

# VALIDITY OF OTTAWA KNEE RULES AT A TEACHING HOSPITAL OF EASTERN NEPAL

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## ABSTRACT

### Introduction

Knee injuries are encountered frequently in Orthopedic emergency and Outpatient departments. Radiographs are routinely ordered in them, but not all of them demonstrate clear fractures. The decision for radiography based on subjective evaluation can help to reduce cost, decrease waiting time, and unnecessary radiation exposure. We lack this information in our context.

### Objective

The objective of this study was to find the validity of the Ottawa knee rule (OKR) in patients presenting with acute knee injuries at a teaching hospital in eastern Nepal.

### Methodology

A cross-sectional study was conducted from March 2018 to February 2019 including 210 cases of acute knee injuries. The patients were evaluated as per OKR and their X-rays were evaluated too. Collected data were entered in MS Excel and analyzed by SPSS for validity.

### Results

Out of the total of 210 eligible patients (122 males and 88 females) with a mean age of 43.97 years, the radiography rate was 100% but the yield rate was only 10.5%. Overall 69% of patients presented to the hospital within 24 hours of the injury and direct hit/trauma was the commonest mode of injury. Patella fractures were commonest followed by proximal tibia fractures. There was a high sensitivity of 100% and a specificity of 42.02%. The rule yielded a Positive and Negative Predictive value of 16.79% and 100%, respectively. The OKR, if applied correctly, could result in radiography rate reduction by 37.61%. The Fisher exact test result was significant at  $p < 0.05$ .

### Conclusion

OKRs is a valid tool to predict fractures in patients who has a history of acute knee injuries without chances of missing fractures. This rule can reduce unnecessary radiography in our setup as well.

## KEYWORDS

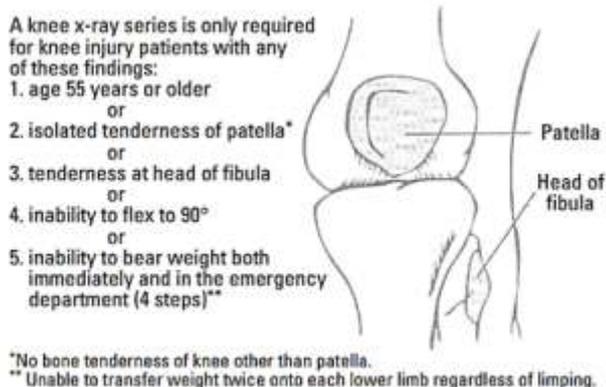
Fractures; Knee injuries; Ottawa Knee Rule; X-ray.



## INTRODUCTION

Acute knee injuries are very common injuries presenting to hospitals globally.<sup>1-4</sup> Routine radiographs are ordered to rule out fractures in all but surprisingly fractures are reported in less than 7% of cases only.<sup>2,5</sup> It's well known that the majority of knee injuries have either meniscal or ligamentous ruptures but on contrary, the knee radiographs are done more which demonstrate only fractures.<sup>3</sup> Here comes the role of "clinical prediction rules" to improve diagnostic efficiency.<sup>6</sup> There are many clinical prediction rules developed at various institutions by different groups for the determination of the need for radiography to detect fractures in patients presenting with an acute knee injury.<sup>1,8,9</sup> Most of them comprise of three or more variables obtained from the history, physical examination, or simple diagnostic tests, and are developed after original data collection and multivariate statistical analysis.<sup>1,7-9</sup>

The Ottawa Knee Rule (OKR) described by Stiell et al. is a highly sensitive and reliable clinical tool to determine the need for knee radiographs that have even proven to be 100% sensitive for fracture prediction following knee injuries in Canada.<sup>1,2</sup> Few studies have reported that using these rules could reduce knee radiography by 28% without missing any clinically significant fractures.<sup>2,10</sup> This rule comprises five simple variables based on the history and physical examination including age 55 years or older, isolated tenderness of the patella, tenderness at the head of the fibula, inability to flex the knee to 90 degrees, and inability to transfer weight for four steps both immediately after the injury and in the emergency department (figure 1).<sup>1,2,11</sup>



