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Two-dimensional echocardiographic visualization of the peripheral right coronary artery in patients with mucocutaneous lymph node syndrome

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Summary

New two-dimensional echocardiographic techniques to visualize the proximal, mid and distal portions of the right coronary artery (RCA) and posterior descending artery were described in patients with mucocutaneous lymph node syndrome (MCLS).

The proximal portion of the RCA was imaged by modified apical approach, and its length was longer than that by the conventional parasternal method. This artery was detected in all patients.

The mid portion of the RCA was detected by directing the transducer to the right from parasternal window. Adequate visualization of this portion was obtained in 78 percent of patients.

To image the distal portion of the RCA, the transducer was directed inferiorly from the parasternal four-chamber view. Adequate imaging of this portion was possible in all.

The posterior descending artery was examined by tilting the transducer inferiorly after obtaining the parasternal long-axis view. In 56 percent of patients, a sufficient echogram was not obtained.

Validity of these methods was confirmed by reasonable agreement between two-dimensional echocardiographic and coronary angiographic findings. Using these approaches, no peripheral aneurysm was missed by two-dimensional echocardiography.

New approaches are useful in evaluating the RCA in patients with MCLS, and are also recommended to evaluate the RCA in other disorders.

Key words

Two-dimensional echocardiography　Mucocutaneous lymph node syndrome　Right coronary artery
Coronary aneurysm

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In 1967, Kawasaki[1] described the mucocutaneous lymph node syndrome (MCLS) in infants and young children. This disease is an acute febrile illness with mucocutaneous involvement and cervical lymphadenopathy. Coronary arterial lesions, such as aneurysms and thromboses, have frequently been demonstrated in children with a history of this syndome, and death occurs in 0.7 percent of patients mainly as a result of these lesions.[2]

To evaluate the coronary arterial lesions, coronary angiography has been performed.[3] But the mortality and morbidity rates of this procedure are not always low. This, therefore, should not be applied repeatedly in the acute stage.

Two-dimensional echocardiography has also been used for the evaluation of coronary arterial lesions.[4] This method is safe and noninvasive, and can be examined repeatedly. But the visualized range of the coronary artery is limited to the proximal portions, and the adequate recording is not always possible. Especially the right coronary artery (RCA) is difficult to record because this artery usually lies directly under the sternum.[5] Concerning peripheral parts of the RCA, there has been no reported method to detect using two-dimensional echocardiography (2DE).

The main purpose of this study is to describe new approaches to visualize the proximal, mid and distal portions of the RCA and the posterior descending artery using 2DE.

Materials and Methods

Materials were consisted of 37 children with MCLS (15 females and 22 males) aged from 3 months to 12 years, in whom coronary angiography was performed in 25 children. The diagnosis of MCLS was made on the basis of the guideline proposed by the Japanese Mucocutaneous Lymph Node Syndrome Research Committee in 1978.

2DE was performed using Mark III Real Time Echocardiographic System (Advanced Technology Laboratories, Inc) with a three-element, 3 MHz rotating scan head. Still frames were recorded by a line scan recorder.

In addition to the conventional approach, four new approaches were applied for visualizing the proximal, mid and distal portions of the RCA and the posterior descending artery.

In the conventional approach, the RCA is imaged with the transducer located in either the third or forth intercostal space along the left sternal border (parasternal approach). With an appropriate setting of the examination plane to cut across the aorta, the proximal portion of the RCA is detected in the echoes from the atrioventricular sulcus. Our new approaches are different from the conventional approach in the followings. The transducer is located near the apex rather than the parasternal area, and the ultrasonic beam is directed to the right shoulder and is set to cut the aorta (modified apical approach). With small rotating adjustment, the proximal portion of the RCA is imaged in the atrioventricular sulcus derived from the lumen of the aorta (**Fig. 1**).

To image the mid portion of the RCA, the transducer is located along the left parasternal border (**Fig. 2**). Then it is rotated counterclockwise to bring the ultrasonic beam almost parallel to the long axis of the trunk. The transducer is then tilted rightward gradually until the tricuspid valve is disappeared from the plane. When the echoes from the atrioventricular sulcus are visualized, the mid portion of the RCA running within this echoes is imaged.

Visualization of the distal portion of the RCA is started with the parasternal four-chamber view (**Fig. 3**). The examination plane is then gradually directed inferiorly until the echoes from the tricuspid valve are disappeared and the posterior wall of the right ventricle is imaged. The distal portion of the RCA is detected just posterior to this wall and is observed to be running parallel to it.

