Validation of the Telemedicine-Based Goniometry for Measuring Elbow Range of Motion

Cholawish Chanlalit MD*,
Pinkawas Kongmalai MD*

** Department of Orthopedics, Faculty of Medicine, Srinakarinwirot University, Nakhon Nayok, Thailand*

Objective: *To examine the validity of a Telemedicine-Based for measuring elbow range of motion*
Material and Method: *Cross-sectional descriptive studies in elbow flexion-extension and forearm pronation-supination were measured on 30 subjects.*
Results: *The intraclass correlation (ICC) and the percentage of degree of difference within fifteen and ten degrees between measurements obtained by telemedicine-based technique(VDO-clip) and clinical goniometry were found high percentage of correlation in flexion and extension. Pronation and supination, although not as good as flexion and extension, still showed some degree of correlation.*
Conclusion: *Remote range of motion assessment using telemedicine-based is technically feasible.*

Keywords: *Elbow range of motion, Measure, Tele-medicine, Tele-assessment*

J Med Assoc Thai 2012; 95 (Suppl. 12): S113-S117
Full text. e-Journal: *http://jmat.mat.or.th*

Due to the communication via internet are easier and has multiparameter contents, the adaptation of this technology for the patients to clinical assessment are interesting. Telemedicine is a services delivered at a distance using this kind or similar technologies through the products of daily appearing (camera, recorder). These services include evaluation and treatment, as well as education, consultation, and coordination of care. This service would be particularly valuable for patients who need periodic assessments to determine treatment progression or to determine if they qualify to be met or refer to the expert. This application had showed the benefit result in neuro-medicine, psychiatric, rehabilitation[1-4] . To date, few studies have investigated standard assessment tests applied to telemedicine in Orthopedics field. O'Driscoll's study used photography-based goniometry show the accurate and reliable for access elbow flexion and extension[5].

The present study was designed to investigate the validity and reliability of one kind of remote patient assessment (telemedicine with VDO clip) in elbows range of motion.

Correspondence to:
Chanlalit C, Department of Orthopaedics, Faculty of Medicine, Srinakarinwirot university, 62 Moo 7 Nakhon Nayok 26120, Thailand.
Phone: 08-1837-0705
E-mail: chanlalit@hotmail.com

Material and Method

Subjects

Sample size calculations (by PASS 2008) indicated that 30 subjects were necessary to detect greater than moderate reliability (alpha = 0.05 and beta = 0.1)[6]. Fifteen women and fifteen men were recruited from hospital staffs.

Exclusion criteria were: 1) Subjects with obvious deformity of the elbow that precluded the use of goniometer. 2) Subjects who unable to still in the extreme position to measure the joint range of motion

Methods

Elbow flexion and extension, forearm pronation and supination were measured by a specialist elbow surgeon using standard goniometer. The observer took the measurements using the goniometer facing the blinded part.

The position of the arm during the measurement of the active ROM was standardized for all the patients, as follows. The patients were asked to stand upright and flex their shoulder to 90°. Extension was measured with the elbow extended as fully as possible with the thumb point to the ceiling (Fig. 1). The patient was then instructed to flex the elbow as fully as possible, while keeping the humerus parallel to the floor (Fig. 2). The bony landmarks to use are the center of the humeral head as the proximal reference, the lateral epicondyle as the center of rotation and the

