The Historical Background and Current Status of Nuclear Cardiology in Korea

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There has never been an age in which science and our daily life are related so closely as today. In particular, atomic energy has become the strongest of any other means which has been developed until now for human beings to investigate and control the world and themselves. But like the strong giant from Aladin's Magic Lamp, it can be destructive or constructive according to the user. As a peaceful means, the wide application of atomic energy to our daily livings will bring about a great change in the world civilization. And there is no telling how far medical science will have advanced by the end of this century through constructive use of the giant.

Nuclear cardiology in Korea, in both the quantity and quality, has devloped steadily during the last 20 years, and it will be able to become an example for the other developing countries.

In this conference studying and discussing new topics, I believe that it must be valuable to review the use of nuclear cardiology in the developing country and the course being used in moderation with the reality.

Before making mention of nuclear cardiology in Korea, I would like to introduce to you the realization and progress of nuclear medicine in Korea.

The medical application of radioisotopes in Korea has its origin in the prescription of the radioiodines for hyperthyroid patients in 1959[1], as in the other countries did.

In April 1960, we opened the radioisotope clinic in Seoul National University Hospital, and in the next year in December 1961, we established the Korean Society of Nuclear Medicine.

Facilites of the pioneer days included the well type gamma counter of Tracer Lab. Co., and the dot scanner and so on.

In March 1967, the initial number of the Korean Journal of Nuclear Medicine was issued. At that time, mainly using these machineries and parts, cardiac output and blood volumes etc. were measured in the field of cardiology[2~4].

In 1969, after introducing the gamma camera for the first time, a real study of the image parts was started[5]. In 1979, Seoul National University Hospital was removed to a new building and our medical equipments were newly modernized. In particular, the computer was introduced and as a result, a new field of nuclear cardiology was opened.

The use of radioisotopes in medical fields has increased steadily and as of 1984 with the economic growth there are 67 institutes which make use of radioisotopes all through the country: 26 of those 67 are equipped with computers to allow the practice of quantitative nuclear cardiology (Fig. 1).

The Fig. 2 is a geographic distribution of medical institutes. One half of the gamma cameras are located around Seoul.

1. Radionuclide Angiocardiography

The Table 1 shows the distribution of congenital heart disease in Korea[6]. Using radionuclide

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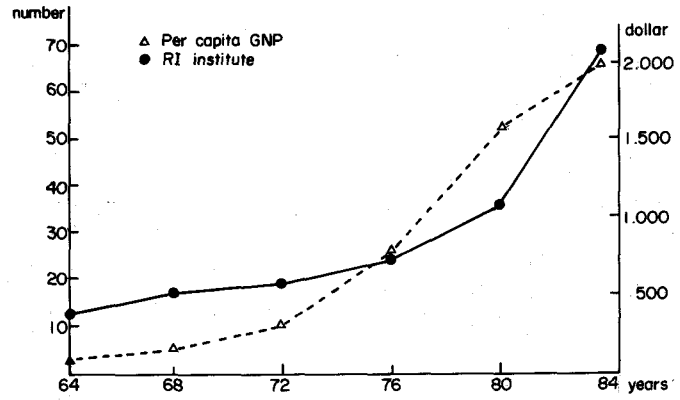

Fig. 1. Annual change in the number of medical institutes which use radioisotope and per capita GNP.

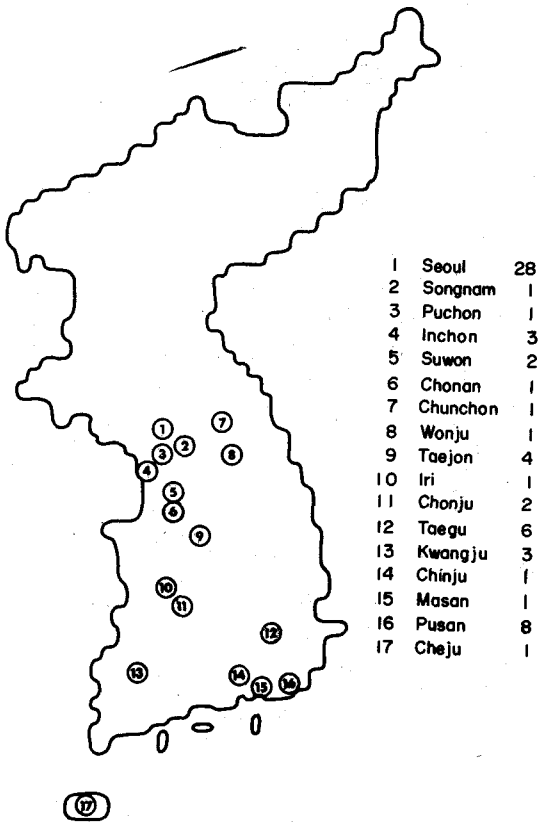

Fig. 2. Geographic distribution of medical institutes.

