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A COMPARISON OF ARM-CUFF AND WRIST-CUFF BLOOD PRESSURE PATTERNS IN POLYGRAPH CHARTS

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Because a number of examiners have been conducting polygraph tests with a bloodpressure cuff on the subject's wrist, instead of the more frequently used upper arm, this experimental work has been conducted to learn what differences in patterns might be expected. It is usually asserted that the blood pressure cuff on the wrist is more comfortable; and, therefore, permits the recording of a slightly longer test. It is also generally conceded that the wrist-cuff produces a somewhat smaller pattern. Accepting the general observation that the wrist-cuff or radial-ulnar pattern is smaller than a recording from the upper arm or brachial pattern, the essential question is whether or not there is a qualitative difference.

The question of quality here involves legibility and reaction. As for legibility, there does not appear to be any practical problem with instruments manufactured during the last few years. There have been a few cases where the radial-ulnar pattern was insufficient. These cases were readily handled with the more customary brachial recording. The occasional instance where the radial-ulnar pattern is insufficient does not present a serious problem because all instruments that utilize a wrist-cuff will also use an arm-cuff. The important factor in changing the size of the blood-pressure cuff is in noting the possibility of errors in chart interpretation. This will be discussed in more detail later.

To achieve a useful knowledge of the differences in these two types of patterns, two programs were followed. In the first, over four hundred charts of each type were reviewed. These charts were all from regular cases (not experimental). Second, a series of experiments were conducted in which simultaneous recordings were used. That is, a wrist-cuff on one arm and an arm-cuff on the other. (While this was not very comfortable, no ill effects were noted.)

The review of charts from actual cases could only

lead to general observations. From these it was determined that wrist-cuff patterns are generally smaller, and this meant less frequent use of the resonance control, and less recentering of cardio-sphygmograph patterns. The operating pressure varied from twenty to forty millimeters higher at the wrist than at the arm, which is necessary because of the higher pressure in the arteries at the radial-ulnar location. This makes little or no practical difference in testing, so long as the instrument pressure is at or near the mean pressure of the artery from which the recording is made. Most instruments manufactured in recent years are capable of recording at the increased pressure without damaging the tambor. As for the subject, this higher pressure at the wrist is offset by the smaller area that becomes numb; that is, only the hand instead of the arm and hand.

As was to be expected, the pulse rate was as easily counted from one pattern as the other. In the radial-ulnar patterns there were more cases in which the dicrotic notch was not clear, or not legible at all. This is unfortunate because the dicrotic notch is more important in radial-ulnar patterns where pressure changes are often subtle. From the study of charts it was also noted that radial-ulnar reactions were most noticeable as rises in the diastolic, or bottom side of the pattern. Most important, *these reactions were often so small that they would have been considered insignificant in an arm-cuff pattern.*

EXPERIMENTS

Because we replaced the pneumograph unit with a second cardiosphygmograph unit, our research polygraph could not be used in routine cases. The results are therefore of an experimental type. Several combinations of tambors were used. In each test, the tambor used was less than a year old. In some cases an Associated Research (Keeler Poly-

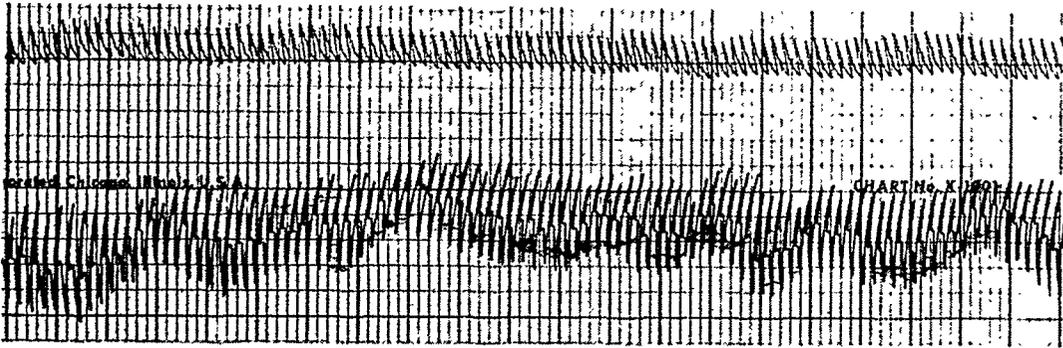


Figure 1

Upper pattern recorded with a wrist-cuff placed over the radial-ulnar arteries. Lower pattern recorded with an arm-cuff over the brachial artery. Although the recordings were simultaneous, the pen tip locations were not side-by-side. Therefore, a pulsation in the upper pattern should be compared with the pulsation in the lower pattern that is 7 vertical lines to the right. Note the extreme difference in sensitivity between these recordings.

graph) tambor was used for the arm and a C. H. Stoelting tambor was used for the wrist recordings. In other tests both patterns were made with C. H. Stoelting tambors.¹ All recordings were made with as much standard equipment as possible. The pens were always those for which the tambor was designed. The kymograph was standard; in some cases an Associated Research unit, in others a C. H. Stoelting unit. Both used charts designed for Esterline Angus sprockets and calibrated to the standard six inches per minute.

Seventy-nine persons were tested with the apparatus. In every case, the recording from the brachial artery was greater in amplitude than that from the radial-ulnar arteries. In each case, the subject stated that the cuff over the radial-ulnar arteries was more comfortable than that over the brachial artery. In each test, clear, sharp, interpretable patterns were obtained with both tambors. As expected, pulse frequency recordings were identical. In comparison charts, reactions were generally smaller in amplitude and proportion in the radial-ulnar pattern than in the brachial artery pattern recorded at the same instant. The most serious aspect of these comparisons is the occasional occurrence of reactions in the brachial pattern without a corresponding reaction of any kind in the radial-ulnar

pattern (see figure 1). It is assumed that these reactions have been dampened in traveling the length of the arm.