The fourth approach is to visualize the posterior descending artery. After obtaining the standard parasternal long-axis view of the left ventricle, the transducer is tilted inferiorly until the aortic and mitral valves disappeared, then the posterior descending artery running

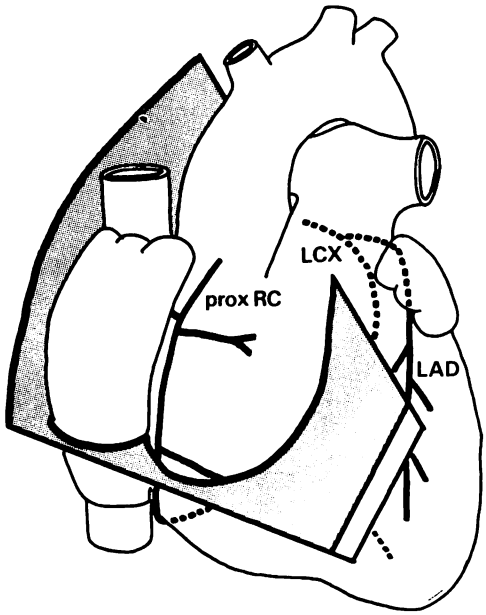

Fig. 1. Schematic drawing of the proper scan plane to obtain the proximal portion of the right coronary artery.

prox RC=proximal portion of the right coronary artery; LCX=left circumflex artery; LAD=left anterior descending artery; AP-S-RC=modified apical-short axis-right coronary artery view.

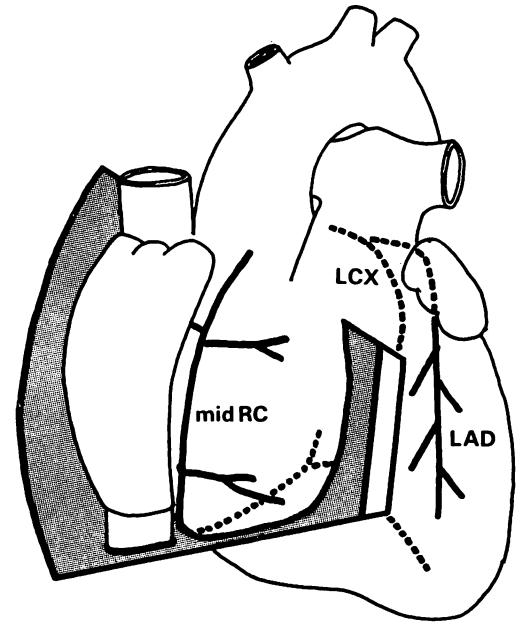

Fig. 2. Schematic drawing of the proper scan plane to obtain the mid portion of the right coronary artery.

mid RC=mid portion of the right coronary artery; LCX=left circumflex artery; LAD=left anterior descending artery; PS-L-midRC=parasternal-long axis-mid portion of the right coronary artery view.

along the inferior interventricular sulcus is visualized (**Fig. 4**).

Results

The proximal portion of the RCA was imaged in all of 37 patients by both conventional parasternal approach or modified apical approach. The technical difficulty inherent to both methods was almost the same. **Fig. 5** is a representative record by conventional method obtained from a boy aged one year and 9 months without angiographically proven coronary arterial dilatation. The RCA was imaged as a linear echo-free space coming from the aorta. The visualized length was about 1.2 cm. On the other hand, **Fig. 6** is a still frame recorded from the same patient using the new approach, and the detected length was longer (about 2.8 cm) than by the conventional approach.

Fig. 7 demonstrates the comparison between the length of the RCA detected by the conventional parasternal approach and by the new apical approach. Without exception, the length by the latter approach (mean 2.8 cm) was longer than by the former approach (mean 1.4 cm) with a statistically significant difference ($p<0.001$).