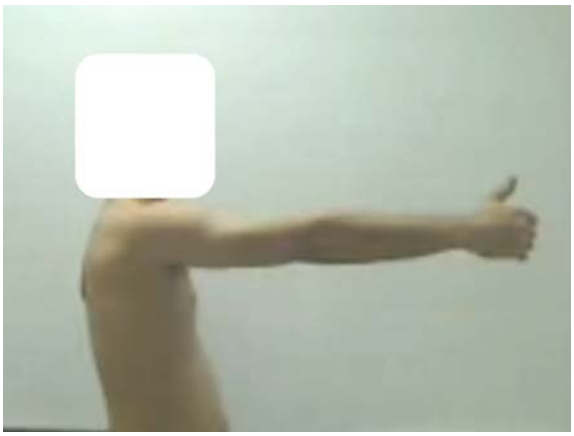

Fig. 1 Elbow extension

Fig. 2 Elbow flexion

center of the ulna as a distal landmark. To measure forearm rotation, the patient stands facing the examiner with elbows tucked snugly against the sides while holding drumsticks in both hands with the elbows were flexed 90°. To test supination, the patient is then instructed to rotate the forearms until the palms are facing up (Fig. 3). To test pronation, the patient is then instructed to rotate both forearms until the palms are facing down (Fig. 4) The amount of supination and pronation are measured as the angle between the alignment of drumsticks and a imaginary vertical line.

On the same day that the above goniometry

Fig. 3 Forearm supination

Fig. 4 Forearm pronation

measurements were performed, VDO recording of all patients were performed in the same protocol. One week apart, the VDO clip were displayed and ranges of motion were measured from free down load soft ware (PicPick, 3.1.0, NTe works) by elbow specialist using the same landmarks as described.

Statistical analysis

The data were analyzed using Bland-Altman analysis that defines the "limits of agreement". This system is based on the mean and standard deviation of the difference between ratings of the same subject[7-9]. The dash line represents the upper limit of agreement for each motion (|average| + 1.96*SD). A reference value to accept or refuse the telemedicine-based as a reliable method to assess range of motion will be 15° and 10°. The intra-class correlation coefficient (ICC) two-way mixed model on absolute agreement was used to analyze

measurement reliability[10]. The values of the ICC can range from 0 to 1, with a higher value indicating better reliability. ICC less than 0.40 was considered as poor; 0.40 to 0.59 as fair; 0.60 to 0.74 as good, and 0.75 to 1.00 as excellent. In addition, the lower and upper limit of 95% confidence interval of ICC was calculated to provide an estimate of the quantity of the measurement error. (SPSS statistics 17.0)

Results

Sixty elbows in thirty subjects were included in the present study and were evaluated by elbow specialist. The average age of subjects was 42 (31-57) years old. The Bland-Altman analyses for each elbow range of motions were shown in Fig. 5 to 8. The percentage of range of motions those were within the upper limit of agreement at 15° were 100% in extension motion and be 97% when flexion. In rotation the percentage of agreement were 83% both in supination and pronation. If the upper limit of agreement of the degree at 10°, the percentage of agreement in rotation motion would be 62-68% and flexion and extension be 85 and 98% respectively (Table 1).

The ICC between measurements obtained by clinical goniometry and VDO-based showed excellent in elbow extension, fair in elbow flexion. But The ICC of forearm pronation and supination were poor (Table 2).

Discussion

The validity of VDO clip-based goniometry method was determined by comparing it to clinical goniometry by the elbow specialist. When the authors used the upper limit of agreement at 15° and 10°, the percentage of measurements those were within limit

