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USEFUL BASE PLATE TO SUPPORT THE HEAD DURING LEKSELL SKULL FRAME PLACEMENT IN GAMMA KNIFE PERFEXION RADIOSURGERY

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ABSTRACT

We developed an original base plate to support both the patient's head and a Leksell stereotactic skull frame during frame placement in the supine position. The base plate is made of transparent acrylic board with holes at the posterior posts for injection of local anesthetics and maneuver of fixation screws through them. A stable and comfortable position of the patient's head in a supine position is obtained and maintained on this base plate with an air-pressure cuff beneath the patient's head. The patient is able to keep a stable, relaxed and comfortable posture during the procedures of skull frame placement.

Key Words: skull frame placement, Gamma Knife, Perfexion, stereotactic surgery, stereotactic radiosurgery

INTRODUCTION

Skull frame-based image-guided stereotactic surgery and radiosurgery are common and indispensable techniques in the treatment of intracranial lesions with sub-millimeter spatial accuracy. Gamma Knife (GK) radiosurgery is performed using a dedicated Leksell stereotactic G skull frame (Elekta, Tokyo).[1)] We developed an original base plate to support both the patient's head and a Leksell skull frame during frame placement in the supine position. This reports describes the characteristics and advantages of the base plate in skull frame placement. The base plate was designed with features including transparent acrylic board with holes of sufficient size, loose holding of both the patient's head and frame position, and easy horizontal position adjustment in the anterior-posterior direction by use of acrylic spacer boards and an air cuff. The patient is able

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to keep a stable, relaxed and comfortable posture during the procedures of skull frame placement.

FEATURES OF ORIGINAL BASE PLATE

Parts of base plate

The base plate system consists of a bottom plate, a top plate, and some spacer plates placed between them. All plates are made of transparent acrylic boards with two holes of sufficient size for injection of local anesthetics and maneuver of fixation screws through them on both sides at the posterior posts (Fig. 1a). The length of the bottom plate is adjusted to about half the length of the back plate of the commercially-available ordinal stretcher (Paramount Bed Co., Tokyo) (Fig. 2a), so as not to disturb the half-head-up position when it is needed. The width of the bottom plate is the same as that of the stretcher. A top board with a frame support is placed for the skull frame to keep it standing during the frame fixation procedure (Fig. 2b). Acrylic spacer boards with thicknesses of 10 and 20 mm can be mounted between the bottom plate and the top plate (Fig. 2c), to achieve a comfortable position of the patient's head and neck. An air cuff beneath the patient's head (Fig. 3a) provides fine adjustment of the horizontal head position (Fig. 3b).

Maneuver through the base holes of transparent acrylic boards

All plates of the base plate system have a large hole of the same size. It is easy to administer a local anesthetic and maneuver quick fixation screws from an arbitrary direction to the patient's head (Fig. 4). During the skull frame fixation procedure, we usually mount a Leksell stereotactic indicator box on the frame, without using ear bars, to give the patient's head lateral support.

Loose holding of the head and a skull frame with fine adjustment of the level of the head

The top board equipped with a frame support part plays a simple role in loosely holding the patient's head and the skull frame (Fig. 1b). It is easy to adjust and maintain a good positional relationship between the front posts of the skull frame and the patient's facial plane, usually almost parallel, because position of the patient's head can be changed flexibly. A comfortable positional relationship between the patient's head and the frame is easy achieved.

Fig. 1a

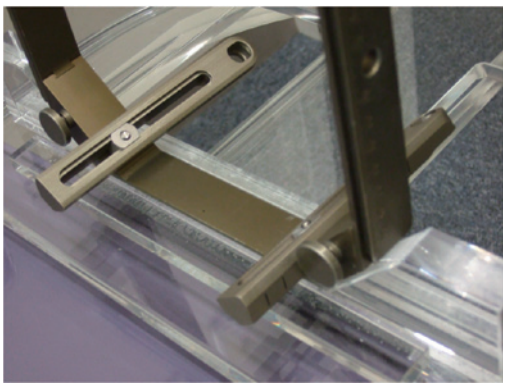

Fig. 1b

Fig. 1 The base plate for skull frame placement (a). A Leksell skull frame is placed on the frame support parts of the top plate by trapping in the narrow gap between two acrylic plates (b).

