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original article

Validity and reliability of the Thai functional internal rotation scale for shoulder arthroplasty

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ABSTRACT

Background: The Functional Internal Rotation Scale is an excellent clinical tool for evaluating patients with shoulder arthroplasty, but it has not been adapted to the Thai version. The objectives of this study were to translate the English version and culturally adapt the Functional Internal Rotation Scale to the Thai version and to examine the psychometric properties of the Thai Functional Internal Rotation Scale among Thai participants having shoulder arthroplasty.

Methods: The Functional Internal Rotation Scale was translated to Thai, including cross-cultural adaptations, following standard guidelines. Psychometric properties were evaluated with shoulder arthroplasty patients. Content validity was evaluated using the content validity index (CVI). Criterion validity was assessed using the Pearson correlation coefficient. An Independent *t*-test was used to evaluate construct validity. Internal consistency reliability was assessed using Cronbach's alpha coefficient. Intraclass correlation coefficient (ICC) was used to determine test-retest reliability over a 14-day interval.

Results: Of 45 participants, 20 total shoulder arthroplasty (TSA) patients and 25 reverse shoulder arthroplasty (RSA) patients, the majority of participants were female (69%) and retired (91%) with a mean age of 72.9 years (SD 9.1). CVI evaluation was acceptable, with a total CVI of 0.92. The correlation of the Thai Functional Internal Rotation Scale with the Thai version of the American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (Thai ASES) and the internal rotation subscale (IR subscale) of the Thai ASES was 0.73 ($P < 0.001$) and 0.75 ($P < 0.001$), respectively. For construct validity, TSA patients scored, on average, 10.8 points higher than RSA patients (43.7 vs. 32.9, $P < 0.001$, 95% confidence interval 6.3–15.3). Cronbach's alpha coefficient of the Thai Functional Internal Rotation Scale was 0.95. The test-retest reliability revealed excellent reliability (ICC 0.99).

Conclusion: The Thai Functional Internal Rotation Scale has good validity and excellent reliability in assessing internal rotation function in Thai shoulder arthroplasty patients.

Authors' contribution

All conceived the ideas and collected the data. T.I. analyzed the data. T.I. drafted the manuscript. N.K. and P.C. revised the manuscript. All authors critically reviewed the manuscript and approved the final version of the manuscript.

1. Introduction

Shoulder arthroplasty cases have increased in number recently, especially reverse shoulder arthroplasty (RSA).[1,2] Indications for RSA have been extended to include rotator cuff tear arthropathy (CTA), symptomatic massive irreparable rotator cuff tear, proximal humerus fracture in the elderly, tumors of the proximal humerus and failed total shoulder arthroplasty (TSA).[3–5]

The subscapularis is located anterior to the glenohumeral joint capsule. The subscapularis' main functions include the internal rotator of the shoulder[6] and the prevention of anterior shoulder dislocation.[7] Subscapularis management is crucial before approaching the glenoid. Subscapularis tenotomy, lesser tuberosity osteotomy, and subscapularis peel-off are current options for

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subscapularis management.[8,9]

After subscapularis management, failure to repair the subscapularis leads to poor shoulder range of motion, anterior shoulder instability, and weakness.[10,11] Patients also report a limited range of motion after RSA, especially internal rotation.[12,13]

Internal rotation motion is required for several daily tasks, notably bathing, toileting, and getting dressed.[14,15] However, most patient-reported outcome measures (PROM) assess activities with flexion, abduction, and external rotation motions.[15] This bias toward these activities can lead to "good" outcomes despite poorly performed internal rotation activities.[16]

Functional Internal Rotation Scale is a novel PROM created especially for assessing internal rotation activities in shoulder arthroplasty patients. The questionnaire is a 10-question Likert-type scale to evaluate patients' satisfaction with internal rotation activities. The scores are graded in an ordinal manner from 1 to 5, with five equating to no difficulties with each task. A score of 50 meant no dissatisfaction with any tasks, and a score of 10 equated to complete dissatisfaction with all the tasks. The questionnaire showed high reliability with all questions and can be used with other PROMs to better assess internal rotation in patients following shoulder arthroplasty.[16]

For these reasons, the purposes of the present study were to translate and culturally adapt the Functional Internal Rotation Scale to the Thai version and to assess its validity and reliability. The author hypothesized that the Thai Functional Internal Rotation Scale would be a valid and reliable questionnaire to assess Thai shoulder arthroplasty patients.

