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The Accuracy of the VISA-P Questionnaire, Single-Leg Decline Squat, and Tendon Pain History to Identify Patellar Tendon Abnormalities in Adult Athletes

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Patellar tendinopathy is highly prevalent among athletes.[1,26,36] It is frequently induced by excessive tendon overload and characterized by localized tendon pain with or without morphological abnormalities.[5,11,19,30] Jumping frequency, training, and competition volumes have been described as risk factors for patellar tendinopathy.[1,27] The identification of patellar tendon abnormality (PTA) in symptomatic athletes would assist in the prognosis and decision making for appropriate treatment. In some athletes, tendon pain may not be associated with structural tendon abnormalities.[20] Such athletes seem to have a better prognosis, and their treatment may not involve modalities directed to tissue remodeling. On the other hand, athletes with PTA might have worse prognosis and demonstrate greater functional disabilities, increased risk of rupture due to reduction of tensile strength of tendon, and longer recovery time.[19,29] In these cases, the most recommended conservative treatment is an eccentric training protocol.[33] This protocol is suggested to promote tissue remodeling through controlled tendon stress.[19,29] In order to help ensure the proper treatment approach to athletes with patellar tendon pain, it is necessary to identify the instances in which the athlete has

STUDY DESIGN: Cross-sectional clinical assessment.

BACKGROUND: Patellar tendinopathy is not always accompanied by patellar tendon abnormalities (PTAs). Thus, clinical screening tools to help identify patients with patellar tendon pain who have PTAs could enhance clinical decision making and patient prognosis.

OBJECTIVES: To test the diagnostic accuracy of the Victorian Institute of Sport Assessment-Patella (VISA-P) questionnaire, a single-leg decline squat (SLDS), tendon pain history, age, and years of sports participation to identify athletes with symptomatic patellar tendons who have PTAs confirmed on imaging.

METHODS: Data provided by ultrasound examination, the VISA-P questionnaire, the SLDS, tendon pain history, age, and years of sport participation were collected in 43 athletes. A classification and regression tree (CART) model was developed to verify variables associated with PTA occurrence. Likelihood ratios (LRs) were computed for positive and negative tests.

RESULTS: The SLDS, VISA-P questionnaire, and tendon pain history were associated with PTA occurrence. Athletes with negative results on all 3 tests (CART model) had a lower likelihood of having PTAs (negative LR = 0.3; 95% confidence interval [CI]: 0.2, 0.5). The isolated use of the SLDS or tendon pain history (positive LR = 4.2; 95% CI: 2.3, 7.14 and 4.5; 95% CI: 1.8, 11.1, respectively) had similar influence on probability of PTA presence compared to the CART model (positive LR = 4.1; 95% CI: 2.5, 6.3).

CONCLUSION: Although the objective was to investigate a clinical test to identify PTAs, the combined use of the tests had greater accuracy to identify individuals without PTAs.

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structural tendon abnormalities. The challenge in this case is to identify clinical tools that have appropriate diagnostic accuracy for PTA.

The gold standard for the diagnosis of PTA is ultrasonography.[33] However, ultrasound equipment is not readily available for all sports teams, clubs, or rehabilitation facilities, given its costs, difficult maintenance, and the need for the presence of a trained imaging professional. Clinical measures such as the Victorian Institute of Sport Assessment-Patella (VISA-P) questionnaire and the single-leg decline squat (SLDS) have been used to identify individuals with patellar tendon pathology (eg, pain, inflammation, and limited function).[28,33,36] The VISA-P questionnaire and SLDS are frequently used as screening tools to identify individuals with patellar tendon pain, in spite of the presence or absence of PTA. However, the establishment of the injury prognosis and proper treatment depends on identifying whether the individual has PTA. Unfortunately, the diagnostic accuracy of these tools to identify individuals with PTA has yet to be evaluated.

The objective of the present study was to verify the diagnostic accuracy of clinical tests to identify PTA occurrence. In addition to the VISA-P and SLDS, tests traditionally used to evaluate patellar tendinopathy, the patient's history of tendon pain, age, and years of sports participation were also evaluated. The latter 3 variables were selected because they may reflect the cumulative loading on the patellar tendon.[17,21,25] To identify the best procedure to classify symptomatic athletes with PTAs, the accuracy of these tests was evaluated individually and in combination.[9]

METHODS

Study Design

This was a cross-sectional study approved by the Universidade Federal de Minas Gerais Ethics in Research Committee (approval report number 0493.0.203.000-09). The study design and report are in accordance with the Standards for Reporting of Diagnostic Accuracy (STARD initiative).[3]

Study Sample

Fifty-two athletes participating in sports with a high prevalence of PTA (volleyball, basketball, soccer, and running)[8,14,36] were recruited by telephone using the records of a previous preseason assessment at the university. To be eligible for the study, participants had to be older than 18 years of age, to have no history of lower-limb surgery in the past 6 months, and to be fully participating in sports activities competitively. The exclusion criterion was having Osgood-Schlatter disease or Sinding-Larsen-Johansson syndrome, identified on ultrasound imaging. All athletes who agreed to participate read and signed a consent form.