Fig. 8 is a lateral view of the right coronary cineangiogram from a boy aged one year and four months, in which coronary aneurysms are noted in the proximal, mid and distal portions of the RCA. **Fig. 9** shows the 2DE of the same patient obtained by the conventional parasternal method, which demonstrates two

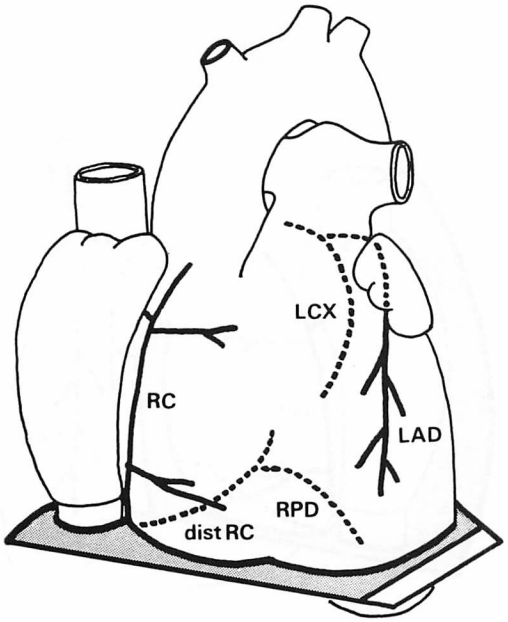

Fig. 3. Schematic drawing of the proper scan plane to obtain the distal portion of the right coronary artery.

RC=right coronary artery; dist RC=distal portion of the right coronary artery; RPD=right posterior descending artery; LCX=left circumflex artery; LAD=left anterior descending artery; PS-S-distRC =parasternal-short axis-distal portion of the right coronary artery view.

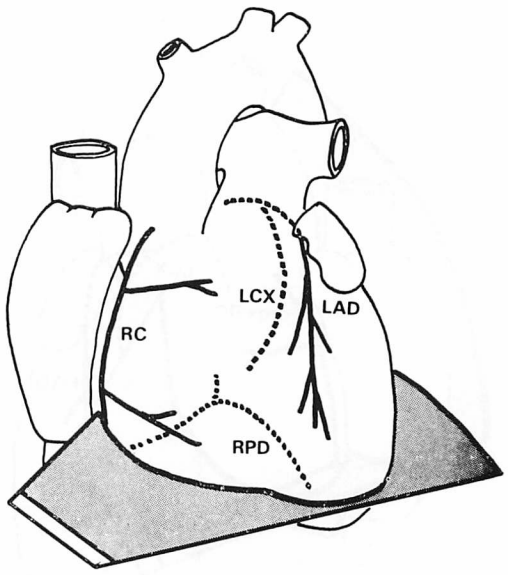

Fig. 4. Schematic drawing of the proper scan plane to obtain the posterior descending artery.

RC=right coronary artery; RPD=right posterior descending artery; LCX=left circumflex artery; LAD=left anterior descending artery; PS-L-RPD= parasternal-long axis-posterior descending artery view.

coronary aneurysms located in the most proximal portion of the RCA, though the other aneurysmal dilatation located in the more distant area was not visualized. On the other hand, the 2DE obtained by the new technique enabled the visualization of the more distant coronary aneurysm in addition to the two proximal aneurysms (**Fig. 10**).

The technique to visualize the mid portion of RCA seemed to be the most difficult approach in all techniques described in this study. As stated in the introduction, this portion lies just beneath the sternum, so that the transducer should be moved sufficiently downward to rock the scan-head at a fixed point on the chest wall. The atrioventricular sulcus where the mid portion of the RCA runs is elusive and is imaged merely as a narrow echo free linear space whenever no dilatation is associated. The adequate visualization of this artery was, therefore, not possible in about 22 percent of our patients.

Fig. 11 is a representative echogram obtained from a three year-old boy with the normal right coronary artery proved by angiography. A narrow echo free linear space which corresponds with the mid portion of the RCA was imaged along the atorioventricular sulcus.

A right coronary angiogram obtained from a 12 year-old boy with multiple coronary aneurysms is shown in **Fig. 12**, and **Fig. 13** is the echogram demonstrating the same finding.

There was no technical difficulty in imaging the distal portion of the RCA in all patients using new approach, although it required careful control of the gain and rejection to avoid

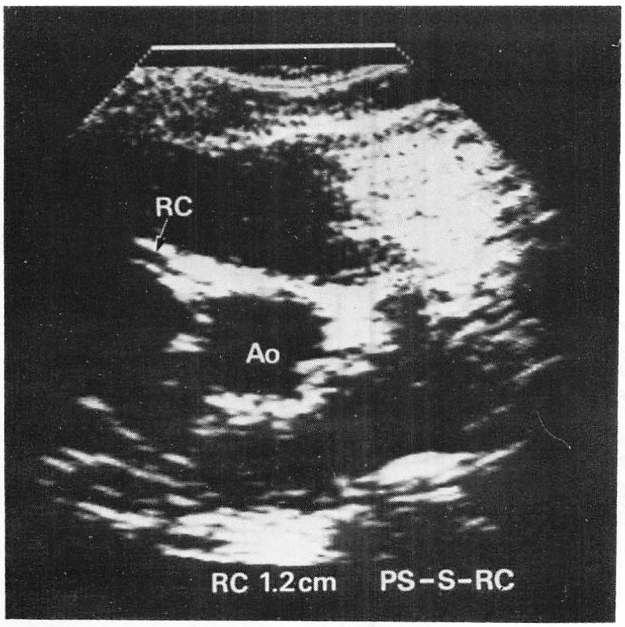

Fig. 5. Parasternal-short axis-right coronary artery view.
RC=right coronary artery; Ao=aorta.

