Original Article

ANATOLIAN CURRENT MEDICAL

DOI: 10.38053/acmj.1855387

Anatolian Curr Med J. 2026;8(2):265-269

Evaluation of patellar height indices in individuals with Osgood-Schlatter disease: a magnetic resonance imaging based study

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Cite this article as: Akdal Dölek B, Tekdemir H, Duran S. Evaluation of patellar height indices in individuals with Osgood-Schlatter disease: a magnetic resonance imaging based study. *Anatolian Curr Med J.* 2026;8(2):265-269.

Received: 03.01.2026 ◆ **Accepted**: 06.02.2026 ◆ **Published**: 10.03.2026

ABSTRACT

Aims: To compare magnetic resonance imaging (MRI), derived patellar height indices, the Insall-Salvati Index (ISI), Blackburne-Peel Ratio (BPR), and Caton-Deschamps Index (CDI) between adults with Osgood-Schlatter disease (OSD) and matched controls, and to determine whether plateau-based indices (BPR, CDI) provide more anatomically reliable assessment of patellar height on MRI than the tuberosity-based ISI in the presence of tibial tuberosity distortion.

Methods: In this retrospective study, 350 adults were evaluated, including 175 patients with radiologically confirmed OSD and 175 age- and sex-matched controls. Knee MRI examinations were reviewed using standardized sagittal T1-weighted sequences. Patellar height was assessed using ISI, BPR, and CDI measured independently by two blinded radiologists.

Results: Median ISI, BPR, and CDI values were significantly higher in the OSD group (ISI: 1.13 vs. 1.00; BPR: 1.17 vs. 1.00; CDI: 1.23 vs. 1.00; all $p<0.001$), indicating a consistent pattern of patella alta in individuals with OSD. ISI demonstrated elevated values consistent with patella alta, whereas the plateau-based indices (BPR and CDI) likewise showed significantly greater patellar height in the OSD group. Age and sex distribution did not differ between groups ($p>0.05$).

Conclusion: Adults with OSD exhibit significantly increased patellar height across all MRI-derived indices. In the presence of tibial tuberosity distortion, plateau-based indices (BPR and CDI), which reference stable anatomical landmarks and are validated in normal populations, represent a more anatomically robust option for MRI-based patellar height assessment than the ISI.

Keywords: Osgood-Schlatter disease, Insall-Salvati Index, blackburne-peel ratio, caton-deschamps index, MRI, patella alta

INTRODUCTION

Osgood-Schlatter disease (OSD), a traction apophysitis of the tibial tuberosity, remains one of the most common causes of anterior knee pain among physically active adolescents and young adults. Although it was historically viewed as a self-limiting disorder, there is growing evidence indicating that symptoms can persist into adulthood, resulting in chronic pain or functional limitations in some individuals.[1,2] Recent studies emphasize that repetitive tensile forces on the patellar tendon and excessive loading at the tibial tubercle are two major factors in the pathogenesis of OSD.[2,3]

Advances in magnetic resonance imaging (MRI) have greatly enhanced the characterization of OSD, with detailed assessment now possible for the tibial tubercle, patellar tendon, associated edema, and cartilage changes.[3-5] Further MRI studies have delineated that OSD is not a simple disorder of the bone-apophysis but an interplay of tendon stress with growth plate morphology and dynamic knee biomechanics.[3,4] Several recent imaging studies have demonstrated variations in extensor mechanism anatomy and underscored the need for assessment of patellar height and alignment in individuals with symptoms.[5,6]

Patellar height is a critical determinant of patellofemoral mechanics. Abnormally elevated patellar position-patella alta-is associated with altered contact forces, increased patellofemoral stress, and greater quadriceps and patellar tendon tension.[7-9] Computational and kinematic models have demonstrated that patella alta acts not only to translate patellofemoral joint contact superiorly but also to increase load transmission through the patellar tendon, especially during jumping or running activities.[9,10] These biomechanical changes have the potential to increase traction forces at the tibial tubercle and thus suggest a possible contributory role of patella alta in either the development or persistence of OSD.[11,12] Previous work has confirmed that patellar height

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indices, particularly the Insall-Salvati ratio, can be reliably applied on sagittal MRI with good agreement compared with radiography and other modalities.[13-15] Because OSD alters the morphology of the tibial tuberosity, the accuracy of tuberosity-based patellar height measurements such as the Insall-Salvati Index (ISI) may be compromised. In contrast, plateau-referenced indices such as the Blackburne-Peel Ratio (BPR) and the Caton-Deschamps Index (CDI) do not rely on the tibial tuberosity and may provide more reliable patellar height assessment in OSD. In adults, OSD is generally considered a manifestation of persistent or residual changes from adolescent disease rather than an active apophyseal process.

