

Reliability and Validity of The Korean Translation of The Achilles Tendon Total Rupture Score

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Abstract

Background

The Achilles tendon Total Rupture Score (ATRS) is a widely used patient-reported outcome measure to assess clinical outcomes of Achilles tendon rupture, but it has not been validated in Korean yet. The purpose of this study was to translate the ATRS into Korean and evaluate its reliability and validity in a Korean population.

Methods

The ATRS was translated into Korean according to recommended guidelines for forward-backward translation. Thirty-eight patients who underwent surgical treatment for Achilles tendon rupture from 2017 to 2019 were enrolled. Reliability was evaluated by the intraclass correlation coefficient (ICC), standard error of the measurement (SEM), minimal detectable change (MDC), and Cronbach's alpha. Construct validity was assessed with Spearman rank correlations with the Foot and Ankle Outcome Score (FAOS) and Numeric Rating Scale (NRS) for pain in daily activity.

Results

The Korean translation of the ATRS had excellent test-retest reliability (ICC = 0.838) and acceptable internal consistency (Cronbach's alpha = 0.84). The SEM was 6.63, and the MDC was 18.38 at the individual level and 2.98 at the group level. The Korean translation of the ATRS was strongly correlated with the FASO ($r = 0.876$). Correlation with the NRS in daily activity ($r = -0.659$) was moderate.

Conclusion

The Korean translation of the ATRS showed sufficient reliability and validity for use in the Korean population.

Introduction

Achilles tendon rupture is one of the most common tendon injuries in the human body. Due to greater participation in sports activities, this injury has been on the rise. Indeed, the overall incidence of Achilles tendon rupture was 21.5/100,000 per year in 2011 compared to 2.1/100,000 per year in 1979 [1–3]. In line with this trend, various treatments have been introduced, requiring accurate evaluation of the clinical outcomes of these treatments.

Patient-reported outcome measures (PROMs) are questionnaires completed by the patients themselves, and they should play a significant role in the evaluation of treatment results and decision making for

rehabilitation in Achilles tendon rupture. Among available PROMs, the Achilles tendon Total Rupture Score (ATRS) [4] was specifically developed to evaluate outcomes in patients treated for acute Achilles tendon ruptures, and it is one of the commonly used PROMs for this condition. The ATRS was originally developed in Swedish but has been validated in English, Danish, Dutch, Persian, Polish, Turkish, Greek, Norwegian, Chinese, Italian, Brazilian Portuguese, and French [5–16].

To date, no Korean PROMs have been validated specifically for Achilles tendon rupture. For the Korean population, ankle-specific PROMs such as the Foot and Ankle Outcome Score (FAOS) have been validated [17], but an Achilles tendon-specific PROM is important for a more precise evaluation of treatment outcomes, especially since the incidence of this injury is growing. Therefore, the purpose of this study was to translate the ATRS into Korean and to validate its measurement properties. This will facilitate future research on the treatment of Achilles tendon ruptures in the Korean population.

Methods

Translation procedure

The validated English ATRS was translated into Korean according to the guidelines of cross-cultural adaptation, which standardize the translation procedures into six steps to achieve linguistic and cultural equivalence between the original and translated versions of the questionnaire [18]. Forward translations from English to Korean were performed by two independent bilingual translators, and discrepancies were resolved by judgement of a third bilingual translator. The backward translation into English was performed by another two independent bilingual translators. A diverse group of 15 volunteers checked to ensure clear comprehension of each question. If there were discrepancies, they were resolved by consensus discussion among translators.

Study population

This study included patients who underwent surgical treatment for acute Achilles tendon rupture from June 2017 to May 2019. Exclusion criteria were concomitant lower limb injury, age less than 18 years, and unable to read, write, and understand Korean. After approval by the by the local Ethics Committee, patients who were eligible were informed of the objectives of the study and consent was obtained from those willing to participate. Because there is no consensus regarding sample size calculations for the validation of PROMs, we aimed to recruit as many participants as possible during the study period. Among 67 patients with Achilles tendon rupture during the study period, two were excluded, 24 were not willing to participate in the study, and three did not complete the questionnaires. Therefore, questionnaires from 38 patients were used for the statistical analysis.

Questionnaires

All questionnaires contained the Korean-translated version of the ATRS, a validated Korean FAOS, and Numeric Rating Scale (NRS) for pain. The ATRS questionnaire contains 10 questions, and each question is answered on an 11-point Likert scale ranging from 0 to 10. The total score ranges from 0 to 100 and is

calculated by summing the individual Likert items. Higher scores indicate good physical activity and lower symptoms [4].

