Life Sciences, Vol. 51, pp. 1877-1880 Pergamon Press
Printed in the USA

A TRANSIENT RISE IN PLASMA β-ENDORPHIN AFTER A TRADITIONAL 47°C HOT-SPRING BATH IN KUSATSU-SPA, JAPAN

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(Received in final form October 6, 1992)

Summary

To clarify the mechanism of the intoxicating feeling attained after a traditional 47°C hot-spring bath called 'jikan-yu' in Kusatsu-spa, Japan, we examined the change in plasma levels of β-endorphin and methionine enkephalin in 7 healthy subjects. The mean sublingual temperature rose from 36.8°C to 38.6°C and the plasma β-endorphin level from 16.2 pg/ml to 49.5 pg/ml 2 minutes after completing a 3-minute bath in 47°C hot-spring water. However, the plasma methionine enkephalin level was not changed. This feeling of intoxication may be explained by the transient rise in plasma β-endorphin level.

In Kusatsu-spa, Japan, a unique time-limited bath in 47°C hot-spring water called 'jikan-yu' has been passed down for 130 years (1). It was in former days used in the treatment of leprosy and syphilis. One squats with bended knees, soaking in water up to one's chin in a bathtub about one meter deep filled with 47°C hot-spring water for exactly 3 minutes. Usually, one takes 3 or 4 baths a day for a couple of weeks. The pH of the hot-spring water is 1 to 2 and the main components dissolved in it are sulphates. When once experienced, one feels an intoxicating sensation and desires to bathe more and more.

To elucidate the mechanism of the intoxicating feeling after jikan-yu, we examined the change in plasma levels of β-endorphin and methionine enkephalin.

Methods

Seven healthy male volunteers aged 26-36 years, who gave informed consent, participated in this study. They were not accustomed to practicing jikan-yu. They were required to abstain from alcohol and smoking overnight. After relaxing in a comfortable room for 1 hour, they took a 47°C hot-spring bath for exactly 3 minutes by the method described above at 10 a.m. of one day. Then, they spent free time in a comfortable room until the end of the study. As a control, they took a regular 42°C hot-spring bath for 10 minutes 1 week later. Excepting the temperature of the water and the bathing time, all other factors were the same as those for jikan-yu.

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0024-3205/92 $5.00 + .00

Before and at several points after bathing, sublingual temperatures were recorded and blood samples obtained by repeated venipunctures were used for the assays of plasma levels of β-endorphin and methionine enkephalin. Plasma β-endorphin levels were measured with the use of a radioimmunoassay kit from INCSTAR (Stillwater, MN). The sensitivity of the assay is 15 pg/ml and the cross-reactivity with β-lipotropin is less than 5%. The inter-assay and intra-assay coefficients of variations were 18.0% and 10.1%, respectively. Plasma methionine enkephalin levels were measured using a radioimmunoassay kit from INCSTAR. The sensitivity of the assay is 30 pg/ml and the cross-reactivity with leucine enkephalin is 2.8%. The inter-assay and intra-assay coefficients of variations were 7.8% and 5.3%, respectively.

Results

The sublingual temperature showed the highest value 2 minutes after completing the 47°C bath and the mean increase was 1.8°C, from 36.8°C to 38.6°C (Fig. 1). With the 42°C bath for 10 minutes, its increase was only 1.1°C. However, the sublingual temperature returned similarly to the baseline level within 30 minutes of either 47°C or 42°C bathing.

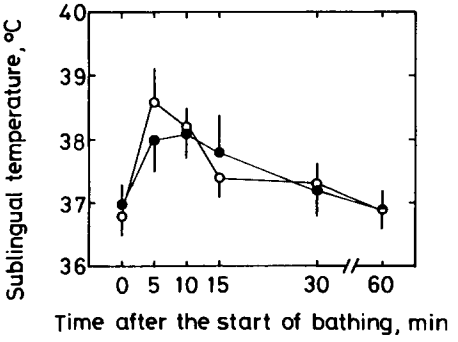

Fig. 1

Change in the sublingual temperature after a 47°C bath for 3 minutes (○) and a 42°C bath for 10 minutes (●). Each point represents the mean±SD from the 7 subjects.

The plasma β-endorphin increased from the baseline level 16.2 pg/ml to the maximum level 49.5 pg/ml 5 minutes after the start of 47°C bath and returned to the baseline level 30 minutes later (Fig. 2a). In contrast, such a plasma β-endorphin increase was not observed after the 10-minute 42°C bath. On the other hand, the plasma methionine enkephalin level was not changed after either 47°C or 42°C bathing (Fig. 2b).

Discussion

This study has shown that a transient rise in the plasma β-endorphin level was observed immediately after completing the 47°C hot-spring bath, jikan-yu. This rise in plasma β-endorphin level may explain the intoxicating feeling that almost all people experience after jikan-yu. To disclose a direct evidence for this,

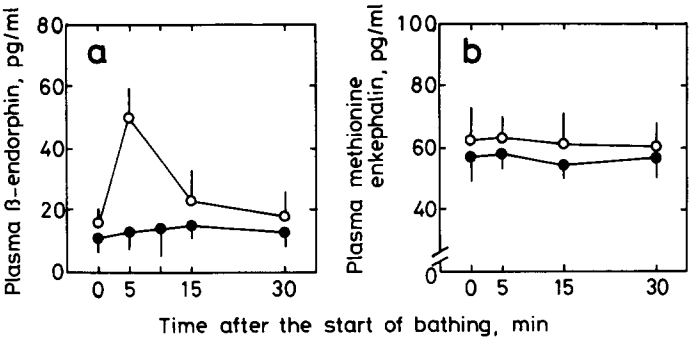

Fig. 2

Change in the plasma levels of β-endorphin (a) and methionine enkephalin (b) after a 47°C bath for 3 minutes (○) and a 42°C bath for 10 minutes (●). Each point represents the mean±SD from the 7 subjects.

a study preadministering an opiate antagonist would be of interest. In contrast, such a phenomenon was not observed in 42°C bathing. The reason why a 10-minute bath in 42°C hot-spring water was chosen as a control in this study was that in Japan we customarily have a dip in a bathtub about one meter deep filled with 38-42°C water for several minutes.

The rise in plasma β-endorphin level after the 47°C bath is considered to be due to the hyperthermal action of the hot-spring water but not due to some components dissolved in it, because such a phenomenon was not observed in the 42°C bath using the same hot-spring water. It was reported that similar plasma β-endorphin changes were noted in healthy persons having a sauna bath (2-4) and in cancer patients undergoing whole body hyperthermia (5, 6). Robins et al described that pain relief and the well-being sensation recognized in cancer patients with whole body hyperthermia are understood by considering the increase in plasma β-endorphin level (5).

Vescovi et al reported the lack of a methionine enkephalin response to the hyperthermal stress of sauna bath (4). The result in our study is consistent with theirs. These findings indicate that plasma β-endorphin and methionine enkephalin respond differently to whole body hyperthermia.

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