

Stereotactic-CT Biopsy

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Stereotactic surgery is a method of locating areas of the brain using a frame attached to the head and guiding a probe to a specific area.¹ When used in conjunction with computed tomography (CT), the exact area to be biopsied can be precisely located and a probe directed to it under local anesthesia.

The first recorded use of guided probes was in 1873.² In 1908, Horsley and Clarke published a paper that provided plans for their stereotactic system, which was used on monkeys to study their cerebellar function. A stereotactic system developed by Spiegel and Wycis in 1946 was designed for use on humans.² A plaster cap attached to the head with a moveable probe carrier attached to the cap was the basic design of their system. Today's stereotactic systems are similar, using a frame attached to the head instead of a plaster cap.

Types of Systems

The polar coordinate system requires that the probe path be described in terms of angles. At least two angles are necessary, in planes perpendicular to each other, to describe a path or trajectory. The depth of the probe must also be determined in order to reach the specific target point along the trajectory.²

The arc radius system works on the principle that a probe equal in length to the radius of the semicircular arc, introduced perpendicular to a tangent anywhere along the arc, will reach the center of the system. Linear adjustments of the arc supports, in three dimensions, move the probe impact point to any desired target coordinates.²

The focal point system works on the arc-radius principle with one difference. The target is brought to the impact point by moving the patient's head instead of bringing the impact point to the target.²

The phantom target system can theo-

retically use any coordinate system, but has almost always been used with polar coordinate frames. The phantom target allows the angles and probe length of polar coordinate devices to be determined mechanically. In addition, the surgery can be rehearsed on the phantom before the surgery on the patient begins.²

Introduction of the CT-Scan

The use of the CT-scan with stereotactic surgery was introduced in the early 1980s.³ The principle of the CT-scan is based on the same type of coordinate system as the stereotactic system. Each point in space is defined in three dimensions. Therefore, any point identifiable on a CT-scan can be related to stereotactic coordinates, as long as the correlation between the CT-scan and the stereotactic system is known.

Many indications for stereotactic-CT surgery have been presented since its inception. The most common use of this technique is the biopsy of intracranial masses. Other indications for stereotactic-CT surgery are vascular malformations, aneurysms, hydrocephalus, evacuation of hematomas, and endoscopy and drainage of abscesses and cysts.³

Goals of Surgery

The goal of stereotactic-CT surgery for biopsy is to access the biopsy site safely and rapidly with a minimal amount of risk and discomfort to the patient. Obtaining a tissue diagnosis so that appropriate treatment can be planned is of primary importance.

Equipment

The Leksell Stereotactic System is the system currently in use at Enloe Hospital in Chico, California. The Leksell system consists of the following items:

- A coordinate frame and four posts with cranial fixation screws with which

to attach the frame to the patient's head (Figures 1 and 2).

- Ear plugs with holders that help stabilize the frame on the patient's head.
- A semicircular arc, which attaches to the coordinate frame with the arc support slides.
- The Twist Drill Kit, used to drill a hole through the skull (Figure 3).
- The Sedan Needle Biopsy Kit, used to obtain the tissue sample (Figure 4).
- A CT-adaptor, which attaches the frame to the CT-table.
- A Mayfield adapter, used to attach the frame to the surgical table.

A hand drill is needed for use with the drill driver, which is contained in the Twist Drill Kit.

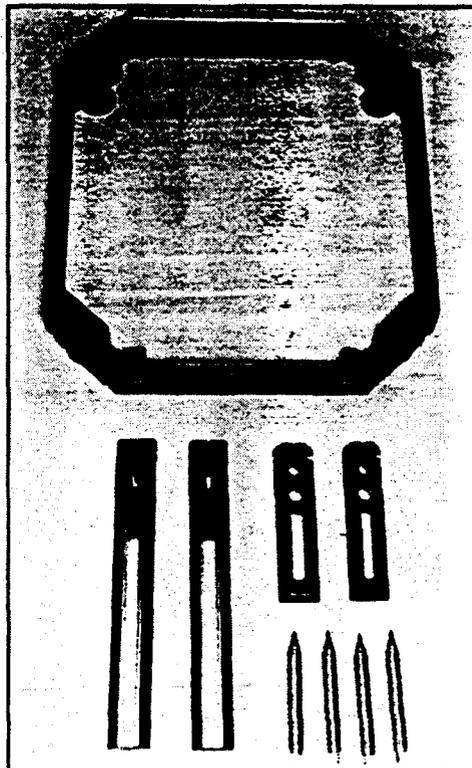


Figure 1. The coordinate frame, posts, and fixation screws unassembled.

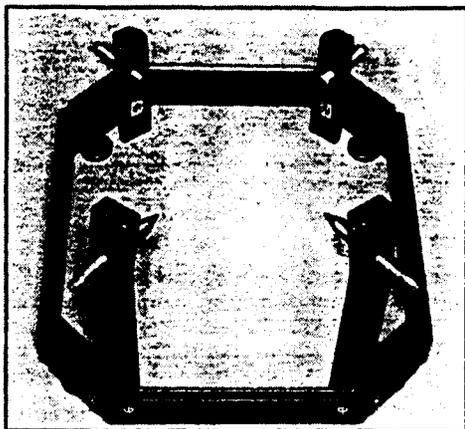


Figure 2. The coordinate frame, posts, and fixation screws assembled.

