

# Review of Diagnostic Accuracy of the Ottawa Knee Rules in Adult Acute Knee Injuries

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## ABSTRACT

Acute knee injuries are commonly found in athletic populations. The wide range of knee injuries can present a challenge deciding which injuries require imaging. Currently, radiography is considered the gold standard of imaging for knee fractures. However, imaging is often costly not only for the patient, but also for the healthcare system. Since imaging is expensive, it is critical that clinicians decipher which patients require such testing. The Ottawa Knee Rules (OKR) is a predictor tool created by Stiell et al in 1995 to help clinicians accurately distinguish potential knee fractures from non-fractures for imaging purposes. The OKR guidelines state that a patient should be referred for radiography if he/she meets at least one of the following criteria: (1) 55+ years of age (2) tenderness over fibular head (3) secluded pain on the patella (4) cannot flex knee to 90 degrees (5) cannot bear weight for at least four steps. The OKR has been used in clinical settings to rule out knee fractures in patients. The ability of OKR to accurately differentiate knee fractures from non-fractures has been investigated to determine how effective the tool is. This article examined eight research studies including over 7,000 participants to determine the diagnostic accuracy of OKR in adults. This examination showed that OKR exhibited high accuracy in diagnosing knee fractures needing imaging. The OKR demonstrated a sensitivity of 0.99, specificity of 0.49, LR+ of 1.86, and LR- of 0.07. This data indicates a confidence interval (CI) of 95%. Furthermore, OKR showed low risk of bias and was beneficial to reducing medical costs and medical wait times. More than half (5) of the studies indicated a reduction rate in imaging completed when utilizing OKR. Therefore, OKR is a beneficial and accurate tool to implement in clinical decision-making when making imaging referrals for acute knee injuries in adults.

**Content Focus:** Health Care Competency

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## ORIGINAL REFERENCE

*Sims JJ, Chau MT, Davies JR. Diagnostic accuracy of the Ottawa Knee Rule in adult acute knee injuries: A systematic review and meta-analysis. Emerg Radiol. (2020);30:4438-4446. doi: 10.1007/s00330-020-06804-x.*

## SUMMARY

### CLINICAL PROBLEM AND QUESTION

Acute knee pain is a common complaint amongst the patients seen in emergency departments. Despite a high incidence of this, only a small number of cases are due to fractures.<sup>1</sup> Plain radiography has minimal use in detecting injuries to soft-tissue structures in the knee such as muscular and ligamentous anatomy. In addition there is a significant financial burden for ordering radiographs in high volume.<sup>1</sup> By performing an economic analysis of the effect of the Ottawa Knee Rules (OKR), it was reported that when used, there was a \$3M USD dollar annual reduction in healthcare cost nationwide. The savings were found to be about a \$34 USD per patient.<sup>2</sup> Before the establishment of the OKR in 1995 by Stiell et al, there were no uniform methods to rule out knee fractures.<sup>1</sup> Currently, the suggestion to refer for imaging due to a potential knee fracture includes one or more the following criteria: inability to bear weight after injury (regardless of limp), injury

to the patella specifically, tenderness over the fibular head, inability to achieve 90° of knee flexion, and any patient older than 55 years old.<sup>1-4</sup> Leading up to this study there are no systematic reviews or meta-analyses regarding the accuracy of the OKR in the adult population only.<sup>1</sup> To prevent the ordering of unnecessary radiographs and cut down on costs, there is a need for a clinical decision aide to enable health care professionals to predict the presence of a knee fracture prior to an emergency department visit. Therefore, the purpose of this article was to examine the accuracy of the OKR in clinical settings.

## **SUMMARY OF LITERATURE**

The databases Embase (Elsevier), MEDLINE, PubMed, and Scopus were searched to gather articles to include in the systematic review and meta-analysis. The criteria for articles included was original works where the OKR was utilized by physicians in emergency settings to diagnose the presence of acute knee injuries. Acute knee injuries were defined as the timespan of the first seven days after the initial trauma.<sup>2</sup> To begin the process, abstracts were first manually screened by two reviewers to determine the potential eligibility of each article. Once eligible articles were established, complete reading took place. Upon final evaluation, the articles from 1995 to present that provided sufficient data about the diagnostic accuracy of OKR in adults were used. Each study within the articles included a follow-up radiography report to confirm the presence of a fracture. Articles looking at the accuracy of the OKR in pediatric patients were excluded. After the initial search, 116 articles were found. There were 54 duplicate articles and after screening, 8 articles were deemed eligible and included in the study.

