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Capillary resistance as a clinical index of adrenal function in surgical patients

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CAPILLARY RESISTANCE AS A CLINICAL INDEX OF ADRENAL FUNCTION IN SURGICAL PATIENTS

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Shock in patients after operation is not an uncommon condition. When the cause is not apparent, acute adrenal insufficiency is often implicated (1). The empiric administration of adrenal corticosteroids in such instances has two drawbacks: (a) It may lead to satisfaction that all necessary has been done for the patient when more thorough investigation would reveal the true cause of the shock; and (b) because of their side effects, corticoids should not be administered if their application is unnecessary.

A simple accurate clinical test to identify the patients who are truly suffering from adrenal insufficiency would be valuable. The Thorn test (2) and the application of the eosinophil count as an index of adrenal function is well known. More recently Perlmutter (3) has introduced a test for adrenal function by the measurement of urinary and blood levels of sodium. We have studied the measurement of capillary resistance as an index of adrenocortical function.

Capillary resistance has been shown to be an index of adrenal function (4,5,6,7,8,9). We determined the capillary resistance on 82 hospitalized patients. Serial capillary resistance determinations were made on patients before and after operation and on patients receiving ACTH. Urinary 17-hydroxycorticosteroid levels were determined in some of these patients.

We have correlated the changes in capillary resistance with the stress of operation and the administration of ACTH. Our findings would suggest that the capillary resistance test may be another simple clinical means of evaluating adrenal function.

METHODS

Selection of patients.--All patients studied were in the University Hospital, and most of them were on the surgical service. We chose those patients for whom major operations were planned so a hospital stay of several days would allow time for serial studies.

Method of study.--Capillary resistance was determined in four different areas of the body to find the most suitable area. The infraclavicular area, the medial aspect of the arm, the volar aspect of the forearm, and the medial aspect of the thigh were the areas studied. In studying the early results, it was learned that the infraclavicular area was the most sensitive to the formation of petechiae. Often the other areas would not give a positive capillary resistance test, even with the maximum negative pressure of our instrument. After determining the initial resistances of the various areas, daily changes in resistance were followed by determinations in the infraclavicular area. The element of time prohibited making daily determinations in all four areas.

Serial determinations were made on patients after surgery, and in addition, determinations during control and ACTH stimulation periods for the determinations of urinary 17-hydroxycorticosteroids were made on both medical and convalescent surgical patients. One patient given cortisone while in the hospital was also followed before and after the cortisone administration.

Technic of measurements.--A Petechiometer[1] (see Figure 1) was used to measure the capillary resistance. It is a modified resistometer for the application of negative pressure (suction), and gives standard suction at three different levels, i.e., 10, 20, and 30 cm. of mercury. Operation of the Petechiometer is accomplished by pushing in on the plunger with the 2 cm. bell of the instrument against the skin. Suction is applied when the plunger is released. The amount of suction is varied by placing a metal stop ring on one of the three different grooves of the plunger. With each determination, a small amount of lubricating jelly was rubbed on the test area to insure a good seal with the skin.

Suction was applied for one minute and then after five minutes the petechiae were counted. The clear plastic disc supplied with the Petechiometer, outlining an area 1 cm. in diameter, was placed in the center of the tested area. Counting of the petechiae within the outlined area was facilitated by the magnification produced by the top of the clear plastic suction bell of the Petechiometer. If light was not sufficient, the beam of a flashlight directed diagonally through the side of the suction bell provided ample light.

All determinations were made by finding the least amount of negative pressure still producing petechiae. The petechiae produced were then counted. For example, if petechiae were produced at 20 cm. and none were produced at 10 cm., then the number produced at 20 cm. were counted. This means that the capillary resistance is greater than 10 cm. but less than 20 cm. If only a few petechiae were formed, the capillary resistance was considered to be nearer to 20 cm. as contrasted to the formation of many petechiae making it nearer to 10 cm. Therefore, on serial studies, a decrease in the number of petechiae at a given pressure was considered to be an elevation of the capillary resistance. The formation of one or two petechiae was interpreted as the exact capillary resistance of the particular setting of the instrument. For example, two petechiae at the 20 cm. setting was interpreted as a capillary resistance of 20 cm.

In six patients, determinations of capillary resistance before and after ACTH stimulation were made. The same technic was used as those made in the serial studies of postoperative patients. Twenty-five units of ACTH in 1000 cc of glucose was started at 8:00 A.M. and was given within a period of six hours. The capillary resistance was measured before and again six hours after starting the administration of ACTH. Urine was collected for 17-hydroxycorticosteroid determinations for twenty-four hours beginning at 8:00 A.M. on one day and for twenty-four hours the day of ACTH stimulation. Therefore, urine was collected for two consecutive twenty-four-hour periods.