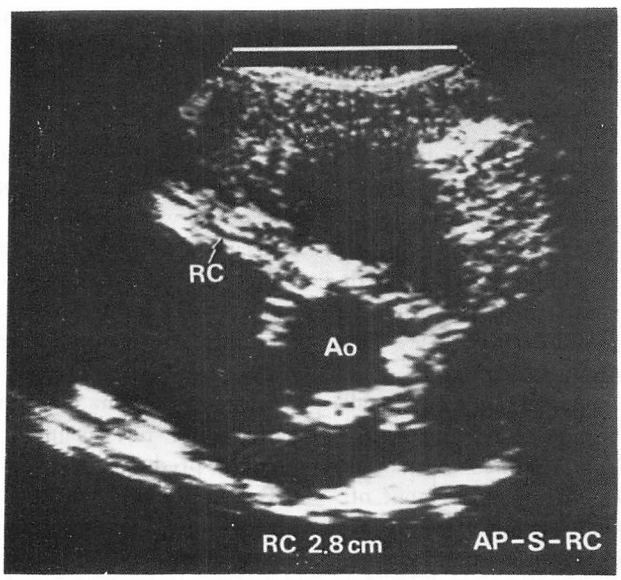

Fig. 6. Modified apical-short axis-right coronary artery view, obtained from the same patient in figure 5.
RC=right coronary artery; Ao=aorta.

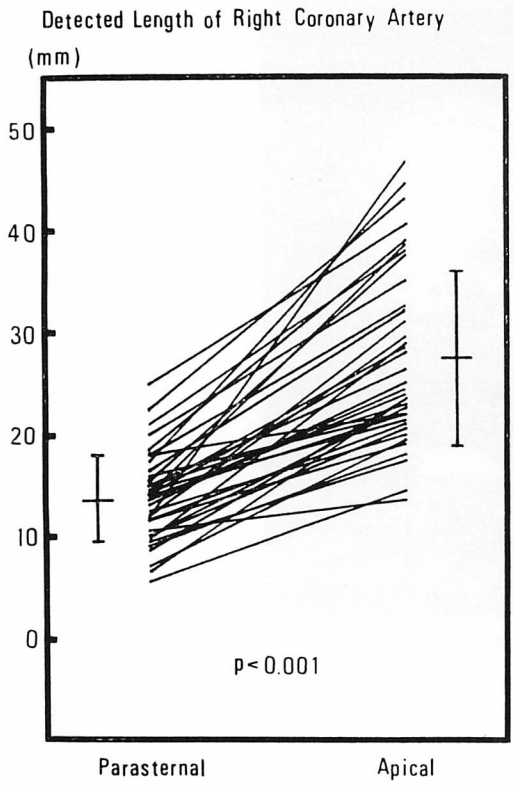

Fig. 7. Comparison of the detected length of the right coronary artery obtained using parasternal and apical approaches.

Fig. 8. Lateral view of the selective right coronary arteriogram.

the equivocal records. The confirmation of the validity of this technique was made comparing with the findings of the coronary angiography. The solitary aneurysm located in this portion in an one year-old boy demonstrated reasonably good agreement between the coronary angiogram (**Fig. 14**) and 2DE (**Fig. 15**).

Fig. 16 is a right coronary angiogram of a two year-old girl with a small solitary distal aneurysm as well as a large proximal aneurysm. This finding exactly corresponded with the image of 2DE (**Fig. 17**). A small segment of the relatively normal distal portion of the RCA running into a large echo free area represents the aneurysmal dilatation.

