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Original Article

CT Guided Stereotactic Brain Tumor Biopsy

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Abstract:

153 cases of CT guided stereotactic biopsies for intra-axial deep seated brain lesions performed by one neurosurgeon has been analyzed regarding procedure, success rate and complications. Of the 153 cases, positive tissue biopsy was found in 143 cases. In 6 patients, biopsy showed gliotic grain tissue or normal brain tissue.4 patients had complications after the procedure. Three patient developed intracerebral haemorrhage of the two died, and other died Massive MI. There was no post operative new deficits seen. CT guided Stereotactic biopsy is a very effective and low cost procedure caomparing with frameless image guided brain biopsies or open craniotomy for biopsy due to it's higher complication rate. The detail procedure are being discussed.

Key words: CT guided, Stereotactic biopsy.

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Introduction:

Stereotactic neurosurgery has a long history, Sir Victor Horsely and Clarke first described stereotactc frame in 1908.The main purpose for this frame was to treat patients for delivery of radiation, surgical targeting of electrodes, epilepsy, vascular malformations, and pain syndromes.

Interest in the development of stereotactic surgery in humans has been documented in the literature as early as the 19th century,[1,3,4]

At that time they used an apparatus with an electrode guide based on the 3D cartesian coordinate system, they described lesioning targets in a monkey brain based on skull landmarks.

Stereotactic surgery after the Second World War is reviewed, with an emphasis on the pioneering work of Gillingham, Hitchcock, Knight, and Watkins and the contributions from Bennett, Gleave, Hughes, Johnson, McKissock, McCaul, and Dutton after the influences of Dott, Cairns, and Jefferson

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This problem was the research focus of Spiegel et al[16] who described stereotaxy in relation to landmarks inside of the skull by using radiographs (the ventricles using pneumoencephalograms and the calcified pineal gland).

The result of surgery were not satisfactory.

After advent of CT scan, The CT Guided surgery became a point of interest again due to it's easy minimally invasive technique, high success rate and very low complication rate.

Newer frames are being designed and applied

Material and Methods:

All our procedures were done by using "KOMAI" frame of Japanese origin

Introduction to the Frame system

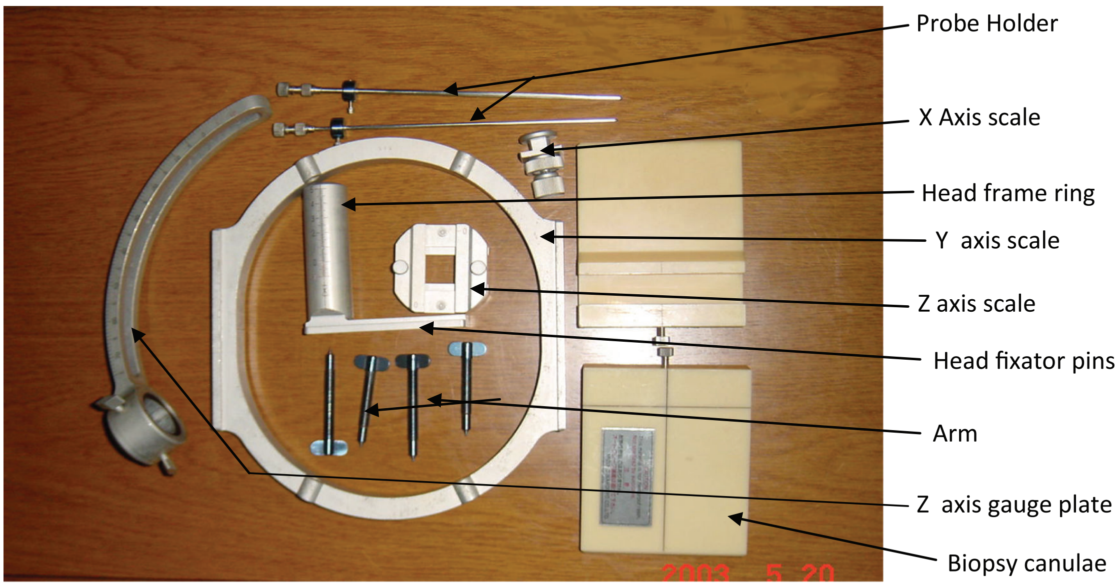

Fig.-1: *Parts of the "KOMAI" Stereotactic frame system*

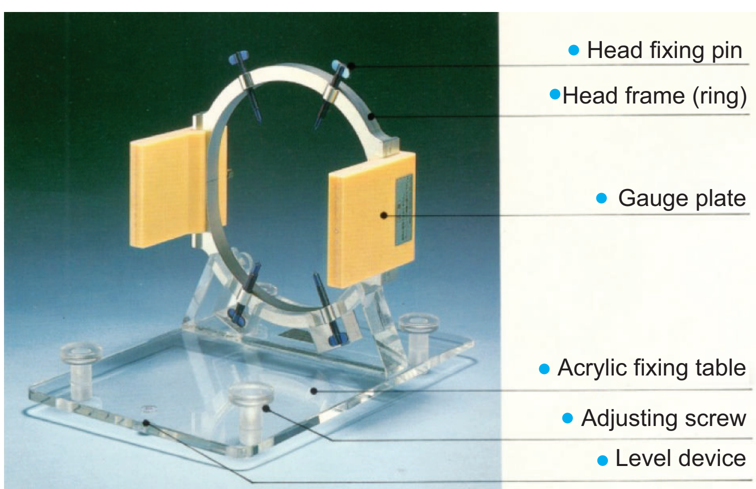

Fig.-2: *Basic setting for a "KOMAI" frame system*

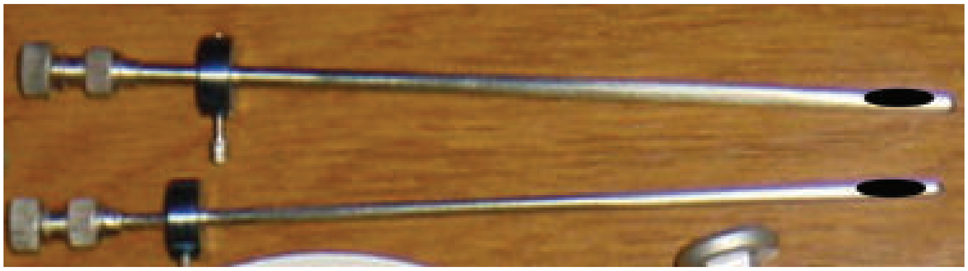

Fig.-3: *Biopsy canulae*

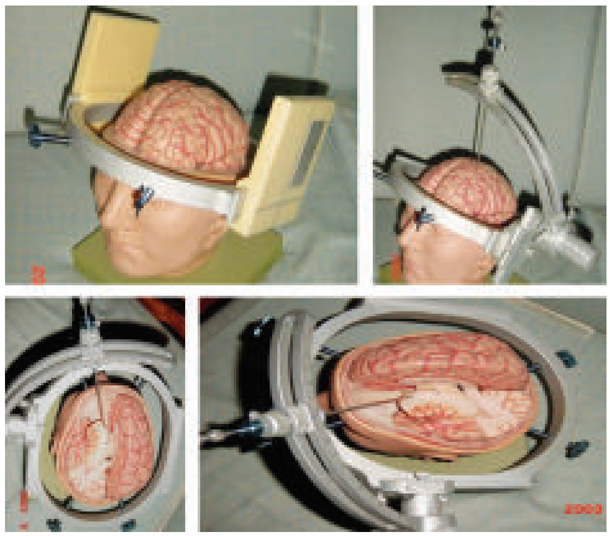

Fig.-4: *How to fix on a head (shown on a model)*

Desired trajectory point is determined at a non eloquent area

Procedure:

Frame fixation:

A CT scan of brain is obtained. The lesion is seen.

The frame and all its attachments are sterilized except the gauge plates..

Patient is brought to OT or procedure room. A broad spectrum antibiotic injection is given. Head is preferably shaved. If the patient is alert he is placed on wheel chair or if not so alert he is placed on a patient trolly. A pain killer injection or suppository is given one hour prior to bring the patient for frame fixation. A scalp block is the given. Local anaesthetic agents are injected over the scalp down to percranium at four point of screw insertion. Then the frame is held horizontally without tilt and four screws are fixed. The midline mark on the frame is kept at a midline mark given previously. (Figure 5)

