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Validity of a tablet computer version of the Japanese Orthopaedic Association hip disease evaluation questionnaire: a pilot study

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ABSTRACT

The Japanese Orthopaedic Association hip disease evaluation questionnaire (JHEQ) was established as a new patient-reported outcome for patients with hip disease. We developed a JHEQ application beta version for tablet computers. The application has a slider system to input visual analogue scale (VAS) measurements. The purposes of this study were 1) to test whether the VAS that was acquired from this slider system was equal to the value recorded on paper and 2) to evaluate the validity and agreement of the JHEQ tablet version. A total of 57 patients were analyzed in the study (mean age, 60.2 years; range, 29–81 years). They received either the paper-and-pencil version (paper version) or the tablet computer version (tablet version). To evaluate the validity of the tablet version, we analyzed differences in the VAS and total scores between the paper version and tablet computer version. In addition, we calculated Cronbach's alpha, the intraclass correlation coefficient (ICC), and the Pearson's correlation coefficient (CC). The VAS scores in the tablet version were significantly lower than those in the paper version (22.3 ± 5.4 vs. 17.0 ± 4.5 and 28.1 ± 6.1 vs. 23.5 ± 5.3, respectively; all $P < 0.05$). Values of Cronbach's alpha, the ICC, and the CC among subscales ranged from 0.90 to 0.95. In conclusion, the total JHEQ score on the tablet computer beta version was in agreement with the score on the paper version. However, the VAS on the tablet version, which used a slider bar system, proved unreliable.

Key Words: osteoarthritis of hip, patient-reported outcome, Japanese Orthopaedic Association hip disease evaluation questionnaire (JHEQ), tablet computer

INTRODUCTION

In recent years, there has been increased interest in evaluating quality of life in patients with hip osteoarthritis. Patient-reported outcomes (PROs) are outcomes reporting consequences of disease and/or its treatment as reported by the patient, including perceptions of health,

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well-being, functioning, and treatment satisfaction. PROs serve as assessment tools for use in medical research, but are increasingly used to enhance decision-making during the doctor-patient consultation.[1)]

In 2012, The Japanese Orthopaedic Association hip disease evaluation questionnaire (JHEQ) was established as a PRO for hip osteoarthritis patients.[2)] The JHEQ has two characteristic features: (1) it reflects an Asian lifestyle (e.g., standing up from the floor) and (2) it includes a visual analogue scale (VAS) to measure patient satisfaction and hip pain (Appendix 1). The JHEQ consists of pain (28 points), movement (28 points), and mental (28 points) subscales, with higher scores indicating a better outcome. First, dissatisfaction with the patient's current condition and each hip joint are evaluated on the VAS; 0 mm indicates complete satisfaction or no pain at all, while 100 mm indicates complete dissatisfaction or maximum pain. The VAS for hip joint pain is then converted to 0–4 points (4, VAS 0–20 mm; 3, 21–40 mm; 2, 61–80 mm; 0, 81–100 mm). Next, questions evaluating pain, movement, and mental subscales are graded on a five-point scale (0, strongly agree; 1, agree; 2, uncertain; 3, disagree; 4, strongly disagree). Each item is scored between 0 and 4 points, and the maximum total score is 84 points. The reliability and validity of the JHEQ has been established in a previous study.[3)]

Currently, computer-based systems for data extraction that are in use for adaptation of existing PRO measures may lead to less administrative burdens, high patient acceptance, avoidance of secondary data entry errors, easy implementation when a respondent skips one or more questions based on responses to the previous questions, and more accurate and complete data.[4)] However, the data for the JHEQ are only entered manually with paper and a pencil (JHEQ paper version). Therefore, we developed the JHEQ application beta version for the iPad® (Apple, Inc., Cupertino, CA) (JHEQ tablet version). On the tablet version, we used a slider bar system instead of a VAS scale because it is technically difficult to recreate the VAS as it exists on the paper version (Fig. 1). A slider system was created as a graphical control element with which the user sets a value by moving an indicator.

The purpose of this study was (1) to test whether the VAS using a slider system was equal to the value on the paper version and (2) to evaluate the validity and the agreement of the JHEQ tablet version.

