ALTERED CORTISOL LEVELS IN RELATION TO RAMADAN

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During the month of Muslim fasting (Ramadan) many people alter their sleeping habits and stay awake most of the night. We investigated the effect of this alteration on morning and midnight cortisol levels in 10 healthy adults in their homes. Four of the subjects showed alteration of the cortisol rhythm during the last 2 weeks of fasting with reversal of the morning/midnight ratio in some values. One lady was admitted for 24-h cortisol profile on Day 15 of Ramadan when the acrophase and nadir showed a forward shift by about 5-6 h, consistent with the shift of the subject's sleep. The morning cortisol returned to normal in all subjects 4 weeks after Ramadan. However, the midnight value was above 250 nmol/l in three of the subjects who exhibited the alteration during Ramadan.

These findings suggest that single-point cortisol values can be misleading in many Muslim countries during or shortly after Ramadan.

One of the important obligations on adult Muslims is to observe the fasting of one lunar month every year. During this month (Ramadan) Muslims refrain from drinking, eating and smoking from dawn until sunset every day. This causes some change in the sleeping pattern as the meals would be taken early in the day and late at night. During this month many people stay awake most of the night and do not sleep until dawn. This is especially marked when Ramadan coincides with the summer holidays. The daytime working hours are reduced during this month in many Muslim countries and many firms resort to longer evening shifts. The majority of shops stay open at night until around 2.00 a.m.

Although there are a few reports on some metabolic and biochemical changes during Ramadan (Angel & Schwartz, 1975; Gumaa et al., 1978; Mustafa et al., 1978; Fedail et al., 1982; Prentice et al., 1983), cortisol was not studied in any of them.

We carried out this study to see whether the alteration of sleep/wake cycle has any effect on cortisol levels when associated with Muslim fasting.

Subjects and methods

Ten consenting adults were investigated during Ramadan at home (7 men and 3 women). Their age range was 19–56 years (mean 36.3). They were normal on physical examination and were not taking any medications. All of them maintained the Muslim fasting and followed their usual lifestyle for this month. They had normal sleeping patterns before fasting with 2 a.m. as the main peak of their activity, but stayed awake for the most part of the night during Ramadan, as they usually do during this month. They returned to their pre-fasting sleep pattern after the end of the month.

Blood samples were taken 1 day before fasting, on Days 3, 10, 17 and 24 of Ramadan, and repeated 4 weeks after the end of fasting. On each occasion, 10 ml of venous blood was collected in plain glass tubes from each subject while resting at home at 10.00 a.m. and at 12.00 midnight.
We chose 10.00 a.m. because it was the time when most people had woken up to start work during Ramadan. The subjects were woken up if they were asleep at 10.00 a.m. on the days of sampling. Specimens were centrifuged as soon as clotting was complete and sera stored at -18°C until analysed in batches.

One lady was investigated as an in-patient on Day 15 of Ramadan for a 24-h cortisol profile. Blood samples were taken from her every 2 h via an in-dwelling venous catheter.

Serum cortisol was measured by a radioimmunoassay technique using Amerlex Cortisol Kits (Amersham International plc, Amersham, UK). The reference range for this kit in our laboratory is 200–700 and 50–250 nmol/l for the 8.00 a.m. and 12.00 midnight cortisols respectively.

![Graph showing plasma cortisol levels over 24 hours](image)

**Figure. Twenty-four hour profile of plasma cortisol in one subject on day 15 of Ramadan.**

**Discussion**

Between the 3rd and 4th week of Ramadan four subjects showed alteration of their normal temporal pattern, with lower morning and higher midnight values. It is unlikely that this was the result of fasting alone as it has been demonstrated that plasma cortisol increases in the morning (Henson & Heber, 1983) or at least remains unchanged during fasting (Scriba et al., 1979). The most likely explanation for this change is the alteration of the 24-h sleep/wake cycle which takes at least 1 week to change the pituitary-adrenal cycle (Orth, Island & Liddle, 1967).

