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ORIGINAL ARTICLE

# Derivation of a clinical prediction rule to determine fall risk in community-dwelling individuals with knee osteoarthritis: a cross-sectional study

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## Abstract

*Summary* We derived a clinical prediction rule (CPR) to determine fall risk. The probability of falls increased, with positive likelihood ratio being 17.8 and post-test probability (positive predictive value) being 88.2%, in cases where the CPR score was 2 points. Our CPR could be a useful screening test to detect fall risk probability.

**Purpose** We aimed to examine the risk factors for falls in individuals with knee osteoarthritis (OA) and derive a clinical prediction rule (CPR) to determine fall risk.

**Methods** Eighty-one individuals with medial compartment knee OA were included. The outcome was whether the participants had a self-reported fall within the past 1 year of this study being conducted. The collected data included sex, age, body mass index, Kellgren-Lawrence grade, lesion type (bilateral or unilateral knee OA), pain (rated using the visual analog scale), muscle strength test of the quadriceps femoris, one-leg standing test (OLST), five times sit-to-stand test (FTSST), and 5-m walk test, which were used in binomial logistic regression analysis. The outcome measure of the analysis was whether the study participants belonged to a fall or non-fall group. Receiver operating characteristic (ROC) analysis was performed for the outcome measurements, and the factors were selected by binomial logistic regression analysis. Then, a CPR to determine fall risk was extracted, and its diagnostic characteristics were calculated.

**Results** Binomial logistic regression analysis showed that the OLST and FTSST were significant. ROC analysis showed that the cut-off values of the OLST and FTSST were 5.3 s and 7.9 s, respectively. The post-test probability (positive predictive value) increased to 88.2% (positive likelihood ratio = 17.8) when the OLST and FTSST were both positive (the CPR score was 2 points).

**Conclusion** The CPR obtained from this study would be useful as a screening test to detect the fall risk probability in individuals with knee OA.

**Keywords** Prognosis prediction · Clinical prediction rule · Osteoarthritis · Knee · Falls

## Introduction

Fall-related injuries cost the patients a large amount of medical fees or result in a long-term decline of their quality of life (QOL) [1]. Rubenstein [2] reported that about 40% of community-dwelling elderly people had experienced a fall at least once a year and one out of 40 individuals who experienced a fall at least once a year had been hospitalized. As the physical activities and QOL in elderly people are easily affected by fall-related injuries, rehabilitation medicine should aim to prevent such falls. Previous studies have reported that muscle strength tests and dynamic balance measurements are strongly related to falling in elderly people [3, 4]. While various fall prevention measures already exist, more precise assessments of individuals, related to falling and multiple component interventions, based on these more sophisticated assessments are actually indispensable to preventing falls [5]. Studies on fall risk are becoming increasingly important to maintain a healthier lifestyle.

Knee osteoarthritis (OA) is a common joint disease that can affect physical activities and is considered one of the risk factors for falls [6]. Manlapaz et al. [7] reported that the risk factors for falls in patients with knee OA were impaired

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balance, muscle weakness in the lower limbs, increasing number of symptomatic joints, and pain in general. Sex, aging, obesity, and gait speed are also generally considered risk factors for falls [8–11]. The cut-off values related to the muscle strength test for the lower limbs [12], one-leg standing test (OLST) [13], and five times sit-to-stand test (FTSST) [14] have been reported to enable differentiation between elderly fallers and non-fallers. Moreover, it has been shown that physical therapy, such as balance training and muscle exercises, is effective as a fall prevention measure in patients with knee OA [15, 16]. Although detailed clinical features in individuals with knee OA, such as walking ability or muscle strength, are rather diverse, previous studies mostly considered knee OA as just one single factor when they addressed the fall problems. Therefore, we should address the detailed multiple features of knee OA when individuals with knee OA face fall problems.

The clinical prediction rule (CPR) can be a useful tool for clinical decision making. For example, McGinn et al. [17] have reported that the CPR could help differentiate between patients in whom any interventions would be promising and those in whom they would not be promising. If the CPR could determine whether individuals are at a high risk of falling, it would significantly help in the implementation of interventions for fall prevention. Therefore, the purpose of this study was to examine the risk factors for falls in individuals with knee OA and derive a CPR to determine fall risk.