The posterior descending artery needed an elaborate and careful investigation to be detected by 2DE. This artery was also imaged as a narrow echo free linear space, and only a small segment was visualized. Moreover, this artery disappeared from the examination plane due to the respiratory change of the location of the heart. Therefore, the adequate recording rate of this artery was 44 percent of our children. Coronary arteriography demonstrated no abnormality in this artery in all children, so that we could not examine whether our method could predict the abnormality of this artery. But we confirmed the validity of this technique by demonstrating the continuity of this artery to the distal portion of the RCA, which was lately ascertained by coronary angiography. **Fig. 18** is one of the echograms showing the continuity of these two arteries. The

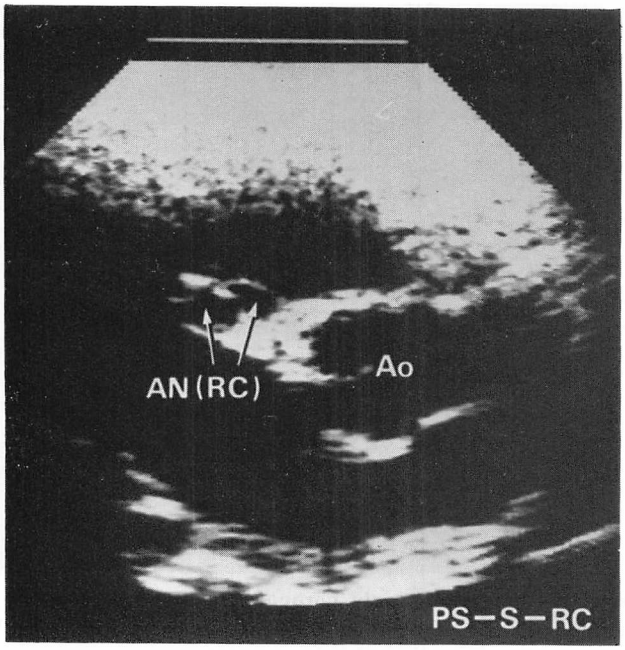

Fig. 9. Parasternal-short axis-right coronary artery view obtained from the same patient in figure 8.

AN(RC)=aneurysm of the right coronary artery; Ao=aorta.

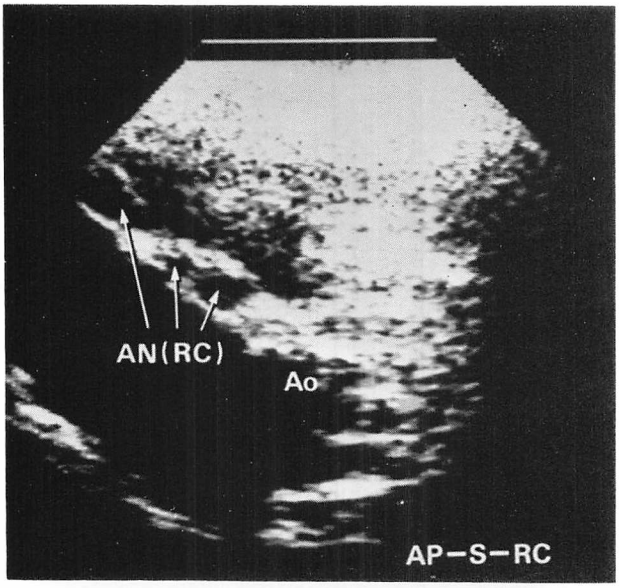

Fig. 10. Modified apical-short axis-right coronary artery view of the same patient in figures 8 and 9.

AN(RC)=aneurysm of the right coronary artery; Ao=aorta.

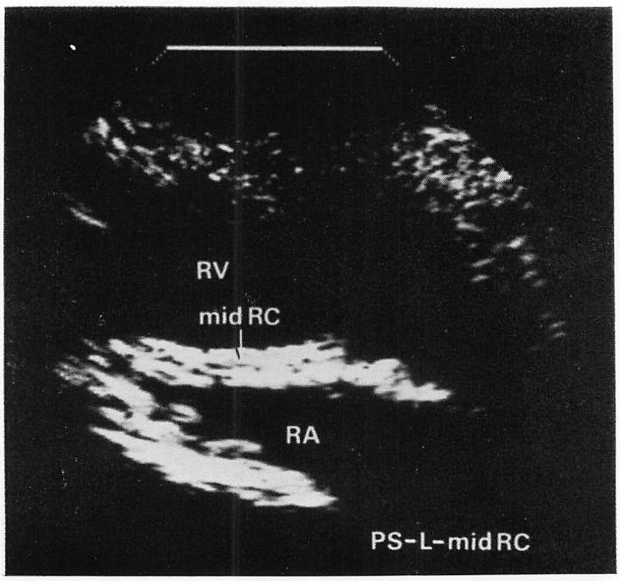

Fig. 11. Parasternal-long axis-mid right coronary artery view.
RV=right ventricle; mid RC=mid portion of the right coronary artery; RA=right atrium.