cardiac angiography we can easily find the flow of intracardiac shunt[7,8]. The Table 2 shows the result of my data in SNUH. Omitting 31 cases of technical failure due to poor bolus, we detected

Table 1. **Incidence of Individual Lesions of Congenital Heart Disease**

Disease	No. of cases	%
Ventricular septal defect	306	29.1
Tetralogy of Fallot	213	20.2
Patent ductus arteriosus	148	14.1
Atrial septal defect(secundum)	62	5.9
Endocardial cushion defect	25	2.4
Dextrocardia	20	2.0
Pulmonary stenosis	19	1.8
V.S.D.+P.S.(L. to R. shunt)	14	1.3
Ebstein's anomaly	13	1.2
Tricuspid atresia	12	1.1
Others	218	20.8
Total	1,050	100.0

shunts in 459 cases of 481 evaluations, so the detectability rate was 95.4%. The cases which couldn't be detected by this method had small amounts of shunt. Only in our hospital we are doing 500 cases of shunt study per year.

In postoperative evaluations, 18 out of 411 patients with left to right shunt and 10 out of 140 right to left shunt were found to have remnant shunts with radionuclide cardiac angiography. All except one of these patients had membraneous ventricular septal defects and those with left to right shunts had moderate to severe pulmonary hypertension and shunt amount(Table 3).

Table 2. **Detectability of Shunt**

Type	Number	RI cardiac angiography		
		Shunt	No shunt	Inadequate
Left to right shunt	372	327	19	26
Right to left shunt	140	132	3	5
Total	512	459(95.4%)	22(4.6%)	31

Table 3. **Follow Up of Shunt Operation**

Type	Opreation Number	RI cardiac angiography	
		Correct	Residual shunt
Left to right shunt	411	393	18
Right to left shunt	140	130	10
Total	551	523	28(5.1%)

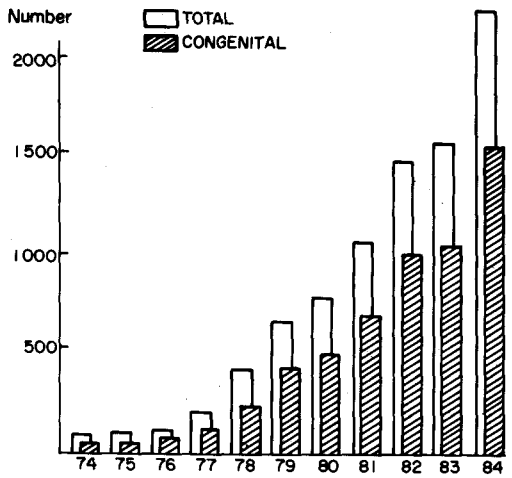

Fig. 3. Annual increase of open heart surgery.

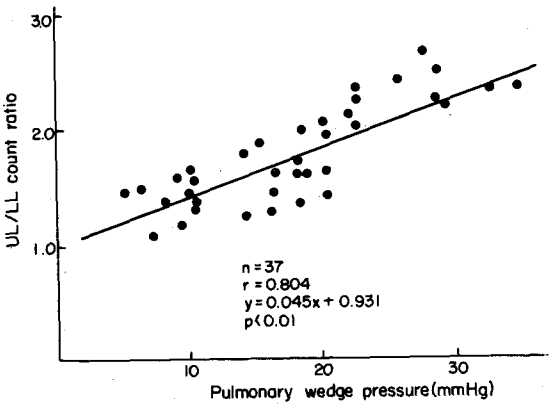

Fig. 4. Correlation between upper lung/lower lung count ratio in heart scan and pulmonary wedge pressure.

The figure 3 shows the annual increase of open heart surgery in Korea. Recently, the movement for the correction of the congenital heart diseases increased and consequently, the application of radionuclide cardiac angiography has risen. We can ascertain with radionuclide cardiac angiography whether the intracardiac shunts after surgery are correct or not.