Biopsy Procedure

The patient is brought to the operating room and positioned in a sitting position on the transporting gurney. It should be kept in mind that access to the back of the head as well as the front is needed. Care must be taken to ensure the patient's comfort. Taking the time to make certain that full access and patient comfort are accounted for at this time, rather than while trying to place the frame on the patient, can save both time and trouble. A blood pressure cuff, electrocardiogram leads, and pulse oximeter are placed on the patient and baseline vitals are recorded. An intravenous line

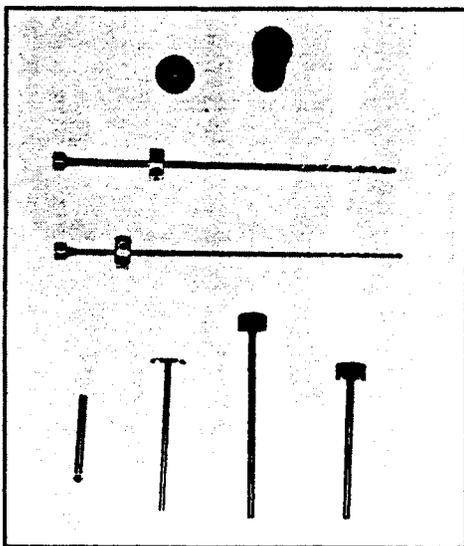


Figure 3. The twist drill kit (starting from top, left to right): instrument stop, instrument guide, 3.2-mm twist drill with adjustable stop, drill driver, reducing tube, long sleeve, and short sleeve.

is started in case medication must be administered.

The ear plug holders are placed on the right and left sides of the coordinate frame. The coordinate frame is then held in place over the patient's head; the ear plugs are placed in the holders and inserted into the ear canal so that the tip of each plug is at the junction of cartilage and bone. With the coordinate frame held in place in a like manner, it is easy to see where the pins will line up for attachment to the skull. These areas are wiped with alcohol swabs. At the four pin entry points, 0.5% bupivacaine with epinephrine 1:200,000 is injected. The pins are then placed through the posts and tightened into the skull. This four-point fixation attaches the frame firmly to the patient's head (Figure 5). The ear plugs and holders are then removed.

At this point, the patient is disconnected from the monitors and transported to the radiology department for CT scanning. The patient is transferred to the CT table. The frame is attached to the CT adapter. Both the surgeon and radiology personnel have been specially trained in the use of the scanner software. CT images are taken and the correct "slice" is chosen for the target. The center of the frame is identified on the CT image. The coordinates are then determined using the scanner software that has been designed specifically for use with the Leksell Stereotactic System. The Leksell Stereotactic System is an example of an arc-radius system that operates under the principle that the target point is identified by the distance from the center of the frame.⁴ The x-coordinate refers to a left-right distance from the center of the frame. The y-coordinate refers to an anterior-posterior distance from the center of the frame. The z-coordinate refers to a superior-inferior distance from the center of the frame.⁴ Once the coordinates are obtained, the patient is returned to the operating room by gurney.

The patient is transferred from the gurney to the surgical table and placed in a sitting position. The monitors are again placed on the patient. Again, access to the entire head is kept in mind while ensuring patient comfort. The Mayfield adapter is attached to the coordinate frame and then connected to the Mayfield attachment, which is already in place on the surgical table (Figure 6).

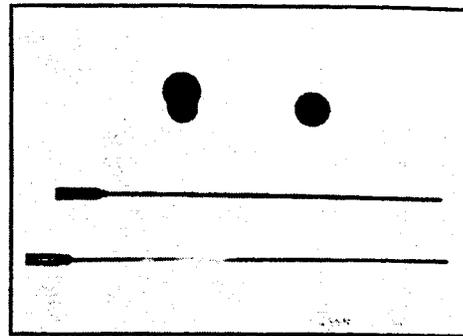


Figure 4. Sedan needle biopsy kit: instrument guide, instrument stop, outer cannula, and inner cannula.

The arc support slides are attached to the right and left sides of the frame and set at the correct Y-coordinate. The arc supports are inserted into the slides, moved to the correct z-coordinate, and tightened in place. The axis on the arc is set to the correct x-coordinate and tightened in place.

Next, the arc is attached to the frame. The x-axis on the arc, which has already been set, is attached to the ring on the arc support on the right side of the frame. The non-engraved ring on the arc is pushed toward the ring of the arc support on the left side of the frame and locked in place. The arc will move freely anterior to posterior until the rings are locked. Once the arc is positioned in the desired position, the knobs on the rings are tightened and the arc is locked in place. It is a good idea to double-check the settings of the coordinates and to make sure that everything is tightened

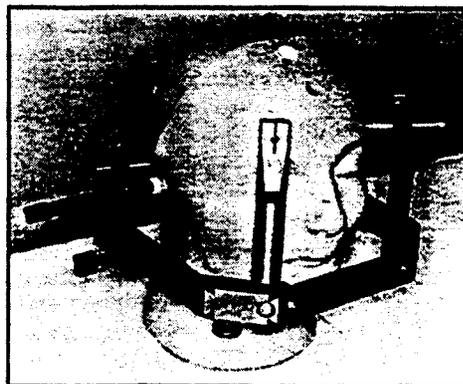


Figure 5. The coordinate frame attached to the head with the fixation screws. (Note that the frame is steadied by the ear plugs placed through the ear plug holders and attached to the sides of the coordinate frame.)

