Special Lecture

Geriatric Nuclear Medicine

M. Iio

Department of Nuclear Medicine and Radiological Sciences
Tokyo Metropolitan Geriatric Hospital

For the long history of medical care, the sick aged were used to be confined inside the sanatorium or home for the aged without providing the newest medicare mostly due to economic reasons. Even though they are the final state of human being, understanding of geriatrics is still not sufficient. They are suffered usually plural disorders at the same time, physically weak to tolerate for the modern diagnostic means such as angiography, biopsy and etc. They are even economically and socially not fully supported for enjoying the fruits of the advanced modern medical procedures.

Many nuclear medicine specialists or laboratory have to work on such aged patient, however, their knowledge on the geriatric patient is probably still limited to draw conclusive remarks on each geriatric cases based on the current knowledge of medicine.

Taking the advantage of newly established Geriatric Medical Center and Institute of Gerontology, I have tried to compile the first summary on the geriatric nuclear medicine. Of course, I know my present knowledge is still far from complete. However, I believe I will gradually and steadily walk the road towards our final goal.

Tokyo Metropolitan Geriatric Hospital and Institute for Gerontology have established in 1972 with 930 staffs and 750 acute beds and 550 chronic beds.

During the first three years, five thousand and five hundreds imaging procedures were analyzed carefully compared with autopsy results which amounted 800 cases in the past three years. Higher incidence of disagreements were noted between clinical diagnosis and autopsy diagnosis in cerebrovascular accident (15%), pneumonia (12%), cardiac infarction (44%) and in renal cancer (67%). Therefore special attention was paid on the diagnosis of such disorders.

When the percent abnormal in each nuclear medicine procedures were compared between pediatric hospital (Dr. Gilday), general hospital (Univ. of Tokyo Hospital) and our geriatric hospital, the highest incidence of abnormal percent was noted in every procedures performed in geriatric hospital.

Because of the fact that Geriatric patient has such characteristics as multimorbidity, atypical symptoms and microsymptoms, objective and quantitative diagnostic procedures such as nuclear medicine was frequently needed for the detection of the disease states frequently hidden behind the aged patients.

1) Brain disorders

Comparison of imaging and autopsy revealed that accurate diagnosis was made by scanning procedure in 95% for brain tumor and 43% for
CVD. CVD with extended lesion and poor prognosis was noted to show higher incidences of positive brain scan for a long period. In two cases eventually died, continuous positive accumulation of $^{99m}$TcO$_4^-$ was observed for almost one year.

It should be stressed that brain tumor is one of the important asymptomatic brain disorders among aged. From 1960 to 1972 before this hospital has completely reorganized 18, cases with brain tumor was found among 1299 autopsied cases. No clinical diagnosis of brain tumor had been made on any single case among this group. However, during the recent 3 years when new technology including nuclear medicine has been introduced, correct clinical diagnosis of 16 brain tumor has been made in 18 brain tumors among 639 autopsied cases. This tremendous improvement of the accurate clinical diagnosis is due mostly to brain scan and etc. Seven cases of asymptomatic brain tumor has been presented. The largest asymptomatic brain tumor we have experienced was meningioma with $6 \times 7 \times 7$ cm. in size. Not only brain tumor, subdural hematoma also remain asymptomatic for years. Without typical signs and symptoms patient with subdural hematoma are treated as senile dementia and/or as psychiatric patients. The largest asymptomatic subdural hematoma proven finally by brain scanning occupied entire hemisphere covered with 5 mm thick capsule.

Functional color image of the cerebral regional blood flow was presented. After intracarotid arterial injection of $^{133}$Xe saline solution, clearance from $64 \times 64$ matrices of the hemisphere are calculated with 9 points smoothing. Details of the method are reported elsewhere. By this method effect of brain tumor upon ipsilateral cerebral blood flow was clearly visualized. Decreased hemispherical blood flow by the tumor explain the concomitant deterioration of the brain function. Silent cerebral infarction by the conventional scan can be clearly visualized by the functional blood flow image as wedge shaped area of decreased blood flow.

2) The 3rd Circulation
Disturbance of the cerebrospical fluid circulation represents the highest percent abnormality among various nuclear medicine procedures on the aged. Two hundred sixty two cisternography was performed on 235 cases. In almost all aged cases convexity block of the 3rd circulation was noted. Activity of the cerebral compartment show the highest value at 6 hours after injection in the adult, however in the aged, peak activity of the cerebral compartment was reached usually after 24 hrs. The ratio of count of the brain compartment at 24 hrs. and 6 hrs. ($C_{24}/C_6$) was taken as an index of the cerebrospinal fluid circulation. If the value of $C_{24}/C_6$ is below unity it indicate CSF circulation is normal. In the aged, especially after 6th decade, increased $C_{24}/C_6$ ratios were frequently observed. These marked findings of the delayed CSF circulation showed good correlations with ADL test and IMC testing. This fact represents the important correlation between the brain function and the third circulation of the aged people.

Among aged cases studied delayed CSF circulation was noted in 60%, ventricular filling in 35%, convexity block in 98% and normal cisternography was observed in only 1%. Correction of the disturbed CSF circulation by V-P shunting was performed in 13 cases and improvement of the symptoms were found in 11 cases who accompanied also improved cerebral blood flow.

3) Cardiopulmonary disorders
By pulmonary scanning major fissure sign, decreased perfusion to the lower lung field were noted in 47% and 22% respectively. High incidence of these findings also show good correlation with aging and were found only after the 5th decade. Serial microscopic examination of the pulmonary arterial structure failed to reveal the presence of vascular damage. Characteristic major fissure sings
and other findings observed by perfusion scan were, therefore, concluded to be due to air way disorders and neither due to multiple micro embolie as James reported nor to pulmonary arterial disorders. Transmission scan by $^{133}$Xe also revealed quite a frequent existence of bullous lesion in the lower lung field. Examination by aerosol inhalation scan also supported the results.