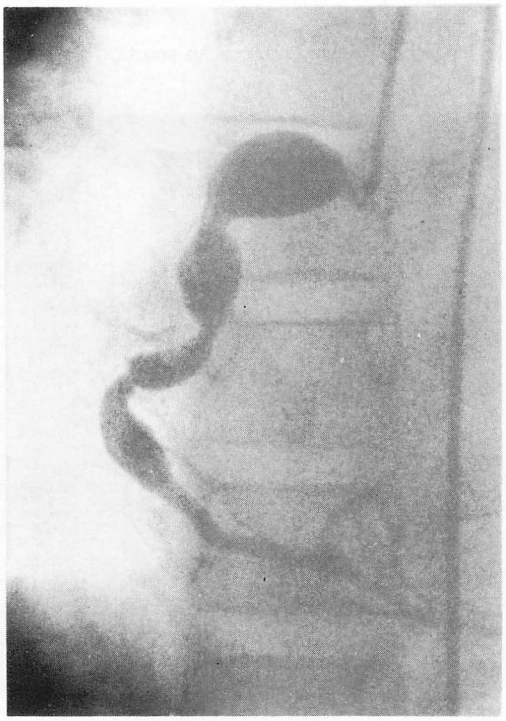

Fig. 12. Frontal view of the selective right coronary arteriogram obtained from a 12-year-old boy.

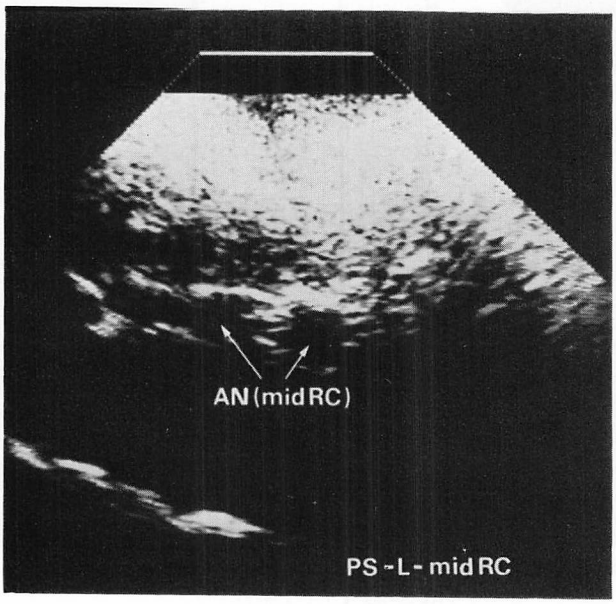

Fig. 13. Parasternal-long axis-mid right coronary artery view obtained from the same patient in figure 12.

AN (midRC)=aneurysm of the mid portion of the right coronary artery.

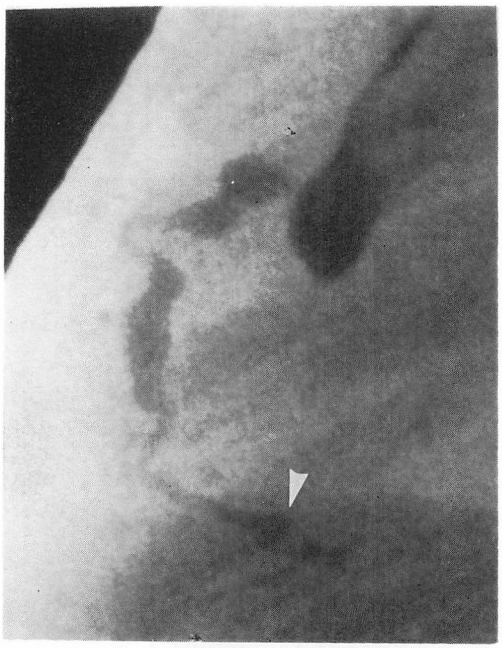

Fig. 14. Lateral view of the selective right coronary arteriogram obtained from an one-year-old boy.

A white arrow indicates an aneurysm in the distal portion of the right coronary artery.