## Methods

### Participants

Eighty-one individuals (62 women and 19 men, average age 72.4 ± 8.6 years) participated in this cross-sectional study (Table 1). Among them, 24 individuals (29.6%) belonged to the fall group. All study participants involved in this study had medial compartment knee OA. The inclusion criteria for participant selection were as follows: community-dwelling individuals (1) having a diagnosis of knee OA; (2) not being hospitalized, but undergoing physical therapy in clinics; (3) having the ability to stand from a chair without assistance or the use of upper extremity support; and (4) having the ability to walk 11 m or more without assistive devices on a level walkway. The exclusion criteria were as follows: (1) having had surgeries on knee joints prior to the study; (2) having a diagnosis of multiple-joint OA other than the knee joint, such as hip osteoarthritis and spine osteoarthritis; (3) having neurological impairments such as sensory disturbances or motor paralysis; and (4) having cognitive or psychological disorders.

### Assessments

The outcome was whether the participants had a self-reported fall within the past 1 year of this study being conducted. Having a fall was defined as the study participant losing balance while standing up or walking and touching the floor or the ground with some body part, except for the feet. The present study included sex, age, the body mass index (BMI), the radiological stage of knee OA according to the Kellgren-Lawrence grade (K-L grade), lesion type (bilateral or unilateral knee OA), pain in the knee joint rated using the visual analog scale (VAS), the muscle strength test (the maximal isometric contraction) of the quadriceps femoris, OLST, FTSST, and the 5-m walk test (5mWT) in the analysis.

**Table 1** The characteristics of the participants and the measurement results

| Variable | | All (*n* = 81) | Fall group (*n* = 24) | Non-fall group (*n* = 57) |
|---|---|---|---|---|
| Individual factors | Sex (%) | Women, 62 (76.5) | Women, 19 (79.2) | Women, 43 (75.4) |
| | Age (years) | 72.4 ± 8.6 | 73.2 ± 8.0 | 72.1 ± 8.8 |
| | BMI (kg/m$^2$) | 24.5 ± 3.8 | 26.3 ± 4.3 | 23.7 ± 3.4 |
| | K-L grade | I, 17 (21.0); II, 37 (45.7); III, 18 (22.2); IV, 9 (11.1) | I, 3 (12.5); II, 9 (37.5); III, 8 (33.3); IV, 4 (16.7) | I, 14 (24.6); II, 28 (49.1); III, 10 (17.5); IV, 5 (8.8) |
| | Lesion type | Bilateral knee OA, 51 (63.0) | Bilateral knee OA, 16 (66.7) | Bilateral knee OA, 35 (61.4) |
| | VAS (mm) | 26.2 ± 21.8 | 32.8 ± 18.9 | 23.5 ± 22.5 |
| Measurement | Muscle strength test (Nm/kg) | 1.09 ± 0.42 | 0.82 ± 0.21 | 1.21 ± 0.44 |
| | OLST (s) | 13.59 ± 10.19 | 6.09 ± 5.66 | 16.74 ± 10.05 |
| | FTSST (s) | 8.96 ± 2.44 | 10.60 ± 2.19 | 8.27 ± 2.22 |
| | 5mWT (s) | 3.59 ± 1.08 | 4.31 ± 1.50 | 3.28 ± 0.65 |

Data are presented as mean ± standard deviation or *n* (%)

*BMI*, body mass index; *K-L grade*, Kellgren-Lawrence grade; *OA*, osteoarthritis; *VAS*, visual analog scale; *OLST*, one-leg standing test; *FTSST*, five times sit-to-stand test; *5mWT*, 5-m walk test

**Table 2** Related factors of fall risk in individuals with knee OA

| | Partial regression coefficients | *P* value | Odds ratios | 95% confidence intervals | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| OLST | − 0.22 | 0.003 | 0.81 | 0.70 | 0.93 |
| FTSST | 0.56 | 0.006 | 1.74 | 1.18 | 2.58 |
| Sex | − 0.23 | 0.779 | 0.79 | 0.16 | 4.02 |
| Age | − 0.11 | 0.050 | 0.90 | 0.80 | 1.00 |
| BMI | − 0.07 | 0.517 | 0.93 | 0.76 | 1.15 |
| K-L grade | 0.34 | 0.423 | 1.40 | 0.61 | 3.19 |
| Lesion type | 0.15 | 0.842 | 1.16 | 0.28 | 4.81 |
| VAS | − 0.01 | 0.661 | 0.99 | 0.96 | 1.02 |