Top view of bottom plate
800×1100×10 mm

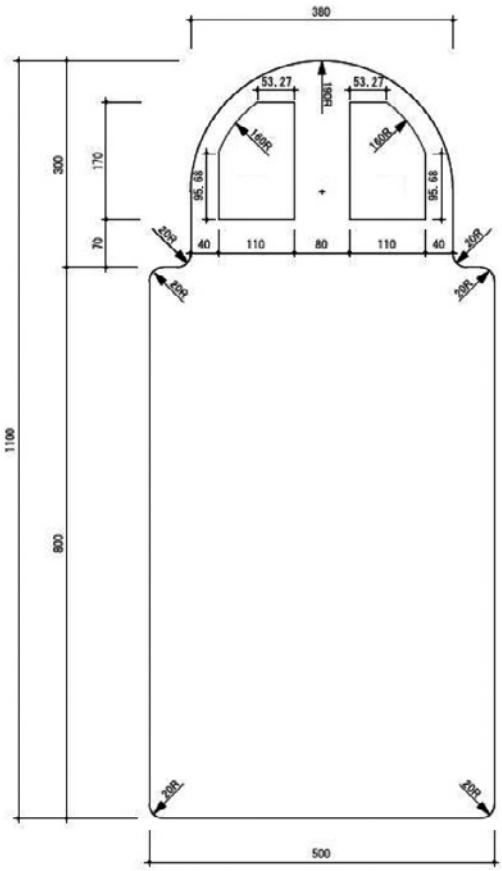

Fig. 2a

Top view of spacer plate
380×300×10 mm
380×300×20 mm

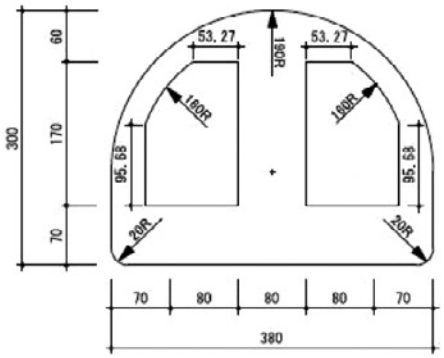

Fig. 2c

Fig. 2 Design of the original base plate. The base plate consists of three parts; top plate, spacer plate, and bottom plate. Top view of a bottom plate (a), a spacer plate (b), and top plate with frame support parts (c).