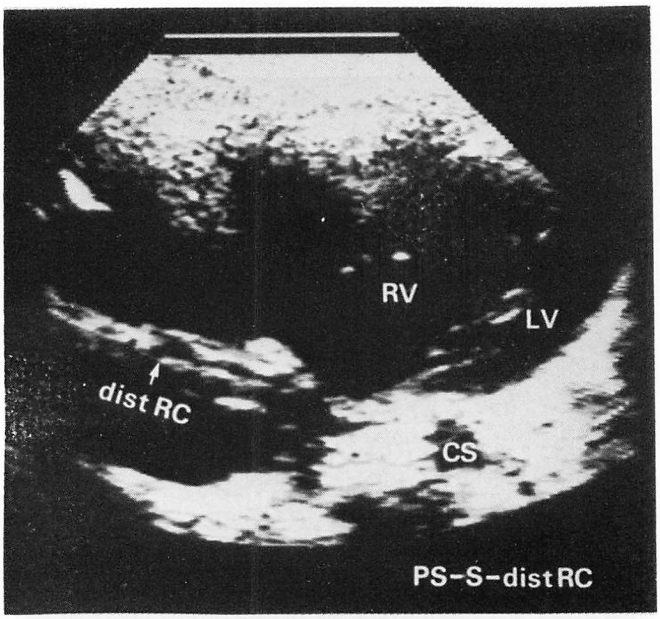

Fig. 15. Parasternal-short axis-distal right coronary artery view obtained from the same patient in figure 14.

dist RC=distal portion of the right coronary artery; RV=right ventricle; LV=left ventricle; CS=coronary sinus.

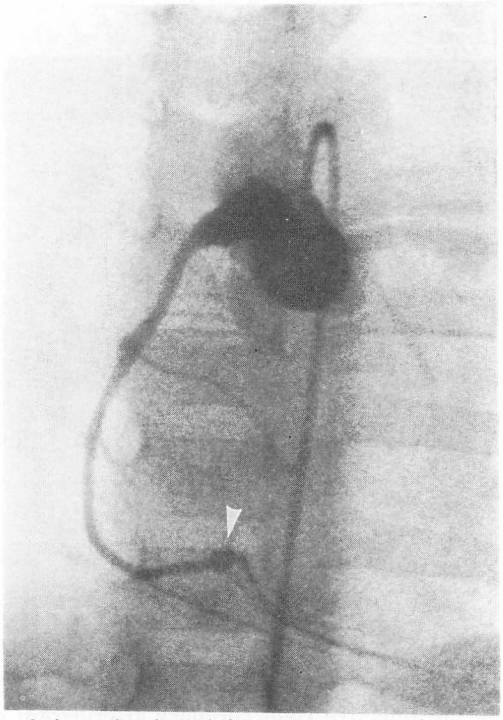

Fig. 16. Frontal view of the selective right coronary arteriogram obtained from a two-year-old girl.

A white arrow indicates an aneurysm in the distal portion of the right coronary artery.

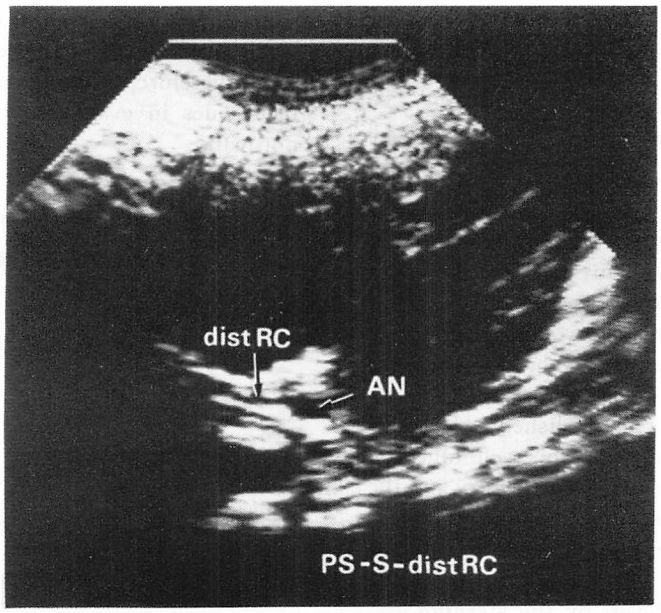

Fig. 17. Parasternal-short axis-distal right coronary artery view obtained from the same patient in figure 16.

dist RC=distal portion of the right coronary artery; AN=aneurysm.