The FAOS is a self-administered questionnaire originally designed to evaluate patients with ankle ligament injuries, but it has also been used for Achilles tendon rupture [4, 19]. The FAOS includes 42 questions with five subscales: pain, other symptoms, activities of daily living (ADL), function in sports and recreation, and foot- and ankle-related quality of life (QOL). Each question is answered on a 5-point Likert scale ranging from 0 to 4. A normalized score is calculated for each subscale, with 100 indicating no symptoms and 0 indicating severe symptoms [19].

The NRS is a commonly used assessment of pain severity. To express the intensity of pain, patients quantify their pain on an 11-point Likert scale ranging from 0 to 10, with 0 indicating no pain and 10 indicating the worst pain imaginable [20]. In this study, the NRS in daily activity was assessed.

Reliability

Each patient completed the questionnaires twice, with a 2-week interval, between 6 and 12 months after surgery. Because patient health status should be unchanged over the 2-week interval, patients did not receive any rehabilitation or treatment that could significantly affect their condition during the test-retest period. One of the authors evaluated the health status of patients at baseline and after 2 weeks, and patients who reported a change in their health status were excluded.

Test-retest reliability, which represents the stability of the scale over time, was evaluated by using the intraclass correlation coefficient (ICC) [21]. The ICC was judged according to the following criteria: very low (< 0.20), low (0.21–0.40), moderate (0.41–0.60), good (0.61–0.80), and excellent (0.81–1.00) [22]. The standard error of the measurement (SEM) and minimal detectable change (MDC) were calculated as follows: $SEM = \text{standard deviation (SD)} \times \sqrt{(1-ICC)}$, $MDC \text{ at the individual level} = 1.96 \times \sqrt{2} \times SEM$, and $MDC \text{ at the group level} = (1.96 \times \sqrt{2} \times SEM) / \sqrt{n}$ [23].

Internal consistency refers to the degree of homogeneity of the responses to the items of the questionnaire and was evaluated with the Cronbach alpha coefficient. A Cronbach alpha coefficient greater than 0.7 was considered to be acceptable [24].

Construct validity

Construct validity was evaluated with correlations between the Korean translation of the ATRS and the five subscales of the FAOS and the NRS in daily activity. Correlations were measured with Spearman rank correlations and assessed with the following criteria: uncorrelated (lower than 0.4 or higher than - 0.4), moderate (between 0.4 and 0.7 or between - 0.4 and - 0.7), and strong (higher than 0.7 or lower than - 0.7) [25]. On the basis of the results of Dutch and Swedish validation studies [4, 11], we hypothesized that the Korean translation of the ATRS would be strongly correlated with the FAOS symptom, pain, function, and ADL subscales, and moderately correlated with the FAOS QOL subscale and the NRS in daily activity.

Floor and ceiling effects

If more than 15% of responders achieve the lowest or highest possible score, floor or ceiling effects are considered to be present [25]. When either effect is present, patients with a minimum or maximum score cannot be distinguished from one another, which reduces the interpretability of the questionnaire. In the current study, floor and ceiling effects were evaluated with histograms.

Statistical analysis

Data normality was determined with the Kolmogorov-Smirnov test. Continuous variables showing a normal distribution were summarized as mean and SD. Clinimetric properties were calculated as described above. Statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS®) software, version 23.0 (IBM, Armonk, New York, USA), and significance was set at $p < 0.05$.

Ethics

This study was approved by the Ethics Committee of Korea University Medical Center (IRB No. 2019GR0477). Informed consent was obtained from all participants. All methods were carried out in accordance with Declaration of Helsinki.

Results

Translation process

Both forward and backward translation were performed without significant difficulties. Despite a few semantic differences during translations, there were no major discrepancies in translation to discuss, and few adjustments were necessary. Volunteers checked the Korean version of the questionnaire and found it to be clearly comprehensible. Therefore, we approved the final version of the Korean translation of the ATRS (Appendix 1).

Demographics

Patient characteristics were similar between non-participants and participants, with no significant difference observed between groups (Table 1).