Procedures

Data from ultrasound imaging, the VISA-P questionnaire, and the SLDS and information about patellar tendon pain history, years of sports participation, and age were collected over 2 consecutive days to avoid changes in the athletes' clinical status before completion of all assessment. The imaging assessment was the last measure performed. All clinical measures were kept confidential by the principal investigator (N.B.), who was blinded to the ultrasound examination results. All ultrasound assessments were performed by the same radiologist (L.F.), who was blinded to the results of the clinical tests. A third researcher (L.M.) performed the statistical analyses.

The SLDS consisted of 1 repetition of a single-leg squat, performed barefoot on a 30°-decline ramp, from a position of knee extension to 30° of knee flexion.[36] Data were collected on both eccentric and concentric phases for each leg. Data collection was conducted following 3 trials to familiarize the participant with the exercise. The goal of this test was to evaluate tendon reactivity during the squat, using the presence of patellar tendon pain during the squat to indicate a positive test. The VISA-P questionnaire was used to characterize athletes' functional profile and to classify the severity of patellar tendon symptoms.[28,31] The questionnaire is self-administered and has 8 questions (7 answers scaled from 0 to 10 and 1 scaled from 0 to 30). Six questions are related to patellar tendon pain during functional/sports activities (eg, sitting, squatting, jumping) and 2 are related to the level of sports performance. Scores under 80 are usually indicative of patellar tendinopathy.[7,21,33] History of tendon pain was recorded for each leg. All athletes indicated whether they had sports-related progressive patellar tendon pain that interfered with their performance in the past 6 months (traumatic cases and those related to growth spurt were excluded).[33]

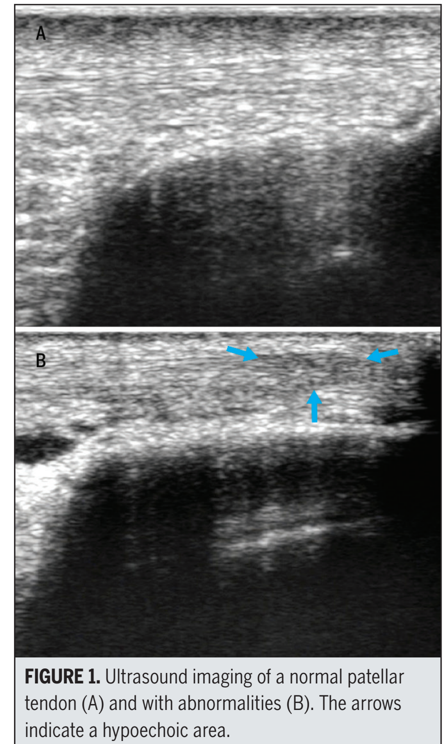

FIGURE 1. Ultrasound imaging of a normal patellar tendon (A) and with abnormalities (B). The arrows indicate a hypoechoic area.

A radiologist (L.F.) with 12 years of experience attending elite volleyball and basketball athletes performed all blinded ultrasound assessments. All athletes were placed in supine with the knees flexed and feet supported. The radiologist examined the entire extension of both patellar tendons on the longitudinal

TABLE 1	Sample Descriptive Data
Sample Characteristics (n = 43)	**Value***
Age, y	24.8 ± 6.7 (18-44)
Weight, kg	87.6 ± 13.7 (54-125)
Height, m	1.93 ± 0.1 (1.52-2.13)
Time of sport participation, y	11.01 ± 5.4 (2-25)

Values are mean ± SD (range).

(sagittal) and transverse (axial) planes using a high-resolution, 12- to 19-MHz, linear-transducer ultrasound (Voluson 730; General Electric, Fairfield, CT). The transducer was kept perpendicular to the tendon to avoid false-positive results due to anisotropy.[33] Echogenicity (presence of hypoechoic areas) was evaluated to determine PTA occurrence.[32] The subjects were asked not to provide any information about the presence of symptoms to the ultrasound examiner. A positive diagnosis of PTAs was given when a tendon had hypoechoic areas (**FIGURE 1**).

Test-retest reliability of the VISA-P and intrarater agreement of the SLDS were tested in a pilot study prior to data collection. Seven volunteers, 6 male and 1 female (mean ± SD age, 38.57 ± 18.8 years; weight, 78.57 ± 13.01 kg; height, 1.73 ± 0.10 m), were examined with an interval of 4 days using the same procedures described previously. The results showed excellent intrarater reliability values, with an intraclass correlation coefficient (model 3,3) of 0.99 for the VISA-P and a kappa of 1 (P<.0001) for the SLDS.

Similarly, a pilot study was conducted to evaluate the test-retest reliability of the ultrasound measures. Six volunteers, 2 male and 4 female (mean ± SD age, 23.0 ± 1.7 years; weight, 55.6 ± 3.7 kg; height, 1.6 ± 0.1 m), participated. The same procedures previously described were adopted in the reliability study. The examiner performed 2 ultrasound examinations with a rest period of 4 days between exams. A kappa coefficient of 0.75 (P = .047) revealed good test-retest reliability of ultrasound examination.