**Figure 1:** Ottawa Knee Rule

According to OKR, acute knee injuries are categorized into two groups; those with at least one positive variable are considered likely to have a fracture and are advised for radiographs, whereas those without any positive variable are considered less likely to have a fracture and thus radiography can be safely deferred in them. This results in decreased radiation exposure, cost savings to some extent, and a reduction in the number of negative knee radiographs without adversely affecting patient care as well.<sup>2,10-13</sup> A meta-analysis of the results of six OKR validation studies by Bachmann et al. showed a pooled sensitivity of 98.5% and specificity of 49% for specific knee fractures.<sup>14</sup> The authors, however, even recommended additional validation studies.

In low socioeconomic countries like Nepal, this rule would be quite helpful to health personnel working at the periphery without X-ray facilities. It would help to decide whom to send for an X-ray thereby reducing unnecessary referrals. Even at urban health care centers with X-ray facilities, the decision for radiography based on subjective evaluation can help to reduce the cost, waiting time, and unnecessary radiation exposure. Furthermore, the use of OKRs will help in the development of skill and attitude among doctors & other medical personals regarding the importance of clinical evaluation of patients and they will invest more time examining patients rather than writing radiological requisition. However, in the context of eastern Nepal, we lack the validation of this information. Hence, this study aims to find the validity of the Ottawa knee rule (OKR) in patients presenting with acute knee injuries at a teaching hospital in eastern Nepal.

## METHODOLOGY

A cross-sectional study was conducted from March 2018 to February 2019 at Orthopedic department of Nobel Medical College Teaching Hospital located in eastern Nepal. After taking ethical approval from the Institutional Review Committee, 210 patients having acute knee injuries were enrolled consecutively. Based on OKR, the patients with acute knee injuries were evaluated. The knee anatomy was broadly described to include the patella, the head and neck of the fibula, the proximal 8 cm of the tibia, and the distal 8 cm of the femur. Blunt trauma was defined as any injury involving a direct trauma or mechanical force applied to the knee. Inability to bear weight was defined as the patient not being able to bear weight immediately (for four steps) after the injury and in the emergency department (ED). The inclusion criteria included any patient of 18 years or above presenting to either the outpatient department (OPD) or the emergency department (ED) having acute knee pain within 7 days of injury and without any skin wound. Patients younger than 18 years, pregnant, referred from other hospitals with radiographs, more than 7 days old knee injuries, multiple injuries, and paraplegics were excluded.

Attending physicians were trained to assess the patients as per the OKR. The finding was recorded in specifically designed pro forma and ordered for knee radiographs as usual practice, independent from OKR. All the patients had at least two views taken in their radiographs; anteroposterior and lateral, whereas the tangential (skyline) view of the patella was at the discretion of the treating physician. The radiographs were reviewed by the treating physician for immediate treatment and were interpreted, within 24 hours, by an orthopedic surgeon who had been blinded to the contents of the data collection sheet. The results of the radiographic examination were recorded on the data collection sheet.

Now, the patients were divided into two groups; OKR positive and OKR negative groups, and their X-ray findings as fracture were further divided into two sub-groups; X-ray positive and X-ray negative groups. The univariate analysis

was performed for frequency and percentage and bivariate analysis was performed for fisher exact test and validity.

**RESULTS**

Among 210 patients, there were more males (58%) than females (42%). The age ranged from 20 years to 74 years with a mean age of 43.97 years. Regarding mode of injury, direct trauma (fall/object impact) was the commonest cause (48.1%), followed by a twisting knee injury (table 1).

**Table 1: Mode of Injury (n=210)**

	Frequency (Total)	Frequency (Male)	Frequency (Female)
Direct trauma (fall/object)	101 (48.1%)	57 (46.7%)	44 (50.0%)
Twisting	80 (38.1%)	46 (37.7%)	34 (38.6%)
Other indirect	29 (13.8%)	19 (15.6%)	10 (11.4%)
<b>Total</b>	<b>210</b>	<b>122</b>	<b>88</b>

More cases presented to ED (53%) in comparison to OPD (47%) and 69% of the patients presented within 24 hours of sustaining the injury.

