CHAPTER V

RESEARCH METHODOLOGY

5.1 Research Design

This study is an observational study, cross sectional study design.

5.2 Sample

5.2.1 Target population

Brain phantom perfusion images by SPECT at Section of Nuclear Medicine, Department of Radiology, at King Chulalongkorn Memorial Hospital.

5.2.2 Sample population

Brain phantom perfusion images in condition of ictal and interictal, with different size and site of lesions by SPECT at Section of Nuclear Medicine, Department of Radiology, King Chulalongkorn Memorial Hospital.

5.3 Material

5.3.1 Brain phantom

Brain phantom used in this study is locally made in elliptical shape (as shown in figure 5.1). The brain dimension is 2.5 cm thick, 13 cm wide and 18 cm high. The inner volume is 300 cc. It simulates the activity distribution in the human brain. The ratio of count density of the gray matter, white matter and ventricles is 4:1:0 , respectively.

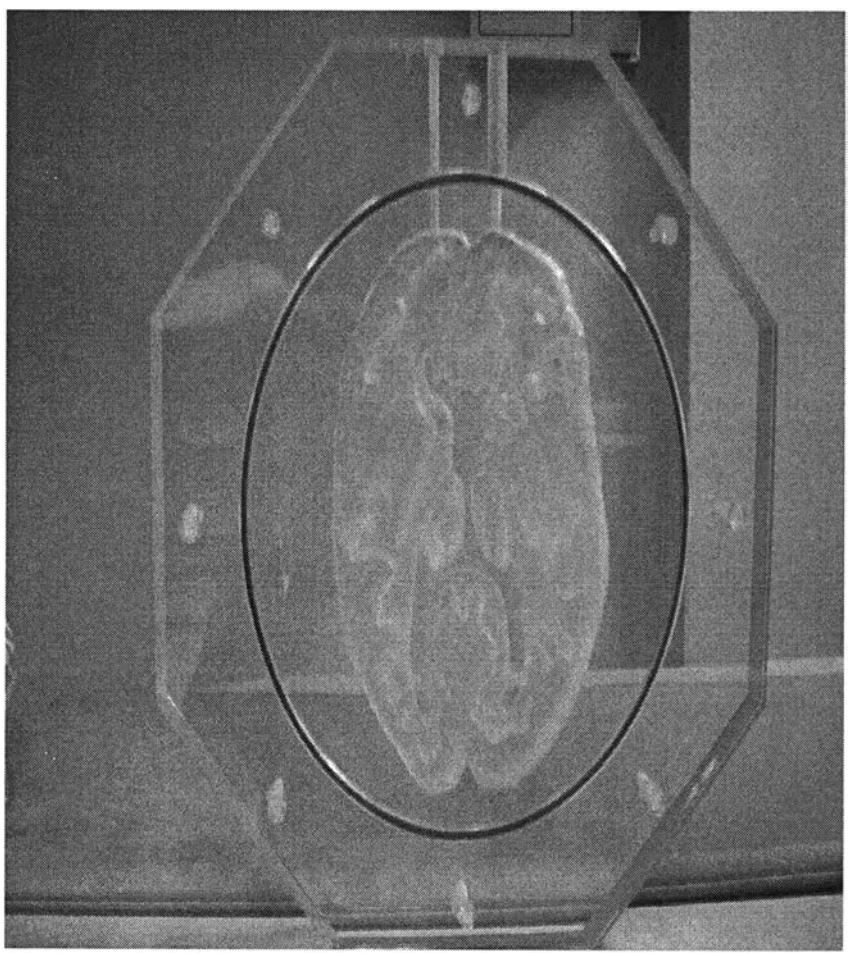

Figure 5.1 : Brain phantom

5.3.2 Artificial lesions

There were three size of lesions (with cylindrical shape) used in this study. (figure 5.2)