Data Analysis

An independent investigator (L.M.), not involved with the test procedures, was responsible for all statistical analysis. A receiver operating characteristic (ROC) curve was used to determine clinically relevant cutoff points for the VISA-P questionnaire, age, and years of sports participation. The largest distance from the reference line and the sensitivity and 1-minus-specificity values were used as parameters to select the cutoff points.[23] These cutoff points were used to dichotomize these variables for further analysis. Each athlete was considered positive on the VISA-P questionnaire when scoring below the cutoff point identified by the ROC curve (score attributed to the symptomatic knee to allow matching with the ultrasound exam). Athletes with scores above or equal to the cutoff point were identified as negative on the test (score attributed to the dominant lower limb). For all assessments, athletes with bilateral pain had only the most symptomatic knee, and those with negative results had only the dominant lower limb, included in the analysis.

A classification and regression tree (CART) model was developed to identify the variables associated with PTA occurrence. This analysis promotes binary recursive divisions of the initial data set, considering the predictors that best classify the individuals in each of the outcome categories,[16] which in this case were the presence and absence of PTA. According to the classification tree, it is possible to identify the predictors and the combinations of predictors associated with the outcome variable.[16] The VISA-P, SLDS, tendon pain history, age, and years of sports participation were dichotomized and entered in the CART model.[18] A ROC curve was used to verify the accuracy of the model developed.[2] Contingency tables were constructed for each test selected by the CART model and also for the CART model as a whole, to derive positive and negative likelihood ratios (LRs) and 95% confidence intervals (CIs) with OpenEpi (www.OpenEpi.com).[3,9,10,12]

RESULTS

Recruitment occurred between June and September 2012. Of 52 athletes asked to participate in the study, 47 agreed to participate. Four of these were later excluded on ultrasound imaging due to the presence of Osgood-Schlatter disease or Sinding-Larsen-Johansson syndrome. Thus, 43 athletes (volleyball, n = 26; basketball, n = 14; soccer and running, n = 3) were eligible for inclusion in the study (38 male, 5 female). **TABLE 1** describes the descriptive characteristics of the study participants and **FIGURE 2** illustrates the recruitment flow diagram.

In the 43 athletes tested, 27 tendons were diagnosed as having PTA (11 athletes had bilateral PTA and 5 athletes had unilateral PTA) and 59 tendons were classified as normal at ultrasound (27 athletes without and 5 athletes with unilateral PTA). The mean score of the VISA-P questionnaire for athletes with PTA was 77.3 ± 23.5 and was 92.5 ± 12.7 for those without PTA (P = .008; mean difference, –15.24; 95% CI: –26.37, –4.10).

The ROC curves identified cutoff scores of 88 points for the VISA-P questionnaire (P = .035; area under the curve [AUC], 69; 95% CI: 52, 87; 77.8% sensitivity and 62.5% specificity), 25.5 years for age (P = .008; AUC, 25.6; 95% CI: 10, 40; 22% sensitivity and 32% specificity), and 9.5 years for sport participation (P = .12; AUC, 35.8; 95% CI: 10, 50; 48% sensitivity and 25% specificity).

The CART analysis selected only the SLDS, tendon pain history, and VISA-P

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scores as predictors of PTA (**FIGURE 3**). A ROC curve was derived to indicate the accuracy of this model (*P* = .001; AUC, 80; 95% CI: 66, 94). Absence of PTA was related to negative results on the SLDS, tendon pain history, and VISA-P score (node 5, n = 18, 81%). Presence of PTA was associated with positive results on the SLDS (node 2, n = 10, 71%) or positive tendon pain history when athletes had negative SLDS results (node 4, n = 2, 66%).

TABLE 2 shows the contingency table results and LRs for each test selected by the CART and for the CART model as a whole. A positive likelihood ratio (+LR) represents the shift in probability of the target outcome (PTA occurrence) when a specific finding is present (positive test). On the other hand, a negative likelihood ratio (–LR) describes how the outcome probability shifts when the specific finding is absent (negative test).[10,22] According to LR values, the isolated use of the SLDS (+LR = 4.2) or history of patellar tendon pain (+LR = 4.5) increases the probability of PTA occurrence by about 25%.[22] A similar shift of probability for the presence of PTAs was also obtained for the CART model (+LR = 4.1). While the isolated negative result on the SLDS (–LR = 0.4) or for history of patellar tendon pain (–LR = 0.6) decreases the probability of PTA by about 15% to 20%,[22] negative results on all 3 tests (CART model) decrease the probability of PTA by about 25%.[22] The isolated use of the VISA-P resulted in the lowest +LR.