Both sides were almost equally affected with a slight predominance of the right side (52%). There were fewer numbers of fractures overall (10.5%) of which patella fractures (5%) were the most common followed by proximal tibia fractures (table 2 and figures 2a-2e).

**Table 2: Fracture pattern (n=16)**

	Frequency (Male)	Frequency (Female)	Frequency (Total)
Patella	7 (5.8%)	3 (3.4%)	10 (4.8%)
Proximal Tibia	6 (4.9%)	1 (1.1%)	7 (3.3%)
Tibial spine	1 (0.8%)	0 (0%)	1 (0.5%)
Head of Fibula	1 (0.8%)	0 (0%)	1 (0.5%)
Distal Femur	1 (0.8%)	2 (0%)	3 (1.4%)
<b>Total</b>	<b>16</b>	<b>6</b>	<b>22</b>



**Figure 2a:** Patella fracture **Figure 2b:** Proximal tibia fracture



**Figure 2c:** Distal femur fracture **Figure 2d:** Tibial spine fracture

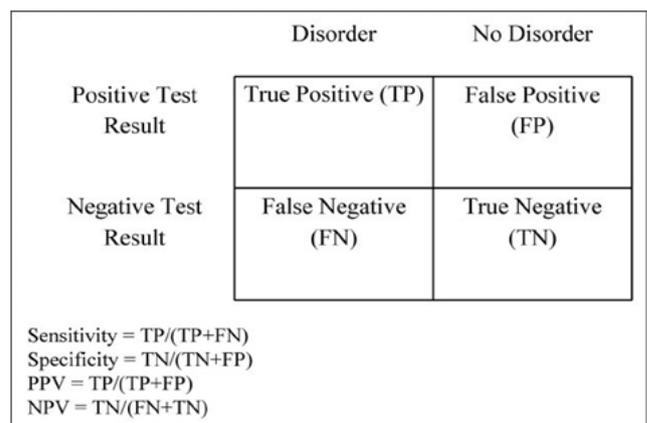


**Figure 2e:** Fibula head fracture

Since the sample size was relatively smaller, so we used the Fisher exact test with a 2 x 2 contingency table (table 3). The Fisher exact test result was significant at p<0.05.

**Table 3: Validity analysis**

		X-ray result for fracture		Total
		Positive	Negative	
OKR	Positive	22	109	131
	Negative	0	79	79
Total		22	188	<b>210</b>



**Figure 3:** Calculation of Sensitivity, Specificity, Positive Predictive and Negative Predictive Values(Carvajal et al.<sup>TM</sup>)

Calculation of Sensitivity, Specificity, Positive Predictive and Negative Predictive values were done using formulas recommended by Carvajal et al. (Figure 3).<sup>15</sup> As shown in table 3, the sensitivity was 100% and the specificity was 42.02%. The Positive Predictive Value (PPV) was 16.79% and the Negative Predictive Value (NPV) was 100%, with an X-ray reduction rate of 37.61%. The 100% sensitivity ensures that none of the patients with fractures were missed and the Negative Predictive value of 100% signifies that the chance of observing clinically significant fractures in patients who were diagnosed as OKR negative was zero. The high X-ray reduction rate signifies that unnecessary radiography was done in a lot of patients. But the patients and their radiographs were evaluated by different persons, so chances of inter-observer and intra-observer variations exists and we accept it as one of the limitations of our study.



## DISCUSSION

Ian G Stiell and colleagues performed the first study among 1054 adult patients in 1995 at two university hospitals' emergency departments in Ottawa, Canada to derive a highly sensitive clinical rule for fracture prediction following acute knee injuries.<sup>1</sup> This decision rule had a sensitivity of 1.0, a specificity of 0.54 for knee fractures identification, and accounted for relative reduction by 28% for radiography use as well. They had localized bony tenderness over the patella or the head of the fibula or were unable to bear weight both immediately after the injury and in the emergency department. These features were called the Ottawa knee Rules (OKRs). Soon after that, Stiell et al. performed a second study to validate and refine the previously derived OKR.<sup>2</sup> The study again showed that the decision rules had a sensitivity of 100% with a 28% relative reduction in the use of radiography. Thereafter, Steill et al. conducted an interventional study to assess the impact on the clinical practice of implementing the OKR.<sup>5</sup> They found that there was a relative reduction of 26.4% in the proportion of patients referred for knee radiography in the intervention group (77.6% vs 57.1%;  $P < 0.001$ ), but a relative reduction of only 1.3% in the control group (76.9% vs 75.9%;  $P = 0.60$ ). These changes over time were significant when the intervention and control groups were compared ( $P < 0.001$ ). The rule was found to have a sensitivity of 1.0 (95% CI, 0.94–1.0) for detecting 58 knee fractures.