Though in measuring upper lung/lower lung count ratio generally MAA or microsphere is used, during the single-pass radionuclide angiocardiography we also evaluated regional pulmonary blood flow in mitral valvular heart disease[9].

A modified upper lung/lower lung count ratio was obtained by the counts from upper one third of the lung field and those from the lower one third in the computer image.

We tried to find relationships between the upper lung/lower lung count ratio and various data of

cardiac catheterization. The relationship between the upper lung/lower lung count ratio and the pulmonary wedge pressure was linear. The correlation coefficient was 0.804 as shown in the Fig. 4.

2. ECG Gated Blood Pool Scan

We assess the ventricular function with ECG gated blood pool imaging. Using this device, various indices including regional and global ejection fraction[10~12], wall motion[13], ventricular volume[14], ejection velocity, diastolic filling rate, and regurgitant fraction[15] were measured. Though in Seoul National University Hospital we are performing about 400 cases of gated blood pool scan, present circumstance is that it is not used actively owing to the progres of echocardiography and their lack of undertstanding in cardiology part. We measured the left ventricular regurgitation amount by calculating the ratio of left ventricular to right ventricular stroke counts in gated blood pool scan[15].

Stroke volume ratio was classified by regurgitation grade using X-ray cine-ventriculography. In grades of mild regurgitation(Grade Ⅰ-Ⅱ), the stroke volume ratio was 2.02±0.29, and in grades of severe regurgitation(Grade Ⅲ-Ⅳ), stroke volume ratio was 2.55±0.38. And after valvular replacement, the stroke volume ratio decreased to normal values.

Also we measured the left ventricular volume index using the gated blood pool scan[14]. We used the non-geometric count method.

These left ventricular volume indices were compared with left ventricular volume obtained by contrast cine-ventriculography. We found that the correlation coefficient between the left ventricular volume index and left ventricular volume was 0.829(Fig. 5).

By the radial sector division method I measured the regional ejection fraction for the quantitative assessment of regional LV dysfunction[16,17]. We divided left ventricle into 12 regions. Regional ejection fraction was high in apex area and low in spetal area.

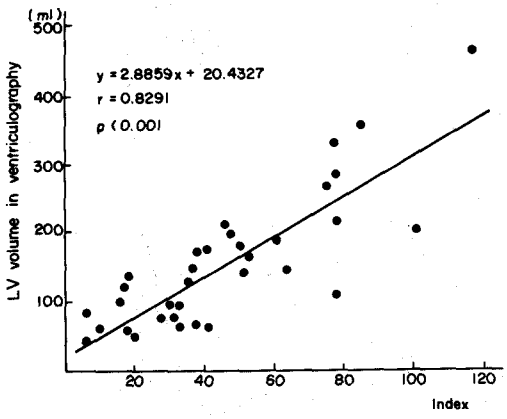

Fig. 5. Relationship between LV volume index and LV volume in contrast ventriculography.

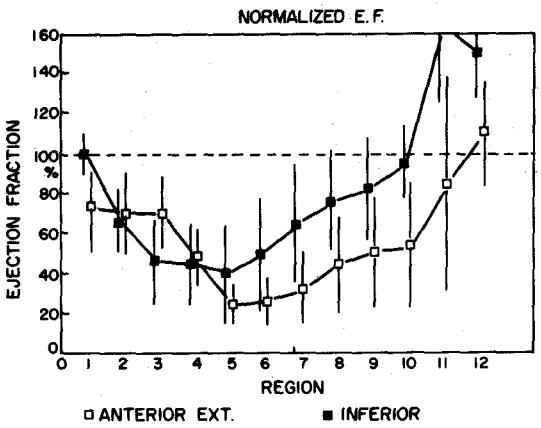

Fig. 6. Comparision of mean normalized regional ejection fraction.

Normalized regional ejection fraction in patients with anterior wall infarction showed significantly lower values in area 4 to area 8. And lower values were also seen in patients with inferior wall infarction in area 2 to area 5(Fig. 6).

3. Myocardial Scan

In addition, coronary arterial diseases increase in Korea because of the westernization of life styles(Fig. 7), the same change as Japan has undergone during the last several years. Also myocardial scans with 99mTc-pyrophosphate or 201-Thallium have become popular.