Therefore, the purpose of this study was to compare MRI-derived ISI, BPR, and CDI values between adults with OSD and matched controls, with the aim of determining whether plateau-based indices can serve as valid alternatives to ISI in the presence of tibial tuberosity distortion.

METHODS

Ethics

The study was conducted with the permission of the Scientific and Ethical Review Board of Ankara Bilkent City Hospital Medical Researches (Date: 12/24/2025, Decision No: TABED2-25-1738). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

This retrospective study was performed in the Department of Radiology at a tertiary care center after receiving approval from the Institutional Review Board. Knee MRI examinations performed between January 2019 and December 2024 were reviewed using the PACS and the radiology information system. Of the 350 adult patients, 175 were diagnosed with OSD, and 175 were age- and sex-matched healthy controls. Exclusion criteria included prior knee surgery, major ligamentous or meniscal injury, congenital or acquired abnormalities of the knee extensor mechanism, inflammatory arthropathy, systemic rheumatologic disease, and inadequate image quality for accurate measurement. The control group comprised individuals scanned for mild trauma or nonspecific knee pain during the same period, with no clinical or imaging evidence of OSD or other patellofemoral abnormalities.

Radiological diagnosis of OSD on MRI was established based on characteristic findings including one or more of the following: fragmentation, irregularity, or hypertrophy of the tibial tuberosity; thickening and/or increased signal intensity of the distal patellar tendon; bone marrow edema within the tibial tubercle; and adjacent soft tissue edema. Only patients with imaging features consistent with chronic or residual OSD were included.

MRI Acquisition and Measurements

All MRI studies were performed at 1.5 Tesla using a GE system (GE Healthcare, Milwaukee, WI) with a dedicated knee coil. The institutional knee MRI protocol included the following sequences: axial fat-suppressed PDW FSE, sagittal fat-suppressed PDW FSE, coronal fat-suppressed PDW FSE, sagittal T1-weighted FSE and sagittal T2-weighted 3D cube. Sagittal T1-weighted images (3-to 4-mm slice thickness, minimum interslice gap, and a field of view of 14 to 18 cm) were used to measure patellar height because this series provides the best visualization of the patella, patellar tendon, articular surfaces, and tibial plateau landmarks. The knee was positioned in near full extension, and the patella aligned centrally within the imaging coil to minimize tilt-related distortion. The mid-sagittal slice was defined as the image showing: (1) the patellar apex, (2) the patellar tendon aligned with its midpoint, and (3) the intercondylar notch clearly visible. If multiple slices met these criteria, the slice with the longest patellar articular surface was selected. Patellar height was quantified using three indices: the ISI, the BPR, and the CDI. All measurements were obtained from mid-sagittal images using the digital caliper tool on the PACS workstation. The ISI was measured as the ratio of the patellar tendon length to the patellar length (**Figure 1**). The BPR was measured as the ratio of the perpendicular distance from the tibial plateau to the inferior patellar articular surface to the articular surface length (**Figure 2**). The CDI was measured as the ratio of the distance from the anterosuperior corner of the tibial plateau to the inferior patellar articular surface to the patellar articular length (**Figure 3**). Two radiologists with 11 and 5 years of experience independently performed all measurements while blinded to group assignments, and discrepancies were resolved by consensus.

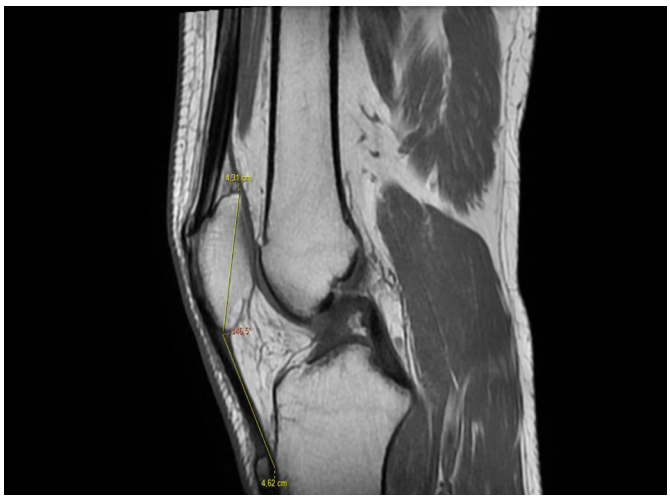

Figure 1. Mid-sagittal T1-weighted magnetic resonance image of the knee demonstrating measurement of the Insall-Salvati Index (ISI). The ISI is calculated as the ratio of the patellar tendon length (distance from the inferior pole of the patella to the tibial tuberosity insertion) to the greatest longitudinal length of the patella