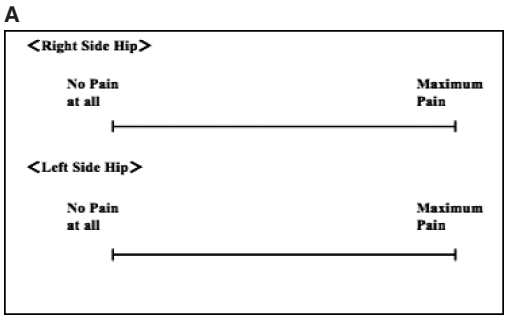

Fig. 1(A)

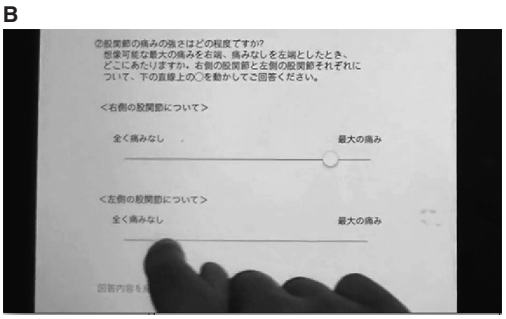

Fig. 1(B)

Fig. 1(A) Visual analogue scale (VAS, 0–100mm) in JHEQ paper version (B) Our slider bar system for VAS on a tablet computer with examinee's finger

METHODS

This study was approved by our institution's research ethics boards, and all participants provided written informed consent.

In 2014, eligible patients were recruited at their regularly scheduled follow-up visit at our outpatient clinic. The following inclusion criteria were employed: 3-month history of symptomatic osteoarthritis of the hip or history of surgery for the hip and ability to comprehend the Japanese language. Exclusion criteria were as follows: age under 20 years and inability to use a tablet computer for any reason. Subjects were invited to complete both the paper-and-pencil version and the tablet computer version of the JHEQ.

They received either the paper-and-pencil version (paper version) or the tablet computer version (tablet version) first. There was a 15-minute interval between the two assessments, as described in a previous study by Ferrari.[5] The order in which the two versions of the questionnaires was completed was randomly assigned by a computer software according to age, sex, and disease.[6]

SAMPLE SIZE

We sought to determine the sample size requirement to provide estimates of the agreement between the tablet version and the paper version of the data using the same protocol described by Jacquelyn Marsh.[7] We required a total of 56 participants (28 per group). A total of 62 patients were enrolled for the study. Two patients were not eligible because they were not completely able to use the tablet version by themselves. Three patients using the paper version were excluded. The reasons for cxclusion were as follow; One patient did not complete the VAS. Two patients had two or more unanswered items in their questionnaire. Finally, 57 patients were analyzed.

STATISTICAL ANALYSIS

The patient demographics are presented in Table 1. The mean age of participants was 60.2 years (range, 29–81). Furthermore, 41 (68.4%) patients had osteoarthritis of the hip (71.9%). Ten patients had Idiopatic osteonecrosis of femoral head 3, 2, and 1 patient suffered from bone tumors, ankylosing spondylitis, and transient osteoporosis of the hip, respectively. This survey included 43 women (75.4%). Thirty-three, 12, 5, and 7 patients were treated by total hip arthroplasty, periacetabular osteotomy or femoral osteotomy, revision of total hip arthroplasty, and conservative treatment, respectively.

Statistical analysis of data was performed using the Student t-test to compare VAS values between the two groups.

The validity and agreement of the assessment criteria have been verified on the paper version.[3] To assess the validity of the tablet version, we analyzed differences in the VAS and total score between the paper version and tablet computer version. In addition, we calculated Cronbach's alpha, the intraclass correlation coefficient (ICC), and the Pearson's correlation coefficient (CC). Cronbach's alpha is an indicator of the internal consistency of scales. The ICC takes into account systematic differences as well as random differences between variables and is therefore more appropriate when assessing the level of agreement.[7] The ICC also provides information about the total variance.[9] The CC was analyzed to determine the ability of the score of the tablet version to predict the score obtained from the paper version. We calculated the 95% confidence intervals for the ICC and CC.

Cronbach's alpha values larger than 0.70 were considered satisfactory.[10] We considered ICC

Table 1 Patient demographics

		Paper version first	Tablet version first	*P* value
n		28	29	
Age (±SD)		60 ± 14.1	60.8 ± 12.7	0.9
Disease (%)	OA	20 (71)	21 (72)	0.64
	ION	4 (14)	6 (21)	
	Others	4 (14)	2 (7)	
Sex (%)	Female	21 (75)	22 (76)	0.96
	Male	7 (25)	7 (24)	
Treatment (%)	THA	18 (64)	15 (52)	0.82
	Osteotomy	5 (18)	7 (24)	
	Revision	2 (7)	3 (10)	
	Conservative	3 (11)	4 (14)	

SD, standard deviation; OA, osteoarthritis; ION idiopathic osteonecrosis of the femoral head, THA; total hip arthroplasty

The Student's t-test was used to compare mean patient age. Fisher's exact test was used to compare the number of disease, sex and treatment. $P < 0.05$ were significant

values ≥0.75 as indicators of excellent agreement and a value <0.75 as an indicator of poor to moderate agreement.[7] The statistical analysis was performed with EZR (Saitama Medical Center, Jichi Medical University).[8]

RESULTS

The VAS score for hip-joint condition in the tablet version averaged 33.6 ± 6.4, which was lower than that in the paper version (36.2 ± 6.6), but there were no significant differences in satisfaction between the tablet version and the paper version (P = 0.36). The VAS scores for both right hip pain and left hip pain in the tablet version were significantly lower than in the paper version (22.3 ± 5.4 vs. 17.0 ± 4.5 and 28.1 ± 6.1 vs. 23.5 ± 5.3, respectively; all P < 0.05) (Table 2).