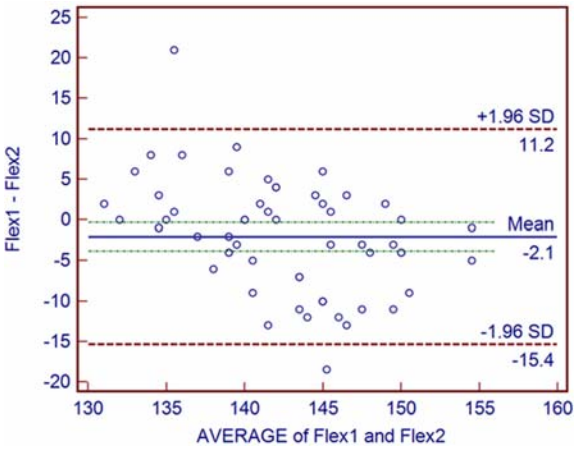

Fig. 5 Bland-Altman analysis of elbow flexion

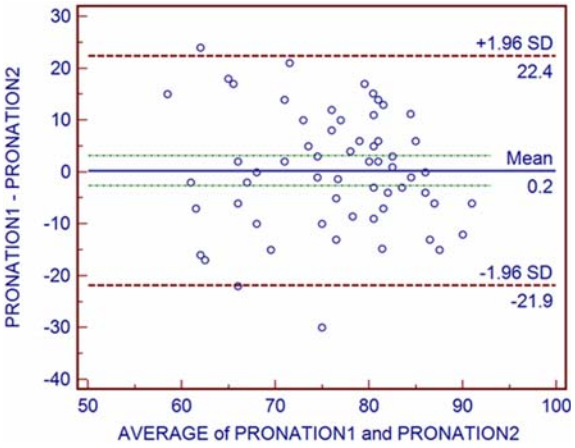

Fig. 7 Bland-Altman analysis of elbow pronation

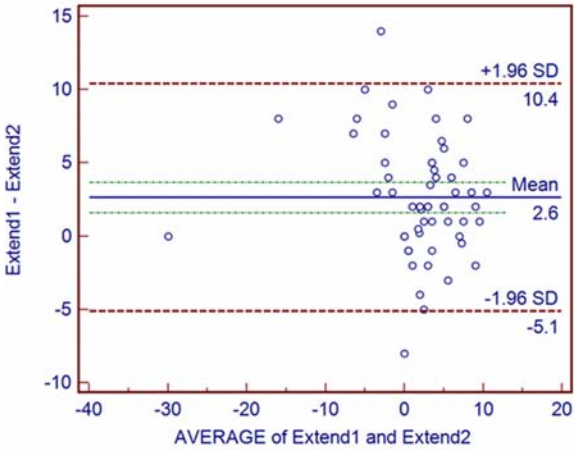

Fig. 6 Bland-Altman analysis of elbow extension

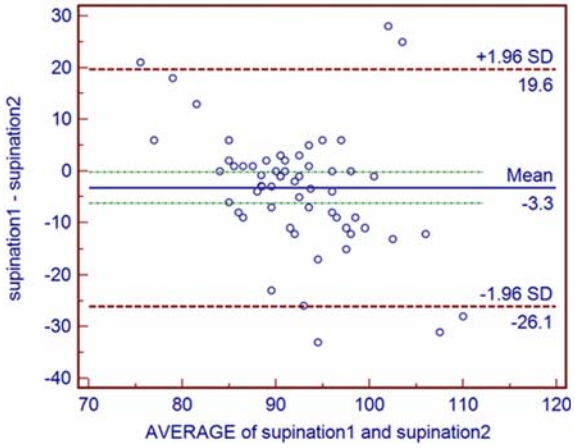

Fig. 8 Bland-Altman analysis of elbow supination

Table 1. The percentage of range of motions within the upper limit of agreement at each interval

Motion	Within upper limit of agreement (%)	
	15 degrees	10 degrees
Flexion	96.7	85.0
Extension	100.0	98.3
Pronation	83.3	61.7
Supination	83.3	68.3

Table 2. ICC between clinical goniometry measurement and VDO clip-based goniometry

Motion	ICC	95% Confidence interval	
		Lower limit	Upper limit
Flexion	0.46	0.23	0.64
Extension	0.81	0.71	0.88
Pronation	0.35	0.16	0.55
Supination	0.11	-0.10	0.40

were high for elbow flexion and extension. The Bland-Altman analysis and ICC results showed the validation of VDO clip-based goniometry method for measuring elbow flexion and extension compared with clinical goniometry. For forearm rotation, when the authors used the upper limit of agreement at 15°, the percentage of measurements those were within the limit were high. However, they were shown less reliable for the upper limit of agreement at 10°. Due to the results in the upper limit agreement at 10° were starts to deterioration, the authors decided not to further calculation in 5° of upper limit of agreement.