## **SUMMARY OF INTERVENTIONS**

The Ottawa Knee Rules are intended to help clinicians accurately distinguish when to refer a potential knee fracture for imaging using the criteria found in Figure 1.<sup>1</sup>

## **SUMMARY OF OUTCOMES**

Eight studies were enrolled in the meta-analysis, which involved a total of 7,385 adult patients. The patient and study characteristics included a patient age range of 18 to 101, seven prospective studies, one controlled clinical trial, and only two patients identifying as false-negative diagnoses. The QUADAS-2 tool identified most studies presented with a low risk of bias and concern regarding applicability. Several studies stood out in terms of presenting bias. One study presented with a high risk of bias for patient selection, while a different study presented with a risk of bias to the “flow and timing” criterion.<sup>5,6</sup> Another study demonstrated bias related to the reference test. This is because the radiographs were read by both the physician and traumatologist.<sup>7</sup> However, the gold standard for the radiograph is to be interpreted by the radiologist alone.<sup>7</sup> Heterogeneity, a random effects model, between the eight studies was examined by the calculation of  $I^2$  statistic, as well as, a bivariate random effects meta-analysis to calculate sensitivity, specificity, LR(+), and LR(-). Spearman’s rank correlation test and Begg’s test for publication bias were also calculated.

## **FINDINGS AND CLINICAL IMPLICATIONS**

The meta-analysis demonstrates that there is a strong ability to rule out knee fractures using the OKR for adults who sustain acute knee injuries. The rule was derived from Stiell et al, and was validated and implemented over 2 years, yielding a 1.0 sensitivity and negative predictive value in all trials that were conducted.<sup>6,8</sup> The analysis of eight studies exploring 7385 adult patients demonstrated a high diagnostic

performance of OKR with a pooled sensitivity of 0.99 (95% CI, 0.97-1.00) and specificity of 0.49 (95% CI, 0.47-0.51). A pooled LR+ of 1.86 (95% CI, 1.72-2.01), LR- of 0.07 (95% CI, 0.02-0.24) and DOR of 25.10 indicated that a positive OKR increased the odds of having a knee fracture twofold, whereas the odds decreased by 99.03% given a negative OKR. Furthermore, a moderate non-significant heterogeneity sensitivity range of 0.86-1.0 and a high significant heterogeneity specificity range of 0.23-0.54 were calculated. This means that there was low variability between the eight studies for sensitivity and high variability between the eight studies for specificity ( $I^2 = 27.6\%$ ;  $I^2 = 79.3\%$  respectively). **Table 1** provides the full results. Spearman's rank correlation test demonstrated that there was no evidence of a threshold effect. Begg's test for publication bias was moderate with a  $p$  value of 0.805. This means that there was moderate association between the eight studies used in this meta-analysis and moderate risk of bias.

**Table 1.** Results from Original Studies

Study Authors	Participants	Country	Results	Clinical Significance	Overall Risk of Bias
Atkinson et al. <sup>10</sup>	130	England	Sensitivity: 1.00 Specificity: 0.54	N/A	Very Low
Cheung et al. <sup>14</sup>	90	Netherlands	Sensitivity: 0.86 Specificity: 0.23	N/A	Very Low
Emparanza et al. <sup>7</sup>	1522	Spain	Sensitivity: 1.00 Specificity: 0.52	49% RR	Low
Jalili and Gharebaghi <sup>11</sup>	283	Iran	Sensitivity: 0.95 Specificity: 0.44	41% RR	Low
Ketelslegers et al. <sup>5</sup>	261	Belgium	Sensitivity: 1.00 Specificity: 0.43	25% RR	Low
Stiell et al. <sup>8</sup>	1096	Canada	Sensitivity: 1.00 Specificity: 0.49	28% RR	Very Low
Stiell et al. <sup>6</sup>	3907	Canada	Sensitivity: 1.00 Specificity: 0.48	26.4% RR	Moderate
Szucs et al. <sup>4</sup>	96	United States	Sensitivity: 1.00 Specificity: 0.47	N/A	Low

\*RR - estimated reduction rate

However, within the eight studies, it was unclear whether there was a need for further imaging giving a negative result on radiograph. According to the American College of Radiology Appropriateness Criteria, evidence-based guidelines for specific clinical conditions that are reviewed every three years by a multidisciplinary panel, both magnetic resonance (MR) and computerized tomography (CT) imaging are not recommended for acute knee injuries unless significant trauma or dislocation is observed.<sup>9</sup> Although insurance may influence which tests are performed based on coverage and the sequency of testing, MR and CT imaging should not be dismissed when evaluating an acute knee injury because CT shows high accuracy in diagnosing

occult and tibial plateau fractures, while the MR also plays an important role in the diagnoses of soft tissue pathologies.<sup>9</sup> Although further radiography may be needed, this review showed that five of the eight studies produced a reduction of 26.4%-49% in radiography when using OKR.%.