The response was not uniform in all subjects because of the diversity of factors that control serum cortisol. The change of the sleeping time to around 5.00 a.m. in the subjects whose sleep was not split into two periods can be regarded as analogous to a 'jet lag' produced by flying westwards. With this shift, cortisol secretion may take 3 weeks for the adaptation to the new clock time (Désir et al., 1981). Moreover, instead of the basal cortisol pattern of one major acrophase and one major nadir, two major acrophases and/or nadirs were reported in the course of adaptation (Désir et al., 1981), interpreted as reflecting a splitting of the rhythm.
<table>
<thead>
<tr>
<th>Subject</th>
<th>Sleeping hours during Ramadan</th>
<th>Before Ramadan (nmol/l) 10.00 am</th>
<th>Before Ramadan 12.00 midnight</th>
<th>Day 17 of Ramadan (nmol/l) 10.00 am</th>
<th>Day 17 of Ramadan 12.00 midnight</th>
<th>Day 24 of Ramadan (nmol/l) 10.00 am</th>
<th>Day 24 of Ramadan 12.00 midnight</th>
<th>4 weeks after Ramadan (nmol/l) 10.00 am</th>
<th>4 weeks after Ramadan 12.00 midnight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.00 am–3.00 pm</td>
<td>375</td>
<td>345</td>
<td>114</td>
<td>185</td>
<td>73</td>
<td>275</td>
<td>604</td>
<td>340</td>
</tr>
<tr>
<td>2</td>
<td>5.00 am–6.00 am &amp; 2.00 pm–6.00 pm</td>
<td>464</td>
<td>107</td>
<td>355</td>
<td>150</td>
<td>125</td>
<td>259</td>
<td>748</td>
<td>82</td>
</tr>
<tr>
<td>3</td>
<td>5.00 am–12.00 noon &amp; 4.00 pm–5.00 pm</td>
<td>426</td>
<td>101</td>
<td>140</td>
<td>344</td>
<td>355</td>
<td>141</td>
<td>374</td>
<td>285</td>
</tr>
<tr>
<td>4</td>
<td>5.00 am–1.00 pm &amp; 8.00 pm–9.00 pm</td>
<td>571</td>
<td>64</td>
<td>122</td>
<td>122</td>
<td>223</td>
<td>72</td>
<td>312</td>
<td>332</td>
</tr>
</tbody>
</table>
The total sleeping hours were reduced and/or split between the morning and afternoon for some of the subjects during Ramadan. This may change the cortisol rhythm, as it has been shown that adopting a 12-, 19- and 33-h sleep/wake schedule may result in two cortisol cycles (Orth et al., 1967). We cannot rule out two cortisol cycles per 24 h in our subjects whose sleeping hours were interrupted because of the small number of samples. However, the 24-h cortisol profile of the in-patient shows mainly a shift of cortisol acrophase and nadir by about 5–6 h, which corresponds to the shift of sleeping hours. This is likely to be the case in those who are not working during Ramadan and can have their continuous hours of sleep uninterrupted.

The overall shift of day activities to night during Ramadan involves prolonged exposure to light and this may affect the rate and extent of phase-shifting of plasma cortisol (Vernikos-Danelis & Winget, 1979). Social cues have similar pronounced effects and as our subjects were living in different housing and social conditions we expect them to have different rates of phase-shifting.

Serum samples drawn 4 weeks after Ramadan showed return of the morning cortisol to normal in all four subjects. However, the midnight values were still over 250 nmol/l in three of them. This is not surprising since the reversed circadian rhythm for cortisol may persist for 6 weeks after the change of the sleep/wake cycle (Orth et al., 1967).

In conclusion, morning and midnight serum cortisol values seem to be altered in some subjects in relation to Ramadan, most probably due to the associated change in the sleeping hours. It is of the utmost importance for physicians looking after Muslim patients during, or shortly after, Ramadan to be aware of this alteration. Although many physicians may use single resting cortisol values to investigate some patients, because of convenience and low cost, this seems totally inappropriate in relation to Ramadan.

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References