Statistical Analysis

Data analysis was performed using SPSS software, version 20.0 (Armonk, NY: IBM Corp.) The distribution of continuous variables such as ISI, BPR, and CDI was tested for normality using the Shapiro-Wilk and the Kolmogorov-Smirnov tests. As several variables were not normally distributed, nonparametric tests were selected for group comparisons. Continuous variables were summarized as medians and interquartile ranges, and comparisons between the OSD and control groups were conducted by Mann-Whitney U

test. Comparisons of categorical variables were compared using chi-square test. Interobserver reliability for ISI, BPR, and CDI measurements was assessed using the intraclass correlation coefficient (ICC, two-way random effects, absolute agreement). ICC values were interpreted according to standard criteria (poor <0.5, moderate 0.5-0.75, good 0.75-0.90, excellent >0.90). For all the analyses, a two-sided p-value <0.05 was regarded as statistically significant.

Figure 2. Mid-sagittal T1-weighted magnetic resonance image illustrating measurement of the Blackburne-Peel Ratio (BPR). The BPR is defined as the ratio of the perpendicular distance from the tibial plateau line to the inferior margin of the patellar articular surface divided by the length of the patellar articular surface

Figure 3. Mid-sagittal T1-weighted magnetic resonance image demonstrating measurement of the Caton-Deschamps Index (CDI). The CDI is calculated as the ratio of the distance from the anterosuperior corner of the tibial plateau to the inferior margin of the patellar articular surface divided by the length of the patellar articular surface

RESULTS

A total of 350 participants were included in the study, comprising 175 individuals with OSD and 175 age- and sex-matched healthy controls.

Patellar height indices were significantly higher in the OSD group compared with controls. Median ISI values were increased in individuals with OSD, consistent with a tendency toward patella alta (1.13 [IQR 1.05-1.20] vs. 1.00 [0.90-1.07], p<0.001). Similarly, median BPR (1.17 [1.10-1.25] vs. 1.00 [0.90-1.05], p<0.001) and CDI values (1.23 [1.15-1.30] vs. 1.00 [0.95-1.10], p<0.001) were significantly higher in the OSD group (**Table**).

Table. Comparison of demographic and patellar height measurements between osd and control groups

Variable	OSD (n=175)	Control (n=175)	p-value
Age (years)	38 (28-50)	36 (31-40)	0.06
Sex (female/male)	15/160	26/149	0.067
Insall-salvati index	1.13 (1.05-1.20)	1.00 (0.90-1.07)	<0.001
Blackburne-peel ratio	1.17 (1.1-1.25)	1.00 (0.90-1.05)	<0.001
Caton-deschamps index	1.23 (1.15-1.30)	1.00 (0.95-1.10)	<0.001

Values are presented as median (interquartile range). OSD: Osgood-Schlatter disease

There were no statistically significant differences in age between groups (median 38 vs. 36 years, p=0.06). Compared with controls, individuals with OSD demonstrated a 13% higher median ISI, a 17% higher BPR, and a 23% higher CDI.

Interobserver reliability was excellent for all measurements, with intraclass correlation coefficients of 0.93 for ISI, 0.91 for BPR, and 0.94 for CDI.

DISCUSSION

The principal finding of this MRI-based study is that patellar height indices were significantly higher in individuals with OSD than in matched controls across all three commonly used measurements.

The ISI is based on the length ratio of patellar tendon to patellar length and thus requires correct localization of the tibial tuberosity. For the general population, indices ranging from 0.8 to 1.2 correspond to the physiological range, while indices greater than 1.2 have been used to identify patients with patella alta.[7,13]

Nevertheless, prior MRI and radiographic studies have shown that OSD is not uncommonly accompanied by fragmentation, hypertrophy, or irregularity of the tibial tuberosity.[4,16,17] These morphological changes could potentially contribute to difficulties in precise localization of the distal patellar tendon insertion. As a result, the anatomical fidelity of ISI measurements may be affected, despite acceptable interobserver correlations. While ISI is thus far a reproducible method in a general population,[13-15] its reliance on a changed landmark would not make it an appropriate choice if tibial tuberosity morphologies are abnormal.