RESULTS

The results obtained by the technic of measurement we used are difficult to express in absolute values. Actually, the values can only be expressed as being either greater than, or less than, the three different levels of negative pressure.

Our first consideration was to attempt to determine the range of values of the capillary resistance in the four different areas.

The infraclavicular and upper arm areas were definitely more sensitive to petechial formation than the other two areas, as is shown in table 1. Of those two, the infraclavicular area was the most sensitive. At a negative pressure of 10 cm. of mercury, six patients had a positive test in the infraclavicular area and no patients had a positive test in the other areas at 10 cm. of mercury. In the same manner, fewer patients had negative tests at 30 cm. of mercury in the infraclavicular area than in any other area. The mid thigh region was the most resistant to the formation of petechiae.

The preoperative and postoperative capillary resistance determinations in the infraclavicular area in 48 surgical patients are tabulated in table 2. There is no typical response or pattern of capillary resistance change noted in these patients. Many patients would have a drop in resistance during the immediate postoperative period, others would have an elevation. The remainder showed no marked change.

A decrease in capillary resistance to 10 cm. or less was found in 10, or approximately 21 per cent, of these patients some time during the postoperative period. Seven of the 10 patients showed this low resistance during the first two days postoperatively. Of the other three patients, one developed the low resistance on the third, one on the fourth, and one on the ninth postoperative day.

Increases in capillary resistance to values greater than 30 cm. on at least one occasion were found in 35, or 73 per cent, of these 48 surgical patients. Twenty-one of the 35 gave this high resistance during the first two days postoperatively.

The results tabulated in table 1 were from patients who had not been subjected to the stress of operation. Of those, only 6 patients, or 8 per cent, had capillary resistances of 10 cm. or less. Also, among the same 75 patients, 20, or 27 per cent, gave values of 30 cm. or greater.

The comparison as to the number of patients with high and low capillary resistances in the two groups of patients suggests quite strongly that in the immediate postoperative period there is a wide range of capillary resistance values. This wide range is not so marked in the patients not subjected to the stress of operation.

A small number of determinations were made on patients who had 24-hour urinary 17-hydroxycorticoid studies before and after ACTH stimulation. The capillary resistance and corticoid values of these patients are tabulated in table 3. The normal range of values for corticoids in mg/24 hours at the University Hospital is 10 ± 4 for men, and 7 ± 3 for women. All patients stimulated with ACTH had normal control values, and all had adequate responses.

Except for patient 3, of those stimulated with

ACTH, all subjects had a high resistance during the control period. Because of this fact, it was impossible to determine whether the capillary resistance was significantly elevated during ACTH stimulation. It can be stated, however, that in no instance was there a fall in capillary resistance six hours after the onset of administration of 25 units of ACTH intravenously.

Patient 7 (see table 5) was found to have very low--10(35)--capillary resistance six hours postoperatively. After finding such a low value, urine was immediately saved and collected for 24 hours. The patient was not in shock and had a normal postoperative course. The resistance the following day had risen to 20(7), and the 24-hour 17-hydroxycorticosteroid excretion was slightly elevated (15.4 mg).

Patient 3 developed hemorrhage in the eye after a cataract extraction. The capillary resistance at that time was found to be less than 10 cm. of mercury. Urine was collected for corticoid studies. ACTH was then given and urine was again collected for corticoid determinations. After the ACTH administration the bleeding was controlled. There was a definite elevation in capillary resistance, and the urinary 17-hydroxycorticosteroids were found to be 26.2 mg as compared to 7.5 mg/24 hours before the ACTH was given. Within a few days, capillary resistance was again found to be below 10 cm. of mercury, but she had no recurrence of bleeding. No further corticoid levels were determined.

The results of studies done on a patient with pituitary insufficiency after treatment for a craniopharyngioma are illustrated in table 4. This patient was placed on 5 mg. of cortisone three times daily. Daily capillary resistance values were made and by the fourth day the resistance was greater than 30 cm. of mercury. It remained at this high level until he was discharged, which was on the eighth day of cortisone administration.

DISCUSSION

Our observations suggest that the capillary resistance test is probably rather crude, but in spite of this, values of capillary resistance at extremely low or high levels may have significance. Abnormally low capillary resistance values would be expected in a patient suffering from adrenal insufficiency. We did not have any patients to exemplify such findings. Cortisone therapy was considered for several patients in postoperative shock. They were checked for low capillary resistance and in every case values were greater than 30 cm. of mercury. Further studies found these patients to have other explanations than adrenal insufficiency for their shock. One had a mesenteric thrombosis, two had myocardial infarctions, and three were suffering from blood loss secondary to postoperative bleeding.