5.3.2.1 Large size : diameter 14 mm. , length 7 mm., volume1.5 cc

5.3.2.2 Medium size : diameter 9mm., length 5 mm., volume 0.4 cc

5.3.2.2 Small size : diameter 4 mm., length 5 mm., volume 0.1 cc

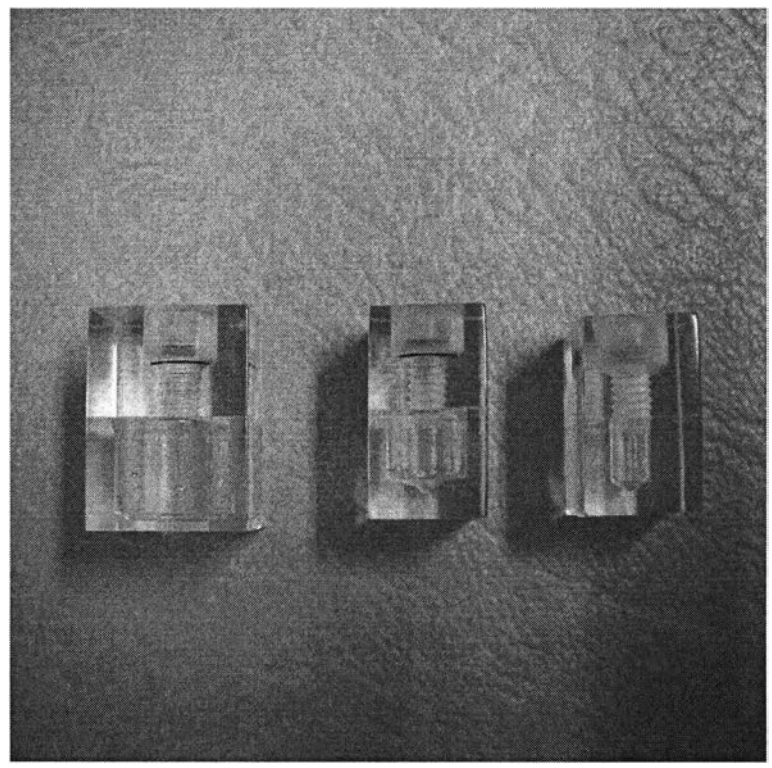

Figure 5.2 : Artificial lesions

5.3.3. Single Photon Emission Computed Tomography (SPECT)

SPECT camera used in this study is a triple head (Trionix Research lab, Model Triad, XLT 20T Twinsberg OH, USA) linked with SUN computer at the Section of Nuclear Medicine, Department of Radiology, King Chulalongkorn Memorial Hospital. (figure 5.3)

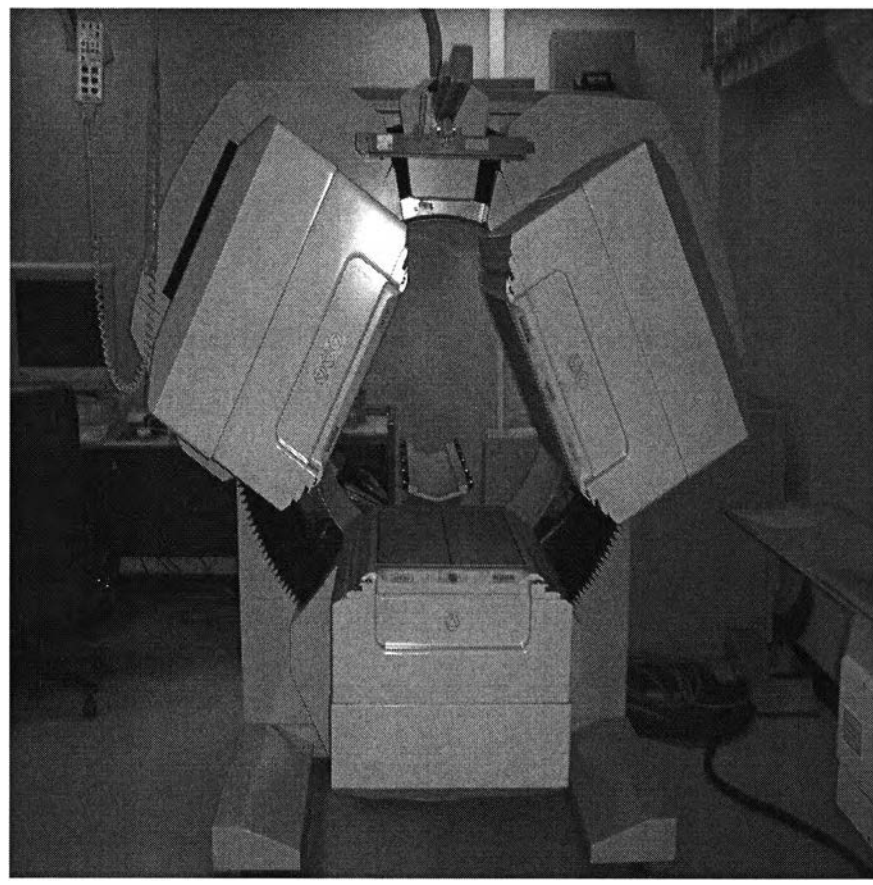

Figure 5.3 : Single Photon Emission Computed Tomography (SPECT)