The BPR and CDI, on the other hand, are based on the tibial plateau rather than the tuberosity and are well validated in normal subjects. The original Blackburne-Peel Ratio described mean measurements of 0.8 to 1.0 in asymptomatic subjects, while ratios in excess of 1.0 to 1.06 were consistent with patella alta.[7] The CDI described the norm as lying between 0.8 and 1.2; values in excess of 1.3 were considered abnormal.[16,17]

Follow-up radiographic and MRI analyses have confirmed and supported the relevance of these values for diverse populations and imaging techniques. Barnett et al.[20] showed

that CDI is still reproducible in patients with trochlear dysplasia and hence is not dependent on tibial tuberosity. Recently, Kızılgöz[18] showed that values for BPR are indeed reproducible in sagittal views of an MRI and are equivalent to those obtained radiographically in normal populations.

In our study, the median values of BPR of 1.17 and CDI of 1.23 in the OSD group exceeded the normal limits considered acceptable in the previous studies, while the values for the control group remained around 1.00. The fact that the values concur with the previous determination of thresholds strongly validates the use of plateau values for general patellar height assessment instead of disease-specific measures.

From a measurement-selection perspective, patellar height indices should be chosen based on the integrity of their anatomical reference points. When the tibial tuberosity is morphologically altered, as frequently documented in OSD, indices that depend directly on this structure such as the ISI may be less appropriate. Plateau-based indices anchor measurements to the tibial plateau, a structure that retains consistent morphology even in the presence of tuberosity fragmentation or remodeling.

The observation that BPR and CDI values in our OSD cohort exceeded established normal ranges derived from previous radiographic and MRI studies reinforces their anatomical robustness. Rather than suggesting universal replacement of ISI, these findings emphasize that plateau-based indices represent a more logical and reliable selection for MRI-based patellar height assessment when tibial tuberosity landmarks are compromised. This selection-oriented approach aligns patellar height measurement with anatomical conditions, improving interpretability and consistency across patient populations.

From a clinical practice perspective, preferential use of plateau-based indices (BPR and CDI) may improve the reliability of MRI interpretation in adults with OSD by avoiding reliance on distorted tibial tuberosity landmarks. This is particularly relevant for longitudinal follow-up and for studies requiring consistent comparisons across groups.

Limitations

This study has several limitations. First, its retrospective design may introduce selection bias, and factors such as activity level, body mass index, and skeletal maturity could not be evaluated. Second, although MRI offers high anatomical precision, patellar height measurements can be affected by knee positioning and slice selection. Because examinations were performed in full extension and non-weight-bearing conditions, MRI-derived indices may not be directly interchangeable with radiograph-based thresholds obtained under standardized flexion or weight-bearing. Finally, the cross-sectional nature of the study does not allow determination of whether patella alta is a predisposing factor for OSD or a coincidental anatomical variation.

CONCLUSION

Adults with OSD show significantly increased patellar height in all MRI-derived indices compared with age and sex matched controls. However, where distortion of the tibial tuberosity occurs, plateau-based measurements such as the BPR and CDI, reliant as they are on more stable anatomical landmarks and validated in a population with normal anatomy, provide a more anatomically robust and reliable option than the tuberosity-dependent ISI for MRI-based assessment of patellar height.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was conducted with the permission of the Scientific and Ethical Review Board of Ankara Bilkent City Hospital Medical Researches (Date: 12/24/2025, Decision No: TABED2-25-1738).

Informed Consent

As this was a retrospective study, formal written informed consent was not required and was therefore not obtained.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Financial Disclosure

The authors received no financial support for the conduct or publication of this research.

Author Contributions

Concept: BAD, HÖ, SD; Design: BAD, SD; Control: BAD, SD; Data Collection and/or Processing: BAD, HÖ, SD; Analysis and/or Interpretation: BAD, HÖ, SD; Literature Review: BAD, SD; Article Writing: BAD, SD; Critical Review: All authors.