In actual practice the situation is not as critical as it appears when considered only from the experimental viewpoint. Large reactions recorded from the brachial artery always appeared in the radial-ulnar pattern; and the nervousness of a subject being tested usually assures reactions of sufficient amplitude. However, it is a reasonable possibility that the per cent of tests that are unresolved because the subject appears to be a "non-reactor" may be greater with those tested with the blood pressure cuff over the wrist, than with those tested with the blood pressure cuff on the upper arm. The greatly reduced proportion of wrist-cuff reactions should also be noted. Not only do they make interpretation more difficult for an experienced examiner but they represent a danger of misinterpretation for the inexperienced. This writer strongly recommends that an examiner who is not familiar with wrist-cuff patterns should undertake their study, and experiment with them before using them in actual tests. Otherwise, *there is a serious danger of overlooking significant reactions.*

For those who routinely use a wrist-cuff there may be some cases where a change to the arm-cuff will be beneficial. For example, if a wrist-cuff does not produce a pattern of sufficient amplitude, or if the subject appears by that pattern to be a "non-reactor," changing to an arm-cuff may produce a pattern of sufficient amplitude and sensitivity to be interpretable. The relative difference in the general amplitude and sensitivity to reactions in these two types of recordings must be considered

¹ Attempts to run both patterns with Associated Research tambors were unsuccessful. The Associated Research tambor is designed with a capacity of more than twice the air space of the Stoelting tambor. For that reason it does not always produce a pattern of sufficient amplitude when used with a standard $4\frac{3}{4}$ " x $2\frac{3}{4}$ " wrist cuff. A satisfactory wrist pattern can sometimes be obtained with an Associated Research tambor by using an arm-cuff, $9\frac{3}{8}$ " x $4\frac{7}{8}$ " folded over and placed over the wrist.

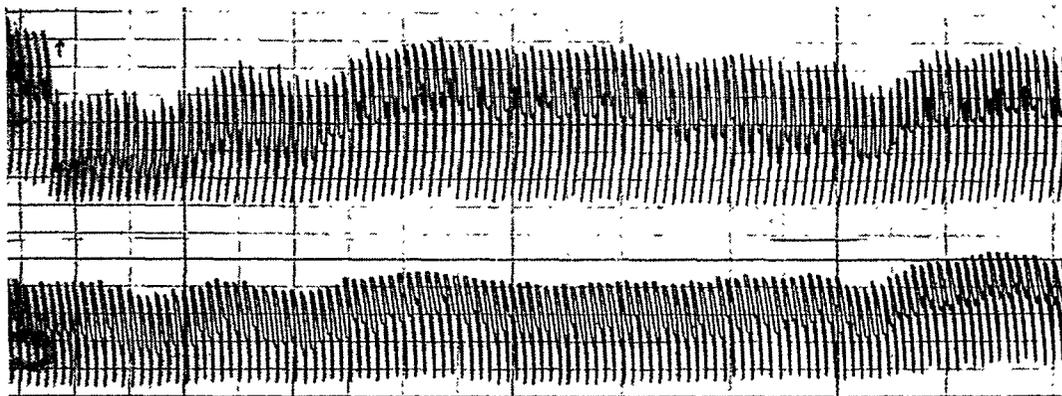


Figure 2

Upper pattern is an excellent wrist-cuff pattern, recorded from the radial-ulnar arteries. The lower pattern, an arm cuff pattern from the brachial artery offers only slightly more sensitivity. The pen tip locations were side-by-side in this recording.

in the interpretation. Conversely, if you use an arm-cuff and the subject's nervous tension is so unusual that the arm-cuff pattern is difficult to interpret, the reduced amplitude and sensitivity of the wrist-cuff may produce an interpretable pattern. However, changing the blood pressure cuff size and location is not recommended unless the examiner is experienced in the interpretation of both types of patterns (figure 2).

SUMMARY

The advantage of the wrist-cuff placed over the radial-ulnar arteries is found in the relative comfort. Although both the arm and wrist cuffs do produce some mild discomfort, that of the wrist-cuff is noticeably less. In some cases this may permit tests of longer duration. In other cases it may have some value in reducing nervous tension. The matter of relative comfort will be of more interest to those who conduct commercial pre-employment screening tests than to those in law enforcement. In occasional cases the interpretation of wrist-cuff patterns may be easier because the extraneous reactions caused by general nervous tension may not appear in the pattern. In other words, reduced sensitivity is sometimes desirable. There are also a few cases in which it is not possible to obtain a satisfactory pattern from the upper arm because of excessive fat; a situation sometimes resolved by

the use of a wrist-cuff. It appears that even when the upper arm is fat the wrist is often fairly lean, thus making a recording possible.

The disadvantage of the wrist-cuff is in the smaller reaction pattern. If a reaction does not appear on the chart there is the genuine risk of misinterpretation. It is also likely that the use of the wrist-cuff results in a larger per cent of unresolved tests; in which the subject is considered a "non-reactor." Most important is the serious danger of an examiner misinterpreting wrist-cuff charts based on his previous work with the more common arm-cuff. At least every examiner should be aware of the vast difference in the relative amplitude of reactions from the two positions before using a wrist-cuff. Similarly, if there are some examiners whose experience is limited to the wrist-cuff, they should exercise extreme caution and seriously study arm-cuff patterns before changing.

From these studies and experiments it is concluded that the arm-cuff over the brachial artery produces a consistently better pattern and should be used in preference to the wrist-cuff over the radial-ulnar arteries whenever the problem of relative comfort or test length is not essential. However, it is concluded that the difference is not so serious as to preclude the use of the wrist-cuff by an examiner familiar with the pattern it produces.