As we can not produce Thallium-201, it is very expensive, and so myocardial perfusicn studies

Table 4. **Regional Sensitivity, Specificity and Predictive Value of Positive and Negative Test**

	Antero lateral	Anterior	Antero septal	Septal	Postero lateral	Posterior	Postero inferior	Inferior
Sensitivity(%)	70.0	67.5	62.5	67.5	52.2	38.2	61.2	65.4
Specificity(%)	92.0	88.0	80.0	84.0	76.2	46.8	93.5	89.7
Predictive: positive(%)	93.3	90.0	83.3	87.1	57.1	92.9	90.5	80.9
Value negative(%)	65.7	62.9	57.1	61.8	72.7	58.8	65.9	79.5

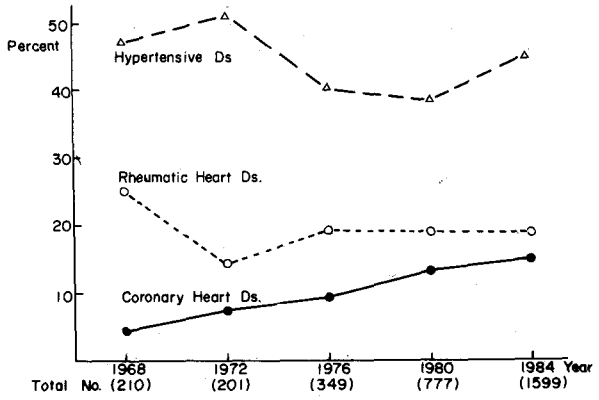

Fig. 7. Change of patients' population with circulatory disease admitted to Department of Internal Medicine, SNUH.

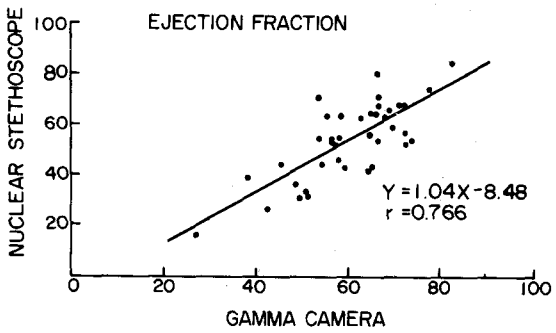

Fig. 8. Relationship of ejection fraction measured by nuclear stethoscope and gamma camera.

using Thallium-201 have increased only recently according to the increasement of ischemic heart disease[18,19]. The most common are exercise studies for evaluating patients with suspected or known coronary disease. The sensitivity for detecting a narrowing of more than 50% of the coronary artery diameter in the anterolateral wall was 70% compared to 65.4% for the inferior wall, and 38.2 % for the posterior wall(Table 4)[20].

We used dipyridamole infusion method only in patients who couldn't exercise. But equally good results were obtained with dipyridamole method and exercise method. Dipyridamole is infused at a rate of 0.56 mg/kg for 4 minutes with careful monitoring of blood pressure and the electrocardiographic response. Although chest discomforts were felt in many patients, those were trivial. And those were reversed rapidly with aminophylline.

4. Researches

Besides the clinical studies on nuclear cardiology, experimental researches such as topics of doxorubicin cardiotoxicity[21], calcium metabolism in myocardial infarcion[22] have been done.

On the one hand, SNUH in joining with the department of Biomedical Engineering developed a nuclear stethoscope. Currently we are devoloping the dual probe's stethoscope.

The Fig. 8 shows the relationship between the left ventricular ejection fraction measured by the nuclear stethoscope and the ejection fraction by

gamma camera. At present, some experimental studies to the measurement of cardiac function using this nuclear stethoscope has already been under way.

Last year, cyclotron was introduced in my country for the first time, and thallium will be produced around this spring. And so we plan to begin metabolic studies together with PET. As the instrument of nuclear magnetic resonance was produced by our techniques, we are now testing the clinical utility.

As have been said above, Korea will hold the 1986 Asian Games and 1988 Olympic Games. As Japan had attained startling growth in all part as well as in economy after the 1964 Olympic Games in Japan, the 1988 Olympic Games will give us such opportunity.

I am confident that Korea's increase in national strength and international exposure can be matched by equal gains in nuclear cardiology and medical science as a whole.

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