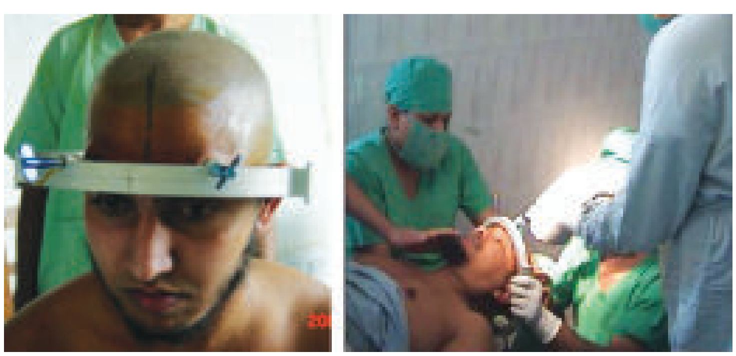

Fig.-5: *Getting the CT scan*

Then the patient is taken to CT scan room to get a CT scan. The gauge plates are attached on both side to get the "Z" axis measurement. The scan should include the whole frame (Figure 6

Grid is placed, Target selected. Target for biopsy is measured. In this case "X" is lateral measurement from mid line : 4 cm and "Y" is – 3.86 cm as it is posterior to the center. "Z" measurement (Depth) is measured from the distance in between two dots shown in white arrows. Obtained in the CT scan from the Gauge plates (figure 7)

The Biopsy procedure:

The patient is then taken to the operating room. Placed on the operating table head frame is placed on the Acrylic frame, An "L " burr is fixed to make the patient's face free to breath and observation. A IV line is established and Normal saline started. Pulse oxy meterand a BP culf is fixed to monitor Oxygen saturation, pulse rate and Periodic BP. Then properly draped with sterile towels (figure 8)

Now the patient's head is properly cleaned, painted and draped. The X, Y and Z attachments are fixed according to the measurement taken from CT Scan.

A safe trajectory is choosen. A burr hole is done after injecting Local anesthetics (figure 9)

Then the Biopsy canula adaptor is fixed on the arc. The biopsy canula is inserted slowly up to the mark given on the canula. The biopsy canula is a double barreled hollow (including the trocar) canulas. There are two slit opening in each canula. There is a mark on the top of the canulae that indicate when the both slit openings are in the same place. At this point with a 10 cc syringe a small vacume pressure is applied so that some tumor tissue enters in to the biopsy tube.

Then immediately the inner canula is rotataed to any side, the tissue inside is cut and the inner canula is taken out and we can get a piece of tiny tissue. Three or four samples are take in the same way from different sides by rotating the main canula (Figure10)

Then the canula is withdrawn slowly. All the attachments are removed (Figure 11)

The burr hole site is, repaired in two layers a dressing is given. Patient is the sent to his bed . Close follow up for 24 hours is done then sent back home on the next day (figure 12)

Fig.-6: *The CT scan is done*

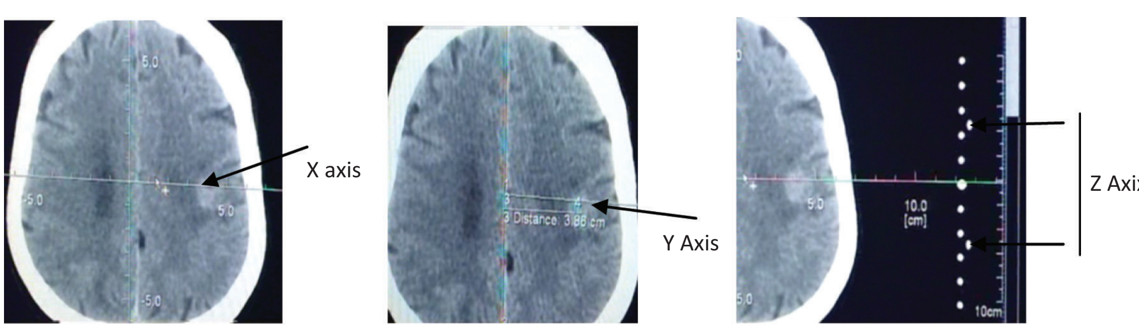

Fig.-7: *The "X". "y", "Z" measurements are recorded in a camera and written on a paper not to loose them.*