2. Materials and methods

The Institutional Review Board, the Royal Thai Army, Medical Department approved this observational study. The study was composed of two stages. The first stage was translating into Thai and cross-culturally adapting the original Functional Internal Rotation Scale. The second stage was to investigate the validity and reliability of the Thai Functional Internal Rotation Scale questionnaire.

3. Translation and cross-cultural adaptation

After receiving permission from Aleem et al. to translate the original Functional Internal Rotation Scale into a Thai version, the authors adhered to the process of translation and cross-cultural adaptation stated by the American Association of Orthopedic Surgeons (AAOS) Outcome Committee. The translation and adaptation process consisted of 5 stages as follows.[17]

Stage 1: Initial translation. Two independent bilingual translators (a Thai sports medicine fellowship and an academic English language lecturer) individually prepared forward translations into Thai (T1 and T2 versions) from the original Functional Internal Rotation Scale.

Stage 2: Synthesis of the translations. The translators discussed translation differences in the two versions and created one standard translation (T12). Disagreements regarding translation were discussed with sports medicine staff to reach a consensus.

Stage 3: Back translation. The T12 version was independently translated back into the original language (BT1 and BT2 versions) by two bilingual native English speakers to warrant that the original version's concepts had been preserved.

Stage 4: Expert committee review. Review by a committee of experts on sports medicine and measurement development. The pre-final questionnaire was consolidated from all the translated versions (T1, T2, T12, BT1, and BT2) by an expert committee consisting of 3 sports medicine surgeons, one physical therapist, and two linguistic experts.

Stage 5: Test the prefinal version. Fifteen healthy volunteers and 15 patients with shoulder pain were recruited for the field test. All were native Thai speakers who could read, write and understand Thai.

4. Psychometric testing of the Thai functional internal rotation scale

The Thai Functional Internal Rotation Scale was evaluated for content validity, criterion validity, construct validity, internal consistency reliability, and test-retest reliability in patients recruited prospectively at the Sports Medicine Clinic, Phramongkutklao Hospital, from September 2021 to May 2022.

Inclusion criteria were patients who were returning for post-operative follow-up (at least six months) for TSA or RSA, whose first language was Thai, and who were able to read and understand Thai, were least 20 years old and could finish the questionnaire without major assistance. Patients with an ipsilateral upper extremity musculoskeletal disorder, an active cerebral disease, or communication problems were excluded. After receiving informed consent, patients were registered in the study. The rights of the patients were also protected. Demographic data, including age, sex, dominant hand, operated shoulder, and diagnosis, were recorded.

5. Content validity

Content validity is the degree to which its content adequately reflects the construct to be measured.[18] Content validity index (CVI) was used to judge the relevance of all items related to the construct to be measured by an expert panel including five sports medicine surgeons. The scoring system for each item was described as $+1$ = clearly measuring, 0 = degree to which it measures the content area is unclear, and -1 = clearly not measuring. The CVI value in each item was assessed by the summation of scores from each expert divided by the number of experts. A CVI value of more than 0.8 was acceptable.[19]