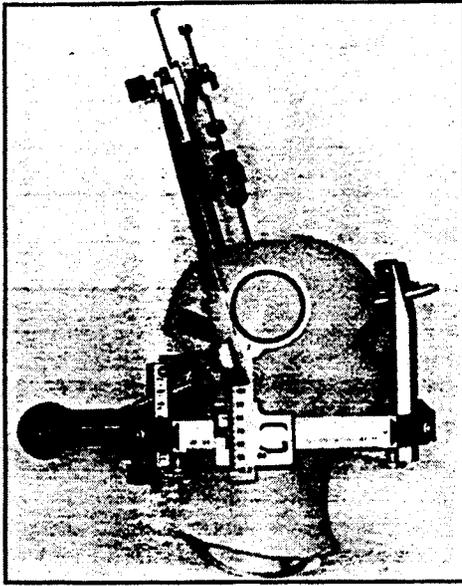


Figure 6. Mayfield adapter attached to the posterior portion of the coordinate frame.

securely.

The instrument carrier slides along the whole arc and is locked in the position desired by the surgeon; this ensures that the active part of the biopsy needle will land at the precise point determined by the CT coordinates.

The burr-hole site is prepped and 0.5% bupivacaine with epinephrine 1:200,000 is injected at the burr-hole site. An incision of approximately 1 cm is made in the scalp, using a No. 15 blade on a No. 7 knife handle. The correct stop and guide are inserted in the instrument carrier. The drill sleeve is placed in the instrument guide and is advanced

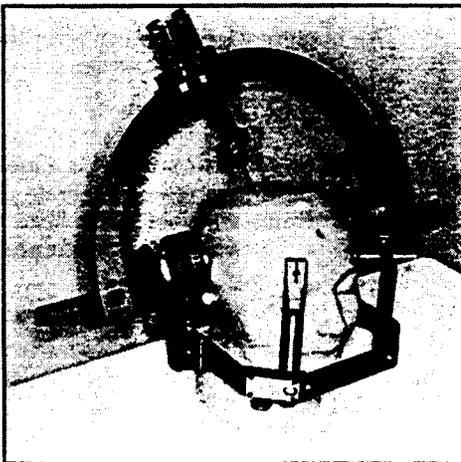


Figure 7. Twist drill in place on the arc.

through the scalp until it sits securely against the skull. The selected drill and its adjustable stop are placed through the instrument stop and sleeve, with the tip of the drill resting against the skull (Figure 7). The drill's adjustable stop is brought all the way down to the instrument stop and locked in this position. The surgeon accesses the thickness of the skull at the selected point of penetration and lowers the instrument stop by an equal number of millimeters, and then locks it in place. With the drill driver attached to a hand drill, the tip of the drill driver is placed against the exposed end of the drill and the drill handle is turned. When the adjustable stop on the drill reaches the instrument stop, the tip of the drill will have reached a depth equal to the preset number of millimeters on the instrument stop. If further drilling is needed, the procedure is repeated.

Once the burr hole is drilled, the biopsy can begin using the Sedan Needle Biopsy Kit. With the instrument stop set at zero, the needle is inserted with the window closed, all the way to the probe stop. The inner cannula is turned 180 degrees, which opens the window of the cannula. A 10-cc syringe is attached to the cannula. While aspirating with the syringe, the inner cannula is turned 180 degrees to close the window. The inner cannula is removed and a small amount of sterile saline is flushed through the cannula to remove the specimen; the specimen is then sent for frozen section. If the specimen is unsatisfactory, the procedure can be repeated. When a satisfactory specimen has been retrieved, the inner cannula is reinserted into the outer cannula and turned so that the window is closed. Both cannulas are then removed together. At this point, the arc is removed and the skin is closed with interrupted 4-0 monofilament nylon suture. The fixation pins and the frame are removed. Povidone-iodine ointment is applied to the pin holes and the incision site. The patient is returned to his or her room and is kept overnight for observation of potential complications.

Complications

Since stereotactic-CT surgery for biopsy is carried out under local anesthesia, the risk of anesthetic complications are minimal. Possible complications from the biopsy procedure include seizure, neu-

rological deficit, infection, and hemorrhage, which could necessitate the need for a craniotomy.

In obtaining information necessary for diagnosis and treatment, this minimally invasive procedure provides a definite advantage over a craniotomy. This, coupled with the fact that the patient may return home the next day, may well outweigh the risks involved. Δ

Acknowledgements

The author would like to thank Mary Snelgrove, RN, Randy Moon, RN, and Bruce Burke, MD, for their invaluable assistance in the preparation of this article.

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