It would seem that high values in shock would suggest a marked increase in adrenocortical function. The factor of vasoconstriction and decreased blood in the superficial tissues must also be considered. However, according to Zweifach (10), this is not the case. He states that the feature of adrenal insufficiency is the profound collapse of the circulation. In adrenal insufficiency, there is an increased fragility of the supporting pericapillary connective tissue and the muscular venules show a pronounced tendency to rupture (10). A capillary resistance less than 5 cm. of mercury suggests marked fragility (11). Therefore, a marked production of petechiae at a low level of negative pressure in a postoperative patient might suggest adrenocortical insufficiency.

Scarborough (12), in 1944, before any extensive investigations had been done on capillary fragility and adrenal function, noted that capillary resistance increased in patients after surgical operations. This increase appeared to be independent of the age, sex, anesthetic employed, or the nature of the operation. At that time he had no explanation for the mechanism of the "striking phenomenon." In the same year, Ungar (13) noted an increase in capillary resistance and a decrease in bleeding time in guinea pigs subjected to trauma. He reproduced these findings by injecting serum from the traumatized animals into normal animals. He suggested that the results were due to corticotrophic hormone of the pituitary which also shortens the bleeding time and increases capillary resistance.

Measurement of adrenal function

(a) Eosinophil count.--Thorn's test (2) has been accepted as a measure of adrenal function. Since then many investigators have used the eosinophil count, on which the Thorn's test is based, as an index of adrenal function. The stress of operation produces a profound drop in the circulating eosinophils in the postoperative period (6,14,15). This results from an increase in adrenocortical function. With a decrease in function the eosinophil count rises (16). Administration of ACTH which also increases adrenal function produces a marked fall in the number of circulating eosinophils (4,17,18). Forsham (18) found circulating eosinophils to fall 74 per cent in normal patients with presumably intact adrenal glands as compared to a mean fall of only 4 per cent in patients with well established Addison's disease after a single injection of ACTH. As might be expected, cortisone administration will also depress the eosinophil level (7,17,18).

More recent investigations by Thorn (19) and his associates show that the eosinophil response is not necessarily specific for adrenocortical stimulation. They found that epinephrine administration to normal subjects did not induce an appreciable alteration in 17-hydroxycorticosteroid excretion, and the eosinopenia induced by epinephrine is not dependent upon an intact pituitary-adrenal system. In spite of the fact that the eosinophil response is nonspecific, it is still important as an index of adrenal function. A better index is needed, however.

(b) Capillary resistance.--With an increase in adrenocortical activity there is an increase in capillary resistance. Hypofunction has the opposite effect (20). ACTH administration has been found to produce marked elevations in capillary resistance (4). Robson and Duthie (5) also found that there is a distinct rise in resistance after cortisone administration.

Kramar (7) found an inverse relationship between cortisone levels and capillary resistance in normal and adrenalectomized rats. If cortisone concentration increases, the capillary resistance rises and the eosinophil level falls. In the same manner when the cortisone level decreases, the capillary resistance drops and eosinophilia occurs. Kramar (6) also found a typical response pattern in the capillary resistance after the effect of surgical trauma in rats. There are four successive phases: (a) a more or less pronounced increase in the first days, (b) a critical drop at the end of the first or in the course of the second two weeks, (c) a state of pathologically low resistance lasting about two weeks, and (d) a period of recuperation. The entire phenomenon, the second and third phases of which he terms "capillary crisis," lasts approximately one month. The explanation is offered that the "capillary crisis" found after surgical trauma or ether anesthesia may be an expression of a transient hypofunction or depletion of the adrenal cortex. Cortisone prevented the "capillary crisis" but DOCA and ACTH failed to do so. Some of our patients had a decreased capillary resistance although adrenal function as measured by corticoid determinations was normal.

Some of the recent investigations (21,22,23,24) with somatotrophic hormone may help to explain the wide range of postoperative capillary resistance values we obtained. According to Selye (25), the effects of the glucocorticoid compounds such as cortisone are directly opposed to the actions of "growth hormone."

Kramar (21) treated adrenalectomized rats with cortisone and found the capillary resistance to rise. When STH was added to the cortisone, the capillary resistance promptly decreased. When STH was stopped and cortisone was given alone, the capillary resistance again increased. The two hormones were given conjointly and there was no rise in resistance. The rise came only when STH was discontinued. The results indicate that the effect of the cortisone upon the capillary resistance is antagonized by STH at a peripheral level without the mediation of the adrenal cortex. Thus, the level of capillary resistance may reflect the balance between these two hormones. Wilhelmj (23) found similar antagonistic effects in dogs.

