STUDIES OF METHODS OF DETERMINING CAPILLARY FRAGILITY*

II. NEGATIVE PRESSURE TECHNIC USING THE PETECHIOMETER®

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INTRODUCTION

In a previous study of capillary fragility in 190 white male subjects, the authors reported that age of subject and time of test exert some influence on the result of the Rumpel-Leede test (1). One hundred of these same individuals were also tested with a Petechiometer®† which has been advocated as a simple, accurate and readily available suction (or negative pressure) type of instrument (2, 3). The results obtained with the Petechiometer are discussed in the present report.

MATERIALS AND METHODS

The present experimental group was composed of 100 white male subjects including 20 individuals in each of 5 age groups ranging from 20 to 70. This series included 35 from a veterans domiciliary institution; 25 post-surgical patients convalescing from hemorrhoidectomy, herniorrhapy or appendectomy; 34 who had recovered from skin diseases in whom there had been no involvement of the test areas; and 6 from the medical service who were ready for discharge. There were no subjects in this test group who had hypertension, tuberculosis, febrile illness, diabetes, hemorrhagic or purpuric or other known systemic disease with the exception of arteriosclerosis in the older subjects.

The areas, each of which was tested bilaterally, included the flexor surface of the forearm, upper arm, proximal anterior thigh, lateral surface of the calf, and upper back. In each individual the Petechiometer test on the forearm preceded the Rumpel-Leede determination. Excessively hirsute areas were shaved before the tests were performed. With the subject lying in a supine position each test site was marked with an ink stamp having two concentric circles. The inner circle was one centimeter and the outer was two centimeters in diameter. The petechiae were read in the inner circle only. Previously pigmented spots in the test area were covered by ink. A three-inch rounded lens was used to exert diascopic pressure thereby facilitating the recognition of petechiae. All subject were at rest for 30 minutes before the tests were initiated.

The Petechiometer consists of a clear plastic Bier bell suction cup two centimeters in diameter. A black barrel containing a plunger is permanently attached to the suction cup. In the commercially available Petechiometer, the plunger has three grooves corresponding to 10, 20, and 30 centimeters of mercury suction. A six-grooved plunger was used in the

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† ® Trade Mark, Rexall Drug Company, Los Angeles, California.
present experiments, each groove representing an increment of five centimeters of mercury suction ranging from 5 to 30 centimeters. The various suctions are obtained by placing a stop ring on the appropriate slot on the plunger, for example the 20 centimeter slot. Next the plunger is pushed into the barrel up to this ring, thereby expelling the air. The edge of the bell is lubricated with petrolatum and then firmly placed on the previously marked test site. Next the plunger is released and the suction produced is applied for exactly one minute (measured by a General Electric Interval Timer).

The test site was observed for five minutes after the test. If two or more petechiae were not observed in the central one centimeter area of the test site additional tests were made using 25 centimeters. If more than two petechiae resulted from the 20 centimeter mercury suction, 15 centimeters was tested, or lower pressures until a negative result was obtained. The lowest pressure yielding two or more petechiae was considered as the end point and was recorded as the capillary fragility (or resistance) of the test site. The lowest possible reading was 5 centimeters, the highest was 30 centimeters. In those areas where no petechiae followed the application of 30 centimeters of mercury suction, the results were recorded as greater than 30 centimeters. In these instances it was impossible to determine whether the true capillary resistance was 35, 40, 45 or even greater.

**TABLE 1**

<table>
<thead>
<tr>
<th>SIDE</th>
<th>FOREARM</th>
<th>UPPER ARM</th>
<th>INFRACLAVICULAR</th>
<th>BACK</th>
<th>LEGS</th>
<th>THIGHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>19.1</td>
<td>19.4</td>
<td>22.6</td>
<td>9.9</td>
<td>&gt;30</td>
<td>30</td>
</tr>
<tr>
<td>Left</td>
<td>24.3</td>
<td>21.7</td>
<td>25.7</td>
<td>9.8</td>
<td>&gt;30</td>
<td>29</td>
</tr>
</tbody>
</table>

In order to check the constancy of the calibrated pressures on the Petechiometer, tests were made at two to three week intervals. The standardizing apparatus* consisted of a wooden stand supporting six vertical glass tubes of the same calibre and height. Each tube was connected to a glass bulb containing mercury and had an adapter on the free end which permitted the fitting of the Petechiometer suction cup over it. The suction pressures indicated by the slots on the Petechiometer plunger could be verified by the height of the mercury column drawn into the glass tube. Throughout the course of the experiments these values remained constant.

**RESULTS**

The present study shows the results obtained in 100 subjects tested with the Petechiometer. In each subject six areas were tested on contralateral sides. Table 1 shows the medians for the right and left side of each of the six areas tested. Where the median did not fall exactly on an even score, e. g., 5, 10, 15, 20, 25, or 30, a corrected score was obtained by linear interpolation. This method is described in detail by McNemar (4).

