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Clinical Study

Pain experience using conventional *versus* angled anterior posts during stereotactic head frame placement for radiosurgeryDoris D. Wang^a, Darryl Lau^a, John D. Rolston^a, Dario J. Englot^a, Patricia K. Sneed^b, Michael W. McDermott^{a,*}^a Department of Neurosurgery, University of California San Francisco, 505 Parnassus Avenue, M 779, San Francisco, CA 94143-0112, USA^b Department of Radiation Oncology, University of California San Francisco, CA, USA

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ABSTRACT

Stereotactic frame placement for radiosurgery is assumed to be an uncomfortable experience. We developed angled anterior posts for the Leksell frame to avoid pin penetration of the temporalis muscle. This study aimed to determine the frequency of angled post requirement and quantify the patient pain experience from frame placement. We prospectively enrolled 63 patients undergoing radiosurgery. Angled posts were used when conventional post trajectory was posterior or within 3 mm of the superior temporal line to avoid temporalis muscle penetration. Pain scores (0 to 10) were collected prior to frame placement, immediately after frame placement, before radiosurgery, after radiosurgery, and a day after radiosurgery. A total of 63 patients were enrolled: 33 (48%) patients required angled posts. Women were significantly more likely to require angled posts than men (60.0% *versus* 33.3%, respectively; $p = 0.034$). Mean pain scores were very low, ranging from 0.33 to 2.23. There were no significant differences in pain outcomes between both groups at all time points. Stereotactic frame placement is not perceived to be a painful procedure. This information may be useful when counseling patients about the pain experience with frame application and the option of using angled anterior posts.

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1. Introduction

Stereotactic radiosurgery is becoming an increasingly frequent treatment for brain tumors, vascular malformations, trigeminal neuralgia, and potentially even epilepsy [1–4]. Effective and safe use of radiosurgery depends on the delivery of a precise focus of ionizing radiation using image guidance. Therefore, accurate positioning and fixation of the frame onto the skull is essential for any stereotactic radiosurgery procedure. With the advent of frameless radiosurgery options such as CyberKnife (Accuray, Sunnyvale, CA, USA), many argue that one major advantage of the frameless system is to avoid the application of the rigid frame to the skull, which is thought to be painful by both treating physicians and patients. However, to our knowledge, no study has actually examined the pain experience of patients undergoing frame application during stereotactic radiosurgery.

Currently, the Leksell frame used in standard Gamma Knife (Elekta AB, Stockholm, Sweden) radiosurgery procedures is fixed

to the outer table of the skull with four skull screws, two anterior and two posterior. When positioning the frame, depending on the size and shape of the patient's forehead, it is not uncommon for the anterior pins to contact the skull behind the superior temporal line (STL), penetrating the temporalis muscle [5]. This not only causes increased pain for the patients during pin insertion, but can also cause temporalis muscle swelling and increased post-procedural discomfort. Given the limitations of the standard frame, there was an opportunity to provide anterior posts with different fixed angles so that the trajectory of the front pins could be modified to avoid muscle penetration.

We have designed custom-made anterior bars for the Leksell frame with angled screw holes at 5, 10, and 15 degrees. These angled posts have been used in over 100 patients who have undergone stereotactic radiosurgery over the last 5 years [5]. However, objective data evaluating the frequency of requirement and the patient pain experience is necessary to further measure and characterize the benefits of using this new device in the clinical setting. Therefore, we performed a prospective study to quantify the patient pain experience from stereotactic frame placement and determine the frequency of use of angled anterior post.

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2. Methods

This prospective study was formally approved by the University of California, San Francisco Committee of Human Research (IRB # 11-07134).

2.1. Patients

The eligibility of the cohort in this study was established by *a priori* inclusion and exclusion criteria. The study included all patients over 18 years of age who underwent Gamma Knife radiosurgery at the University of California, San Francisco, and were able to provide consent. Minors (18 years and younger) and patients with diminished capacity were not eligible to enroll in this study. The study period spanned a 12 month period starting in April 2012 and concluding in April 2013. Demographic and baseline variables were collected, being age at time of Gamma Knife treatment, sex, diagnosis, home narcotic use for pain, and prior craniotomy. For analytic purposes, diagnosis was categorized into four

groups: metastasis, meningioma, schwannoma, and arteriovenous malformation/other. "Other" consisted of pituitary tumor, glioma, gliosarcoma, hemangioblastoma, and hemangiopericytoma.

2.2. Angled screw holes for anterior posts

The development of the custom angled screw holes for the anterior posts was described in detail by the senior author (M.W.M.) in a prior article [5]. In brief, the angled screw holes were drilled at 5, 10, and 15 degree angles (Fig. 1). The angles of the post are based on the angle of contact by the pin with the cranium (Fig. 2).

