

Review

The Reliability and Validity on Measuring Tool of Cervical Range of Motion: A Review

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Cervical problems are major health problems in our society. In order to assess the cervical problem, cervical range of motion is taken as documentation and as an outcome measure for the treatment effect. Since there are few measuring tools which are commonly use to measure the cervical range of motion, thus the aim of this study is to give an overview on literatures investigating on existing measuring tools as outcome measure for cervical range of motion. Literatures were reviewed to find related studies which describing various measuring tools and methods to measure the cervical range of motion. For example the measuring tools commonly use to measure the cervical range of motion are optotrak motion analysis system, iphone, android phone, goniometers, visual estimation and tape measurement. In order to get the high reliability and validity on measuring tool in cervical more studies had been explore and compare. A summary on how each measuring tool was conducted will be compared and discussed. In addition, this review also include the cervical disease, range of the age of the subject and the importance of position of the subject during the assessment by using each measuring tool. Cervical range of motion device, inclinometer, and smart phone are suitable and not costly to be use as instrument to measure the cervical range of motion.

Keywords: Cervical Range of Motion; Goniometer; Smart Phone**Introduction**

Cervical disorders are the common health problems in our society [1]. It is also one of the common reasons to visit professional health

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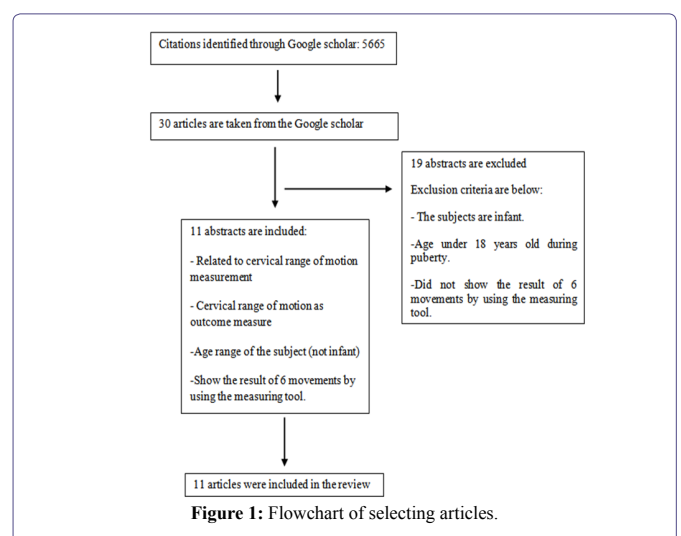
care due to pain and decrease range of motion which may reduce social participation and sick leave during working day [1]. Cervical range of motion is the importance physical assessment for health care professional to take as documentation baseline status and treatment progress [2]. There are numerous tools which available to measure cervical range of motion. For example, inclinometers, measuring tape, cervical range of motion device, Vicon, Optotrak motion analysis system, visual estimation and goniometer. Assessment of cervical range of motion is a significant part for health care professional to evaluating a patient presenting with cervical disease as well as it helps to establish the clinical diagnosis, prognosis and plan an individual treatment plan [1]. For these reasons, valid and reliable assessment tools are necessary.

Previously, a systematic reviews had been publishing in 2008, climimetric evaluation of active range of motion measures in patient with non-specific neck pain, this study conclude that cervical range of motion device and the single inclinometer can be consider as high accuracy among the measuring tools for cervical range of motion in patient with non specific neck pain in clinical practice [3]. After few years, new measuring tools had been come and some article had been publish for example using android phone, iphone, VICON and 3D motion capture motion analysis system to use as measuring tool to measure the range of motion in cervical.

The objective of this systematic review is to provide an overview of the current knowledge on the different type of the instruments that can be use in clinical practice when evaluating cervical range of motion in patient as well as use as the documentation for health care professional.

Results

There are total 6 journal articles and 1 systematic review selected from the literature search of research done from year 2005 to 2018 in Google scholar. The details of articles selection procedure are presented in Figure 1.

**Figure 1:** Flowchart of selecting articles.

From the result of 11 articles review all the measuring tools are valid in reliable in flexion, extension, left lateral flexion and right lateral flexion. The studies included mostly are in the age between 18 to 80 years old. 9 articles are mostly pure to find out the validity and reliability on measuring tools in cervical range of motion. However, 2 articles are related to poor posture of body and cervical disease cause the limitation of the neck movement and need the measuring tools to give the outcome measure before-after the treatment. From the 11 articles review, optotrak motion analysis system and VICON are the high validity and reliability to measure the 6 movement in cervical. Cervical range of motion device, goniometer, inclinometer, iphone, android phone are valid and reliable to measure 4 movement in sagittal plane in human.

The CROM device is an affordable tool for clinics, easy to use, can be installed quickly. Besides that, it requires minimal palpation to locate landmarks, without changing the position of the inclinometer; it can test cervical ROM in all directions including flexion, extension, left and right rotation and left and right lateral flexion. It is made of

a plastic frame placed on the head covered the nose and the ears, secured by a Velcro strap. There are total of three inclinometers, 1 in the sagittal plane and 1 in the frontal plane, are attached to the frame and indicate the position of the head in order to obtain the line of gravity. The third inclinometer, acts as a reference position, is positioned in the horizontal plane and indicates the position of the head in rotation [4].