6. Criterion validity

The criterion validity of an outcome measure is tested by comparing the results of the outcome measure (target test) to a gold standard (criterion test). If the target test measures what it intends to measure, its results should agree with the gold standard criterion test results.[20] The Thai version of the American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (Thai ASES) was the alternative tool for evaluating the concepts being measured in this study.[21] Pearson correlation coefficient (r) was used to assess the subscales among the Thai Functional Internal Rotation Scale and the Thai ASES. The degree of correlation was interpreted as follows: 0.90 to 1.00 = very high positive correlation; 0.70 to 0.90 = high positive correlation; 0.50 to 0.70 = moderate positive correlation; 0.30 to 0.50 = low positive correlation; and 0.00 to 0.30 = negligible correlation.[22]

7. Thai ASES

The patient self-report section of the ASES is a condition-specific scale. It is designed to measure functional limitations and pain in the shoulder.[23] The Thai version of ASES was translated by Porramatikul et al.[21] Thai ASES are divided into two areas: pain (1 item) and function (10 items). The response to the single pain question is marked on a 10-cm visual analog scale (VAS). The ten items in the function area include daily activities such as managing the toilet, putting on a coat, etc. There are four categories for response options

from 0 (unable to do) to 3 (not difficult). The final score is calculated by summation of pain score ((10 − VAS for pain) × 5) and functional score (cumulative activity score × 5 ÷ 3) for a total of 100, with lower scores indicating more significant disability. Within ten functional items, three items (items 1, 3, and 4) were internal rotation subscales (IR subscale), which intended to evaluate internal rotation function.

8. Construct validity

Construct validity reflects the ability of a test to measure the underlying concept of interest. This approach is based on the assumption that if you give the test to two groups of subjects that you know differ on the construct of interest, the test scores of the groups should vary if the test measures what it is supposed to measure.[24] Independent *t*-test was used to examine the construct validity of the Thai Functional Internal Rotation Scale by comparing the questionnaire results of a postoperative TSA group to those of a postoperative RSA group.

9. Internal consistency reliability

Internal consistency is the degree of interrelationship between the items of the measurement. Cronbach's alpha coefficient, a parameter of internal consistency, was used to evaluate each subscale and the total score of the Thai Functional Internal Rotation Scale. The Cronbach alpha value range is from 0 to 1, with greater values representing higher interrelatedness between items. The values of at least 0.70 were considered adequate.[25]

10. Test-retest reliability

Test-retest reliability measures the reproducibility of measurement, e.g., the ability to obtain similar results when repeating the same test with the same target population after some time. The recommended time between the initial and repeat administrations is two weeks, long enough to prevent recall and short enough to certify that clinical change has not occurred.[26] In this study, the Thai Functional Internal Rotation Scale was assessed twice with a two to four weeks interval during which clinical symptoms remained stable. The intraclass correlation coefficients (ICC) value ranges from 0 to 1. We accepted coefficients >0.7 as representing high reliability.[27]

11. Statistical analysis

Categorical demographic data are described as frequencies and percentages. Continuous variables are presented as means and standard deviations (SD). Statistical significance was agreed at P value < 0.05. All data were analyzed using STATA software (Stata Corp, College Station, TX, USA).

12. Results

12.1. Translation and cross-cultural adaptation

One item was translated with minor cross-cultural adaptation. The item “I have difficulty putting my arm in a jacket” was translated into Thai directly for the first time. However, some experts realized that not many Thai people wear a jacket due to the warm weather in Thailand. Therefore, this item was changed to “I have difficulty putting my arm in a long sleeve shirt,” which uses the same shoulder movement.

The demographic data of the participants are shown in Table 1. Forty-five patients met the inclusion criteria and were included in the study (20 TSA and 25 RSA). The average age was 72.9 years (SD 9.1). Most were female (69%) and retired (91%). The most frequently affected side was the right (53%). The most common diagnosis was osteoarthritis (49%) and rotator cuff tear arthropathy (40%). There were no significant differences in age and operative side between the TSA and RSA groups.

12.2. Content, criterion, and construct validity

After translation and cross-cultural adaptation were completed, the final Thai Functional Internal Rotation Scale was judged for content validity. CVI evaluation by the experts of each item was more than 0.8, an acceptable level, with the total CVI being 0.92.