2.3. Frame positioning with conventional and angled anterior posts

All patients who underwent Gamma Knife radiosurgery and participated in this prospective study underwent an established protocol for placement of the stereotactic frame. The decision to use the angled anterior post depended on the proximity of the pin and STL as determined by the senior author. Prior to placement of the frame, the STL was marked on the skin on either side of the head. The frame was then positioned in a standard fashion. The trajectory and the point of contact of the anterior pins were marked on the skin (site #1). The distance from site #1 to the STL was measured in mm. If the marked pin site (site #1) was within 3 mm anterior to the STL or posterior to it, the angled posts (5, 10, or 15 degrees) were used instead of the standard post. The new trajectory and contact point of the angled post was marked on the skin (site #2) (Fig. 2). The anterior angled posts were then secured in a standard fashion after topical spray with ethyl chloride followed by subcutaneous and 15–20 cc of intradermal injection of 50:50 1% lidocaine/0.5% bupivacaine. No patients received intravenous fentanyl or midazolam prior to frame placement.

2.4. Pain assessment

A standardized pain assessment questionnaire was administered to all patients at multiple time points: immediately before frame fixation, immediately after frame fixation, before the Gamma Knife procedure, after the Gamma Knife procedure, and on the day following the procedure. A 10 point numeric pain scale was utilized to assess severity of pain.

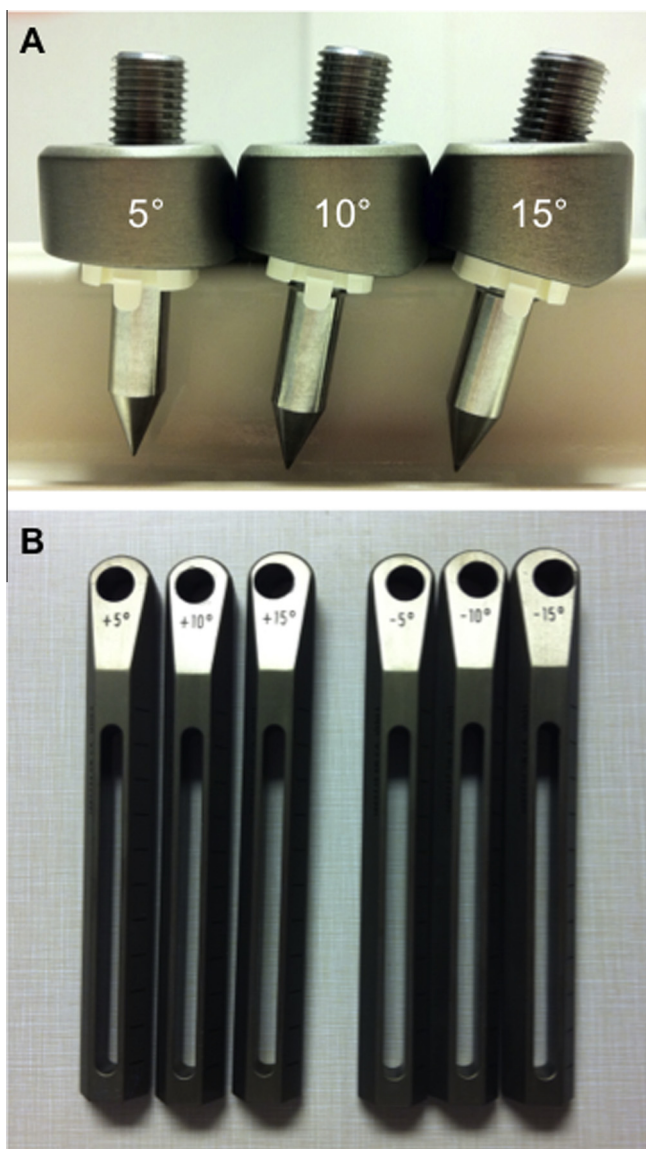


Fig. 1. (A) Close-up view of anterior posts with angled holes of 5 degrees, 10 degrees, and 15 degrees with pins in place. The progressive angulations of the pins can be easily appreciated. (B) Complete view of anterior posts with angled holes of both negative and positive degrees for the left and right side. (This figure is available in colour at <http://www.sciencedirect.com/>.)



Fig. 2. Skin marks on a patient for 5 and 10 degree pin hole posts for a left-sided frame. The vertical line indicates the superior temporal line (STL). (This figure is available in colour at <http://www.sciencedirect.com/>.)

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