In the difference between the paper version and the tablet computer version, the standard deviation value of hip-condition VAS was 17.8. The standard error of hip-condition VAS was 2.8. The standard deviations of each hip joint VAS were 15.5 and 14.3, respectively. The standard errors of each hip joint were 2.5 and 2.3, respectively (Table 3).

The standard deviation of the difference of the total JHEQ score between paper version and tablet computer was 5.4, and the standard error was 0.8. The standard deviations of the differences in the pain, movement, and mental subscales were 3.2, 2.2, and 2.7, respectively. The standard errors of the differences in the pain, movement, and mental subscales were 0.5, 0.3, and 0.4, respectively (Table 4).

Cronbach's alpha values were as follows: pain subscale, 0.90; movement subscale, 0.95; mental subscale, 0.95. The ICCs were as follows: pain subscale, 0.90 (0.83 to 0.95); movement

Table 2 Comparison of visual analog scale scores between the paper-pencil version and the tablet version

Visual analog scale	Paper (±SD)	Tablet computer (±SD)	*p* value
Hip-joint condition	36.2 ± 6.6	33.6 ± 6.4	0.36
Pain			
Right hip	22.3 ± 5.4	17.0 ± 4.5	0.039
Left hip	28.1 ± 6.1	23.5 ± 5.3	0.048

SD, standard deviation

Table 3 The difference of VAS between paper version and tablet computer version

	ΔVAS of hip-joint condition	ΔVAS of right hip pain	ΔVAS of left hip pain
Mean	–2.7	–5.4	–4.5
Maximum	44	15	21
Minimum	–54	–56	–57
Standard deviation	17.8	15.5	14.3
Standard error	2.8	2.5	2.3

ΔVAS of hip-joint condition = (the VAS of hip-joint condition collected from tablet computer version) – (the VAS of hip-joint condition collected from paper version)
ΔVAS of right hip pain = (the VAS of right hip pain collected from tablet computer version) – (the VAS of right hip pain collected from paper version)
ΔVAS of left hip pain = (the VAS of left hip pain collected from tablet computer version) – (the VAS of left hip pain collected from paper version)

Table 4 The difference of the score to answer choices in JHEQ between paper version and tablet computer version

	ΔTotal	ΔPain	ΔMovement	ΔMental
Mean	0.25	0.18	–0.4	0.5
Maximum	20	14	6	8
Minimum	–8	–5	–7	–4
Standard deviation	5.4	3.2	2.2	2.7
Standard error	0.8	0.5	0.3	0.4

ΔTotal = (the total JHEQ score collected from tablet computer version) – (the total JHEQ score collected from paper version)
ΔPain = (the score of JHEQ pain subscale score collected from tablet computer version) – (the score of JHEQ pain subscale score collected from paper version)
ΔMovement = (the score of JHEQ movement subscale score collected from tablet computer version) – (the score of JHEQ movement subscale score collected from paper version)
ΔMental = (the score of JHEQ mental subscale score collected from tablet computer version) – (the score of JHEQ mental subscale score collected from paper version)

subscale, 0.95 (0.91 to 0.98); mental subscale, 0.93 (0.87 to 0.98). We showed the correlation diagram between the total score of paper version and the total score of the tablet version (Fig 2). The CC of total score was 0.96 (95% confidence interval: 0.93–0.98). The Pearson's CC between the tablet version and the paper version for the JHEQ subscales were as follows: pain subscale, 0.90 (95% confidence interval, 0.82 to 0.94); movement subscale, 0.93 (0.91 to 0.98); and mental subscale, 0.95 (0.87 to 0.98) (Table 5).

