Commentary

iMedPub Journals
www.imedpub.com

International Journal of Anesthesiology and Pain Medicine
ISSN 2471-982X

2021
Vol.7 No.4:45

Validation of Lumbar Compressive Force Simulation in Forwarding Flexion Condition

Xiaohan Xiang*, **Yoji Yamada, Yasuhiro Akiyama, Ziliang Tao, and Naoki Kudo**

Department of Mechanical Systems Engineering, Nagoya University, Furo-Cho, Chikusa-ku, Nagoya, 464-8603, Japan

***Corresponding author:** Xiaohan Xiang, Department of Mechanical Systems Engineering, Nagoya University, Furo-Cho, Chikusa-ku, Nagoya, 464-8603, Japan, E-mail: xiangxiaohan@hotmail.com

Received date: June 04, 2021; **Accepted date:** June 18, 2021; **Published date:** June 25, 2021

Citation: Xiang X, Yamada Y, Akiyama Y, Tao Z, Kudo N (2021) Validation of Lumbar Compressive Force Simulation in Forwarding Flexion Condition. Int J Anesth Pain Med Vol.7 No.4: 45

Description

Safety requirements must be developed to enhance the social acceptability of lumbar-type physical assistant robots which are expected to reduce or mitigate the risk of Low Back Pain (LBP) e.g., for caregivers at clinical sites. In the associated International Safety Standard ISO 13482 [1], however, safety requirement is limited only to conceptual design guidelines stating as "A personal care robot shall be designed to minimize or reduce physical stress or strain to its user due to continuous use". It is also true for the Japanese standard for lumbar-type physical assistant robots, JIS B 8456-1 [2], which simply requires a positive amount of maximum assist force to show effective, safe use of the robots.

However, it is easy to consider that the CF exerted at lumbar vertebra changes depending on the posture and motions of the caregivers. Therefore, safety requirements need to be rigorously made for checking whether such manners as caregivers transfer care receivers are safe enough with the lumbar-type robots worn. Even without raising a technical issue of whether or not such robots are operated with proper posture which is intended by the manufacture of the robots, caregivers at clinical sites desire to learn whether their ways of transferring care receivers are appropriate or not.

Since a comprehensive validation of a simulator in dynamic conditions has not been conducted, we discuss the validation of CF simulators in the study based on inverse dynamics computation. Taking into account that CF simulators can be easily constructed and combined with the moment arm proposed by Chaffin et al. [3], and considering that estimating the CF concerning the lifting motion in the sagittal plane substantially provides information regarding the peak CF estimation, an ergonomic simulator is validated through forwarding flexion invasive experiments.

We also compare the data estimated by one of the CF simulators and those obtained by the regression models proposed by Potvin et al. [4] and Merryweather et al. [5] with the results of previous invasive CF experiments [6-9]. The correspondence between the simulated and experimental Compressive Force (CF), as well as the CF, obtained using two existing models about the unified angle, is investigated. The results show that the CF error between the measurements and the simulator at a flexion angle of 30˚ is 11.8% and is lower than those obtained for the other two models (16.8% and 20.6%). Linear regression shows that the invasive data and estimated CF are close (slope=1) in Merryweather's model and CF simulator but not for Potvin's model. We also evaluate the precision of the simulator by using the intraclass correlation coefficient method.

Merryweather's model is moderately consistent with invasive measurements, with R–0.685 and 0.627 at 0 and 30˚, while the CF simulator shows good consistency with Merryweather's model with R-0.879 and 0836 at 0 and 30˚

We attempt to introduce the above simple dynamic simulators as well as the analytical models because they are promising enough to be simply applied to the estimation of lumbar burden at practical sites and to be standardized. We also studied injury risk curves to clarify the risk level of injury to the lumbar spine due to lumbar compressive force for individuals within a wide age range [10] to apply the verified compressive strength data which are age-dependent.

Ongoing work includes further investigation of estimated CF concerning lifting motions and introduction of EMG measurement to combine the output signals with the analytical model for CF estimation.

References

1. Robots and robotic devices (2014) Safety requirements for personal care robots; International Organization for Standardization: Geneva, Switzerland. ISO 13482.
2. Personal care robots (2017) Physical assistant robots for lumbar support; Japanese Standards Association: Tokyo, Japan. JIS B 8456-1.
3. Chaffin DB, Andersson G, Martin BJ (2006) Occupational Biomechanical Models. In Occupational Biomechanics John Wiley & Sons: 133-134.
4. Potvin JR (1997) Use of NIOSH equation inputs to calculate lumbosacral compression forces. Ergonomics 40: 691-707.
5. Merryweather AS, Loertscher MC, Bloswick DS (2009) A revised back compressive force estimation model for ergonomic evaluation of lifting tasks. Work 34: 263-272.
6. Nachemson ALF, Morris JM (1964) In vivo measurements of intradiscal pressure: Discometry, a method for the determination

of pressure in the lower lumbar discs. J Bone Joint Surg 46: 1077-1092.

7. Wilke HJ, Neef P, Caimi M, Hoogland T, Claes LE (1999) New in vivo measurements of pressures in the intervertebral disc in daily life. Spine 24: 755-762.

8. Sato K, Kikuchi S, Yonezawa T (1999) In vivo intradiscal pressure measurement in healthy individuals and in patients with ongoing back problems. Spine 24: 2468-2474.

9. Takahashi I, Kikuchi SI, Sato K, Sato N (2006) Mechanical load of the lumbar spine during forward bending motion of the trunk: A biomechanical study. Spine 31: 18-23.

10. Kudo N, Yamada Y, Ito D (2019) Age-related injury risk curves for the lumbar spine for use in low-back-pain prevention in manual handling tasks. Robomech J 6: 12.