These results have been statistically analyzed using Mood’s chi-square method of analysis (5). The use of medians was selected rather than means because the

* Made by Lewis-Larsen Company, Los Angeles, California.
Petechiometer did not permit readings of suction greater than 30 centimeters of mercury. Without the test values above 30 centimeters an accurate mean could not be calculated.

Table 2 shows the chi-square and corresponding P values obtained in comparing the right and left sides of five test areas. For example, the P value less than .005 for the forearm means that there are less than 5 chances out of 1000 that the difference between the right and left forearms is due to chance, or that the difference found between the two sides is significant. No chi-square value for the legs could be calculated since the medians were greater than 30.

Table 3 also demonstrates the difference obtained between the right and left side in each of the test areas. There are five columns shown. The first two columns indicate the area and the total number of subjects tested. For each area the subjects who had a reading of 30 on one side and greater than 30 on the other were not included in the total number of patients because the instrument was not adapted to read values greater than 30 centimeters of mercury suction, therefore making it impossible to determine the difference. The third column shows the frequency of occurrence of the same capillary resistance bilaterally for each test site. The fourth and fifth columns show the incidence of a difference of 5 or 10 or more centimeters mercury suction, respectively, for each test area. For example, Table 3 shows that 38 subjects had the same capillary fragility values in both forearms while 30 had a difference of 5, and 25 had a difference of 10 or more centimeters mercury suction.

**Table 2**

<table>
<thead>
<tr>
<th>AREA TESTED</th>
<th>CHI-SQUARE</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forearm</td>
<td>8.7</td>
<td>&lt;.005</td>
</tr>
<tr>
<td>Upper Arm</td>
<td>2.7</td>
<td>.10</td>
</tr>
<tr>
<td>Infraclavicular</td>
<td>1.0</td>
<td>.25</td>
</tr>
<tr>
<td>Back</td>
<td>.75</td>
<td>.25</td>
</tr>
<tr>
<td>Thigh</td>
<td>.68</td>
<td>.25</td>
</tr>
</tbody>
</table>

**Table 3**

<table>
<thead>
<tr>
<th>AREA</th>
<th>NUMBER OF SUBJECTS</th>
<th>SAME</th>
<th>DIFFERENCE OF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Forearm</td>
<td>93</td>
<td>38</td>
<td>30</td>
</tr>
<tr>
<td>Upper Arm</td>
<td>89</td>
<td>31</td>
<td>25</td>
</tr>
<tr>
<td>Infraclavicular</td>
<td>87</td>
<td>51</td>
<td>21</td>
</tr>
<tr>
<td>Leg</td>
<td>89</td>
<td>82</td>
<td>3</td>
</tr>
<tr>
<td>Thigh</td>
<td>84</td>
<td>52</td>
<td>21</td>
</tr>
<tr>
<td>Back</td>
<td>97</td>
<td>74</td>
<td>20</td>
</tr>
</tbody>
</table>
DISCUSSION

The Petechiometer has been advocated as a simple means of testing capillary fragility. Weinberg (2) has cited the advantages of the Petechiometer over the positive pressure methods as follows:

a. Only a small hairless area is required.
b. Multiple determinations can be made and can be frequently repeated.
c. Skin discoloration is limited to an area centimeters in diameter rather than the entire forearm as occurs after a positive Rumpel-Leed test.
d. The procedure is without discomfort or pain to the subject and is not time consuming.

Brown tested 100 subjects with a Petechiometer on one forearm and a modified Dalldorf resistometer on the other. He found that 10 per cent of the patients showed a difference of more than 5 centimeters of mercury suction between the arms but concluded that this was not significant. He also reported that the average capillary resistance found with the Petechiometer was essentially the same as the average reading with the Dalldorf technic.

The present experiment was undertaken to study the capillary resistance of different areas of the body using a negative pressure technic (Petechiometer) and to compare the results between the right and left side of each area. Table 1 shows the median values of the six areas tested and indicates that different areas may vary in their capillary resistance. Generally, the forearm, upper arm, and infraclavicular areas seem to have some difference between the two sides whereas the median capillary resistance for the two sides for the back, legs, and thighs are quite similar. It would seem therefore that the back, legs, or thighs would be better areas for measuring capillary fragility than the other three sites. However, more detailed analysis of the results reveals certain disqualifying evidence for all six areas.

Forearm. As shown in Table 1, the right forearm median is 19.1 and the left is 24.3. When this data was statistically analyzed the P value was found to be less than .005 (Table 2). This means that there are less than 5 chances in 1000 that the observed difference is due to chance. Consequently the variation between the right and left forearms is statistically significant and capillary fragility values are not comparable between the two sides.