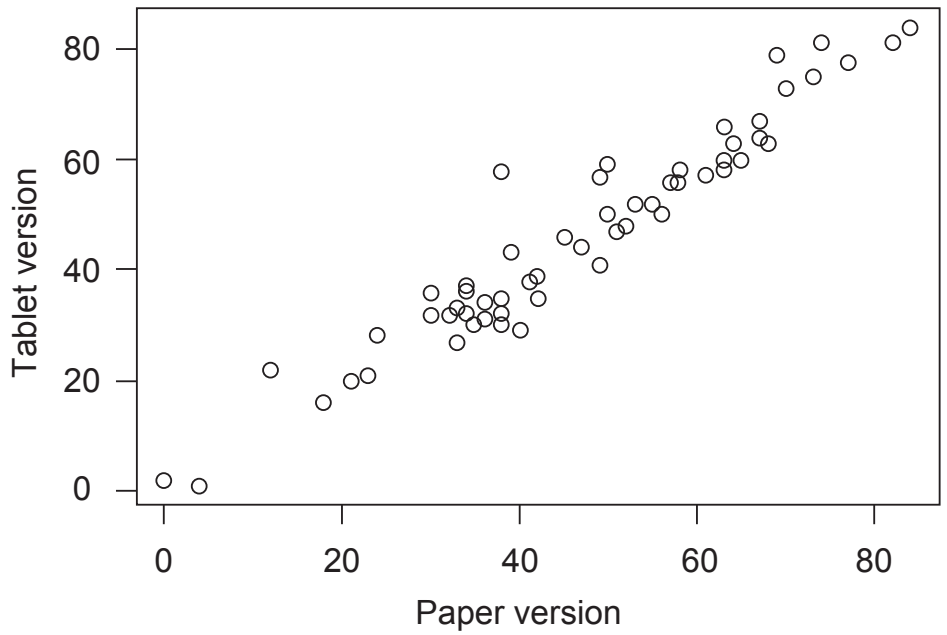

Fig. 2 Correlation diagram between paper version and tablet computer version

Table 5 The Cronbach's alfa, the intraclass correlation coefficient and Pearson's correlation coefficient for the JHEQ subscales

	Paper	Tablet computer	ICC (paper vs tablet)	Pearson's correlation coefficient (paper vs tablet)[95%CI]
Pain				
Mean (SD)	18.4 (7.3)	18.6 (7.3)	0.90	0.90[0.82–0.94]
Cronbach's alfa	0.95	0.94		
Movement				
Mean (SD)	12.0 (7.1)	11.6 (7.1)	0.95	0.93[0.91–0.98]
Cronbach's alfa	0.93	0.93		
Mental				
Mean (SD)	17.0 (7.1)	17.5 (7.0)	0.95	0.95[0.87–0.96]
Cronbach's alfa	0.94	0.94		

JHEQ, Japanese Orthopaedic Association hip disease evaluation questionnaire; CI, confidence interval; SD, standard deviation

DISCUSSION

In this study, the VAS for right side pain and left side pain according to the JHEQ tablet computer version were significantly lower than that with the paper version. The standard deviation and the standard error of the difference in the VAS between the paper version and tablet version were larger than the differences of both the total score and JHEQ subscale between the paper version and tablet computer version. This may be due to the use of the sliding system to collect data. The button on the table was smaller than the examinee's fingertips, the target was hidden by their finger. The lack of visual feedback resulted in unreliable VAS values.[11] In addition, the gaze and view angle on the tablet computer always result in accidental errors. The point of the examinee's view is different from the actual point on the tablet.[12] The position of the slider bar on the tablet computer may also affect the users' gaze, and then the examinee may input inaccurate VAS values. To avoid these errors, it may be effective to use a stylus pen instead of a finger.[13] Therefore, there is room for improvement in the slider system on our tablet version.

However, high validity and agreement between the tablet version and the paper version has been observed using other questionnaires (except the VAS system). These findings demonstrate good validity for the tablet version and good agreement with the paper version. Shervin *et al.* reported that the Spearman correlation among the paper version, web-based version, and touch-screen version of the outcome system for patients who underwent total hip arthroplasty varies between 0.68 and 0.93.[14] They concluded that a computer-based questionnaire provides data comparable with those obtained using paper-based outcome instruments because no significant differences were detected in any of the five outcome systems: Harris Hip score,[15] WOMAC,[16] SF36,[17] EQ5D,[18] and UCLA score.[19] Marsh *et al.* also reported that the scores obtained on the electronic version of the WOMAC and the SF12 had excellent agreement with the paper version (WOMAC: ICC, 0.96; SF12 (PCS): ICC, 0.95; SF12 (MCS): ICC, 0.92).[7] Our results are consistent with these previous findings.

Our study does have some limitations. First, we cannot confirm the Cronbach's alpha, ICC, and CC for each individual disease and each treatment because the sample size was too small. Second, the ICC was high because we enrolled only those patients who could operate the tablet computer. This may have led to selection bias.

We conclude that the JHEQ tablet computer beta version provides data that are in agreement with data obtained using the JHEQ paper version. However, the VAS with a slider bar system on the tablet version results in unreliable values.

CONFLICT OF INTEREST

The authors report no conflict of interest.

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