative findings in the second operation and the suffering effects were more severe than the first operation [3,4]. A fractionated radiotherapy with X-ray procedure is advocated for recurrent trigeminal neuralgia patients who can avoid the embarrassment of negative findings and more importantly to avoid the suffering during a second operation.

In our study, the fractionated radiotherapy with X-ray procedure offers an effective alternative treatment for trigeminal neuralgia. The procedure is safe, less traumatic, and has fewer complications than microvascular decompression. When compared with the results of PRRR and PRGR, the fractionated radiotherapy with X-ray treatment of trigeminal neuralgia is less invasive and has a higher success rate. In elderly patients with other troublesome underlying illnesses, patients who failed MVD, or are reluctant to undergo operations, the x-knife procedure is a good choice for treating trigeminal neuralgia.

The priority of undergoing operative treatment of trigeminal neuralgia has not changed at the present time. A fractionated radiotherapy with X-ray procedure offers an alternative choice of treatment, however, it may not replace the current role of microvascular decompression. MVD is still a well-known effective method of treatment [1,2]. Its long-term results have been shown to reach an 85% cure rate with a 2% recurrence rate per year [23]. The long-term results of the X-ray knife is still to be determined, could be dose-dependent and the latency period of a complete cure can vary, with a mean of 2.5 months, in contrast to the immediate dramatic effect which can be achieved with microvasular decompression.

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以立體定位分次放射來治療三叉神經痛：初步報告

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背景　以立體定位分次放射來治療三叉神經痛是一種新方法。

方法　在我們研究中，20位藥物治療難治之三叉神經痛患者以X光進行立體定位分次放射治療。初步的報告是令人鼓舞的。追蹤時間平均至少有一年以上。

結果　研究中顯示有40%病人完全不再疼痛，有50%病人有疼痛至少減少50%至90%程度，總共有90%病人疼痛有所改善，只有10%病人無進步，平均疼痛降低程度約72.3%，有40%病人不再使用癲通，另外30%病人可以減少癲通用量。照射到疼痛減緩所需時間約2.5個月，沒有嚴重併發症，除了一位病人在照射當中血壓上昇，需予藥物控制。

結論　由以上研究似乎顯示以立體定位分次放射治療三叉神經痛可提供另一可行之治療方式，此種治療方式應有效，較低成本，較少侵犯性，尤其對於年紀大，或復發之三叉神經痛患者，或病人不願意接受手術者，可使用。（中台灣醫誌 2000;5:221-7）

關鍵詞

立體定位分次放射，三叉神經痛

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收文日期：3/16/2000　　修改日期：6/28/2000

接受日期：9/1/2000