Influence of Size of Bath on the Appearance of α Waves in Electroencephalograms during Bathing

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入浴中脳波の α 波出現に浴槽サイズが及ぼす影響について

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抄　録

浴槽のサイズにより入浴時のリラックス度が異なるかどうかを調べるため，10名の健康男性（21-31歳）を対象に，入浴中の脳波を記録し α 波の出現頻度を調べた。被検者は朝より絶食とし，テレメトリー式の脳波計にて，小浴槽での入浴前，入浴中，入浴後10分の脳波を連続記録した。別の日の同時刻に同一被検者が，大浴槽にて同様の記録を行った。小浴槽として60×70×60cmの浴槽を，大浴槽として327×595×107cmのプールを用い，水温は両者とも39℃とした。入浴は胸骨柄の高さまでとし，プールでの水深はプール内の階段を用いて60cmとなるように工夫した。実験終了後全員に，どちらがより快適であったかの質問を行った。小浴槽での入浴中，α 波の出現は有意に減少し（$p<0.01$），出浴後には元に戻った。これに対し大浴槽では，入浴中の α 波の出現は入浴前と比べ変化がなく，出浴後にはむしろ増加した。入浴中の α 波の出現頻度は，小浴槽に比べ大浴槽において有意に高かった（$p<0.05$）。実験終了後に行った質問では，被検者全員が大浴槽の方が快適と答えた。以上より，リラックスする目的で入浴する場合には，より大きな浴槽での入浴が好ましいと考えられた。

Key words : Electroencephalogram, α waves, Size of bath, Bathing

INTRODUCTION

Recently, the number of public baths is gradually decreasing in Japan because of the increase in baths in the home. We usually feel more comfortable in a large bath than in a small one. As one of the purposes of bathing is for relaxation, it may be preferable to use a larger bath to achieve this aim. However, there have been no reports describing the medical advantages of bathing in larger baths. We examined electroencephalograms (EEG) of healthy volunteers during bathing in a large and small bath and obtained findings supportive of the advantages of larger baths.

SUBJECTS AND METHODS

Ten healthy men (aged 21-31) participated in the study. The characteristics of the subjects are shown in **Table 1**. The protocol was as follows. The subjects bathed in a small bath for 10 min. and at the same time on another day they used a large bath. The electroencephalograms of the subjects were recorded before, during and after the bathing.

The experiment was started at 8:00 a.m. and was performed in an experimental room (26℃ room temperature, 55±5% relative humidity). We used two bathtubs of different

Table 1 Characteristics of the subjects

Age	(yr)	22.8 ± 1.6
Height	(cm)	170.2 ± 6.8
Weight	(kg)	62.9 ± 5.0
BMI	(kg/m^2)	21.7 ± 1.6

(N=10)

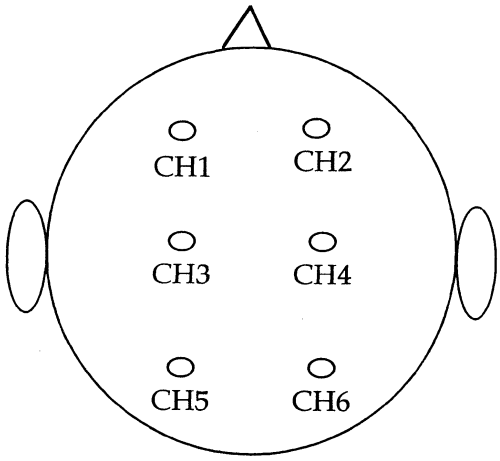

Fig. 1 The location of the electrodes for electroencephalogram.