Fig.-8: *Patient in brought to OR and draped properly*

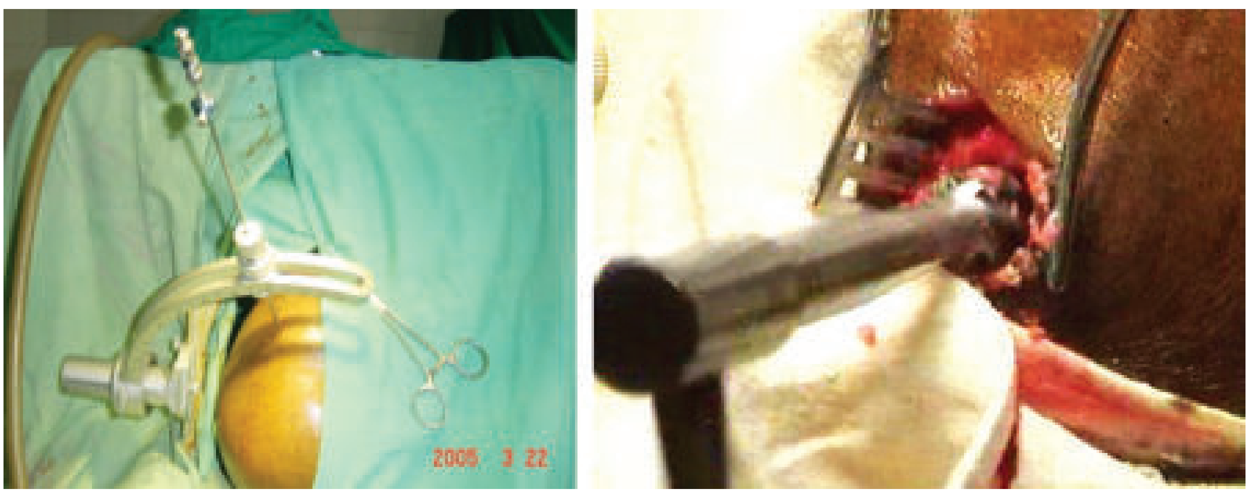

Fig.-9: *X, Y, Z are set and burrhole is made*

Fig.-10: *Taking of samples*

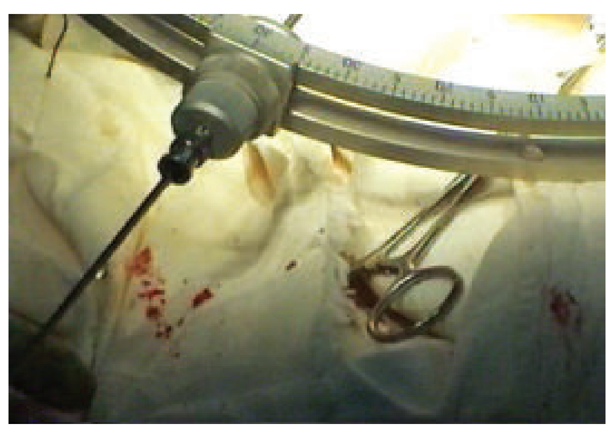

Fig.-11: *Canula in withdrawned and wound closed*

Fig.-12: *Patient in sent to bed for observation*

Discussion:

Stereotactic neurosurgery has a rich history beginning with the first stereotactic frame described by Horsley and Clarke in 1908[10]. Stereotactic neurosurgery began with intracranial targeting for psychiatric and functional disorders (such as movement disorders). Interest in the development of stereotactic surgery in humans has been documented in the literature as early as the 19th century[1,3,4,9]. Around this time the idea that specific parts of the brain had individualized function was beginning to take hold, leading to the study of linking external landmarks of the cranium to cortical topography. The first 3D targeting technique. Coordinates were taken from skull x-ray as there was no CT scan at that time.

The first 3D targeting technique for human neurosurgery was described in a seminal paper published in *Brain* in 1908 by Victor Horsley (neurophysiologist and neurosurgeon) and Robert Clarke (mathematician)[4,10,15] They coined the term “stereotaxis” which is derived from the Greek words stereos meaning “3D” and taxis meaning “orderly arrangement.”[6,10,14]. Following their initial success, the authors had a disagreement and ceased communication for some reason not clear. therefore, neither was unable to use the original device again.