REFERENCES

1. Gholve PA, Scher DM, Khakharia S, Widmann RF, Green DW. Osgood Schlatter syndrome. *Curr Opin Pediatr.* 2007;19(1):44-50. doi:10.1097/MOP.0b013e328013dbea
2. Ladenhauf HN, Seitlinger G, Green DW. Osgood-Schlatter disease: a 2020 update of a common knee condition in children. *Curr Opin Pediatr.* 2020;32(1):107-112. doi:10.1097/MOP.0000000000000842
3. Lucenti L, Sapienza M, Caldaci A, Cristo C, Testa G, Pavone V. The etiology and risk factors of Osgood-Schlatter disease: a systematic review. *Children (Basel).* 2022;9(6):826. doi:10.3390/children9060826
4. Hirano A, Fukubayashi T, Ishii T, Ochiai N. Magnetic resonance imaging of Osgood-Schlatter disease: the course of the disease. *Skeletal Radiol.* 2002;31(6):334-342. doi:10.1007/s00256-002-0486-z
5. Lee DW, Kim MJ, Kim WJ, Ha JK, Kim JG. Correlation between magnetic resonance imaging characteristics of the patellar tendon and clinical scores in Osgood-Schlatter disease. *Knee Surg Relat Res.* 2016;28(1):62-67. doi:10.5792/ksrr.2016.28.1.62
6. Loose K, Pennekamp S, Hitzl W, et al. MRI characteristics and alterations in patellar height in patients with patellar tendinopathy-a retrospective study. *J Pers Med.* 2023;13(4):698. doi:10.3390/jpm13040698

7. Biedert RM. Patella Alta: When to correct and impact on other anatomic risk factors for patellofemoral instability. *Clin Sports Med*. 2022;41(1): 65-76. doi:10.1016/j.csm.2021.07.002
8. Stefanik JJ, Zhu Y, Zumwalt AC, et al. Association between patella alta and the prevalence and worsening of structural features of patellofemoral joint osteoarthritis: the multicenter osteoarthritis study. *Arthritis Care Res (Hoboken)*. 2010;62(9):1258-1265. doi:10.1002/acr.20214
9. Ward SR, Terk MR, Powers CM. Influence of patella alta on knee extensor mechanics. *J Biomech*. 2005;38(12):2415-2422. doi:10.1016/j.jbiomech.2004.10.010
10. Draper CE, Besier TF, Fredericson M, et al. Differences in patellofemoral kinematics between weight-bearing and non-weight-bearing conditions in patients with patellofemoral pain. *J Orthop Res*. 2011;29(3):312-317. doi:10.1002/jor.21253
11. Wheatley MGA, Rainbow MJ, Clouthier AL. Patellofemoral mechanics: a review of pathomechanics and research approaches. *Curr Rev Musculoskelet Med*. 2020;13(3):326-337. doi:10.1007/s12178-020-09626-y
12. Lenhart RL, Brandon SC, Smith CR, Novacheck TF, Schwartz MH, Thelen DG. Influence of patellar position on the knee extensor mechanism in normal and crouched walking. *J Biomech*. 2017;51:1-7. doi:10.1016/j.jbiomech.2016.11.052
13. Miller TT, Staron RB, Feldman F. Patellar height on sagittal MR imaging of the knee. *AJR Am J Roentgenol*. 1996;167(2):339-341. doi:10.2214/ajr.167.2.8686598
14. Kurowecki D, Shergill R, Cunningham KM, et al. A comparison of sagittal MRI and lateral radiography in determining the Insall-Salvati ratio and diagnosing patella alta in the pediatric knee. *Pediatr Radiol*. 2022;52(3):527-532. doi:10.1007/s00247-021-05207-4
15. Kwak YH, Park SS, Huser AJ, et al. Reliability and modality analysis of patellar height measurement in pediatric knee. *Front Pediatr*. 2024;12: 1323015. doi:10.3389/fped.2024.1323015
16. Aparicio G, Abril JC, Calvo E, Alvarez L. Radiologic study of patellar height in Osgood-Schlatter disease. *J Pediatr Orthop*. 1997;17(1):63-66.
17. Jakob RP, von Gumppenberg S, Engelhardt P. Does Osgood-Schlatter disease influence the position of the patella? *J Bone Joint Surg Br*. 1981; 63B(4):579-582. doi:10.1302/0301-620X.63B4.7298689
18. Kızılgöz V. Using the Blackburne-Peel index to measure the patellar height on magnetic resonance images. *Sci Rep*. 2023;13(1):21950. doi:10.1038/s41598-023-49497-0
19. Koh JL, Stewart C. Patellar instability. *Clin Sports Med*. 2014;33(3):461-476. doi:10.1016/j.csm.2014.03.011
20. Barnett AJ, Prentice M, Mandalia V, Wakeley CJ, Eldridge JD. Patellar height measurement in trochlear dysplasia. *Knee Surg Sports Traumatol Arthrosc*. 2009;17(12):1412-1415. doi:10.1007/s00167-009-0801-5