$\chi^2$ test, $P < 0.001$; Hosmer-Lemeshow test, $P = 0.934$; percentage of correct classifications, 79.0%

*OLST*, one-leg standing test; *FTSST*, five times sit-to-stand test; *BMI*, body mass index; *K-L grade*, Kellgren-Lawrence grade; *VAS*, visual analog scale

The muscle strength test [18] was performed using a handheld dynamometer (μTas F-1; Anima Corp., Tokyo, Japan). The study participants extended the knee joint with a maximal effort while sitting on a chair with their knee joints kept at a 90° flexion. It required just one measurement of the maximal isometric contraction of the quadriceps femoris of the targeted side and was normalized by body weight. The OLST [19] was measured while the participants stood on one foot with the opposite foot slightly but completely elevated from the floor and the eyes open. The maximal time between the two measurements was adopted or 30 s was adopted if the time was 30 s or more. The FTSST [20] was measured once while the participant repeated standing up and sitting down from the chair at a height of about 43–45 cm five times as quickly as possible. The 5mWT [21] was measured once while the participant walked on an 11-m-long indoor level walkway with 3-m margins at both ends as quickly as possible. The data in the case of bilateral knee OA were obtained from the targeted side of the knee joint that was more severely affected according to the K-L grade, more restricted in the range of motion, or more painful, as rated using the VAS.

## Sample size

According to a previous study that investigated falls in individuals with knee OA, 22.3% ($n = 316$) of individuals were in the fall group, with bad outcomes, and 77.7% ($n = 1102$) of individuals were in the non-fall group [22]. On this basis, the ratio of the positive to negative individuals (i.e., fall group to non-fall group individuals) was assumed to be 1 (20.0%) to 4 (80.0%), respectively. The alpha value was set at 0.05, and the power was set at 0.80. The alternate hypothesis and null hypothesis areas under the receiver operating curves were set at 0.75 (moderate power). Consequently, the total number of required cases in this study was estimated to be 61 (positive, 12 cases; negative, 49 cases).

## Statistical analysis

Binomial logistic regression analysis was used to examine the risk factors for falls in this study. The outcome measure of the analysis was whether the participants belonged to a fall or non-fall group (fall group, 1; non-fall group, 0). The confounding variables were sex (men, 1; women, 0), age, BMI, K-L grade, bilateral knee OA (1) or unilateral knee OA (0), and pain (VAS; numerical value from 0 to 100), and the explanatory variables were the muscle strength test, OLST, FTSST, and 5mWT. In binomial logistic regression analysis, the confounding variables were entered following the forced entry method, and the explanatory factors were entered following the backward elimination method (likelihood ratio), simultaneously. Binomial logistic regression analysis was followed by receiver operating characteristic (ROC) analysis that used the outcome measures and factors selected. The explanatory variables were binarized at the cut-off value of ROC analysis. The CPR was obtained using the binarized variables. The CPR would determine the cut-off value of the tests to increase the likelihood ratio and the post-test probability by compounding mutually independent tests with some ability to discriminate between the fall and non-fall groups. We also calculated the sensitivity, specificity, positive likelihood ratio (PLR), negative likelihood ratio (NLR), and post-test probability (positive predictive value and negative predictive value) of the CPR. The software used to analyze the collected data was SPSS (version 22.0; IBM Corp., Tokyo, Japan), and the significance was set at $P < 0.05$.