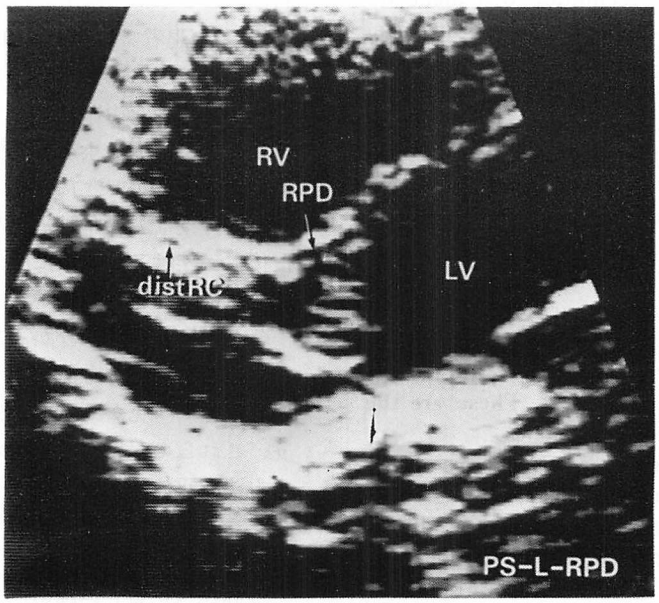

Fig. 18. Parasternal-long axis-posterior descending artery view showing the continuity between the posterior descending artery and the distal portion of the RCA.

dist RC=distal portion of the right coronary artery; RV=right ventricle; RPD=right posterior descending artery; LV=left ventricle.

distal portion of the RCA runs into the posterior descending artery which runs along the interventricular sulcus.

Discussion

The method to detect the coronary artery using 2DE was first described by Weyman and his co-workers.[6] Since then, this technique has been applied to many cardiac disorders including ischemic heart disease[6,7], congenital anomaly of the coronary artery[8] and MCLS.[3,4,9] The clinical usefulness in evaluating the narrowing or dilatation of the coronary artery by this technique has been established. However, despite the widespread use of this technique, the adequate imaging rate is not satisfactory and the detectable length is not long enough by a conventional approach, especially in the right coronary artery because a large part of this artery is hidden from the ultrasonic beam by the sternum.[5]

On the contrary, our method enabled the detection of the most part of the RCA and the posterior descending artery. The confirmation of the validity of our technique was made by the comparison with the angiographic findings, which were in close agreement with those of 2DE.

Although the adequate visualization of the proximal and distal portions of the RCA was possible in the majority of children, the detection of the mid portion and the posterior descending artery was not possible in a significant proportion (about 30 percent). In a patient with the normal coronary artery, a careful control of the gain and rejection is required to obtain a clear echogram because of the narrow image of the coronary artery. These are the limitations of the new approaches.

However, we never missed aneurysms of any portion of RCA prior to coronary angiography. We, therefore, believe that aneurysmal dilatation of the RCA, regardless of its location, can be visualized by 2DE using our new method.

Two-dimensional echocardiography has proved useful in the clinical evaluation of the RCA in patients with MCLS. Although there are some limitations in our method, most part of the RCA is visualized in the majority of patients. We, therefore, recommend the use of our techniques in evaluating coronary arterial abnormality.

超音波断層法を用いる川崎病における右冠動脈起始部，末梢部，後下行枝の新しい検出法

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要　約

川崎病患者において，超音波断層法を用いた右冠動脈起始部，中間部，末梢部，後下行枝の新しい検索法を述べた．

心尖部アプローチ変法を用いれば，右冠動脈起始部は従来の方法に比べ，長い範囲の描出が可能であった．また検出は全被検者で可能であった．

右冠動脈中間部は胸骨左縁より探触子を右方に向けることにより描出し得たが，満足できる像は約78%の患者でしか得られなかった．

右冠動脈遠位部の描出は，胸骨左縁より four chamber 像を描出した後，探触子を下方に向けることで可能であった．全被検者で，満足な像を描出することができた．

後下行枝は胸骨左縁より左心室長軸像を描出した後に，探触子を下方に向けてゆくと，室間溝に沿って描出できた．しかし，約56%の患者では十分な画像が得られなかった．

これらの新しい方法により得られる断層所見と冠動脈造影所見が非常に良く一致することにより，これらの手技の妥当性が確認された．これらの方法を駆使することにより，右冠動脈末梢部にできた冠動脈瘤を超音法断層法にて見落とすことはなかった．

今回述べた新しい検索法は，川崎病患者の右冠動脈病変の評価上，有用であるとおもわれた．また他の疾患における右冠動脈病変の評価にも検討されるべき方法であると思われた．

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