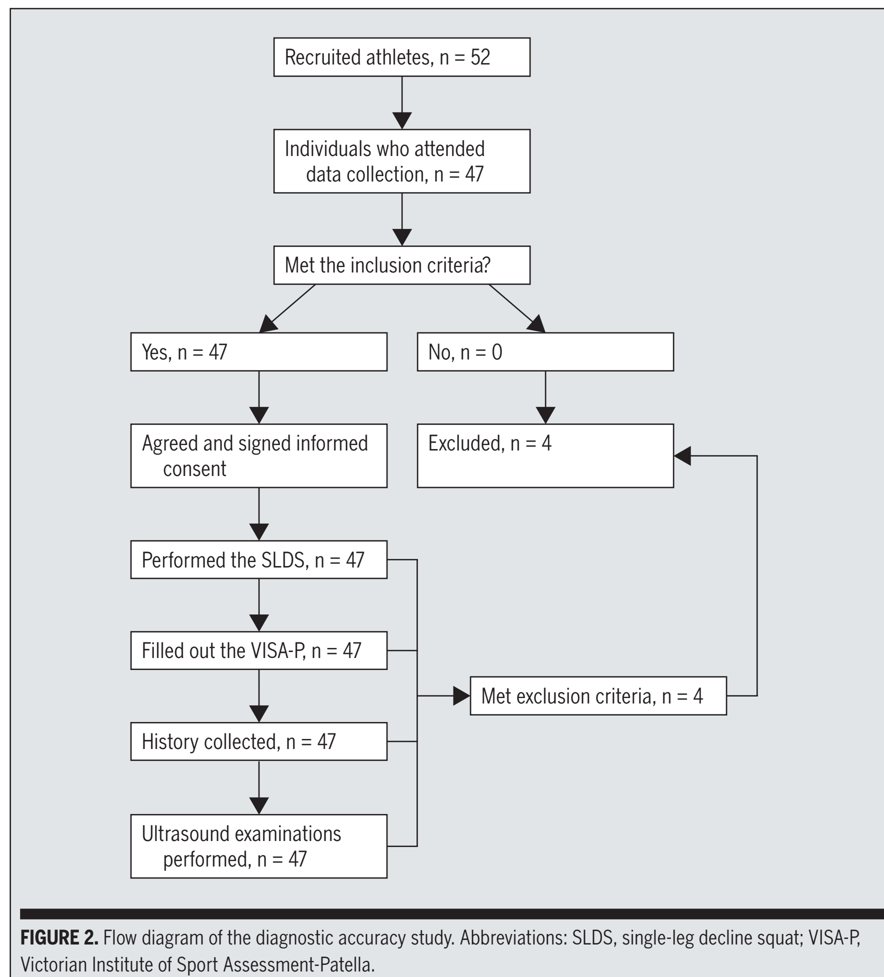

FIGURE 2. Flow diagram of the diagnostic accuracy study. Abbreviations: SLDS, single-leg decline squat; VISA-P, Victorian Institute of Sport Assessment-Patella.

DISCUSSION

The objective of the present study was to assess the diagnostic accuracy of clinical tests to identify PTA occurrence. The accuracy of the tests was evaluated individually and in combination by means of CART analysis. The increase of the probability of PTA identified in the CART model was similar to that observed when the SLDS or history of patellar tendon pain was used in isolation. However, the CART model (specifically, negative results on all 3 tests) was more accurate in identifying the absence of PTA.

Initially, a CART model was developed to investigate the contribution of the VISA-P questionnaire, SLDS, tendon pain history, age, and years of sports participation to the identification of the presence or absence of PTA. The CART results revealed that the SLDS, tendon pain history, and the VISA-P score were associated with PTA occurrence. Although age is associated with decreased tissue metabolism[17,21,25] and years of sports participation inform one about cumulative tendon loading,[1,26] these variables were not associated, in isolation or in combination with the other tests, with the investigated outcome. Considering the divisions performed by the CART analysis (**FIGURE 3**), it was possible to observe that the absence of PTA was associated with negative results on all 3 tests selected (node 5). On the other hand, the presence of PTAs was associated with positive results on the SLDS (node 2) and with positive results for tendon pain history when negative results were obtained on the SLDS (node 4). In addition, node 6 (presence of positive results on the VISA-P associated with negative results on the SLDS and for tendon pain history) suggests that a positive result only on the VISA-P is useless, because athletes with positive results on the VISA-P did not have PTA. Although the ROC curve identified that the CART model was accurate to predict PTA occurrence (AUC, 80; *P* = .001), analysis of LRs obtained for the model is necessary for proper clinical interpretation of the results.

