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Quantitative Method for Biomechanical Evaluation of Bedding Comfortableness

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Abstract: Comfortable bedding is usually designed subjectively because of the difficulty in performing a quantitative evaluation. This paper proposes a quantitative evaluation method of comfortableness of beddings. The bedding shape determining how comfortable an individual may feel in using it depends on the body shape and normal posture of individuals. The internal physical load is expected to relate to the comfortableness of bedding. However, only a few quantitative discussions exist on the relation between the comfortableness of bedding and physical load. This study proposes a new evaluation method of physical load in a relaxed posture. The strain energy of muscles and joints was used as an indicator of physical load. To estimate physical load, a neutral body position (NBP), which is a relaxed posture under zero gravity [1], was simulated from a natural standing posture (NSP) and was used as a reference posture with the neutral condition of muscle lengths. Multiple NSP models and the corresponding NBP models were estimated to consider individual differences in NSP. We estimated muscle strain energy in a posture by using musculoskeletal simulation with the assumption that the muscle lengths in NBP are the natural ones. We also estimated the strain energy of the joint. By considering individual differences, multiple models of NBP were provided. Relaxed posture and its support condition were also simulated using a musculoskeletal model with varying parameters determining posture. Herein, as the parameters, this study uses two types of pillow height at the time of use. The parameters enable to consider effects of pillow heights in both head and neck regions on physical load in a relaxed posture. This physical load can be described using the strain energy of muscles and joints. In a given relaxed posture, the calculated physical load can vary with NBP. This means that the proposed method considers the individual difference in the case of using the same pillow. In this paper, AnyBody Modeling System™ was used not just for muscle force as done in previous studies but for simulating muscle length and joint reaction force. We simulated individual differences of a comfortable pillow height using the proposed models. Physical load in a relaxed posture was varied according to the NSP models. Calculated results show that physical load becomes small when a pillow is comfortable. For both subjective pillow comfortableness and smallness of physical load, there is a similar tendency that the low pillow with the small height difference between head and neck is preferable if the concave depth of back shape of head and neck is small. Moreover, the results show that muscles and joints equally affect the comfortableness of designed pillow by the comfortable pillow formulas [2]. This implies that less total energy required for maintaining the posture contributes to pillow comfortableness.

Keywords: Pillow design; comfort; physical load; musculoskeletal model; neutral body position; biomechanical evaluation

References

1. Mount FE, Whitmore M, Stealey SL. Evaluation of neutral body posture on shuttle mission sts-57 (spacehab-1). *National Aeronautics and Space Administration (NASA)*. **2003**.
2. Kuramoto A, Inui Y, Ichikawa T, Ono H, Sekiyama N et al. Comfortable pillow design based on individual basis. *International Information Institute (Tokyo). Information* **2019**, 20(9A): 6627-6644.

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