Table 1
Patient characteristics

	Non-participants (n = 29)	Participants (n = 38)	p-value
Age, y	40.9 ± 11.4 (22–66)	39.2 ± 9.9 (19–56)	0.573
Sex, n (%)	23 (79.3)	32 (84.2)	0.750
Male	6 (20.7)	6 (15.8)	
Female			
Involved side, n (%)	14 (48.3)	16 (42.1)	0.630
Right	15 (51.7)	22 (57.9)	
Left			
Time between injury and questionnaires, mo		7.6 ± 1.9 (6–12)	NA
Data are mean ± standard deviation (range) unless otherwise noted. NA, not applicable.			

Reliability

Two patients reported a change in health status and were excluded from the reliability test. The overall ICC was 0.838 (95% confidential interval [CI]: 0.687–0.916), indicating excellent test-retest reliability. The SEM was 6.63, and the MDC was 18.38 at the individual level and 2.98 at the group level. The Cronbach alpha coefficient was 0.84, indicating acceptable internal consistency.

Construct validity

Table 2 summarizes the Spearman rank correlations between the Korean translation of the ATRS and the subscales of the Korean FAOS and the NRS for pain. As predicted, the Korean translation of the ATRS demonstrated strong correlations with all FAOS subscales except QOL.

Table 2
Construct validity measured by Spearman rank correlation coefficients

	ATRS	Correlation	p-value
FAOS overall	0.876	Strong	< 0.0001
FAOS symptom	0.725	Strong	< 0.0001
FAOS pain	0.806	Strong	< 0.0001
FAOS function	0.830	Strong	< 0.0001
FAOS ADL	0.792	Strong	< 0.0001
FAOS QOL	0.550	Moderate	< 0.0001
NRS in daily activity	-0.659	Moderate	< 0.0001

ATRS, Achilles tendon Total Rupture Score; FAOS, Foot and Ankle Outcome Score; ADL, activities of daily living; QOL, quality of life.

Floor and ceiling effects

None of the patients achieved the lowest score, and two patients (5.3%) achieved the highest score. Therefore, there were no floor or ceiling effects in the Korean translation of the ATRS.

Discussion

The primary finding of this study was that the Korean translation of the ATRS showed sufficient reliability and validity. Therefore, the Korean translation of the ATRS can be used in the Korean population to evaluate the clinical outcomes of treatment for Achilles tendon rupture.

In this study, the ICC value for test-retest reliability of the Korean translation of the ATRS was 0.838, which is lower than that of previous translations of the original ATRS into other languages, including English (ICC = 0.986) [13], Persian (ICC = 0.98) [10], Turkish (ICC = 0.98) [7], Chinese (ICC = 0.979) [6], Greek (ICC = 0.97) [15], French (ICC = 0.966) [16], Italian (ICC = 0.96) [5], Brazilian Portuguese (ICC = 0.93) [9], Danish (ICC = 0.908) [12], Norwegian (ICC = 0.90) [5], Polish (ICC = 0.90) [14], and Dutch (ICC = 0.852) [11]. We suspect that the relatively low ICC value in this study was due to the timing of completion of the questionnaires, which occurred between 6 and 12 months after surgery. Patients in this study did not reported changes in health status over the 2-week test-retest interval, but may have experienced a marked improvement in activities compared to patients in other studies conducted later after surgery. This difference could have affected the test-retest reliability of this study. Indeed, Carmont et al. [13] evaluated test-retest reliability of the ATRS at 3, 6, and 12 months after treatment and found that reliability increased as time passed after treatment. Although the ICC value of the current study is not as high as other studies, it can still be categorized as excellent. Thus, we conclude that the Korean translation of the ATRS is reliable.

The SEM value in this study (6.63) was in agreement with that of previous studies of ATRS that documented SEM values ranging from 1.56 to 10.91 in other languages, including Brazilian Portuguese (1.56) [9], French (2.58) [16], Turkish (3.2) [7], Persian (3.57) [10], Norwegian (6.13) [5], Danish (6.67) [12], and Dutch (10.91) [11]. In addition, the %SEM value, which is an expression of the SEM as a percentage of the mean score, was 8.8% in the current study. Values of %SEM that are lower than 10% are regarded as acceptable for clinical purposes [26]. The MDC at the group and individual levels indicated that the Korean translation of the ATRS was suitable for identifying real changes when comparing groups of patients with a difference above 2.98 points and individual patients with a difference above 13.38 points.