(c) <u>Corticoid determinations</u>.--A review of the literature finds no investigations correlating capillary resistance directly with adrenocortical steroid levels. In the opinion of Jenkins (26), the index of choice in evaluating adrenal cortical stimulation is the measurement of 17-hydroxycorticoids. He found a significant rise in urinary 17-hydroxycorticoids after stimulation with ACTH.

As one might expect, stress situations such as surgical trauma will cause elevations in the plasma levels of the 17-hydroxycorticoids which in turn result in elevated excretions in the urine. Steenburg (9) found a rapid rise in blood levels of 17-hydroxycorticoids with the beginning of an operation. A similar rise has also been noted by others (8,27,28). Significant elevations in urinary excretion after operations have been noted (17,19,29), but Thorn (19) could not demonstrate that stress altered significantly the urinary excretion of 17-hydroxycorticoids in Addisonian or adrenalectomized patients.

Our studies were determinations over a 24-hour period and it is known that corticoid levels may be low for a portion of the 24-hour period and extremely high for the remainder of the time of urine collection (30). It seems logical to assume, therefore, that 24-hour corticoid levels could still be elevated above normal and yet plasma levels at any one time during the 24-hour period could be below normal. With similar reasoning, capillary resistance values could be low also.

Patient 7 (see table 3) had a postoperative capillary resistance which was extremely low. Urine collection was started, and before the 24-hour period was over his resistance had increased to a normal value. In addition, his 24-hour corticoid level was found to be elevated. A plasma corticoid determination in this patient may have revealed a low value at the time his capillary resistance was low.

Steenburg (9), in studies of free 17-hydroxycorticoids, found a rapid rise in the blood levels with the beginning of operations. He also quite often observed depressed levels on the first postoperative day. Our results would correlate in that we found both high and low capillary resistance values during the immediate postoperative period.

The adrenocortical reserve in patients varies (31), so it might be expected that adrenal depletion would be variable as to its time of occurrence. In our series, some patients would develop low resistances early and in others it would take several days before the resistance would be depressed (see table 2). It has been hypothesized (32) also that in stress there appears to be an increased consumption of adrenal hormone by the peripheral tissues. Thus, it might be suggested that many of the patients would have high corticoid levels and high capillary resistance, while others would show low levels. The results as shown in table 2 would tend to correlate with this hypothesis.

Correlation of capillary resistance with plasma corticoid levels may not be the answer either. According to Tyler and his associates (28), there is impaired liver function postoperatively as measured by BSP excretion, and the magnitude of plasma 17-hydroxycorticosteroid elevation during the same time correlates closely. Thus, the increased plasma levels after surgery are the result of both increased adrenal secretion and impaired hepatic removal.

From a practical point of view, corticoid determinations are of little value in clinical medicine. Such determinations are made in few hospitals. Often, especially in postoperative shock, the surgeon is interested in a rapid evaluation of adrenal function. Urinary determinations, to be of any value, should be made on specimens collected over a period of hours. Therefore, the result would be too late. Plasma corticoid determinations may be of value, but time is required to make such determinations. As already mentioned, a good index of adrenal function should be simple and readily available.

Other conditions influencing capillary resistance

(a) Method of measurement.--Capillary resistance is measured by the pressure necessary to rupture the capillaries. We have both positive and negative pressure technics. The pressure tests act by engorging the small vessels until the blood escapes and forms petechiae (33). This engorgement is accomplished by raising the intravascular pressure in the stasis or positive pressure test, and by lowering the extravascular pressure in the suction or negative pressure test.

The technics for the perfomance of the various negative pressure procedures fall into three general types (33): Type 1, those procedures which seek to find the least amount of negative pressure that will produce the required number (usually one or two) of petechiae in the stated time; type 2, those procedures in which is counted the number of petechiae appearing in the center of the suction area after the application of a constant negative pressure for a given time; type 3, those procedures in which suction is applied at various negative pressures from 10 to 20 cm. of mercury, and the appearance time for the petechiae is noted. The third type is rarely used because it is such a time-consuming procedure and actually does not seem to have any practical value. Type two was the type used in our investigation.

Hare and Miller (33) suggest a disadvantage of the first type. In this "critical-resistance" method, only the strength of the weakest capillary in the test area is measured, thus not giving a true index of the over-all strength of the capillaries. This important criticism is not applicable to the methods producing multiple petechiae.

Copley (34) has suggested that repeated values taken at about the same time may offer a more accurate appraisal of capillary resistance than merely taking single counts. Also, according to Copley (34), the degree of ecchymotic involvement is a more adequate measure of capillary hemorrhagic diathesis than petechial counts. Both the "ecchymosis test" and the multiple petechiae count technics would seem to measure representative capillaries rather than one or two of the weakest capillaries in the test area.