# Results

The binomial logistic regression analysis revealed that the OLST (odds ratio [OR], 0.805; 95% confidence interval [CI], 0.700–0.927) and FTSST (OR, 1.743; 95% CI, 1.177–2.580)

Table 3 Cut-off values and the inspection characteristics of each measurement in the fall risks

| | Cut-off value | AUC | *P* value | Sensitivity | Specificity | PLR | NLR |
|---|---|---|---|---|---|---|---|
| OLST | ≤ 5.3 s | 0.86 | < 0.001 | 0.91 | 0.71 | 3.13 | 0.12 |
| FTSST | ≥ 7.9 s | 0.79 | < 0.001 | 0.92 | 0.58 | 2.18 | 0.14 |

*AUC*, area under the curve; *PLR*, positive likelihood ratio; *NLR*, negative likelihood ratio; *OLST*, one-leg standing test; *FTSST*, five times sit-to-stand test

were significantly associated with the outcome (Table 2). Examination of the multicollinearity by Spearman's correlation did not reveal any independent variables that had a correlation coefficient of 0.80 or more. The ROC analysis showed that the cut-off values of the OLST and FTSST were 5.3 s (area under the curve [AUC], 0.86; $P < 0.001$) and 7.9 s (AUC, 0.79; $P < 0.001$), respectively (Table 3).

Further, the ROC analysis revealed that the scores of the CPR maximally 2 points, minimally 0 point were significant to distinguish between the outcome measures (AUC, 0.874; $P < 0.001$) (Table 4). We called this CPR the "fall risk scale (Table 5)." The post-test probability (positive predictive value) was 46.0% (PLR = 2.0) when the OLST or FTSST alone was positive. It increased to 88.2% (PLR = 17.8) when the OLST and FTSST were both positive. As the pre-test probability of falls was 29.6% (24 out of 81 study participants), this indicated that when the total score of the fall risk scale was 2 points, the individual was likely to have a fall. On the contrary, the NLR post-test probability (positive predictive value) were 0.1 and 3.2%, respectively, in another case where the total score of the fall risk scale was 0 point. Namely, this denoted that when the OLST was above 5.3 s and the FTSST was below 7.9 s, the individual was not likely to have a fall.

## Discussion

We successfully derived a CPR that consisted of two tests in this study: the OLST, with a cut-off value of ≤ 5.3 s, and the FTSST, with a cut-off value of ≥ 7.9 s. Our results showed that the precision to predict the probability of falls would improve when two or more tests provided positive binarized variable values, whereas similar results were reported in other fields of study [23]. As shown in the present study, it was obvious that just one test would not be enough to predict the probability of falls in individuals with knee OA. Since the CPR in this study used two or more tests to improve the likelihood ratio and predictability of the probability of falls, it could be a more useful tool than previous ones to discriminate between individuals who fall and those who do not. This CPR could be especially useful as a screening test to detect the fall risk probability in individuals with knee OA.

A Cochrane systematic review showed that a somewhat arbitrary intervention alone could not prevent falling effectively without precise assessment of the individuals and multiple component interventions [24]. Therefore, it is essential to make precise assessments for individuals with knee OA regarding the probability of falling and to plan multiple component interventions to prevent them from falling. Although the cut-off values for the muscle strength test [12], OLST [13], and FTSST [14] have been reported in previous studies, the influences of other characteristics of the individuals (sex, age, BMI, K-L grade, lesion type, and VAS) on having a fall have never been examined. As a result, our present study showed that only the OLST and FTSST were significantly related to have a fall independently compared with the individual factors, such as sex, age, and K-L stage.

Our fall risk scale is novel because it predicts fall risks in individuals with knee OA, whereas other studies derived different kinds of CRPs that evaluated the validity of the physical therapy programs in individuals with knee OA [25, 26]. There has been no CPR to determine fall risks in individuals with knee OA to date. As knee OA is a common joint disease and considered one of the risk factors for falls [6], the CPR that we developed in this study will be a great help for the clinicians to determine which individual with knee OA definitely has a high risk of fall. This CPR, consisting of the OLST and FTSST, would show the high probability of falls (positive predictive value of 88.2%) in individuals with knee OA when the OLST

Table 4 Diagnostic characteristics at each score of the CPR

| Total score of the CPR | Fall group ($n = 24$) | Non-fall group ($n = 57$) | Sensitivity | Specificity | PLR | NLR | Post-test probability | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Positive predictive value | Negative predictive value |
| ≥ 1 point | $n = 23$ | $n = 27$ | 0.96 | 0.53 | 2.02 | 0.08 | 46.0% | 96.8% |
| = 2 points | $n = 15$ | $n = 2$ | 0.63 | 0.97 | 17.81 | 0.39 | 88.2% | 85.9% |