In a prospective cohort study from Spain in 2001, Emparanza et al. showed that the decision rule had a sensitivity of 100% with an estimated 49% relative reduction in the use of radiography.<sup>3</sup> Studies by Tigges et al. and Ketelslegers et al. also supported OKR validation.<sup>10,11</sup> In our study too, the OKR sensitivity was 100% with X-ray reduction rates of 37.61%. The result was significant at  $p < 0.05$  by Fisher exact test. Patella fracture was the commonest followed by proximal tibia fracture.

In a similar study from Iran by Jalili et al, patella fractures and tibial plateau fractures were most common.<sup>12</sup> Overall, the OKR was 95.4% sensitive in detecting fractures with a specificity of 44%. Our study showed a relatively comparable specificity of 42.02% in concern to this study. In a study from Nepal in 2017 by Kashyap et al, they also found that the OKR was 100% sensitive in identifying fractures of the knee (21 patients with clinically important fractures out of the 92 total patients) and a potential decrease in the use of radiography was estimated to be 29.3%.<sup>16</sup> This study was conducted at a teaching hospital in the capital of the country. However, our study showed better results in comparison to this study.

Our study confirmed the good performance of the OKR in identifying knee fractures, as previously published by the researchers who developed it. The mean age of the patients in this study was 43.97 years with cases ranging from 20 years to 74 years. This is similar to previous studies conducted by Stiell et al. (mean age 37 years), Tigges et al.

(mean age 38 years), Ketelslegers et al. (mean age 41 years), and Beutel et al. (mean age 43.3 years).<sup>2,10,11,17</sup> Their maximum number of cases was usually in the range of 35 years to 50 years.

In our study, males (58%) outnumbered females. The reason may be their more active involvement in outdoor activities in comparison to their female counterparts. Comparable results have been shown by Emparanza et al. (58% males) and Jalili et al. (65.01% males).<sup>3,12</sup> Similar to our study, most of the previous studies also have reported sensitivities approaching 100%.<sup>2,3,5,10–12,18</sup> Similarly, the specificity matching in accordance (42.02%) to our study has been reported by few other studies as well.<sup>2,5,12,19</sup>

According to our study, implementing the OKR would have resulted in an overall reduction in the use of radiographs by 37.61%. However, the true reduction in radiography rates cannot be determined unless an interventional trial is performed. The potential reduction in the number of requested knee radiographs that could be achieved in the emergency department or the outpatient department (OPD) by applying the OKR is slightly lower than the reduction estimated in a study performed by Emparanza et al. (49% reduction rate), and Jalili et al. (41% reduction rate).<sup>3,12</sup> However, it's higher than the rate of reduction in the study by Tigges et al. (17% reduction rate) and Ketelslegers et al. (25% reduction rate).<sup>10,11</sup> This dissimilarity may have resulted from the differences in the practice of ordering radiography in the different institutes where the studies were conducted

## CONCLUSION

The commonest mechanism of knee injury was direct trauma and it occurred mostly in young adults. Ottawa Knee Rules were found to be accurate and highly sensitive tools for the prediction of fractures in patients with acute knee injuries. So, with its correct implementation, the chances of missing fractures are almost zero and have the benefits of reducing treatment cost and radiation exposure.

## LIMITATIONS OF THE STUDY

Our study has few limitations. Inter-observer biases cannot be ruled out. Even the chances of selection bias exist as enrolment in this study was based on the willingness of patients, their relatives, and the co-operation of the duty doctors too.

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None

## CONFLICT OF INTEREST

None

## FINANCIAL DISCLOSURE

None



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