Positive pressure methods of measuring capillary strength were first used, and through the years modifications in technic have been presented by various investigators (35). Essentially the procedure consists of applying a pressure cuff about the arm and then counting the petechiae within a plotted area of the forearm. The pressure applied, the duration of this application, and the size of the plotted area are the usual variables depending on the technic used.

Negative pressure technics have advantages over positive pressure technics and because of these advantages they have nearly replaced the older technics. Positive pressure tests performed on the same individual are limited because the test can be repeated only after a considerable length of time. In negative pressure technics, a new area can be chosen instead of waiting for the repair of the tissue breakdown in the test area. In research, where frequent testing is often necessary, positive pressure technics are of little value. If subjects with weak capillaries are repeatedly tested by positive pressure methods, an apparent improvement in capillary strength is sometimes found to occur spontaneously according to Munro (36). This does not occur in negative pressure methods. There is also the possible effect of hypoxia during stasis, as demonstrated by production of marked fragility associated with complete anoxia in an extremity for five minutes (37). In negative pressure technics, suction is usually applied for one minute thus making the factor of hypoxia unlikely.

(b) Effect of bioflavinoids.--Capillary resistance as a measure of adrenal function has the disadvantage that other conditions may affect capillary resistance. In some patients low capillary resistance values noted postoperatively may be due to vitamin deficiencies with direct effects on the capillaries as well as the indirect effect of a decreased corticosteroid output. The bioflavinoids also affect the capillary resistance.

The bioflavinoids are a group of compounds known as flavinoids which have biological activity (38). As far as capillary fragility is concerned, hesperidin or, as it has been called, vitamin P, is probably the most potent of the bioflavinoids. The bioflavinoids include such compounds as rutin, esculine, quercetin, naringin, and several hesperidin compounds. The bioflavinoids are widely distributed in nature, citrus fruits being the important dietary and pharmaceutical sources.

These bioflavinoids have an effect of maintaining the capillary resistance. Normal capillary resistance is dependent on the bioflavinoids. The mechanism of this effect is not clearly understood. Martin (39) summarizes the explanations which have been recently advanced to account for these effects as follows: (a) direct effect on the capillaries, (b) potentiation of action of ascorbic acid, (c) inhibition of hyaluronidase, (d) inhibition of histamine, (e) inhibition of epinephrine oxidation, and (f) action on bleeding and coagulation time.

Others (40,41,42,43) have found that vitamin P administration raises the capillary resistance. These authors suggest that vitamin C is necessary for the best therapeutic results in elevating capillary resistance. Scarborough (44) points out that both vitamin C and vitamin P are found in the same natural sources (food), so it might be expected that the clinical signs of a deficiency of both vitamins will be associated in a single case such as scurvy.

There are two forms of hemorrhage which develop with a deficiency of these two vitamins (44): In vitamin C deficiency the hemorrhages are large involving mainly the deeper tissues. In vitamin P deficiency petechial bleeding in the superficial tissues is characteristic.

Perhaps bioflavinoid deficiency results in decreased capillary resistance because of impaired adrenocortical function. Ascorbic acid is necessary in corticosteroid synthesis in the adrenal gland. Stepto (45) and his associates found a reduction of steroid concentration in the adrenal cortex during severe ascorbic acid deficiency. They suggest that the reduction is either due to (a) "exhaustion" of the adrenal cortex due to stress and the continuous production of corticosteroids, or (b) diminished production of adrenal corticosteroids in the absence of an adequate concentration of adrenal or otherwise available ascorbic acid. There is a decrease in ascorbic acid after stress (45).

Certainly at the present time no single mechanism can be pointed to as being the correct one and, indeed, it would appear that a series of interrelated actions would be the most logical means of accounting for the profound physiological action of the flavinoids.

(c) <u>**Miscellaneous conditions affecting capillary resistance**</u>.--Many conditions, agents, and disease states have been reported to alter capillary resistance. Disease states commonly mentioned which show low capillary resistance include scarlet fever, measles, scurvy (41,46), rheumatic fever, (47,48), thrombocytopenic purpura (49), hypertension (50,51), diabetes (51), peptic ulcer, colitis, and arteriosclerosis (51,52,53). There is also a decrease in capillary resistance during the menses (46, 54,55). The various possible mechanisms involved in the low capillary resistance in these different diseases will not be discussed.

SUMMARY

Acute adrenal insufficiency is often implicated in unexplained postoperative shock. Capillary resistance has been reported to be low following the stress of surgery as well as in adrenalectomized animals.