Top view of top plate with frame stand
380×300×10 mm

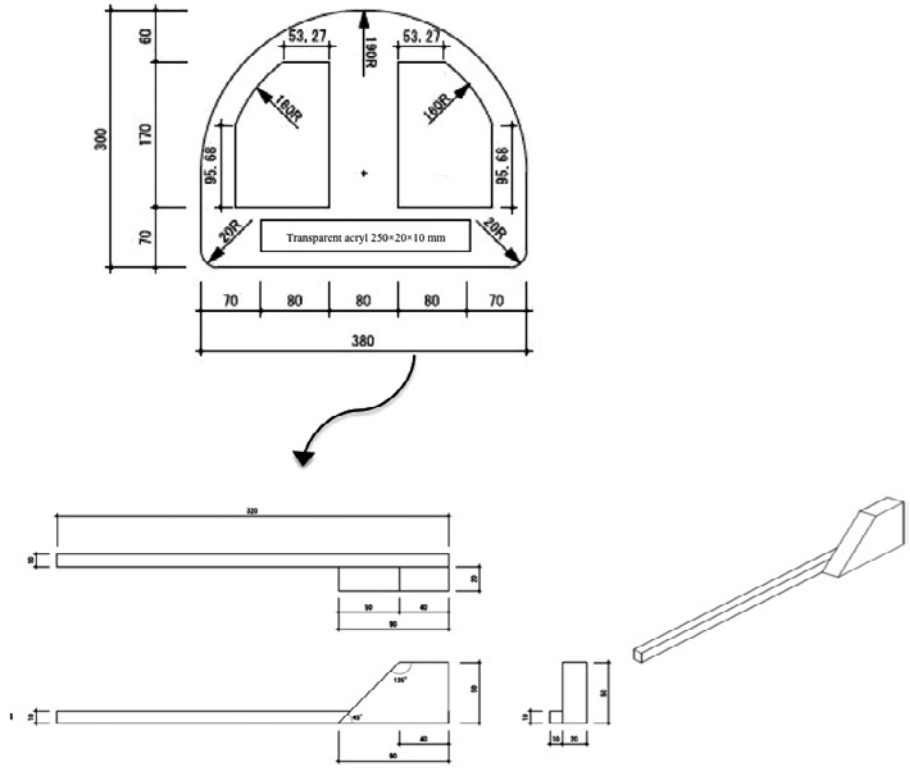

Fig. 2b

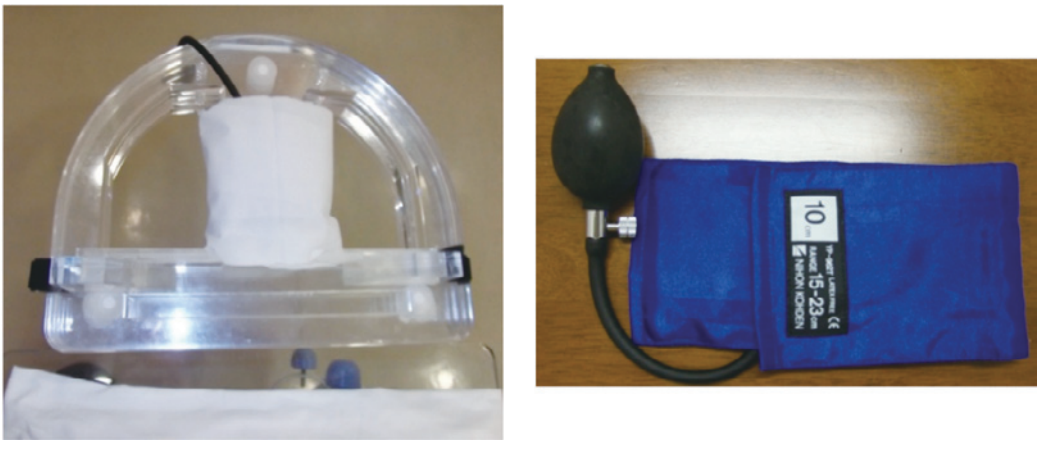

Fig. 3a

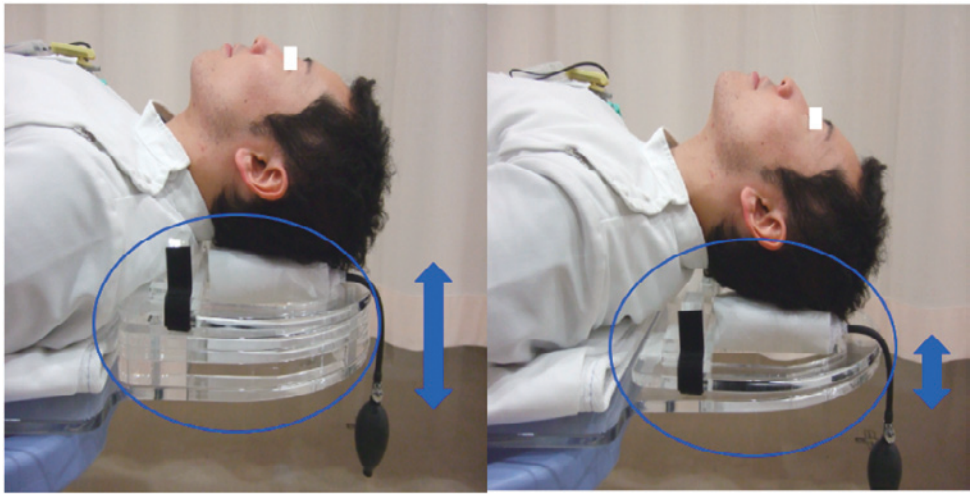

Fig. 3b

Fig. 3 Technical features of the base plate. A comfortable position of patient's head and neck is achieved by changing the thickness of acrylic spacer plates. The air cuff adjusts head height more delicately than using the acrylic plates. Clinically, after rough position alignment among head, neck, and body, the physical relationship between head and frame is fixed by air cuff pressure. Some spacer boards and air-cuff (a). An illustration of adjustment for head and neck positioning using both the spacer boards and the air cuff-control (b).

