Diagnosis of Coarctation of the Aorta with the Aid of the Low Frequency, Critically Damped Ballistocardiograph

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Ballistocardiograms taken with the low frequency, critically damped ballistocardiograph on 17 patients having coarctation of the aorta have a characteristic pattern in which the K wave is absent. In the patients in whom the coarctation was surgically removed, the pattern returned toward the normal type with reappearance of the K wave.

A recent study by Nickerson1 of the origin of the K wave of the ballistocardiogram has indicated that interference with the flow of blood down the descending aorta diminishes or eliminates this wave. The purpose of the present article is to report the ballistocardiographic findings in a series of patients with coarctation of the aorta and to demonstrate the changes in pattern appearing after surgical repair of the defect.

The probability of the existence of a coarctation in all these patients was decided by clinical examination, and a ballistocardiogram under basal conditions was made. The ballistocardiograph used was the low-frequency, critically damped instrument designed by Nickerson and Curtis2 and tested by comparison with the direct Fick method by Nickerson, Warren, and Brannon.3 Ballistocardiograms were also made postoperatively on those patients on whom operative procedures were undertaken. The first of these records was usually made about two weeks after operation and subsequent records were made when the patient returned to the hospital for examination. The records were made both with and without breath-holding, the cardiac output being computed from the records made during quiet breathing. Electrocardiograms were recorded simultaneously with the ballistocardiograms.

Seventeen patients with clinical diagnosis of coarctation of the aorta were studied. These patients ranged from 4 to 48 years of age with 13 of them in the second and third decade of life. Three of these patients were without symptoms while 14 had symptoms varying from slight fatigue on walking to pain, palpitation, coldness of the lower extremities, weakness, and dizziness. Two patients showed mental retardation.

Before operation the resting blood pressure in the upper extremities was in general high, ranging from 139/90 to 230/110, with an average for the whole group of 169/93. The pressure in the lower extremities was obtainable in only 6 of the patients and in these the systolic value averaged 72 mm. below the values in the upper extremities.

After operation the patients so treated showed an average fall from their preoperative pressures of 21 mm. systolic and 6 mm. diastolic in the upper extremities. The pressures in the lower extremities in these patients had become measurable after operation with a systolic value averaging 16 mm. below the upper-limb postoperative systolic pressure, and a diastolic pressure averaging 9 mm. above the upper-limb postoperative diastolic pressure.

Seven patients showed no notching of the ribs. Four patients showed minimal notching while the remaining 6 had marked notching.

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of the ribs. The angiocardiogram demonstrated coarctation definitely in 10 patients while 3 had questionable narrowing of the large vessel. In one patient only, the presence of large collateral vessels was shown without corresponding narrowing of the aorta. In one patient the
angiocardiogram showed no abnormality although a coarctation was demonstrated at operation. In 2 patients angiocardiograms were not made.

In addition to the finding of coarctation of the aorta at operation, 3 patients showed aortic insufficiency and two patients, patent ductus arteriosus.

The ballistocardiographic patterns of all these subjects with coarctation show one striking feature in common, namely, the absence of the K wave. The ballistocardiograms of the patients upon whom operation was not performed are shown in figure 1. The pre- and postoperative ballistocardiograms of the patients having surgical repair of the coarctation are shown in figure 2. The generation of the K wave appears to be due mainly to the footward impact, produced when the systolic rush of blood down the descending aorta is slowed in its course by its accumulation in the lower portions of this vessel. When the aorta is constricted, this rush of blood is absent and absent also is the impact which would carry the critically damped system across the base line of the pattern to produce the K wave.
An examination of figure 2 shows that the operative procedures which improve the flow of blood down the descending aorta also restore small K wave, has now, a year later, a well-developed K wave (fig. 3). This patient had a subclavico-aortic anastomosis and the improvement is probably due to the gradually increasing effectiveness of the new aortic channel.

Similar observations on the absence of the ballistic pattern toward normal with the appearance of a K wave. Patient J. H., in whom the early postoperative pattern showed only a...
K wave in coarctation of the aorta were reported recently by Brown, Hoffman, and De Lolla using a ballistocardiograph of the Starr type (high-frequency and undamped). However, in our experience the coarctation type pattern is more clearly and consistently shown in the critically damped system than with the undamped system.1

Summary

The recording of low-frequency, critically damped ballistocardiograms of 17 patients with clinically diagnosed coarctation of the aorta shows in all the patients a pattern characteristic of the syndrome. This characteristic sign is the absence of the K wave of the pattern. In the 7 of these patients on whom operative removal of the coarctation was performed, the pattern shows a return to normal with restoration of the K wave.

REFERENCES

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