## CLINICAL BOTTOM LINE

It is important for clinicians to understand the most accurate tools to use in the evaluation and diagnostic processes of their practice. This allows a clinician to operate in their settings in the most efficient and practical manner. The OKR is a beneficial tool that can be used to rule out knee fractures in patients which prevents futile imaging from taking place. Based on the results of this study, OKR demonstrated an impressive ability to accurately rule out knee fractures. The OKR had a 0.99 sensitivity indicating that utilizing these guidelines has a significantly high capability of correctly identifying those who do not need imaging and the ability to rule out an acute knee fracture.<sup>10</sup> Furthermore, OKR has exhibited high consistency between examiners, meaning multiple examiners are able to obtain the same results as each other when utilizing this tool.<sup>2</sup>

Accurately identifying those who may have a knee fracture from those who do not is vital to appropriately referring patients for imaging only when necessary to reduce healthcare costs. As previously mentioned, use of the OKR can save \$34 USD per patient and \$3M USD annually in healthcare costs.<sup>2</sup> With fewer people going to medical facilities, such as hospitals and urgent care, the time a person spends waiting to be seen decreases as a result.<sup>5,11</sup> This allows people who absolutely need medical care to be seen and treated more quickly. Diagnostic tools are extremely useful for athletic trainers, physical therapists, and other healthcare professionals to use in clinical settings. One such tool, OKR, is a quick, easy, and costless tool that can be used in a clinic or on-field examination to determine if a patient needs imaging for a knee fracture. The OKR has demonstrated high accuracy when identifying those who do not have a knee fractures a highly accurate tool to use to minimize the number of unnecessary imaging, reduce costs, and limit the amount of time spent waiting in medical facilities.<sup>12-14</sup> Therefore, it is beneficial for clinicians to apply OKR in their evaluation processes to reduce needless imaging, reduce medical costs, and decrease the time spent waiting in medical facilities.

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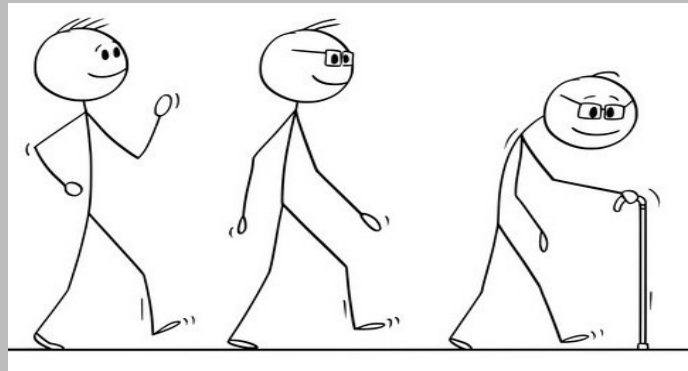
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# The Ottawa Knee Rules

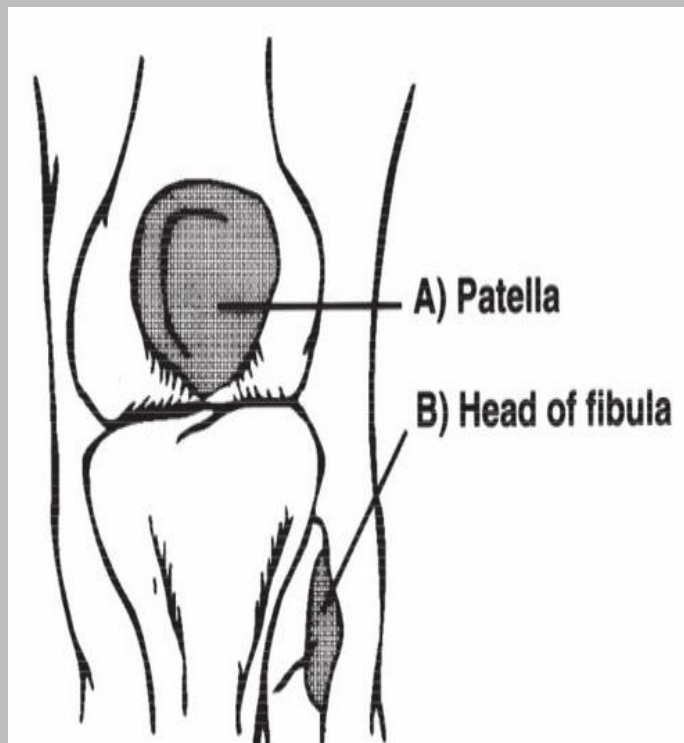
A predictor tool to help clinician decision-making when making imaging referrals for acute knee injuries in adults

A patient should be referred to radiography if they meet at least one of the following criteria:

55+  
years of  
age

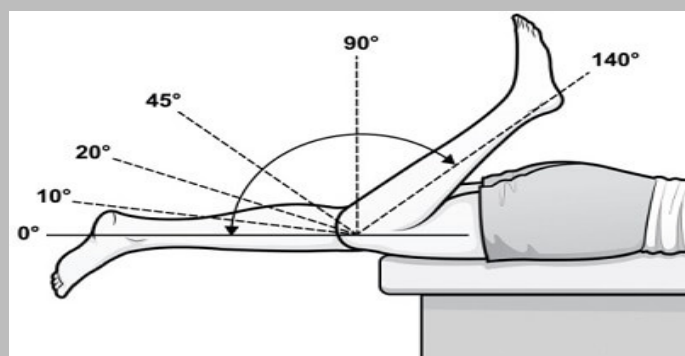


Isolated  
pain over  
the patella  
(A)



Tenderness  
over the  
fibular  
head (B)

Inability to  
flex to 90  
degrees



Inability to  
weight bear  
immediately  
after and in the  
emergency  
department (at  
least 4 steps)



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