In general, from the review of the literature, it may be summarized that as adrenocortical activity increases, either by ACTH stimulation or by response to stress, there is an increase in 17-hydroxycorticosteroid secretion, and with the increased corticoid secretion there is a lowering of the eosinophil level and an elevation of capillary resistance. A decrease in adrenocortical secretion has an opposite effect. Cortisone or hydrocortisone administration have effects similar to increased adrenocortical function. Also, in stress situations, somatotrophic hormone (STH) has an antagonistic effect on cortisone as reflected by capillary resistance changes. STH lowers capillary resistance.

The bioflavinoids also seem to have a direct effect on the capillaries. There is believed to be a synergistic action of vitamin C and the various bioflavinoids, hesperidin being the most potent, in the development of strong capillaries. Both vitamin P, or hesperidin, and Vitamin C are found in the same foods. In scurvy, the decreased capillary resistance as manifested by petechiae is due to a deficiency in vitamin P. To increase the capillary resistance, it is therefore necessary to administer both vitamins.

With these factors in mind, 82 hospital patients, many of which were surgical, were followed by serial capillary resistance determinations. It was hoped that findings of low capillary resistance in the postoperative period, especially in shock, might prove to be indicative of acute adrenal insufficiency.

The results of our studies were tabulated and, in a small group of patients, 24-hour urinary

17-hydroxycorticosteroid determinations were made. This group was too small to make any speculations; however, in the postoperative period after ACTH stimulation, all patients showed high 24-hour urinary corticoid levels.

There was a very wide range of capillary resistance values found in the immediate postoperative period as compared to preoperative levels and control levels in medical patients. We did not have any patients who had adrenal insufficiency and, as stated before, all patients with corticoid determinations showed high levels. Simultaneous capillary resistance and plasma corticoid determinations in patients with adrenal insufficiency would be very interesting. To date, no such investigation can be found in the literature.

CONCLUSIONS

Our results and the observations of others, as has already been discussed, suggests that there is a definite relationship between adrenal function and capillary resistance. More investigation with plasma and urinary 17-hydroxycorticosteroids during capillary resistance determinations will be necessary to determine the specificity of capillary resistance as an index of adrenocortical function. In stress situations, as pointed out by Selye, STH may also play an important role. Capillary resistance tests are crude, but it is our contention that if a patient is in unexplained post-operative shock and has extremely low capillary resistance, then adrenal insufficiency might be implicated. Certainly, if a patient is in shock and has a high resistance, then probably the shock is a result of some other condition and steroid replacement is not indicated. If the hypothesis is correct, then a simple capillary resistance test will be a rapid method for making the diagnosis of acute adrenocortical insufficiency.

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TABLE 1

RANGE OF VALUES OF CAPILLARY RESISTANCE IN 75 PATIENTS

Area	Negative Pressure in cm. Hg.			
	Less than 10	10-20	20-30	30 or greater
Infra-clavicular ..	6[a]	30	19	20
Upper arm	0	28	21	26
Forearm	0	8	15	52
Mid thigh	0	2	15	58

[a]The numbers represent numbers of patients.

TABL

CAPILLARY RESISTANCES DURI
DAYS IN 48 SUR

Patient	Age	Sex	Operation	Pre-Op	Day of Op.
1	56	M	Herniorrhaphy	20(14)	20(30)
2	13	M	T&A	30/	20(8)
3	40	F	Oophorectomy	30/	30/
4	41	F	Thyroidectomy	20(16)	--
5	22	F	Cholecystectomy	20(4)	30/
6	82	M	Sigmoid res.	30(8)	30(22)
7	14	F	Subtotal thyroid	30/	--
8	42	F	Hysterectomy	30(7)	20(1)
9	79	M	Sigmoid res.	20(1)	20(4)
10	79	M	Splenectomy	20(21)	20(45)
11	60	M	Herniorrhaphy	30(15)	10(1)
12	61	M	Herniorrhaphy	30/	30/
13	72	M	Colon res.	20(12)	30(3)
14	33	F	C-Section	30/	--
15	6	M	T&A	20(27)	20(30)
16	8	M	Herniorrhaphy	20(1)	20(30)
17	64	M	Thoracotomy	30(1)	30/
18	54	M	Herniorrhaphy	10(4)	--
19	62	M	Gastric res.	20(3)	30(22)
20	24	M	Thoracotomy	10(2)	--
21	19	F	Herniorrhaphy	30(14)	--
22	86	M	Transurethral res.	20(50)	10(6)
23	52	M	Thoracotomy	30(34)	20(14)
24	52	M	Gastric res.	30(75)	30/
25	39	M	Radical groin res.	10(6)	20(5)
26	72	M	Cholecystectomy	20(12)	20(16)
27	93	M	Colostomy	20(9)	--
28	12	M	Nephrotomy	20(1)	--
29	60	M	Sigmoid res.	20(45)	--
30	51	M	Herniorrhaphy	20(18)	--
31	69	F	Cholecystectomy	20(5)	--
32	49	F	Thyroidectomy	30(3)	--
33	23	M	Pulm-valvulotomy	30(45)	30/
34	76	F	Cholecystectomy	20(13)	--
35	79	F	Celiotomy	30/	30/
36	30	F	Subtotal Thyroid	20(6)	--
37	3	F	Herniorrhaphy	30(3)	30/
38	73	F	Cholecystectomy	20(3)	--
39	64	M	Colostomy closure	20(1)	20(2)
40	62	M	Gastric res.	30/	20(23)
41	4	F	Res. giant nevus	30/	30(60)
42	70	F	Herniorrhaphy	30/	30/
43	22	F	Cholecystectomy	30/	30/
44	7 mo.	M	Meningocele repair	30(1)	--
45	33	F	Varicose vein strip.	30(6)	--
46	53	F	Gastric res.	20(2)	--
47	50	F	Cholecystectomy	20(24)	20(1)
48	59	F	Craniotomy	30/	30/