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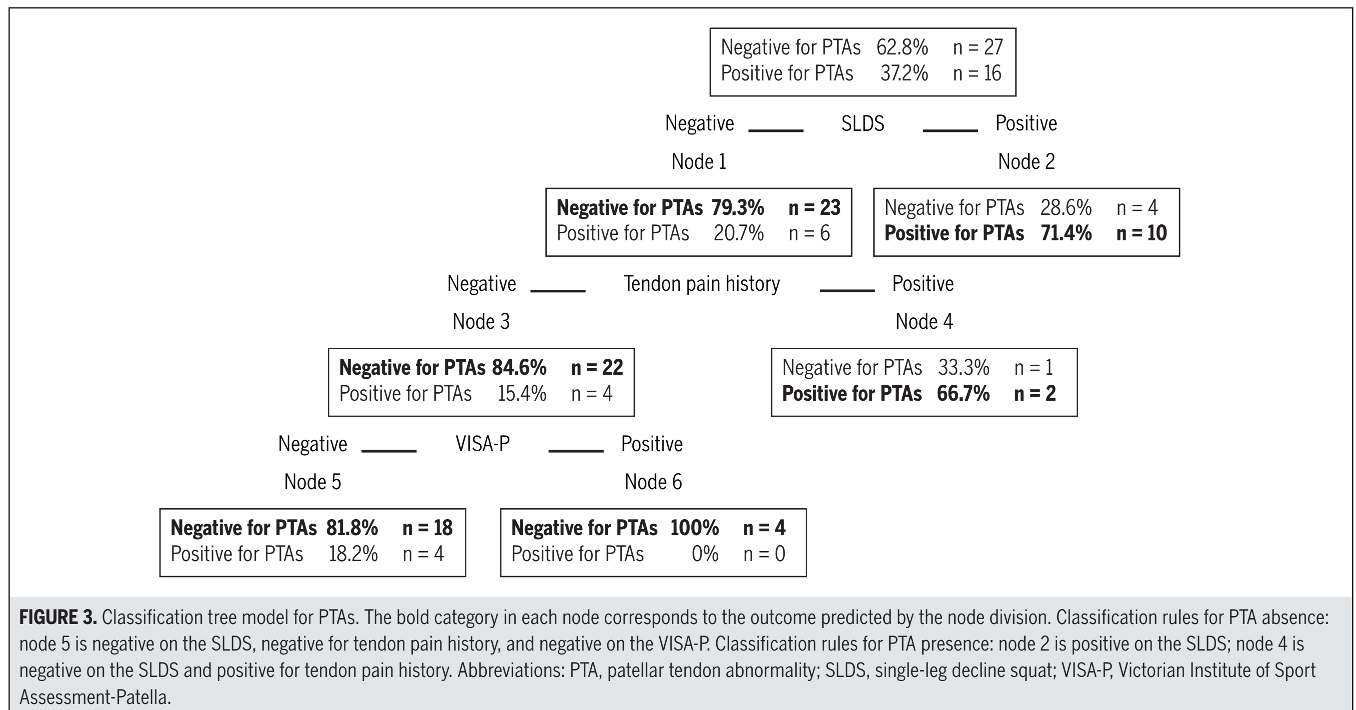

FIGURE 3. Classification tree model for PTAs. The bold category in each node corresponds to the outcome predicted by the node division. Classification rules for PTA absence: node 5 is negative on the SLDS, negative for tendon pain history, and negative on the VISA-P. Classification rules for PTA presence: node 2 is positive on the SLDS; node 4 is negative on the SLDS and positive for tendon pain history. Abbreviations: PTA, patellar tendon abnormality; SLDS, single-leg decline squat; VISA-P, Victorian Institute of Sport Assessment-Patella.

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TABLE 2 CONTINGENCY RESULTS AND LIKELIHOOD RATIOS FOR THE 3 TESTS SELECTED BY THE CART ANALYSIS AND FOR THE CART MODEL

	PTA		
	Present*	Absent*	Likelihood Ratio†
VISA-P			
Positive	10 (62.5)	8 (29.6)	2.1 (1.5, 3.0)
Negative	6 (37.5)	19 (70.4)	0.5 (0.4, 0.8)
Single-leg decline squat			
Positive	10 (62.5)	4 (14.8)	4.2 (2.3, 7.14)
Negative	6 (37.5)	23 (85.1)	0.4 (0.3, 0.6)
History of patellar tendon pain			
Positive	8 (50)	3 (11.1)	4.5 (1.8, 11.1)
Negative	8 (50)	24 (88.9)	0.6 (0.4, 0.7)
CART model			
Positive	12 (75)	5 (18.5)	4.1 (2.5, 6.3)
Negative	4 (25)	22 (81.5)	0.3 (0.2, 0.5)
Total	16	27	...

Abbreviations: CART, classification and regression tree; PTA, patellar tendon abnormality; VISA-P, Victorian Institute of Sport Assessment-Patella.
**Values are n (%).*
†Values in parentheses are 95% confidence interval.

The +LR value obtained for the CART model (+LR = 4.1) suggests an increase in probability of PTA presence of about 25%.[22] A similar shift in probability was observed when the SLDS (+LR = 4.2) or history of patellar tendon pain (+LR = 4.5) was analyzed in isolation. The largest increase in the probability of PTA absence (about 25%)[22] was obtained for the CART model (–LR = 0.3). In this case, the best choice for identifying absence of PTA was the combination of negative results on all 3 tests (SLDS, history of patellar tendon pain, and VISA-P). These changes in the probability of the presence or absence of PTA may be considered small, but sometimes important, according to Jaeschke et al.[10]