Drawing of the craniometer developed by Theodore Kocher demonstrating the relationship of the skull sutures to the frame to localize underlying brain structures. Reprinted from[18],[19]

This problem was the research focus of Spiegel et al who described stereotaxy in relation to landmarks inside of the skull by using radiographs (the ventricles using pneumoencephalograms and the calcified pineal gland). Their apparatus was similar to the Horsley and Clarke version with an electrode carrier suspended above the head, to be adjusted in all 3 planes independently. They coined to term “stereoencephalotomy” to describe intracranial surgery 3D targeting based on the brain itself[19] . in 1936, Hirotaro Narabayashi was also developing a frame adapted from the original Horsley and Clarke orthogonal design in Japan[21].((However, because of Japan’s limited exposure to the rest of the world after the war, he was completely unaware of the concurrent work in the US, France, Germany, and Sweden[17]. In response to Narabayashi’s publication “Procain oil blocking of the globus pallidus” in 1956[16] . Spiegel and Wycis wrote, “In this way they try to create the impression that they were the first who performed stereotactic operations on the basal ganglia, not even mentioning with a single word the fact that we have reported such operations repeatedly since 1949.”[17] .The art of “sharpshooting into the brain” continued to be advanced through the efforts of multiple neurosurgeons and scientists worldwide including Hecaen et al [2,8,10,11,22]

in Russia among others.The leaders in the field of stereotaxy created the International Society for Research in Stereoencephalotomy during an international symposium in Philadelphia in 1961

All these frames were designed to treat mostly the movement disorders specially the parkinson’s disease

With the discovery of levodopa in 1968 for the treatment of Parkinson disease, the interest in stereotactic surgery plummeted[1]

[1] However, the advent of CT scanning and other advanced imaging techniques led to the revival of stereotactic neurosurgery with even more applications. It is now widely used for delivery of radiation, surgical targeting of electrodes, and resection to treat tumors, epilepsy, vascular malformations, and pain syndromes. These treatments are now available because of the pioneering efforts of neurosurgeons and scientists in the beginning of the 20th century. Their efforts focused on the development of stereotactic instruments for accurate lesion targeting. We will review the history of the stereotactic apparatus in the early 20th century, with a focus on the fascinating people key to its development.

Table-I

Numer of patient	Positive biopsy found	Not conclusive	Complication	Type of complication	
153	143	6	4	Haemorrhage 3	Massive MI I And died

Stereotactic surgery is a minimally invasive form of surgical intervention which makes use of a three-dimensional coordinate system to locate small targets inside the body and to perform on them some action such as ablation, biopsy, lesion, injection, stimulation, implantation, radiosurgery (SRS), etc[13].

After advent of CT & MRI various frames are designed, like Leksell frame, CRW frame.and more which uses A stereotactic planning system, including atlas, multimodality image matching tools, coordinates calculator, etc.

Modern stereotactic planning systems are computer based. The stereotactic atlas is a series of cross sections of anatomical structure (for example, a human brain), depicted in reference to a two-coordinate frame. Thus, each brain structure can be easily assigned a range of three coordinate numbers, which will be used for positioning the stereotactic device. In most atlases, the three dimensions are: latero-lateral (x), dorso-ventral (y) and rostro-caudal (z).

Planning station can fuse the CT and MRI images to precisely target the lesion.

Frameless stereotaxy like Neuronavigation also has a great role in taking brain tumor biopsies and other procedures.

However in our cases we used a simple Komai frame devised by Mizuho company in Japan. This frame is very low cost in comparison to Leksell or CRW frame and easy to use. This is a CT guided frame. Although is not so precise as the other modern frames. However can serve the purpose of taking brain biopsy with accuracy in most of the cases. This does not need any CT MRI fusion or any planning station. Coordinates are taken directly from the CT image panel from the monitor. Komai frame can be used for brain tumor biopsies, evacuation of haematoma s and even some minor brain surgeries. In most of the cases we could get proper tissue and positive hitoppathology result. In some cases we could not. It may be due to consistency of tumor. If the tumor consistency is hard or firm, the biopsy needle may not penetrate the target tissue and may cause failure of the procedure. This procedure also has a minimum risk of haemorrhage after surgery which we experienced in our series.

Result: we have operated 153 cases so for deep seated brain tumor biopsies by using our frame system. In 145 cases we could take out proper target tissue. In 2 cases patients developed Extensive haemorrhage on the day after surgery and detriorated and died. One patient died after a massive MI after the day of discharge

In 5 cases we could not take out proper tissue probably because the tumor consistency was hard or firm. (Table 1)

Conclusion:

A simple low cost stereotactic frame like “ KOMAI” may still be used for deep seated brain tumor biopsy as a minimally invasive procedure without any significant complication. It can be done under local anaesthesia and the patient can be send back home on the next day.

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