For criterion validity, the correlation between the Thai Functional Internal Rotation Scale and the Thai ASES and the IR subscale of the Thai ASES were compared (Table 2). A high positive correlation ($r = 0.73$, $P < 0.001$) was found between the Thai Functional Internal Rotation Scale and the Thai ASES. A comparison of the Thai Functional Internal Rotation Scale and the IR subscale of the Thai ASES showed a high positive correlation ($r = 0.75$, $P < 0.001$).

Evaluation for construct validity revealed that TSA patients had a narrow range of total scores, ranging from 34 to 50 total score with a mean of 43.7. RSA patients had a wider range of scores from 18 to 50, with a mean of 32.9. Comparing total scores between the two groups found TSA patients scored on average 10.8 points higher than RSA patients (43.7 vs. 32.9, $P < 0.001$, 95% confidence interval 6.3–15.3). Table 3 shows the results of this comparison.

12.3. Internal consistency and test-retest reliability

The internal consistency of the Thai Functional Internal Rotation Scale was very high. Cronbach's alpha coefficient was 0.95. All participants were retested, and the ICC for test-retest reliability was 0.99 (95% confidence interval 0.98–0.99). The average test-retest interval in the present study was 18 days.

13. Discussion

The original Functional Internal Rotation Scale is recognized as a PROM specific to patients following shoulder arthroplasty.[16] To date, this PROM has never been translated into a different language with cultural adaptation. This study aimed to construct a Thai version of the Functional Internal Rotation Scale through translation and cross-cultural adaptation and to test the psychometric properties of the translation, including validity and reliability.

The translation processes were referred to internationally recommended standards.[17] After translation in the present study, cultural adaptation was performed for the item relating to clothing to suit Thai people better. The questionnaire layout, format, and scoring system for the Thai version of the Functional Internal Rotation Scale are the same as the original questionnaire because the authors aimed to preserve the integrity of the initial questionnaire in all possible dimensions.

The present study showed that the Thai Functional Internal Rotation Scale demonstrated excellent validity. CVI evaluation by the experts to evaluate content validity showed that its content is an adequate reflection of the construct to be measured, with a CVI of more than 0.8 for each item and 0.92 for the total CVI.

Criterion validity revealed a high positive correlation between the Thai Functional Internal Rotation Scale and the Thai ASES and the IR subscale of the Thai ASES also. Two reasons might explain this finding. First, the IR subscale of the Thai ASES measures the internal rotation function of the shoulder as same as the Thai Functional Internal Rotation Scale, which showed a correlation between the two questionnaires. Second, patients with better

Table 1
Demographic data of patients (n = 45).

	TSA (n = 20)	RSA (n = 25)	Total
Age (year) - mean (SD)	71.0 ± 10.6	74.5 ± 7.6	72.9 ± 9.1
Gender			
Male - n (%)	3 (15.0)	11 (44.0)	14 (31.1)
Female - n (%)	17 (85.0)	14 (56.0)	31 (68.9)
Occupation			
Retirement - n (%)	16 (80.0)	25 (100.0)	41 (91.1)
Office - n (%)	4 (20.0)	–	4 (8.9)
Diagnosis			
Osteoarthritis - n (%)	18 (90.0)	4 (16.0)	22 (48.9)
Rotator cuff tear arthropathy - n (%)	–	18 (72.0)	18 (40.0)
Avascular necrosis - n (%)	1 (5.0)	2 (8.0)	3 (6.7)
Rheumatoid arthritis - n (%)	1 (5.0)	1 (4.0)	2 (4.4)
Operated side			
Right - n (%)	9 (45.0)	15 (60.0)	24 (53.3)
Left - n (%)	11 (55.0)	10 (40.0)	21 (46.7)
Duration after operation			
6–12 months - n (%)	3 (15.0)	7 (28.0)	10 (22.2)
1–2 years - n (%)	5 (25.0)	4 (16.0)	9 (20.0)
2–3 years - n (%)	3 (15.0)	5 (20.0)	8 (17.8)
>3 years - n (%)	9 (45.0)	9 (36.0)	18 (40.0)

Table 2
Pearson correlation coefficient between the Thai Functional Internal Rotation Scale and the Thai ASES and the IR subscale of the Tha ASES (n = 45).