The CART model had LRs indicating modest but relevant accuracy to identify true-positive and true-negative cases.[10] There were only 4 false negatives (2 male, 2 female) out of the 16 athletes who had symptomatic PTAs. Two of these athletes were 18 years of age (with 2 and 4 years of sports participation) and the other 2 were volleyball players with less demanding positions (setter and defender). These results suggest that false negatives may be associated with shorter periods of sports participation or less jumping/landing demands, indicating that these athletes were not submitted to high tendon loads, which are necessary for the development of PTA.[20] Of the 27 athletes without PTA on ultrasound imaging, only 5 were classified as posi-

tive using the CART model. Two of these athletes had positive results on the SLDS test, 3 were positive on the VISA-P questionnaire, and none had patellar tendon pain history. One possible explanation for athletes without PTA on ultrasound imaging being classified as positive for PTA using the CART model could be the presence of inflammation in paratendon (paratendinitis). In these cases, athletes may have positive results on clinical tests without alteration of the tendon's integrity.[4,20] However, if these athletes had paratendinitis, the symptoms related to this condition were not sufficient to limit their participation in sports activities, as all athletes were fully participating in training and competitions. These circumstances could be explained by the variability of tendinopathy clinical presentation[6] and demonstrate that identifying the absence or presence of PTAs and related symptoms requires a more comprehensive strategy.

It's important to stress that the small change in probability of PTA occurrence when the SLDS, VISA-P questionnaire, and tendon pain history are used in combination suggests that the CART model is not enough to fully identify the presence or absence of PTA. When suspecting the presence of PTA, athletes with positive results on the SLDS or tendon pain history should undergo ultrasound examination. Because these athletes may have worse long-term prognosis, the confirmation of PTA presence by means of ultrasound examination could help the physical therapist to decide about the appropriate treatment to recover the tendon's structural normality (eg, eccentric training protocol).[13,29,34,35] Athletes with negative results on all 3 tests initially should not be required to undergo ultrasound examination, due to the increased probability of the absence of PTA. These athletes could be treated with therapeutic modalities or other techniques directed toward symptom reduction, as they might not benefit from interventions such as eccentric protocols.

For the CART analysis, we used the ROC curve to identify a specific cutoff point for the VISA-P questionnaire that could be used to define the presence or absence of PTAs. Interestingly, the ROC curve identified a cutoff point of 88 points. This cutoff point is higher than that previously reported (80 points) in studies about patellar tendinopathy.[28,33] However, replication of this cutoff score (88 points) in a larger sample is necessary to provide a new reference value to classify athletes according to VISA-P score.

Our results should be interpreted with caution, as all assessments were conducted during the preseason. During this period, training load is relatively low and, thus, athletes with PTA have a higher chance of being asymptomatic when compared to midseason and/or end-season periods. Therefore, tests that rely on the presence of pain, such as the VISA-P questionnaire and the SLDS, could have better accuracy when performed during midseason or end of season. Another point to be considered is that elite athletes, due to their high demand (high level of training and competitions), may have increased probability that their symptoms will be accompanied by tendon structural abnormalities. On the other hand, in novice athletes, mild symptoms can be present without PTA. Therefore, the clinical interpretation of our results should be performed considering the level of competition, the period of the season in which the evaluation was performed, and that tendinopathy is a condition with a continuum of clinical presentations.[6]

The simplicity and low-cost nature of clinical screening tools may be a cost-effective and timely alternative for the diagnosis of PTA within a sports medicine environment.[15] Given that ultrasound imaging may be costly and not easily accessible, negative results on the composite test could be used to identify athletes who should be discharged from ultrasonography examination. In contrast, a particular subgroup of patients with a greater likelihood of having PTA should undergo imaging. The aggregate value of an approach must be analyzed considering its incorporation in clinical practice. If the new method is less invasive, less time consuming, and less costly, it is possible to critically accept the specific contribution of the method in question.[9,12] The use of the CART model fulfills these requirements, and, therefore, future studies independently validating the results of this preliminary study in a larger sample are warranted.

CONCLUSION

Positive results on the SLDS, VISA-P questionnaire, and tendon pain history were associated with PTA occurrence. However, according to the CART model, these tests are better when used in combination (eg, negative results on all 3 tests) than when used individually to diagnose PTA absence. In athletes with positive results on either the SLDS or tendon pain history, the identification of PTA should be confirmed by ultrasound examination. ◉

KEY POINTS

FINDINGS: Simultaneous negative results on the SLDS, VISA-P questionnaire, and tendon pain history could be considered a useful index to assist with the identification of PTA absence.

IMPLICATIONS: Athletes with negative results on all 3 tests appear unlikely to have PTAs. In contrast, only athletes with positive results on either the SLDS or tendon pain history appear likely to require PTA confirmation by ultrasound imaging.

CAUTION: The data of the present study were collected only during preseason evaluation in active athletes. The contribution of the VISA-P score, SLDS, history of tendon pain, age, and years of sports participation to the occurrence of symptomatic PTA should also be investigated during midseason and/or end-season periods, which are characterized by higher training load among athletes who voluntarily seek care. The results of

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the present study are preliminary, and the CART model cannot confidently be used in clinical practice until the results have been independently validated in a larger sample.

