Professor Bennett,
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(17)

From the *Journal of Anatomy and Physiology,* Vol. III.

THE EFFECTS OF ROWING ON THE CIRCULATION, AS SHOWN BY EXAMINATION WITH THE SPHYGMOGRAPH.

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DURING the summer of the present year, I took advantage of an opportunity for making a number of observations on the effects of rowing on the circulation. These were recorded with the exactitude that the sphygmograph has now made possible; and, apart from any intrinsic importance, they may prove of some interest in relation to recent discussions on the possibly injurious effects of rowing-exercise.

The observations were made on the crew of one of our University four-oar boats, and they extended over two-thirds of the period of training immediately antecedent to the races. The members of the crew were men in robust health, their ages varied from twenty-one to twenty-eight years, and they were, at the time, living in the quiet and regular manner—with prescribed diet and exercise—which is usually considered necessary on such occasions.

The instrument employed was the well-known Sphygmograph of Marey; and in the absence of any arrangement to ensure uniformity and definiteness of pressure on the artery —the importance of which has been ably pointed out by Drs Anstie, Sanderson, B. Foster, and others—great care was always observed in obtaining such pressure as was necessary to produce the highest systolic ascent. Tracings were made immediately before the crew left the boat-house, and, on the same member or members, a few minutes after their return. In this interval a row of from two-and-a-half to three miles had been taken, of which the final mile consisted of a 'spurt,' during which the boat is impelled at the greatest possible speed. I thus obtained tracings immediately before and after violent rowing exercise. The changes that were produced were of an extremely uniform character, not only on the different occasions, but also with the different members of the crew. The examination of one set of tracings is, therefore, sufficient to show what changes are produced. I have selected for illustration those taken from the 'stroke' of the boat, who, as all the initiated are aware, has the greatest share of the labour during rowing.

Figure 1 represents a tracing of the pulsations of the right radial artery, obtained immediately before the crew left the boat-house.

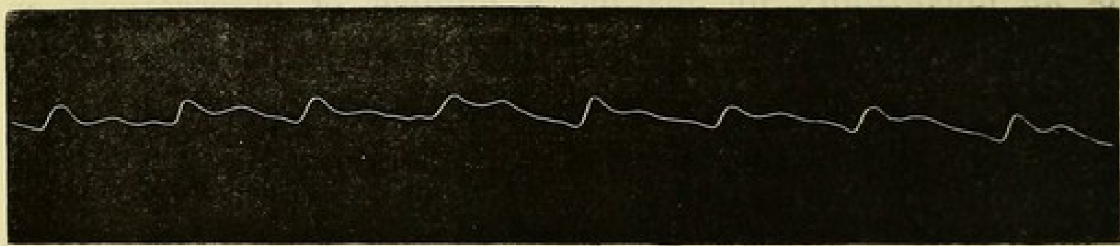

Fig. 1. D. T., aged 21. Right radial artery, before rowing.

The general appearance of this tracing is such as is very usually obtained in normal health. The lowest and highest points of the repeated pulsations are nearly on the same plane; the lines of ascent are short and oblique; and the lines of descent are oblique and somewhat convex, and they are interrupted, in all cases, by a well-marked dicrotic wave, and, occasionally, by several slight undulations. The rate of pulsation was sixty-eight in the minute.

Figure 2 represents a tracing from the same artery, five minutes after the return to the boat-house. The tracing that was taken *immediately* after the return exhibits several irregularities, that were not produced by the condition of the circulation but by unsteadiness of the arm, which it is well known is caused by exercise even when much less severe than that of rowing. It will be observed that in this tracing