	Thai ASES (full scale)	P value	Thai ASES (IR subscale)	P value
Thai Functional Internal Rotation Scale	0.73	<0.001[a]	0.75	<0.001[a]

[a] Statistically significant.

Table 3
Construct validity: comparison of scores between TSA and RSA (n = 45).

Operation	N	Mean ± SD	P value	95% CI
TSA	20	43.7 ± 5.7	<0.001[a]	6.3–15.3
RSA	25	32.9 ± 9.1		

[a] Statistically significant.

internal rotation activity also experience better overall satisfaction with the operated shoulder with other activities, which reflected a correlation between the Thai Functional Internal Rotation Scale and the Thai ASES.

For construct validity, the Thai Functional Internal Rotation Scale results in a different score between TSA and RSA patients, which reflects the ability to test the various constructs of interest. In all TSA patients, the subscapularis was taken down with a wafer lesser tuberosity osteotomy and repaired using nonabsorbable heavy sutures after implantation. The subscapularis was not repaired for RSA patients after peeling off the lesser tuberosity. The present study showed that the TSA group gave a higher average score and narrower range of total score than the RSA group (10.8 points difference, TSA 43–50 points, RSA 18–50 points), which is similar to the results from the original Functional Internal Rotation Scale questionnaire (8.7 points difference, TSA 36–50 points, RSA 19–50 points).[16]

The present study showed that the Thai Functional Internal Rotation Scale demonstrated high reliability. The Thai Functional Internal Rotation Scale had an excellent internal consistency (Cronbach's alpha coefficient 0.95). This result is comparable to the original version (Cronbach's alpha coefficient 0.94).[16] However, this high internal consistency raises some concerns about the duplication of items. In the test-retest reliability analysis, the Thai Functional Internal Rotation Scale presented an excellent correlation (ICC 0.99).

The present study has multiple strengths. First, the present study is the first to translate and cross-cultural adaptation of the Functional Internal Rotation Scale questionnaire and to test the psychometric properties of the translation. Second, this cohort is the first to perform criterion validity of the Functional Internal Rotation Scale questionnaire with the standard ASES questionnaire. Third, this study is the first to achieve test-retest reliability of the Functional Internal Rotation Scale questionnaire.

Limitations of the study include the following. First, the number of patients included in this study is relatively small (n = 45). Second, enrolled participants were from the Sports Medicine Clinic of one tertiary hospital and might not represent the general Thai population.

14. Conclusion

The original Functional Internal Rotation Scale was meticulously translated into Thai to create the Thai version of the questionnaire. The translation process was designed to produce a translation of the highest quality that maintained the integrity of the original version. The present study's findings demonstrate the validity and reliability of patient-rated outcome measurements in Thai patients with shoulder arthroplasty. This Thai Functional Internal Rotation Scale would be a useful outcome measure for evaluating the shoulder's internal rotation functioning in clinical practice.

Ethics statement

Ethics review approval was obtained from the Institutional Review Board, Royal Thai Army Medical Department, Thailand (IRBRTA 1308/2021).

Availability of data and material

More data are available, if necessary, from the corresponding author upon a reasonable request.

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Declaration of competing interest

The authors have no relevant financial or non-financial interest to disclose.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.asmart.2023.08.007.

Abbreviations

ASES	American Shoulder and Elbow Surgeons
CTA	rotator cuff tear arthropathy
CVI	content validity index
ICC	intraclass correlation coefficient
IR	internal rotation
PROM	patient-reported outcome measure
RSA	reverse shoulder arthroplasty
TSA	total shoulder arthroplasty
VAS	visual analog scale

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