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REFERENCES

1. Bahr MA, Bahr R. Jump frequency may contribute to risk of jumper's knee: a study of interindividual and sex differences in a total of 11 943 jumps video recorded during training and matches in young elite volleyball players. *Br J Sports Med*. 2014;48:1322-1326. http://dx.doi.org/10.1136/bjsports-2014-093593
2. Bittencourt NF, Ocarino JM, Mendonça LD, Hewett TE, Fonseca ST. Foot and hip contributions to high frontal plane knee projection angle in athletes: a classification and regression tree approach. *J Orthop Sports Phys Ther*. 2012;42:996-1004. http://dx.doi.org/10.2519/jospt.2012.4041
3. Bossuyt PM, Reitsma JB, Bruns DE, et al. Towards complete and accurate reporting of studies of diagnostic accuracy: the STARD initiative. *Fam Pract*. 2004;21:4-10.
4. Cook JL, Khan KM, Kiss ZS, Coleman BD, Griffiths L. Asymptomatic hypoechoic regions on patellar tendon ultrasound: a 4-year clinical and ultrasound followup of 46 tendons. *Scand J Med Sci Sports*. 2001;11:321-327. http://dx.doi.org/10.1034/j.1600-0838.2001.110602.x
5. Cook JL, Khan KM, Kiss ZS, Purdam CR, Griffiths L. Prospective imaging study of asymptomatic patellar tendinopathy in elite junior basketball players. *J Ultrasound Med*. 2000;19:473-479.
6. Cook JL, Purdam CR. Is tendon pathology a continuum? A pathology model to explain the clinical presentation of load-induced tendinopathy. *Br J Sports Med*. 2009;43:409-416. http://dx.doi.org/10.1136/bjsm.2008.051193
7. Edwards S, Steele JR, McGhee DE, Beattie S, Purdam C, Cook JL. Landing strategies of athletes with an asymptomatic patellar tendon abnormality. *Med Sci Sports Exerc*. 2010;42:2072-2080. http://dx.doi.org/10.1249/MSS.0b013e3181e0550b
8. Fredberg U, Bolvig L. Significance of ultrasonographically detected asymptomatic tendinosis in the patellar and Achilles tendons of elite soccer players: a longitudinal study. *Am J Sports Med*. 2002;30:488-491.
9. Habbema JD, Eijkemans R, Krijnen P, Knottnerus JA. Analysis of data on the accuracy of diagnostic tests. In: Knottnerus JA, Buntinx F, eds. *The Evidence Base of Clinical Diagnosis: Theory and Methods of Diagnostic Research*. Hoboken, NJ: Wiley-Blackwell; 2009:ch 7.
10. Jaeschke R, Guyatt GH, Sackett DL. Users' guides to the medical literature. III. How to use an article about a diagnostic test. B. What are the results and will they help me in caring for my patients? The Evidence-Based Medicine Working Group. *JAMA*. 1994;271:703-707. http://dx.doi.org/10.1001/jama.1994.03510330081039
11. Khan KM, Cook JL, Bonar F, Harcourt P, Åstrom M. Histopathology of common tendinopathies. Update and implications for clinical management. *Sports Med*. 1999;27:393-408. http://dx.doi.org/10.2165/00007256-199927060-00004
12. Knottnerus JA, Muris JW. Assessment of the accuracy of diagnostic tests: the cross-sectional study. In: Knottnerus JA, Buntinx F, eds. *The Evidence Base of Clinical Diagnosis: Theory and Methods of Diagnostic Research*. Hoboken, NJ: Wiley-Blackwell; 2009:ch 3.
13. Kongsgaard M, Kovanen V, Aagaard P, et al. Corticosteroid injections, eccentric decline squat training and heavy slow resistance training in patellar tendinopathy. *Scand J Med Sci Sports*. 2009;19:790-802. http://dx.doi.org/10.1111/j.1600-0838.2009.00949.x
14. Kraemer R, Knobloch K. A soccer-specific balance training program for hamstring muscle and patellar and Achilles tendon injuries: an intervention study in premier league female soccer. *Am J Sports Med*. 2009;37:1384-1393. http://dx.doi.org/10.1177/0363546509333012
15. Laslett M, Aprill CN, McDonald B, Young SB. Diagnosis of sacroiliac joint pain: validity of individual provocation tests and composites of tests. *Man Ther*. 2005;10:207-218. http://dx.doi.org/10.1016/j.math.2005.01.003
16. Lemon SC, Roy J, Clark MA, Friedmann PD, Rakowski W. Classification and regression tree analysis in public health: methodological review and comparison with logistic regression. *Ann Behav Med*. 2003;26:172-181.
17. Longo UG, Loppini M, Marineo G, Khan WS, Maffulli N, Denaro V. Tendinopathy of the tendon of the long head of the biceps. *Sports Med Arthrosc*. 2011;19:321-332. http://dx.doi.org/10.1097/JSA.0b013e3182393e23
18. Lubetzky-Vilnai A, Ciol M, McCoy SW. Statistical analysis of clinical prediction rules for rehabilitation interventions: current state of the literature. *Arch Phys Med Rehabil*. 2014;95:188-196. http://dx.doi.org/10.1016/j.apmr.2013.08.242
19. Malliaras P, Barton CJ, Reeves ND, Langberg H. Achilles and patellar tendinopathy loading programmes: a systematic review comparing clinical outcomes and identifying potential mechanisms for effectiveness. *Sports Med*. 2013;43:267-286. http://dx.doi.org/10.1007/s40279-013-0019-z
20. Malliaras P, Cook J, Ptasznik R, Thomas S. Prospective study of change in patellar tendon abnormality on imaging and pain over a volleyball season. *Br J Sports Med*. 2006;40:272-274. http://dx.doi.org/10.1136/bjsm.2005.023846
21. Mann KJ, Edwards S, Drinkwater EJ, Bird SP. A lower limb assessment tool for athletes at risk of developing patellar tendinopathy. *Med Sci Sports Exerc*. 2013;45:527-533. http://dx.doi.org/10.1249/MSS.0b013e318275e0f2
22. McGee S. Simplifying likelihood ratios. *J Gen Intern Med*. 2002;17:646-649.
23. Mendonça LD, Verhagen E, Bittencourt NF, Gonçalves GG, Ocarino JM, Fonseca ST. Factors associated with the presence of patellar tendon abnormalities in male athletes. *J Sci Med Sport*. 2016;19:389-394. http://dx.doi.org/10.1016/j.jsams.2015.05.011
24. Sharma P, Maffulli N. Biology of tendon injury: healing, modeling and remodeling. *J Musculoskelet Neuronal Interact*. 2006;6:181-190.
25. van der Worp H, van Ark M, Zwerver J, van den Akker-Scheek I. Risk factors for patellar tendinopathy in basketball and volleyball players: a cross-sectional study. *Scand J Med Sci Sports*. 2012;22:783-790. http://dx.doi.org/10.1111/j.1600-0838.2011.01308.x
26. Visentini PJ, Khan KM, Cook JL, Kiss ZS, Harcourt PR, Wark JD. The VISA score: an index of severity of symptoms in patients with jumper's knee (patellar tendinosis). Victorian Institute of Sport Tendon Study Group. *J Sci Med Sport*. 1998;1:22-28. http://dx.doi.org/10.1016/S1440-2440(98)80005-4
27. Visnes H, Aandahl HA, Bahr R. Jumper's knee paradox—jumping ability is a risk factor for developing jumper's knee: a 5-year prospective study. *Br J Sports Med*. 2013;47:503-507. http://dx.doi.org/10.1136/bjsports-2012-091385
28. Visnes H, Hoksrud A, Cook J, Bahr R. No effect of eccentric training on jumper's knee in volleyball players during the competitive season: a randomized clinical trial. *Clin J Sport Med*. 2005;15:227-234.
29. Visnes H, Tegnander A, Bahr R. Ultrasound characteristics of the patellar and quadriceps tendons among young elite athletes. *Scand J Med Sci Sports*. 2015;25:205-215. http://dx.doi.org/10.1111/sms.12191
30. Wageck BB, de Noronha M, Lopes AD, da Cunha RA, Takahashi RH, Costa LO. Cross-cultural adaptation and measurement properties of the Brazilian Portuguese version of the Victorian Institute of Sport Assessment-Patella (VISA-P) scale. *J Orthop Sports Phys Ther*. 2013;43:163-171. http://dx.doi.org/10.2519/jospt.2013.4287
31. Warden SJ, Kiss ZS, Malara FA, Ooi AB, Cook JL, Crossley KM. Comparative accuracy of magnetic resonance imaging and ultrasonography in confirming clinically diagnosed patellar tendinopathy. *Am J Sports Med*. 2007;35:427-436. http://dx.doi.org/10.1177/0363546506294858
32. Wearing SC, Grigg NL, Hooper SL, Smeathers JE. Conditioning of the Achilles tendon via ankle exercise improves correlations between