Until now, no validated questionnaire specific to the evaluation of clinical outcomes of treatment for Achilles tendon rupture, such as the VISA-V [27] or Leppilahti score [28], has been validated in Korean. Therefore, we used the FAOS to evaluate the validity of the Korean translation of the ATRS because the FAOS has been validated in Korean and has been used to assess the outcomes of Achilles tendon rupture, as well as the validity of other translations of the ATRS [4, 5, 11, 17, 29]. The overall correlation between the Korean translation of the ATRS and the FAOS was above 0.7. Although the correlation coefficient was below 0.7 for the FAOS subscale QOL, four out of five a priori hypothesized correlations were confirmed by this study. Therefore, we considered the validity of the Korean translation of the ATRS to be acceptable.

This study had two main limitations. First, the number of participants was relatively small compared to previous studies of the validity and reliability of outcome measures for ATRS. Although there is no agreed optimum method to determine the appropriate sample size for evaluating the validity of PROMs, the 38 participants in this study may be considered insufficient when compared with previous studies that enrolled a mean of 78 participants (range, 46 to 112 participants) [5–16]. Second, the responsiveness or sensitivity to change of the Korean translation of the ATRS was not assessed because no participants reported any changes in their status over the test-retest interval. Evaluating changes in patient status is critical for the assessment of therapeutic interventions, so it will be necessary confirm this in future studies of the Korean translation of the ATRS.

Conclusion

The Korean translation of the ATRS showed sufficient reliability and validity for use in the Korean population to evaluate clinical outcomes of treatment for Achilles tendon rupture.

Abbreviations

PROMs

Patient-reported outcome measures; ATRS: Achilles tendon Total Rupture Score; FAOS: Foot and Ankle Outcome Score; NRS: Numeric Rating Scale; ADL: activities of daily living; QOL: quality of life; ICC: intraclass correlation coefficient; SEM: standard error of the measurement; MDC: minimal detectable change; SD: standard deviation.

Declarations

Acknowledgements

Not applicable.

Authors' contributions

YHP: study design, patient enrollment, data collection, and original draft preparation; HWC: patient enrollment and data collection; JWC: statistical analysis and manuscript correction; HJK: study design, and manuscript correction.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Korea University Medical Center (IRB No. 2019GR0477). Informed consent was obtained from all participants. All methods were carried out in accordance with Declaration of Helsinki.

Consent for publication

Written informed consent for publication was obtained from all participants.

Competing interests

The authors declare that they have no competing interests.

References

1. Ganestam A, Kallelose T, Troelsen A, Barfod KW. Increasing incidence of acute Achilles tendon rupture and a noticeable decline in surgical treatment from 1994 to 2013. A nationwide registry study of 33,160 patients. *Knee Surg Sports Traumatol Arthrosc.* 2016;24:3730-7.
2. Maffulli N, Waterston SW, Squair J, Reaper J, Douglas AS. Changing incidence of Achilles tendon rupture in Scotland: a 15-year study. *Clin J Sport Med.* 1999;9:157-60.
3. Nyyssonen T, Luthje P, Kroger H. The increasing incidence and difference in sex distribution of Achilles tendon rupture in Finland in 1987-1999. *Scand J Surg.* 2008;97:272-5.