[a]The number enclosed within the parenthesi
The number just before the parenthesis re
30/ means that there were no petechiae pr
Capillary resistance determinations were

TABLE 2

ANCES DURING CONTROL AND POSTOPERATIVE
IN 48 SURGICAL PATIENTS[a]

: Op.	Days Postoperative 1	2	3	4	5	6	7	8	9
))	10(35)	20(7)	10(3)						
)	--								
	20(25)	10(10)	30/	--	20(3)	--	30/	--	20(3)
	30/	30(2)	--	20(5)	--	20(9)	--	--	20(35)
	20(2)	30/	30/	--	30/				
2)	20(13)	20(12)	--	20(8)	--	30(16)	--	30/	30/
	20(6)	--	30/						
)	--	30(2)							
)	30/	10(2)	--	20(2)	--	30/	--	30/	
5)	20(40)	--	--	20(2)	--	30(42)	--	--	20(4)
)	--	30/	30/	30/	30/	30(4)	30/	30/	
	30(12)	20(2)	--	30/	--	30/	30/		
)	20(3)	--	30/	--	30(12)	--	20(25)	--	20(17)
	30/	20(3)	30/	--	30/				
))	--								
))	30(3)								
	30/	30/	--	30/	30/	30/	30/	30/	
	30(12)	10(9)	--	30(17)	10(5)	30(14)	20(7)	10(2)	30(50)
2)	20(10)	20(2)	30(24)	20(8)	20(2)	--	30(3)	--	20(4)
	10(5)	20(15)	10(3)	--	30/	--	30/	30/	30/
	30/	30/							
)	20(6)	20(32)	--	20(24)	20(50)	20(6)	30(40)		
)	30(6)	--	30(14)	10(3)	20(1)	30(75)	30/	--	30(10)
	30/	--	30(2)	30(5)	30(18)	30(12)	20(1)	--	30(11)
)	30/	30/	--	30(3)	--	20(3)	--	20(50)	
5)	20(37)	--	10(3)	--	20(9)	30/			
	20(5)	--	30(4)	--	20(10)	--	30/		
	10(3)	--	30/	--	20(5)	--	30(6)	--	30(9)
	20(50)	--	30/	--	30/	--	30/	--	30(3)
	20(13)								
	30/	--	20(5)	--	30/	--	30/	--	30/
	20(17)	--	30/	--	30/	--	30/	--	10(2)
	30/	30/	--	30/	--	30/	--	30/	
	30/	30/	20(3)	--	30(19)	--	20(3)	--	30/
	30(6)	30(3)	--	30/					
	20(6)	20(5)	20(3)						
	--								
	30/	30/	--	20(14)					
	20(16)								
)	30/	30/	--	--	30/				
)	--	20(3)	--	--	20(3)	--	20(6)	--	30(4)
	30/	--	--	30/	--	30/	--	30/	
	30(30)	30/	--	30(1)	--	--	30(6)		
	30(2)	--	30(3)						
	20(2)	30/							
	20(1)	30(15)	--	30/	30/	30/	30/	30(2)	30/
	20(8)	20(1)	20(35)	20(75)					
	30/	30(5)	30/	30/					

parenthesis represents the number of petechiae.
nthesis represents the pressure applied.
techiae produced at 30 cm. of negative pressure.
ions were made in the infraclavicular area.