When compared with younger adult who usually has predominant ventilation and perfusion functions in the middle of lower lung, aged cases, because of the frequent collaps of the lower lung structure, compensate their respiratory function by the upper lung fields.

In 462 consecutive autopsy studies of the last 2 years, we have noted cardiac infarction in 17%. Comparison of EKG examination, revealed that EKG reading provides false positive and false negative reading of the infarction in 44.3% and 43.7% respectively. This is the reason cardiac nuclear medicine such as gated cardiovascular and cardiac muscle scan are now rapidly introducing in the diagnosis of the ischemic heart diseases. Gated methods are presented on a case with marked ventricular aneurysm and multiple infarctions of various organs. Result of digitalis RIA was also reported indicating the frequent observation of digitalis intoxication on such cases with small maintenance dose. This is a result of impaired renal function of the aged, and intoxication frequently accompanies psychiatric and neurological signs and symptoms. RIA results proved that maintenance dose such as 0.125 mg/day is occasionally effective in geriatric patients.

4) Liver Disorders

One of the prevalent hepatic disorders in the aged is malignancy. From among 951 liver scanning, 232 cases were diagnosed to have SOLs. Pathological study revealed that metastatic tumor is predominant and metastatic gastric cancer, followed pulmonary cancer, colon cancer, gallbladder cancer and etc. Primary hepatocellular cancer was, in contrast, very rare in the aged. Only 2 cases of hepatoma were experienced in the last three years.

Reflection the fact of the decrease in liver size by aging, metastatic liver disease accompany rarely hepatomegaly which is usually one of the characteristic sign of such lesion in the adult. Differential diagnosis of liver SOLs by nuclear angiography were very useful.

Another frequent observation in the aged cases is the elevation of right hemidiaphragm of chest rentgenogram. Liver scan confirmed this elevation of hemidiaphragm usually accompany the elevated right dome. Incidence of this finding is more frequent in the female.

As far as liver function is concerned, it is rather difficult to denote the effect of aging by routine biochemical analysis. Loading test such as $^{131}$I-BSP clearance only reveal the presence of the effect of aging as decreased hepatic uptake and hepatobiliary excretion, It requires, however, further refined studies before one reach the final conclusion. Functional color imaging of such liver functions was presented.

Survey of the Australian antigen and antibody by RIA upon a little more than 2,000 healthy aged group showed that 49% of this population has positive Au-antigen. In a few cases coexistence of antigen and antibody was disclosed, due probably to the modified immunological mechanism in the aged.

5) Renal Disorders

Number of glomeruli show remarkable decrease along with aging. Therefore renal dysfunction is quite frequent in the aged when compared with the dysfunction of the liver which is a famous mitotic organ. Incidence of abnormal renogram increases with aging. Interpretation of renogram of the aged, therefore, require different criteria from that of the adult. Because of the diagnostic difficulty of the renal cancer as was described pre-
viously, several nuclear medicine technologies have been applied on the diagnosis of renal SOL. By the current method of $^{99m}$Tc DMSA and pin-hole collimator renal SOL(s) are discernible with more accuracy and precision. Nature of the lesion can be further confirmed by $^{99m}$Tc DTPA renal angiography. Except one case, who has avascular renal cancer, all renal malignancy was supplied by fluent arterial blood flow as represented by hot region at arterial phase of the nuclear angiography. Frequent pyelonephritis and renal infarction among aged due to DIC (disseminated intravascular coagulopathy) can be differentiated by characteristic patterns on the good renal image obtained by DMSA.

6) Bone Disease

Representing the progress of osteoporotic process, aged cases show redistribution of bone seeking radiopharmaceuticals ($^{99m}$Tc-pyrophosphate etc.) to the extremities as seen in growing children to some extent.

When bone malignancy is a problem, prostate cancer in the aged male became the focus of the clinical concern. Seventy cases with prostate cancer were examined by bone scan, roentgenological bone survey, biochemical analysis and etc. When compared with sensitive bone scanning, roentgenological bone survey has overlooked 11% of lumbar lesion, 70% of cranial lesion, 84% of sternum lesion, 58% of shoulder lesion, 50% of rib lesion and 50% of cervical lesion. Extensive metastasis of the prostate cancer was diagnosed also by the decreased 6 hrs. excretion test of $^{99m}$Tc pyrophosphate.

7) Peripheral Circulation

In order to facilitate the rehabilitation program on the patient with hemiplegia or to treat the decubitus of the bedfast patient, peripheral circulation of the aged draw strong attention of the clinicians. Generally speaking, extremity with paralysis exhibit marked decrease in peripheral circulation, Rehabilitation program first introduce increased peripheral circulation of the healthy side which undertook the load on the diseased side. However longstanding observation revealed that increased blood flow of the paralytic extremity was also noted along with improvement of Blum Strom stages. Even though there were much controversy among researchers, it is now generally being accepted that paralytic extremity has reduced peripheral muscular perfusion.

In conclusion, as new field of the nuclear medicine, geriatric nuclear medicine was proposed. It was found that various nuclear medicine procedures are extremely helpful for the diagnosis of these physically weak group and occasionally are consisted only possible diagnostics means because of its nature of nontraumaticity and quantitiveness. Nuclear medicine was not only useful for diagnosis of varieties of geriatric disorders but also was of value to clarify the various physiological parameters of the aging.