5.3.4 Technetium pertechnetate ($^{99m}TcO_4^-$)

Technetium pertechnetate ($^{99m}TcO_4^-$) is the most commonly used radionuclide in organ imaging procedures. This is due to its ideal physical and chemical properties. The monoenergetic gamma emission of 140 keV is well suited for use with modern gamma cameras.

Technetium is a transition element, with an atomic number of 43. The pertechnetate ion ($^{99m}TcO_4^-$) is soluble in aqueous media e.g. water. It is unnecessary to label $^{99m}TcO_4^-$ with other compounds because this experiment was performed in phantom.

5.3.5 Hardware resources

5.3.5.1. PC Computer 1 unit

CPU	:	Intel Pentium 4, 1.7 GHz
RAM	:	256 Mbytes
Hard Disk	:	40 GB
Monitor	:	Super VGA Monitor
Peripheral	:	Keyboard, Mouse

5.3.6 Software resources

Operating System	:	Microsoft Windows XP
Compiler	:	Matlab Version 6.5
	:	MRIcro program
	:	SPM version 2

5.4 Data Collection

Three artificial lesions of three diameters (14 mm, 9 mm, 4 mm) were positioned in 3 different regions [anterior cingulate cortex and posterior cingulate cortex (figure 5.4), deep gray matter (basal ganglia) (figure 5.5)] in the brain phantom.

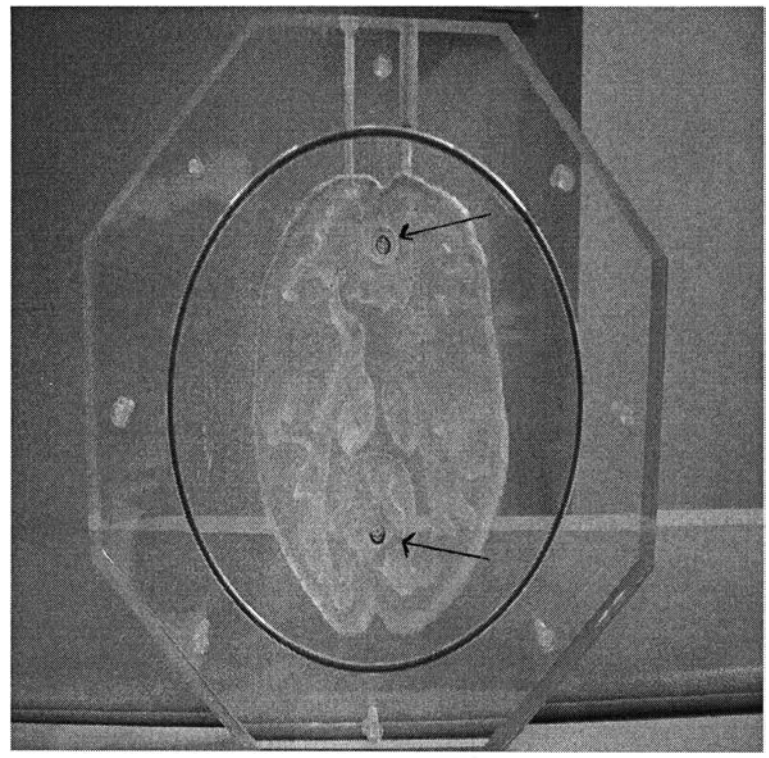

Figure 5.4: Brain phantom with lesions filled with $^{99m}TcO_4^-$ fixed at anterior and posterior cingulate cortex (arrows).