Optotrak Certus is accurate motion capture system [5]. It is a camera based tracker which captures the position of markers of infrared light emitting diodes. This motion capture system is to calculate the 3D position coordinated by using 2D sensor data and it also uses temporal multiplexing to allow many markers to be tracked. Strober is to serves as the interface between markers and system control unit which consist of camera as well as sends date to the host computer for processing [5]. Vicon is the multi-camera three dimensional motion analysis system [6]. It is used Theangle of the head in the three planes as the referenced tothe laboratory axis, normalized to the neutralposition, and change it into kinematic data [6].

Measuring Tools	Type of Review	References	Range of Age & disease	Positioning	Result
-Cervical Range Of Motion Device -Optotrak Motion Analysis System	Journal 2010	[2]	Sitting without back rest	Sitting without back rest	CROM were shown to be reliable in all movement directions
-Goniometer -inclinometer -visual estimation -CROM	Systematic review 2008	[3]	Non specific neck pain; the age is random	Sitting with and without back rest	CROM and the single inclinometer can be consider as high accuracy among the measuring tools for cervical range of motion in patient with non specific neck pain in clinical practice
-Cervical range of motion device	Journal 2013	[9]	Increased thoracic kyphosis; age range is between 60-78 years old,	Sitting without back rest	The CROM used as the outcome measure for pre-post test
-iphone -Cervical range of motion device	Journal 2013	[8]	Healthy subjects; age range is between 19-43 years old	Sitting without back rest	iphone is moderate in validity to use as measuring in cervical flexion, extension and lateral flexion
-android phone -VICON	Journal 2014	[6]	Healthy subjects; age range is between 31-40 years old	Sitting with back rest	Android phone application is valid and reliable to measure ROM of the cervical-spine in flexion, extension and lateral-flexion but not in rotation
- Cervical range of motion goniometer	Journal 2009	[10]	Healthy subjects; age range is between 20-40 years old	Sitting	neck dimension should be incorporated into cervical functional outcome assessment and one should be wary about recorded values for neck motion from non-validated Measurement tools.
-Cervical range of motion with inclinometer	Journal 2013	[1]	Limitation of neck movement, age range is 18 years old and above	Sitting	Inclinometer is used as the outcome measure in the study
-CROM device, -Digital Caliper, -goniometer	Systematic reviews 2018	[11]	Adult (non specific age) with neck related disorders	Did not mention	little evidence to support the reliability and validity of clinical tests to assess head posture, pain location and cervical mobility in adults with neck related disorder
- Goniometers -Ultrasound-based coordinate measuring system (CMS)	Journal 2005	[7]	20-30 years old, asymptomatic adult	Sitting without back rest	CMS has high test-retest reliability and validity in measuring cervical motion
-Coda Motion 3-D Analysis System -X-ray -Cervical range of motion device	Journal 2018	[4]	60 healthy participant, age >18	Sitting with back rest	Coda Motion 3-D Analysis System is reliability for CROM measurements and validity for measurements of the range of extension and flexion motion in healthy subjects.
Goniometer	Journal 2018	[12]	aged 18-65 years; chronic mechanical neck pain > 3 months	Sitting back rest	The outcome is improved in the post treatment.

Table 1: Relevant Studies Describing the measuring tools to measure the cervical range of motion.

Ultrasound-based three dimensional system to detect cervical motion via three miniature ultrasound transmitters (U) with an output frequency of 35 kHz [7]. It is involving 2 sets of ultrasound and triple markers to detect the cervical motion. The coordinate information is recorded by the sensor and analysed by the Win-data 2.11 software as well as applying the principle of coordinate transformation to calculate the desired angle between the local coordinate and reference plan [7]. X-ray is also one of the measuring tools for cervical range of motion. It is calculation the cervical range of motion based on the radiographs [8].

Goniometers are the measuring tool to measure the range of motion in grades base on the landmarks [3]. For example goniometer are myrin goniometer, Spring-T goniometer and cervical range of motion instrument [3]. However, inclinometers are the fluid filled measuring tool that measure base on the gravity [3]. For example inclinometers are liquid inclinometer and spirit inclinometer. Tape measurement is the measuring tool by using tape in centimetres with different landmarks as reference marks [3]. Visual estimation is measuring skill which is observer visually estimate the cervical range of motion in the subject in sitting position [3].

There are many measuring tools used in measure the cervical range of motion in health care professional. From the reviews above, high validity and reliability measuring tools for cervical range of motion are the optotrak motion analysis system and VICON. These two measuring tools can get the accurate result in sagittal plan and frontal plan for the 6 movement in cervical. Goniometer, cervical range of motion device, inclinometer and smart phone are valid to get the movement in sagittal result in 4 movements for cervical and common use in the clinical for health care professional. This is because optotrak motion analysis system and VICON are high cost expense in clinical for health care professional. Goniometer, cervical range of motion device, inclinometer and smart phone are highly recommended because is portable, easy to set up, can get accurate result in 4 movement out of 6 movement in cervical and able to use to assess the assessment and progression for the patient in clinical.

Conclusion

This paper intended to review the measuring tool to measure the cervical range of motion in order to assist the health care professional in their assessment. In the result cervical range of motion device, goniometer, inclinometer, smart phone is invalid and reliable use in measure the cervical range of motion in clinical area.

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