In a new clinical measurement technique, the authors often needed to see whether they agree sufficiently when compared with the standard method. This often analyzed the results by using intra-class correlation coefficient. An alternative approach is Bland-Altman analysis that based on graphical techniques and simple calculations.

O'Driscoll has shown that photography-based goniometry is reliable for measuring elbow ROM. He used the upper limit of agreement of 10° as a reference value to accept or refuse the photography-based goniometry as a reliable method to assess range of motion[5].

The upper limit of variation intervals for measurement result when measured in extension motion was lower than measured in flexion and rotation. The error component of elbow extension measurements was low than measurements in flexion and rotation. The explanation could be the placing the camera eg. The height of camera position was constant for every subject those were record. The authors should adjust this height to be suitable with patient's height for correction angle of camera to be the same for all subjects.

Another potential weakness of the present study is we do not perform the inter-method, inter-observer reliability test. In the further study, intra-method testing, inter-observer reliability test for determine the reproducibility of this technique.

Conclusion

Remote elbow range of motion assessment using VDO clip-based technique is technically feasible. This offers a great opportunity on patients to obtain the valid assessments through this technique.

Potential conflicts of interest

This research has financial support from faculty of Medicine, Srinakarinwirot University.

References

1. Dhurjaty S. The economics of telerehabilitation. Telemed J E Health 2004; 10: 196-9.
2. Shafqat S, Kvedar JC, Guanci MM, Chang Y, Schwamm LH. Role for telemedicine in acute stroke. Feasibility and reliability of remote administration of the NIH stroke scale. Stroke 1999; 30: 2141-5.
3. Engbers L, Bloo H, Kleissen R, Spoelstra J, Vollenbroek-Hutten M. Development of a teleconsultation system for communication between physiotherapists concerning children with complex movement and postural disorders. J Telemed Telecare 2003; 9: 339-43.
4. Mielonen ML, Ohinmaa A, Moring J, Isohanni M. Psychiatric inpatient care planning via telemedicine. J Telemed Telecare 2000; 6: 152-7.
5. Blonna D, Zarkadas PC, Fitzsimmons JS, O'Driscoll SW. Validation of a photography-based goniometry method for measuring joint range of motion. J Shoulder Elbow Surg 2012; 21: 29-35.
6. Donner A, Eliasziw M. Sample size requirements for reliability studies. Stat Med 1987; 6: 441-8.
7. Bland JM, Altman DG. Measuring agreement in method comparison studies. Stat Methods Med Res 1999; 8: 135-60.
8. Bland JM, Altman DG. Comparing methods of measurement: why plotting difference against

standard method is misleading. Lancet 1995; 346: 1085-7.
9. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet 1986; 1: 307-10.
10. Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. Psychol Bull 1979; 86: 420-8.

การทดสอบความน่าเชื่อถือของการใช้ Telemedicine-Based goniometry สำหรับการวัดการเคลื่อนไหวของข้อศอก

ชลวิช จันทร์ลลิต, พิงควรรศ คงมาลัย

วัตถุประสงค์*: ทดสอบความน่าเชื่อถือของการใช้ Telemedicine ในการวัดการเคลื่อนไหวของข้อศอก*
วัสดุและวิธีการ*: เป็นการศึกษาลักษณะ บรรยาย cross – sectional ในการงอเหยียดศอกและการหมุนท่อนแขนในอาสาสมัคร 30 ราย*
ผลการศึกษา*: ผลของ intraclass correlation (ICC) and the percentage of degree of difference within fifteen and ten degrees โดยใช้ VDO clip เมื่อเทียบกับการวัดโดย goniometer ได้ผลดีในการงอเหยียดศอก ส่วนการหมุนแขนได้ผลรองลงมา*
สรุป*: การประเมินการเคลื่อนไหวของศอกในระยะไกลโดยใช้ VDO clip นั้นเป็นเทคนิคที่มีความน่าเชื่อถือได้ในการใช้ในการปฏิบัติจริง*