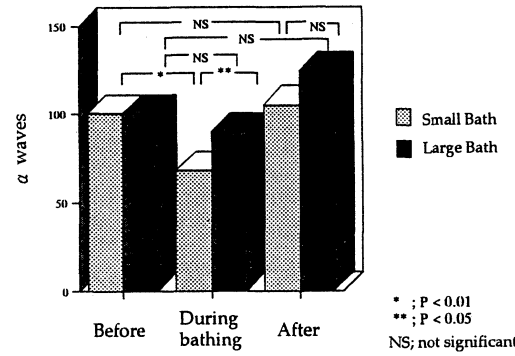

Fig. 2 The influence of size of bath on the appearance of α waves in electroencephalograms during bathing. The results were expressed considering the appearance of α waves before bathing as 100.

sizes; the small one was a 60cm-long, 70cm-wide, 60cm-deep bath (Polybath, TOTO, Tokyo), and the large one a pool in our hospital (327×595×107, [length×width×depth, cm]). When using the large bath, the level of the water was adjusted to 60cm in depth by sitting on a step in the pool. The water temperature was 39℃ in both the small and large baths.

After overnight fasting, the subjects entered the test room 20 minutes before the experiment wearing only swimming trunks. We put the electrodes for EEG on the subjects as shown in **Fig. 1**, and fixed a wireless EEG transmitter (EEG transmitter 1431SP, NEC-Sanei, Tokyo) on the head of each subject. The EEG was received by an EEG receiver (NEC-Sanei) and recorded by a Datarecorder (NEC-Sanei). Another EEG recorder (EEG 1A94, NEC-Sanei) was used for monitoring the EEG during the experiment.

After a 5 minute-rest, the subjects were immersed in the water up to the top of the sternum for 10 min. and took a rest for 10 min. after finishing the bathing. The subjects closed their eyes during the test except for immediately before and after bathing and avoided sleeping. The EEG is usually recorded with eyes closed softly as visual stimuli cause a disturbance with the eyes opened. After finishing the experiment, we asked the subjects in which bath they felt more comfortable.

The data of the EEG were analyzed by the Power Array Program (NEC-Sanei). The data from the four channels, CH3,4,5, and 6, in which the EEG was well recorded were adopted for evaluating the appearance of α waves. The appearance of α waves was calculated every 1 minute. The data 1 min. before and after the beginning and the end of immersion were excluded because the subjects had to open their eyes at those times. The results were expressed considering the appearance of α waves before bathing as 100. Statistical analyses were performed using Statview 4.0 (Abacus Concepts, Berkely, USA). Wilcoxon's rank sum test was used for the comparison of mean values. A probablity level of less than 0.05 was used to indicate statistical significance.

Results

When they were immersed in the small bath, the appearance of the α waves was significantly decreased during the immersion ($p<0.01$) and recovered after it. In contrast, in the large bath the appearance of α waves was not altered during immersion and increased a little after it. During the bathing, the appearance of α waves when the large bath was used was significantly greater than in the small one ($p<0.05$) (**Fig. 2**).

All of the subjects answered that they felt more comfortable during and after bathing in the large bath than in the small one.

Disscussion

We have reported the preferable water temperatures during bathing mainly from the biochemical and immunological viewpoints[1)-4)]. However, there have been no reports about the preferable size of bath during bathing. Thus, we examined whether using a

larger bath is preferable by recording electroencephalogram during bathing.

The brain waves in EEG are classified into 4 waves, α, β, θ and δ by their frequencies[5]. The frequency of the α wave is 8-13 Hz and the wave is observed in a resting and relaxed state. The frequencies of the β, θ, δ wave are 14 to 30, 4 to 7, and 0.5 to 3 Hz, respectively[6]. The α wave in EEG has been used for the evaluation of the mental state. Subjects in which the appearance of the α waves are increased are thought to be relaxed and comfortable.

We usually feel more relaxed and comfortable in a larger bath. These subjective feelings were supported by our EEG findings. The opportunities to use a large bath are decreasing because the bath in each home have become common. However, this study indicates that for relaxation it is preferable to use a larger bath.

As many electrodes are necessary to obtain the EEG, it is difficult to use a wired system during such water immersion. The wireless system we used was very suitable for recording the EEG during bathing because there was no need for the apparatus to be watertight.

Conclusion

To examine whether bathing in a large bath is preferable, we recorded EEGs of ten healthy men during bathing in large and small baths. While bathing in the small bath, the appearance of α waves was significantly decreased, but not in the large bath. While bathing in the large bath, the appearance of α waves was significantly greater than when bathing in the small one. Thus, the EEG findings suggest that using a larger bath is preferable.

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