ured separately but on the same day, from carotid pulse tracing, PCG and ECG. Scintiphotocardiograms were recorded with Pho/Gama HP and all informations were stored in data store play back system. For recording EDV, gate was opened at the summit of R-wave of ECG for 0.05 sec. For recording ESV, it was opened also for 0.05 sec. at a point of time just 0.02 sec. before 2nd heart sound. As RI, $^{99m}Tc$-pertechnetate 10–20 mCi, $^{99m}Tc$-albumin 5–10 mCi was used, with patients in the 2nd oblique position. Radiocardiograms were also recorded with RISA.

**Results**

(1) CO calculated as (EDV-ESV) XHR and measured from scintiphotocardiogram, differed from that calculated from RCG within a range of 23% (SD) in 12 patients.

(2) SV measured from scintiphotocardiogram did not differ significantly from that measured from left precordial dilution curves of $^{99m}Tc$.

(3) In 23 patients, EF was negatively correlated with PEP/LVET ($r = -0.56, p < 0.01$).

**ECG-Synchronized Averaging Radiocardiography**

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Averaging, that is successively adding repetitive sequences of record to improve signal-noise ratio, of radioactivities over the heart area, with trigger pulse derived from simultaneously recorded R-wave in ECG, was attempted to estimate cyclic change of heart volume.

**Method:** Fifty three subjects (16 normal controls; 12 ischemic and/or hypertensive heart diseases; 12 congenital or valvular heart diseases; 13 non-cardiac diseases) were examined. $^{131}$I-RISA of 50 μCi was injected intravenously and routine radiocardiography was done to calculate stroke volume. After ten minutes or more, when equilibrium was reached, a two-inches scintillation detector was positioned over the precordial region of the subject lying in supine position so that the area of collimation would cover the ventricles. Usually apex beat was located in the left lower corner of the collimation. Triggerring R-wave from ECG and pulse signals from PHA were both fed into YHP 4100 8K mini-computer on line so that radioactivity for every 10 msec period following R-wave was added to the memory array element as digital count by a program written in assembler callable BASIC language. After several hundred times repetitive additions were completed, final counts in the elements of memory array were punched out on the paper-tape, smoothed out and displayed graphically on the lineprinter.

**Results and Conclusion**

(1) Sequence of averaged counts triggered with R-wave revealed systolic decrease followed by diastolic recovery, and when graphically displayed, formed a smooth curve, which was very similar to that known as ventricular volume change in cardiac cycle.

(2) More than 600-times repetitive additions were required to get adequate counts (over 5000 counts/10 msec) for good repeatability.
In 53 subjects, ratios of the peak decrease to the maximum count ranged from 0.048 to 0.152, with a good correlation to stroke volumes calculated by radiocardiography (r=0.75).

Ratios of decrease in the initial 200 msec to the peak decrease were calculated to evaluate cardiac ejection in the early systole. They were 0.516±0.039 (mean±s.d.) in normal control group, 0.448±0.088 in ischemic and/or hypertensive heart disease group. These two groups were significantly different (p<0.01)

ECG synchronized averaging RCG, that is a nontraumatic measurement of the cardiac volume change in one cycle on an averaged basis, enables an evaluation of cardiac ejection in the early systole.

Exercise Radiocardiography

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Hemodynamic responses to supine exercise can be studied by the analog computer analysis of radiocardiograms[1] recorded successively at rest and during exercise.

After the control radiocardiogram is recorded and the first sampling of blood is made for the calculation of blood volume at rest, supine exercise is performed by pedaling the Collins electrically braked ergometer. The workload is adjusted over a range of 25 to 75 watts/second, depending on the severity of the patient. The heart rate reaches a plateau in 1.5 minute, when the second sampling of blood and then the second injection of RISA is performed. When the recording of radiocardiogram is finished for initial 40 seconds, the patient stops pedaling for his safety. Exercise of the same workload is started again around the 7th minute of the second radiocardiography, and the final dilution value is recorded at the same heart rate as before. At the same time, the third sampling of blood is made for the measurement of blood volume during exercise.

After the injection of RISA, the count rate in the plasma was found to decrease exponentially. The exponential curve can be determined for each patient from the count rates of the first and the second blood-samples (C₁ and C₂ cpm, respectively) and the interval between the two samplings (T₁=2 min.). Rate of decrease during the second and the third samplings (T₂=3 min.) can be obtained from this exponential curve, and the estimated count rate of background (C₃ cpm) at the time of the third sampling is expressed as follows:

\[ C₃ = C₂ \cdot e^{-\frac{T₂}{T₁}} \cdot \ln\left(\frac{C₂}{C₁}\right) \]

Therefore, if the measured count rate of the third blood sample is C₄ cpm, C₄-C₃ is the true count rate which can be used for the second measurement of the blood volume.

Circulating blood volume thus obtained during exercise was 99.3±4.5% (mean±SD) of that measured at rest.

In 8 cases of mitral stenosis, the increase of cardiac output was small despite the large increase of heart rate, and the pulmonary blood