TABLE 3

CORRELATION OF 24-HOUR URINARY 17-HYDROXYCORTICOSTEROIDS AND CAPILLARY RESISTANCE[a]

		Controls		ACTH Stimulation	
Patient	Sex	Cap. Res.	Corticoids	Cap. Res.	Corticoids
			mg/24 hrs		mg/24 hrs
1	F	30/	4.02	30/	19.40
2	M	30(3)	7.40	30/	30.60
3	F	20(35)	7.50	20(4)	26.20
4	F	30/	7.10	30/	30.00
5	F	30(5)	11.60	30(3)	47.40
6	M	30/	8.60	30/	31.00

[a]Capillary resistance determinations were made in the infraclavicular area.

TABLE 4

THE EFFECTS OF 15 MG. OF CORTISONE DAILY ON CAPILLARY RESISTANCE IN A PATIENT WITH PITUITARY INSUFFICIENCY[a]

	Control	Days after cortisone administration				
		1	2	4	6	8
Cap. resist.	20(30)	20(6)	20(18)	30+	30+	30+

[a]Urinary corticoid determinations were 1.3 mg/24 hours as a control, and 5.25 mg/24 hours with stimulation of 25 units of ACTH intravenously.

TABLE 5

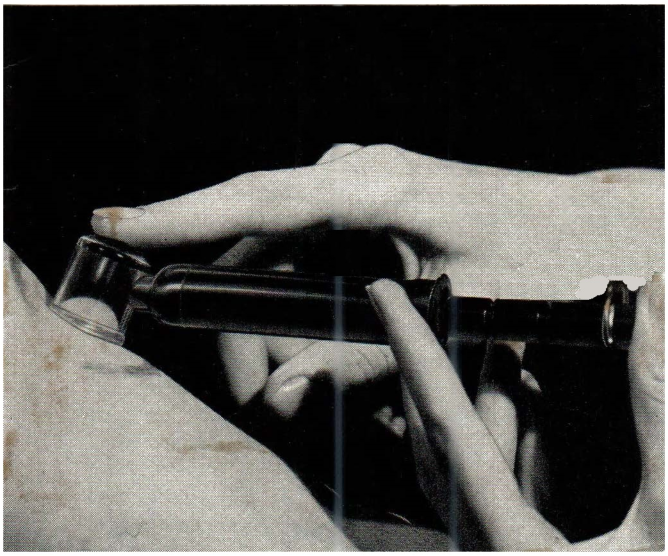
CORRELATION OF 24-HOUR URINARY 17-HYDROXYCORTICOSTEROIDS AND CAPILLARY RESISTANCE[a]

Patient	Sex	Cap. Res.	Corticoids
1	F	30+	4.02 mg/24 hrs.
2	M	30(3)	7.40
3	F	20(35)	7.50
4	F	30+	7.10
5	F	30(5)	11.60
6	M	30+	8.60
7[b]	M	10(35)	15.40
8	M	20(16)	4.95
9	M	20(8)	6.20
10	F	20(20)	5.10

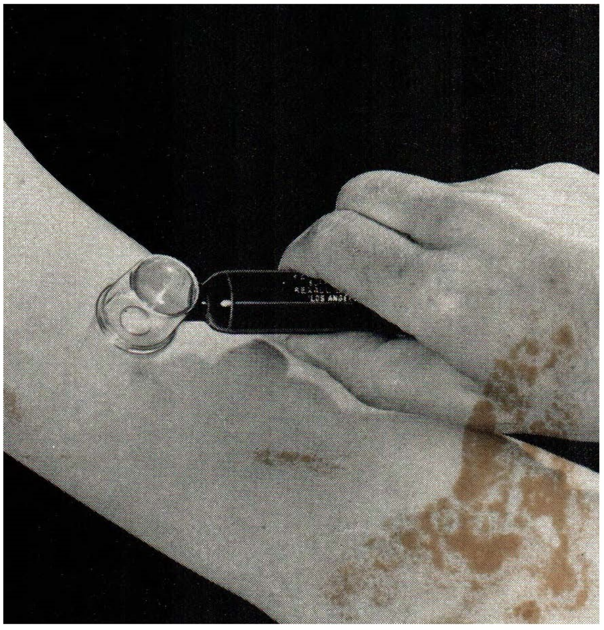
[a]Capillary resistance determinations were made in the infraclavicular area.

[b]This patient had a rise in capillary resistance to 20(7) by the end of the 24-hour period of urine collection.

FIGURE 1



(a) The Petechiometer



(b) Counting Petechiae developed

FOOTNOTES

[1]The Petechiometer is a commercial instrument supplied by the Rexall Drug Company.

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