AUC = 0.874, $P < 0.001$

*PLR*, positive likelihood ratio; *NLR*, negative likelihood ratio

**Table 5** Fall risk scale

| |
|---|
| One-leg standing test |
| 1 point: 5.3 s or less |
| 0 point: above 5.3 s |
| Five times sit-to-stand test |
| 1 point: 7.9 s or more |
| 0 point: below 7.9 s |

was 5.3 s or less and FTSST was 7.9 s or more. Since both the OLST and FTSST are routinely used tests in physical therapy, our CPR would be useful and helpful for the clinicians to take measures to prevent falls in individuals with knee OA.

Several limitations in the present study should be considered. Firstly, whether the participants had a fall or not was determined by the participants' self-reports. Since the accuracy of self-report might affect the study results, we excluded at least those individuals with cognitive diseases. Secondly, as we excluded individuals with hip osteoarthritis, spine osteoarthritis, and neurologic and cognitive diseases, the fall risk scale cannot be generalized to these individuals. Thirdly, we could not include the onset of knee OA, the time of commencement of rehabilitation, medication use, and cardiac or pulmonary diseases, which might affect the results of our present study. Fourthly, as our fall risk scale consisted of only the OLST and FTSST, it might not be very specific for individuals with knee OA. This implies that the CPR to determine fall risk among individuals with knee OA might be applicable to the other elderly populations with different diseases, although this needs to be confirmed in future studies. Considering the previously mentioned limitations, future studies should aim at developing a better fall risk scale to predict the fall risks in individuals with knee OA. Thus, we need to examine the external validity of the CPR and the outcome of holistic intervention using the CPR in future studies.

In conclusion, the CPR obtained from this study can be used as a screening test to detect the fall risk in individuals with knee OA. As the fall risk scale would make more precise assessments of the probability of falling in the individuals with knee OA than previous scales, it would be possible to plan holistic interventions to prevent individuals with knee OA from falling.

## Compliance with ethical standards

All study participants were informed of this study and provided written informed consent. This study was approved by the Research Ethics Committee of Tokoha University (approval no. R-2018-505H).