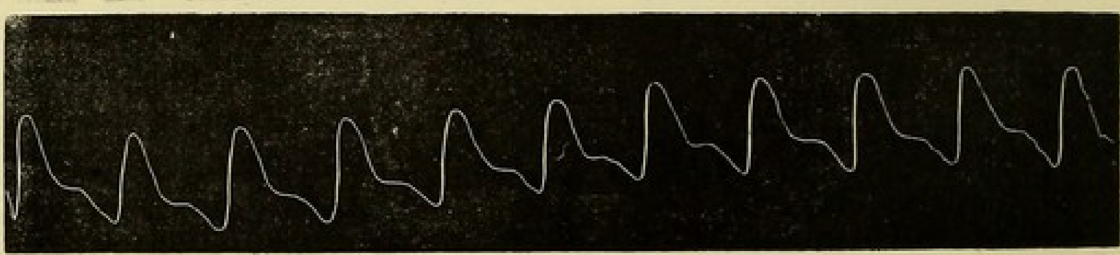

Fig. 2. D. T. Right radial artery, after rowing.

a portion of the unsteadiness still remains, the irregularities in the lines of descent of the last three pulsations being due to it.

The general appearance of this tracing is strikingly different from that of Figure 1. The lowest and highest points of the repeated pulsations are not on the same planes; the lines of ascent are long and vertical; the summits are however, generally, rounded like those of Figure 1; the lines of descent are concave and much less oblique; and the dicrotism consists more of an interruption to the line of descent than of an additional wave. The rate of pulsation was ninety in the minute, and the space occupied by each pulsation is, therefore, shorter than in Figure 1.

The tracing depicted in Figure 2 differs most obviously from that in Figure 1, in the unequal levels of the lowest and highest points of systolic ascent (forming the *lignes d'ensemble*) and in the greater length and more vertical direction of the line of ascent. The curve of the *lignes d'ensemble* is caused by an increase in the respiratory efforts, which rowing, in common with other forms of physical exercise, produces. The effect of respiration in varying blood-tension is thus exaggerated.

The great length of the systolic line of ascent indicates a general diminution, at the moment of ventricular contraction, in the arterial tension, the result, principally, of dilatation of blood-vessels; and the vertical direction of this line shews that the contraction of the ventricles is performed quickly and sharply, or with *suddenness*. This line is continued for a short distance, before its descent, in a somewhat curved horizontal direction. This is a character of considerable importance, as it at once distinguishes the tracing from one where the long vertical line is the result of diminished blood-tension only, in which case the line of descent forms an acute angle with the line of ascent. The line of descent is oblique, and it is interrupted by a dicrotic curve, which does not assume the proportions of a distinct wave. This latter character, viewed in connection with the rounded summit, proves that the heart propels a large stream of blood during each ventricular contraction, so as to fully distend the arterial system, notwithstanding its dilated condition. Further, it is important to note that there is no evidence that the amount of blood propelled into the arteries during each ventricular contraction is greater than can freely pass into the veins.

I met, on one occasion, with an unimportant modification in the form of the horizontal line. This is represented in Figure 3. In place of being a continuous curve, a slight break occurs at the commencement of this line. It would seem to shew that a slight interruption had taken place towards the end of the ventricular systole. All the other tracings from this member of the crew have a form similar to that represented in Figure 2.

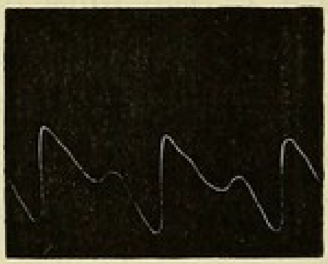

Fig. 3.

The tracings I have obtained, show therefore that an extremely large quantity of blood is being circulated with great rapidity—a condition of the circulation we should consider essential, on *à priori* grounds, for the continuance of prolonged and severe muscular exertion. It is obvious that in the great majority of functional and organic diseases of the vascular system such a condition could not possibly be maintained. The subjects of these diseases are, therefore, completely incapacitated from *violent* rowing-exercise, and cannot be in a position to be injured by it. It is possible that the presence of incipient forms of disease of the vascular system may not altogether prevent such exercise from being undertaken; but I believe that all such diseases may be detected by the use of the sphygmograph in time to prevent further mischief, the examination being made immediately before the boat is entered, and a few minutes after a moderate *pull* has been indulged in.

The effects that rowing produces on the circulation seem to be similar to those that are produced by many other forms of muscular exercise.

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