Adrenal Function During Bed Rest

CAPTAIN FRED H. KATZ, USAF, MC

ABSTRACT

Plasma 17-OH-CS levels as well as adrenal secretory rates of aldosterone and cortisol were measured in healthy subjects before and during periods of bed rest. The circadian rhythm of plasma 17-OH-CS was well maintained during bed rest. There was no change in adrenal cortisol secretion rates during bed rest. Aldosterone secretory rate did not change with bed rest; however, following a period out of bed, there was a diminution of aldosterone secretory rate during a subsequent bed rest period. Inactivity from bed rest therefore does not appear to change adrenal cortisol production. Conclusions cannot be drawn as yet concerning aldosterone production.

Although the metabolic ward used for the bed rest period had its ambient temperature controlled between 75 and 81°F., the subjects were exposed to the outside temperatures of the day during control determinations, which were often in the uncomfortable, above 90°F. range. In addition, activity was not controlled during the “control” days.

Plasma 17-hydroxycorticosteroids (17-OH-CS) were measured by a modification of the technique of Silver and Porter. Cortisol secretion rates were measured by a method previously outlined except that 3µc. cortisol-1, 2-H3, 50 µc./µg., obtained from the Endocrinology Study Section, National Institutes of Health, was the radioactive tracer utilized and the isolated tritiated urinary metabolites were acetylated with C14 labeled acetic anhydride.

Aldosterone secretory rates were determined by an unpublished method of Barlow based on the isolation of the “tetrahydro metabolite” of aldosterone from urine. Three microcuries d-aldosterone-1, 2-H3, (100 µc./µg., from the Endocrinology Study Section, National Institutes of Health, and later obtained commercially, and purified chromatographically on paper in the Bush B5 and E2B systems) were injected in 30 ml. isotonic saline. An aliquot of urine from the subsequent 24 hours was hydrolyzed with beef liver β-glucuronidase at pH 4.7 and 37°C. for 48 hours. Ethyl acetate extracts, washed three times with 1/20 volume in NaOH and then with water were chromatographed in the B5 and E2B systems. The urinary metabolite was detected by radioactivity. Scanning with a Model 880 Vanguard Autoscanner as well as by the Rf of concommitantly chromatographed “tetrahydroaldosterone” (first obtained through the courtesy of Dr. Seymour Lieberman, and later isolated from human urine following the oral administration of 40 mg. d-aldosterone-21-acetate supplied by Dr. C. H. Sullivan, CIBA, Inc., Summit, N. J.). The metabolite was acetylated with C14 labeled acetic anhydride and the resulting triacetate purified using alternating chromatography in the Bush B and B3 systems to attain radiochemical purity. This was considered attained when the tritium/carbon 14 ratio, measured as described elsewhere, varied by less than 10 per cent between consecutive chromatograms. Quantitation could be obtained by acetylating crystalline cortisol with the same batch of acetic anhydride and measuring the specific activity of chromatographically purified cortisol-21-acetate with the aid of the Porter-Silber reaction.

RESULTS

Plasma 17-OH-CS:—Figure 1 indicates that the diurnal variation of plasma unconjugated 17-OH-CS per-
ADRENAL FUNCTION DURING BED REST—KATZ

TABLE I. ALDOSTERONE SECRETORY RATE—µg/24 HOURS

<table>
<thead>
<tr>
<th>Group</th>
<th>Subject number</th>
<th>1 Up Ad lib</th>
<th>II Bed Rest 1</th>
<th>Bed Rest 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>155</td>
<td>148</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>277</td>
<td>259*</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>221</td>
<td>119</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>116</td>
<td>111</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>173</td>
<td>255</td>
<td>146</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>103</td>
<td>139</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>273</td>
<td>109</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>162</td>
<td>126</td>
<td>72</td>
</tr>
<tr>
<td>F</td>
<td>1</td>
<td>172</td>
<td>210</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>151</td>
<td>168</td>
<td>144</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>87</td>
<td>98</td>
<td>89</td>
</tr>
</tbody>
</table>

Mean of all groups | 180 | 162 | 115 |

Comparison of means | t value | p value |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I and II</td>
<td>.618</td>
<td>N.S.</td>
</tr>
<tr>
<td>I and III</td>
<td>2.80</td>
<td>&lt; 0.025</td>
</tr>
</tbody>
</table>

* Exercised between rest periods

DISCUSSION

As far as cortisol production by the adrenal gland is concerned, these studies have confirmed the work of previous authors that this parameter is independent of body position, as shown by plasma 17-OH-CS levels. In addition, direct measurements of the cortisol secretory rate have now established that there is no significant change in the hypodynamic state.

There is no evidence that comparable periods of hypodynamic states would have an adverse effect on the body levels of cortisol.

The results for aldosterone secretory rate do not lend themselves to straightforward interpretation. Although there was no change during the first bed rest period, the diminution in the mean value during the second bed rest period was significant at the 2.5 per cent level. It can be seen from Table I that this change could not be attributed to either of the maneuvers imposed on Groups C and F during bed rest period 2.

To further complicate the interpretation of this data, it may be noted that the lack of change between the control and first bed rest period could hide an increased aldosterone production with bed rest, since the hotter environmental temperatures during the control period might be expected to increase aldosterone production.

The fact that all subjects had already experienced a previous bed rest period might in some way be responsible for the diminution during bed rest period 2.

sisted generally during the two bed rest periods in Groups A, C, and F following ten days of recumbency. The circadian rhythm, with its morning peak, was better established during the bed rest periods than during the period of ad lib activity.

Cortisol Secretory Rate:—The results of the adrenal secretion rate determinations for cortisol are shown in Figure 2. Although there was a good deal of variation in some of the subjects from one period to the next, statistical analysis revealed these differences not to be significant even at the 10 per cent level, for either Group A, C, or F, the only groups tested.

Aldosterone Secretory Rate:—The results for this parameter are shown in Table I. It can be seen that the subjects who were tested during bed rest period 1 showed no difference in aldosterone production compared to the control period. During bed rest period 2 the mean aldosterone secretory rate for the subjects examined was markedly lower than during the other periods.
ACKNOWLEDGMENT

Airman Second Class Joseph C. Perry rendered valuable technical assistance.

REFERENCES