**Conflicts of interest** None.

## References

1. Hartholt KA, van Beeck EF, Polinder S, van der Velde N, van Lieshout EMM, Panneman MJM, van der Cammen TJM, Patka P (2011) Societal consequences of falls in the older population: injuries, healthcare costs, and long-term reduced quality of life. J Trauma 71:748–753
2. Rubenstein LZ (2006) Falls in older people: epidemiology, risk factors and strategies for prevention. Age Ageing 35:ii37–ii41
3. Tinetti ME, Speechley M, Ginter SF (1988) Risk factors for falls among elderly persons living in the community. N Engl J Med 319:1701–1707
4. Stalenhoef PA, Diederiks JP, Knottnerus JA, Kester AD, Crebolder HF (2002) A risk model for the prediction of recurrent falls in community-dwelling elderly: a prospective cohort study. J Clin Epidemiol 55:1088–1094
5. Hopewell S, Adedire O, Copsey BJ et al (2018) Multifactorial and multiple component interventions for preventing falls in older people living in the community. Cochrane Database Syst Rev 7:CD012221
6. Tinetti ME, Kumar C (2010) The patient who falls: "It's always a trade-off". JAMA 303:258–266
7. Manlapaz DG, Sole G, Jayakaran P, Chapple CM (2019) Risk factors for falls in adults with knee osteoarthritis: a systematic review. PM&R 11:745–757. https://doi.org/10.1002/pmrj.12066
8. Tanaka T, Matsumoto H, Son BK, Imaeda S, Uchiyama E, Taniguchi S, Nishino A, Miura T, Tanaka T, Otsuki T, Nishide K, Iijima K, Okata J (2018) Environmental and physical factors predisposing middle-aged and older Japanese adults to falls and fall-related fractures in the home. Geriatr Gerontol Int 18:1372–1377
9. Gale CR, Cooper C, Aihie Sayer A (2016) Prevalence and risk factors for falls in older men and women: the English Longitudinal Study of Ageing. Age Ageing 45:789–794
10. Aibar-Almazán A, Martínez-Amat A, Cruz-Díaz D, Jiménez-García JD, Achalandabaso A, Sánchez-Montesinos I, de la Torre-Cruz M, Hita-Contreras F (2018) Sarcopenia and sarcopenic obesity in Spanish community-dwelling middle-aged and older women: association with balance confidence, fear of falling and fall risk. Maturitas 107:26–32
11. Himes CL, Reynolds SL (2012) Effect of obesity on falls, injury, and disability. J Am Geriatr Soc 60:124–129
12. Ikezoe T, Asakawa Y, Tsutoa A (2003) The relationship between quadriceps strength and balance to fall of elderly admitted to a nursing home. J Phys Ther Sci 15:75–79
13. Vellas BJ, Wayne SJ, Romero L, Baumgartner RN, Rubenstein LZ, Garry PJ (1997) One-leg balance is an important predictor of injurious falls in older persons. J Am Geriatr Soc 45:735–738
14. Ikezoe T, Asakawa Y, Shima H, Ichihashi N (2009) Physical function screening of institutionalized elderly women to predict their risk of falling. JPN J Phys Fit Sport 58:489–498 (in Japanese)
15. Anderson ML, Allen KD, Golightly YM, Arbeeva LS, Goode A, Huffman KM, Schwartz TA, Hill CH (2019) Fall risk and utilization of balance training for adults with symptomatic knee osteoarthritis: secondary analysis from a randomized clinical trial. J Geriatr Phys Ther 42:E39–E44
16. Mat S, Ng CT, Tan PJ, Ramli N, Fadzli F, Rozalli FI, Mazlan M, Hill KD, Tan MP (2018) Effect of modified Otago exercises on postural balance, fear of falling, and fall risk in older fallers with knee osteoarthritis and impaired gait and balance: a secondary analysis. PM R 10:254–262
17. McGinn TG, Guyatt GH, Wyer PC, Naylor CD, Stiell IG, Richardson WS (2000) Users' guides to the medical literature: XXII: how to use articles about clinical decision rules. Evidence-Based Medicine Working Group. JAMA 284:79–84

18. Katoh M, Yamasaki H (2009) Comparison of reliability of isometric leg muscle strength measurements made using a hand-held dynamometer with and without a restraining belt. J Phys Ther Sci 21:37–42
19. Michikawa T, Nishiwaki Y, Takebayashi T, Toyama Y (2009) One-leg standing test for elderly populations. J Orthop Sci 14:675–685
20. Whitney SL, Wrisley DM, Marchetti GF, Gee MA, Redfern MS, Furman JM (2005) Clinical measurement of sit-to-stand performance in people with balance disorders: validity of data for the five-times-sit-to-stand test. Phys Ther 85:1034–1045
21. Wilson CM, Kostsuca SR, Boura JA (2013) Utilization of a 5-meter walk test in evaluating self-selected gait speed during preoperative screening of patients scheduled for cardiac surgery. Cardiopulm Phys Ther J 24:36–43
22. Shimada H, Makizako H, Doi T, Tsutsumimoto K, Nakakubo S (2016) Prevalence of accidental falls in the older adults with mild cognitive impairment. Japanese Journal of Physical Therapy Fundamentals 19:48–54 (in Japanese)
23. Tiedemann A, Shimada H, Sherrington C, Murray S, Lord S (2008) The comparative ability of eight functional mobility tests for predicting falls in community-dwelling older people. Age Ageing 37:430–435
24. Gillespie LD, Robertson MC, Gillespie WJ et al (2012) Interventions for preventing falls in older people living in the community. Cochrane Database Syst Rev 9:CD007146
25. Deyle GD, Gill NW, Allison SC, Hando BR, Rochino DA (2012) Knee OA: which patients are unlikely to benefit from manual PT and exercise? J Fam Pract 61:1–8
26. Currier LL, Froehlich PJ, Carow SD, McAndrew RK, Cliborne AV, Boyles RE, Mansfield LT, Wainner RS (2007) Development of a clinical prediction rule to identify patients with knee pain and clinical evidence of knee osteoarthritis who demonstrate a favorable short-term response to hip mobilization. Phys Ther 87:1106–1119