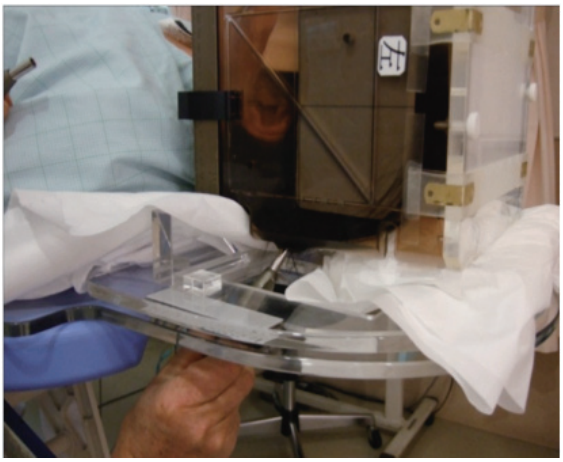

Fig. 4 Ease of procedural access to the occipital region. The large size of right and left holes enables injection of a local anesthetic and maneuvering of quick fixation screws for the occipital region.

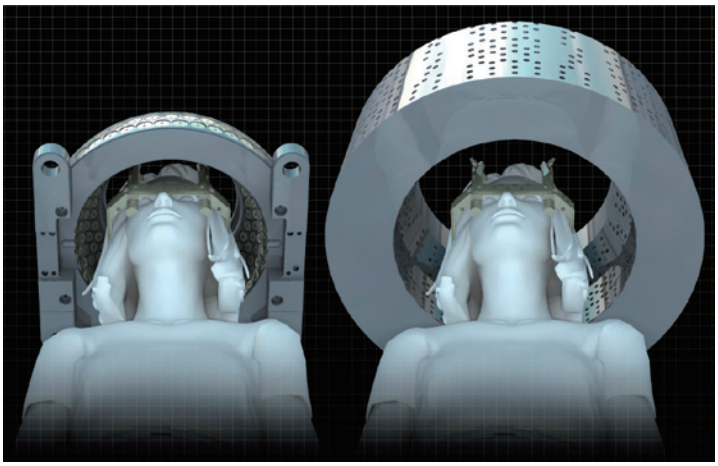

Fig. 5 The collimator helmet shape of both model C (left) and Perfexion (PFX) (right). The accessible space of PFX is much wider than that of model C. Note that the treatable range in model C is as follows: x = 37.5 to 162.5 mm, y = 30 to 170 mm, and z = –11 to 142 mm, while that in PFX is x = 20 to 180 mm, y = 10 to 190 mm, and z = –820 to 167 mm. * This picture was provided by Elekta.

DISCUSSION

An original base plate designed for clinical use in skull frame placement procedure was presented. We have already used this base plate system with more than 1,500 patients having metastatic brain tumors, acoustic schwannoma, pituitary adenoma, and so on, between October 2010 and February 2013. The base plate system has some merits. First, the transparent acrylic boards enable inspection from under the board. Second, the large holes in the plates provide enough room for sterilization and for local injection of anesthetics. Third, loose holding of both the patient's head and the skull frame is safer against unexpected rapid movements of the patient. Fourth, the spacer boards and air cuff control allow to take a comfortable, relaxed and stable posture for the patient. In addition, intravenous sedation under a supine position elicits an effect of easing the pain of the screw fixation.

Perfexion (PFX), the latest version of GK, is equipped with a broad cone-shaped collimator, totally different from model C.[2-4] The spatial treatment range of PFX is significantly wider (Fig. 5) than that of model C. Therefore, in most cases, strict control of skull frame placement is not necessary with PFX; it is sufficient to place the frame around the center of the patient's head, and the frame fixation procedures can be performed in the supine position. In most institutes offering GK treatment, skull frame placement is performed in a sitting position because it is easier to give local anesthetics and maneuver quick fixation screws for posterior post fixation at the occipital regions. However, a patient may feel uncomfortable and may develop hypotension and syncope more frequently while sitting. Previously, with GK model C, the hemispherical accessible space within the collimator was narrow. Skull frame placement had to be controlled more strictly to prevent collision between the patient's head, posts, or screws and the collimator helmet later during actual radiation delivery. When strict control of the spatial relationship between the patient's head and a skull frame is required, frame fixation in a sitting position is better, compared with that in a supine position.

CONCLUSION

Our original base plate provides a stable, relaxed and comfortable position in a supine position during procedures of skull frame placement on the patient's head.

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Conflict of interest: None

This work was presented in oral form at the 2nd meeting of the Asian Leksell Gamma Knife Society held in Nagoya, Japan in November 2010 and oral and electronic poster form at the 16th International Leksell Gamma Knife Society Meeting held in Sydney, Australia in March 2012.

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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