sonographic measures of tendon thickness and body anthropometry. *J Appl Physiol*. 2011;110:1384-1389. http://dx.doi.org/10.1152/japplphysiol.00075.2011
33. Woodley BL, Newsham-West RJ, Baxter GD. Chronic tendinopathy: effectiveness of eccentric exercise. *Br J Sports Med*. 2007;41:188-198; discussion 199. http://dx.doi.org/10.1136/bjsm.2006.029769
34. Young MA, Cook JL, Purdam CR, Kiss ZS, Alfredson H. Eccentric decline squat protocol offers superior results at 12 months compared with traditional eccentric protocol for patellar tendinopathy in volleyball players. *Br J Sports Med*. 2005;39:102-105. http://dx.doi.org/10.1136/bjsm.2003.010587
35. Zwerver J, Bredeweg SW, Hof AL. Biomechanical analysis of the single-leg decline squat. *Br J Sports Med*. 2007;41:264-268; discussion 268. http://dx.doi.org/10.1136/bjsm.2006.032482
36. Zwerver J, Bredeweg SW, van den Akker-Scheek I. Prevalence of jumper's knee among nonelite athletes from different sports: a cross-sectional survey. *Am J Sports Med*. 2011;39:1984-1988. http://dx.doi.org/10.1177/0363546511413370

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