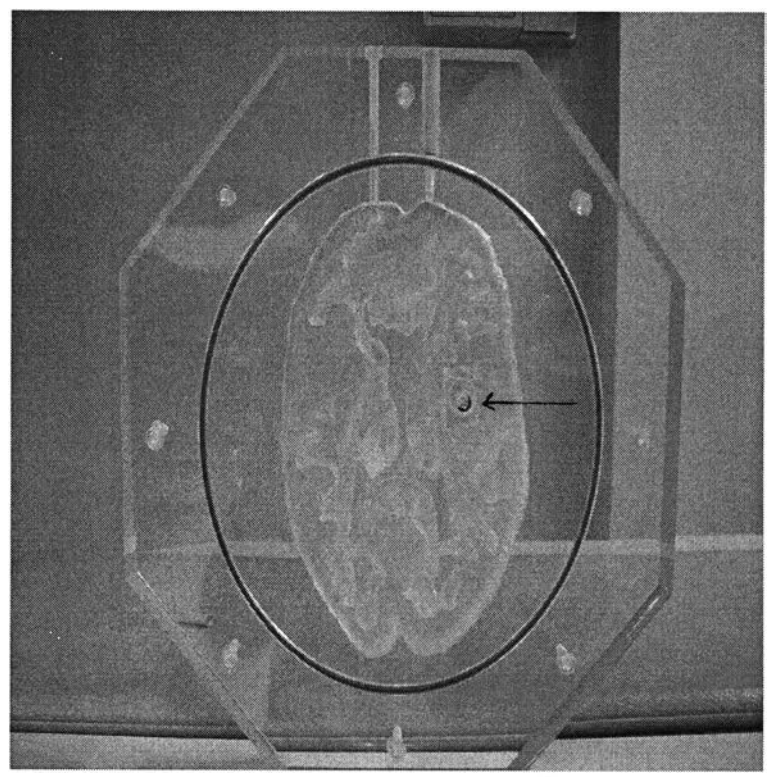

Figure 5.5: Brain phantom with a lesion filled with $^{99m}TcO_4^-$ fixed at basal ganglia (arrow).

In the interictal state, the lesions in the phantom were not filled with radioactivity, while the surrounding brain was filled with 20 μCi/ml of $^{99m}TcO_4^-$. For ictal study, the lesions were filled with radioactivity about 70-150 μCi in each lesions. The three sizes of lesions were placed in 3 regions of the brain phantom. For each data set, acquisition were performed 3 times, which two sites (anterior, posterior) of the same size were performed simultaneously and basal ganglia separately. Identical acquisition parameters were used for all interictal and ictal images which were as followed; LEUR (low energy ultra high resolution) collimators, matrix size 128x128, zoom 1.6, pixel size 2.8 mm, acquisition time 40 sec/frame, No of projections 40 views.

5.5 Data Analysis

The acquisition data were reconstructed and activation ratio of lesion to normal brain in reconstructed images of each lesion size were collected. The reconstruction of data sets followed the protocol commonly used in our section for brain scanning with cut-off frequency 0.7 order 5 and butterworth filter. Four point attenuation compensation were applied.

After reconstruction, the data were exported to interfile format within the SUN workstation. The interfile files were transferred to

personnel computer, and converted to Analyze Format by MRIcro program

By SPM program, the data of ictal and interictal states were co-registered, realigned and transformed into standard Montreal Neurological Institute (MNI) space. This step is designed to co-register a series of image volumes of the same brain to a single representative. All images were then smoothed with a three-dimensional Gaussian filter of 16 mm. full-width-at-half-maximum (FWHM). Gray matter threshold were fixed at 0.8 [4] .Contrast of ictal minus interictal were defined to examine areas of higher tracer uptake in ictal study compare to interictal study. The result demonstrated number of voxels (k_e) in activated focus. For each time of defining contrast, parameter of height threshold which is *p*-value uncorrected for whole brain were adjusted to find the best cut-off level at each size and site of experiment. This type of *p*-value was used because this is a study in a phantom which the lesions location were already known.

The true volume of artificial lesions ($V = \pi r^2 h$) and the volume of voxels detected by SPM (k_e*voxelsize_ x* voxelsize_ y* voxelsize_ z) were calculated and compared.Where

r is radius of the artificial lesion

h is length of the artificial lesion

k_e is number of voxels presented in SPM

voxel size x = 2 mm

y = 2 mm

z = 2 mm

5.6 Ethical Consideration

This study is performed in brain phantom (locally made phantom) and not involve the patients, so these should have no ethical problem.

5.7 Benefit of the study

The optimal parameter in SPM will be defined for the optimal size of lesion detection for further clinical use.

The limitation of size detected by SPM will be defined.

The effect of site on size detection will be identified.