World Academy of Science, Engineering and Technology
International Journal of Bioengineering and Life Sciences
Vol:12, No:10, 2018

Immersive and Non-Immersive Virtual Reality Applied to the Cervical Spine Assessment

Authors : Pawel Kiper, Alfonc Baba, Mahmoud Alhelou, Giorgia Pregnolato, Michela Agostini, Andrea Turolla

Abstract : Impairment of cervical spine mobility is often related to pain triggered by musculoskeletal disorders or direct traumatic injuries of the spine. To date, these disorders are assessed with goniometers and inclinometers, which are the most popular devices used in clinical settings. Nevertheless, these technologies usually allow measurement of no more than two-dimensional range of motion (ROM) quotes in static conditions. Conversely, the wide use of motion tracking systems able to measure 3 to 6 degrees of freedom dynamically, while performing standard ROM assessment, are limited due to technical complexities in preparing the setup and high costs. Thus, motion tracking systems are primarily used in research. These systems are an integral part of virtual reality (VR) technologies, which can be used for measuring spine mobility. To our knowledge, the accuracy of VR measure has not yet been studied within virtual environments. Thus, the aim of this study was to test the reliability of a protocol for the assessment of sensorimotor function of the cervical spine in a population of healthy subjects and to compare whether using immersive or non-immersive VR for visualization affects the performance. Both VR assessments consisted of the same five exercises and random sequence determined which of the environments (i.e. immersive or non-immersive) was used as first assessment. Subjects were asked to perform head rotation (right and left), flexion, extension and lateral flexion (right and left side bending). Each movement was executed five times. Moreover, the participants were invited to perform head reaching movements i.e. head movements toward 8 targets placed along a circular perimeter each 45°, visualized one-by-one in random order. Finally, head repositioning movement was obtained by head movement toward the same 8 targets as for reaching and following reposition to the start point. Thus, each participant performed 46 tasks during assessment. Main measures were: ROM of rotation, flexion, extension, lateral flexion and complete kinematics of the cervical spine (i.e. number of completed targets, time of execution (seconds), spatial length (cm), angle distance (°), jerk). Thirty-five healthy participants (i.e. 14 males and 21 females, mean age 28.4±6.47) were recruited for the cervical spine assessment with immersive and non-immersive VR environments. Comparison analysis demonstrated that: head right rotation ($p=0.027$), extension ($p=0.047$), flexion ($p=0.000$), time ($p=0.001$), spatial length ($p=0.004$), jerk target ($p=0.032$), trajectory repositioning ($p=0.003$), and jerk target repositioning ($p=0.007$) were significantly better in immersive than non-immersive VR. A regression model showed that assessment in immersive VR was influenced by height, trajectory repositioning ($p<0.05$), and handedness ($p<0.05$), whereas in non-immersive VR performance was influenced by height, jerk target ($p=0.002$), head extension, jerk target repositioning ($p=0.002$), and by age, head flex/ext, trajectory repositioning, and weight ($p=0.040$). The results of this study showed higher accuracy of cervical spine assessment when executed in immersive VR. The assessment of ROM and kinematics of the cervical spine can be affected by independent and dependent variables in both immersive and non-immersive VR settings.

Keywords : virtual reality, cervical spine, motion analysis, range of motion, measurement validity
Conference Title : ICVR 2018 : International Conference on Virtual Rehabilitation
Conference Location : Paris, France
Conference Dates : October 29-30, 2018