Furthermore, 25 of 93 subjects (27%) demonstrated a difference between the forearms of 10 or more centimeters of suction (Table 3). Since the Petechiometer is only graduated to measure 10, 20, and 30 centimeters of suction, a difference of 10 or more in 27% of subjects would invalidate any attempt to compare bilateral values in the two forearms of any individual. Also with such a difference noted between the forearms of 27% of subjects, it would be difficult to determine which reading is normal. For example, in one individual who had a capillary fragility of 10 on the right and 20 on the left forearm, there was no way of knowing which of the two values was the normal one. The interpretation would vary also because a reading of 10 might suggest increased capillary fragility while 20 might be a normal value. Since the present experiments indicate that there is a statistical difference between the capillary resistance of the forearms, the previously accepted normal of 20 (6) is probably inaccurate. Until the normal
value has been determined, the Petechiometer would seem to be an inadequate
instrument for measuring capillary resistance in the forearm.

Upper Arm. The P value of .10 (Table 2) obtained from the Petechiometer
tests on the upper arm means that in only 10 instances out of 100 could the dif-
ference found between the two sides be due to chance. Therefore, the difference
observed between the contralateral upper arms is probably significant.

Table 3 offers additional support to the aforementioned conclusion because
23 of 89 subjects (26%) had a difference of 10 or more centimeters of mercury
suction between the right and left upper arms. Since one out of four subjects
would be expected to have this difference, it would be hazardous to test the upper
arm with the Petechiometer when it is necessary to compare the results on the
two sides. Also since 26% have this difference, the so-called normal capillary
fragility value for the upper arm is probably unknown and would be almost
impossible to determine because so many subjects have such a bilateral difference.

Infraclavicular. The P value .25 for this area indicates that in 25 of 100 in-
stances the difference which was obtained between the medians of the two sides
could be due to chance. Therefore the variation observed between the right and
left infraclavicular areas is not statistically significant. However, as shown in
Table 3, there were 15 of 87 subjects (17%) who had a difference of 10 or more
centimeters between the right and left infraclavicular sites; therefore it would
be difficult to determine a normal capillary fragility value for this area. Since
one out of every 6 individuals would be expected to show a difference of 10 or
more centimeters between the two sides, the infraclavicular area is not a site
where accurate comparison of the right and left sides can be made.

Back. The median values obtained on the right and left sides are quite similar
(Table 1). Analysis of the results indicates that the small difference between
the two sides is not statistically significant (Table 2). The data in Table 3 con-
firms the close correlation between the sides in that there were only 3 instances
in 97 where there was a difference of 10 or more centimeters. The major disad-
vantage of the back as a test area lies in the fact that the calculated median of
both the right and left sides is less than 10 centimeters of mercury suction. Since
the ordinary Petechiometer does not measure capillary fragility less than 10
centimeters, it is probably not possible to determine increased capillary fragility
on the back using this test instrument.

Thigh. The medians for the right and left thigh were quite similar and statistical
analysis resulted in a P value of .25. This means that the difference noted between
the medians is not statistically significant (Table 2). Despite this similarity of
the medians, there were 11 of 84 subjects (13%) who had a difference of 10 or
more centimeters between the two sides (Table 3). Therefore comparison of
capillary fragility values on the right and left thighs can not be accurately made
and a normal value would be difficult to obtain. However, it might be of value
to study this area in more detail because the median capillary resistance values
are high. This is important when the problem of decreased capillary resistance
is to be studied. With larger groups of test subjects it is possible that the 13%
difference between the contralateral values might become smaller.

Legs. Comparison of the results of the Petechiometer tests would suggest
that this is a good site for determining the status of capillary resistance because
the medians are the same on both sides (Table 1) and only 3 of 89 subjects had
a difference of 10 or more centimeters of mercury suction between the two sides
(Table 3). The similarity of results may be more apparent than real because
further studies with a resistometer graduated to measure values greater than
30 centimeters might not demonstrate congruous findings. If further studies
substantiate the results of the present experiment, it might be possible to meas-
ure decreased capillary resistance (increased capillary fragility) in the leg be-
because the normal value is at a high level. Additional tests in larger numbers of
subjects, including those with clinically decreased capillary fragility, are neces-
sary.

The results of the present studies with the Petechiometer indicate that none
of the six areas studied are adequate sites for measuring capillary resistance.
The forearm, upper arm, and infraclavicular regions cannot be used because of
the difference observed between the two sides. The back is an inadequate area
for measuring decreased capillary resistance because of its low median value.
The thigh and legs might be of some value as test sites but require additional
studies. Even if such studies would substantiate these regions for testing capillary
resistance, there are many other factors which are thought to exert some influ-
ence. The effects of temperature, barometric pressure, menses, thickness of skin,
season, and allergies would have to be investigated before the Petechiometer
could be considered as an accurate means of measuring capillary resistance in
these areas.

CONCLUSIONS

1. The median capillary resistance values were found to vary in six different
areas of the body tested with a Petechiometer.
2. A statistically significant difference was found between the right and left
forearm and upper arms, thereby invalidating the use of these areas for measure-
ment of capillary fragility with the Petechiometer.
3. The difference obtained between the right and left infraclavicular area,
back, leg and thigh was not statistically significant. However, none of these areas
seem to be ideal sites for determining capillary resistance with a Petechiometer
for reasons which have been discussed.
4. The commercially available Petechiometer is not a reliable instrument
for measuring capillary fragility.

REFERENCES