4. Nilsson-Helander K, Thomee R, Silbernagel KG, Thomee P, Faxen E, Eriksson BI, et al. The Achilles tendon Total Rupture Score (ATRS): development and validation. *Am J Sports Med.* 2007;35:421-6.
5. Myhrvold SB, Sandnes O, Hoelsbrekken SE. Validity and reliability of the Norwegian translation of the Achilles tendon Total Rupture Score. *Knee Surg Sports Traumatol Arthrosc.* 2018;26:2045-50.
6. Cui J, Jia Z, Zhi X, Li X, Zhai X, Cao L, et al. The chinese version of achilles tendon total rupture score: cross-cultural adaptation, reliability and validity. *Health Qual Life Outcomes.* 2017;15:2.
7. Kaya Mutlu E, Celik D, Kilicoglu O, Ozdinciler AR, Nilsson-Helander K. The Turkish version of the Achilles tendon Total Rupture Score: cross-cultural adaptation, reliability and validity. *Knee Surg Sports Traumatol Arthrosc.* 2015;23:2427-32.
8. Vascellari A, Spennacchio P, Combi A, Grassi A, Patella S, Bisicchia S, et al. Cross-cultural adaptation and multi-centric validation of the Italian version of the Achilles tendon Total Rupture Score (ATRS). *Knee Surg Sports Traumatol Arthrosc.* 2018;26:854-61.
9. Zambelli R, Pinto RZ, Magalhaes JM, Lopes FA, Castilho RS, Baumfeld D, et al. Development of the Brazilian Portuguese version of the Achilles Tendon Total Rupture Score (ATRS BrP): a cross-cultural adaptation with reliability and construct validity evaluation. *BMC Sports Sci Med Rehabil.* 2016;8:11.
10. Ansari NN, Naghdi S, Hasanvand S, Fakhari Z, Kordi R, Nilsson-Helander K. Cross-cultural adaptation and validation of Persian Achilles tendon Total Rupture Score. *Knee Surg Sports Traumatol Arthrosc.* 2016;24:1372-80.
11. Opdam KTM, Zwiers R, Wiegerinck JI, Kleipool AEB, Haverlag R, Goslings JC, et al. Reliability and validation of the Dutch Achilles tendon Total Rupture Score. *Knee Surg Sports Traumatol Arthrosc.* 2018;26:862-8.
12. Ganestam A, Barfod K, Klit J, Troelsen A. Validity and reliability of the Achilles tendon total rupture score. *J Foot Ankle Surg.* 2013;52:736-9.
13. Carmont MR, Silbernagel KG, Nilsson-Helander K, Mei-Dan O, Karlsson J, Maffulli N. Cross cultural adaptation of the Achilles tendon Total Rupture Score with reliability, validity and responsiveness evaluation. *Knee Surg Sports Traumatol Arthrosc.* 2013;21:1356-60.
14. Bakowski P, Rubczak S, Wolff-Stefaniak M, Grygorowicz M, Piontek T. Reliability and validity of the Polish version of the Achilles tendon Total Rupture Score. *Knee Surg Sports Traumatol Arthrosc.* 2018;26:2074-9.
15. Touzopoulos P, Ververidis A, Giakas G, Drosos GI. Validation and cross-cultural adaptation of Greek version of Achilles tendon Total Rupture Score. *Foot Ankle Surg.* 2019;25:8-12.
16. Buckinx F, Lecoq G, Bornheim S, Van Beveren J, Valcu A, Daniel C, et al. French translation and validation of the Achilles Tendon Total Rupture Score "ATRS". *Foot Ankle Surg.* 2019; doi:10.1016/j.fas.2019.08.010.
17. Lee KM, Chung CY, Kwon SS, Sung KH, Lee SY, Won SH, et al. Transcultural adaptation and testing psychometric properties of the Korean version of the Foot and Ankle Outcome Score (FAOS). *Clin Rheumatol.* 2013;32:1443-50.

18. Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine (Phila Pa 1976)*. 2000;25:3186-91.
19. Roos EM, Brandsson S, Karlsson J. Validation of the foot and ankle outcome score for ankle ligament reconstruction. *Foot Ankle Int*. 2001;22:788-94.
20. Holdgate A, Asha S, Craig J, Thompson J. Comparison of a verbal numeric rating scale with the visual analogue scale for the measurement of acute pain. *Emerg Med (Fremantle)*. 2003;15:441-6.
21. Barfod KW, Riecke AF, Boesen A, Hansen P, Maier JF, Dossing S, et al. Validation of a novel ultrasound measurement of achilles tendon length. *Knee Surg Sports Traumatol Arthrosc*. 2015;23:3398-406.
22. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics*. 1977;33:159-74.
23. de Vet HC, Terwee CB, Knol DL, Bouter LM. When to use agreement versus reliability measures. *J Clin Epidemiol*. 2006;59:1033-9.
24. Bland JM, Altman DG. Cronbach's alpha. *BMJ*. 1997;314:572.
25. Terwee CB, Bot SD, de Boer MR, van der Windt DA, Knol DL, Dekker J, et al. Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol*. 2007;60:34-42.
26. Atkinson G, Nevill AM. Statistical methods for assessing measurement error (reliability) in variables relevant to sports medicine. *Sports Med*. 1998;26:217-38.
27. Robinson JM, Cook JL, Purdam C, Visentini PJ, Ross J, Maffulli N, et al. The VISA-A questionnaire: a valid and reliable index of the clinical severity of Achilles tendinopathy. *Br J Sports Med*. 2001;35:335-41.
28. Leppilahti J, Forsman K, Puranen J, Orava S. Outcome and prognostic factors of achilles rupture repair using a new scoring method. *Clin Orthop Relat Res*. 1998:152-61.
29. Lee K, Jegal H, Chung H, Park Y. Return to Play after Modified Brostrom Operation for Chronic Ankle Instability in Elite Athletes. *Clin Orthop Surg*. 2019;11:126-30.

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