Can the Ottawa and Pittsburgh rules reduce requests for radiography in patients referred to acute knee clinics?

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ABSTRACT

Our aim was to study the role of the Ottawa and Pittsburgh rules to reduce the unnecessary use of radiographs following knee injury. We prospectively reviewed 106 patients who were referred to our clinic over a 3-month period. The Ottawa and Pittsburgh rules were applied to individual patients to evaluate the need for radiography. One hundred and one patients (95%) had radiography of their knee. Five patients (5%) had a fracture of their knee and in all cases, the Ottawa and Pittsburgh knee rules were fulfilled. Using the Ottawa rules, 27 radiographs (25%) could have been avoided without missing a fracture. Using the Pittsburgh rules, 32 radiographs (30%) could have been avoided. The Ottawa and Pittsburgh rules have a high sensitivity for the detection of knee fractures. Their use can aid efficient clinical evaluation without adverse clinical outcome and may reduce healthcare costs.

KEYWORDS

Ottawa and Pittsburgh – Knee injury rules – Radiography for knee injury – Acute knee

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Knee injuries are encountered commonly in the emergency department in the UK, accounting for over 68,000 presentations each year.¹ Over 92% of patients with acute knee injuries undergo plain radiography, with only 6% of patients actually found to have a fracture.² Despite our ability to clinically differentiate between fractures and non-fractures in many cases, radiography is requested routinely. Reasons for this include fear of litigation, patient expectations and unclear histories.³ There is much scope for improving the efficacy of ordering radiography, thereby saving valuable time and resources as well as reducing unnecessary radiation exposure.⁴ In addition, clear decision rules would improve the diagnostic accuracy of inexperienced emergency department staff.⁵

The Ottawa and Pittsburgh rules for the selective use of radiographic assessment in acute knee injuries were devised initially to reduce the number of unnecessary knee radiographs. The effectiveness of these rules have been well validated in numerous studies conducted in the US^{6,7,8} but there are limited data on their application in the UK.

The Pittsburgh rules were derived from a two-phase study.⁹ Phase 1 used logistic regression to review the clinical indicators of 201 patients retrospectively. Phase 2 consisted of a prospective study of 133 patients presenting with a knee injury. All patients were followed up with radiography to confirm the clinical diagnosis. Mechanism of injury, patient age and inability to ambulate were identified as reliable indicators of a fracture. When combined to make the

Pittsburgh rules, the sensitivity was found to be 100% with a specificity of 80% and a miscalculation rate of 20%. The number of unnecessary radiographs was reduced by 78%.

The Ottawa rules arose from a prospective study of 1,047 adult patients presenting with acute knee injury.¹⁰ Five clinical indicators were identified using recursive partitioning (Table 1). The rules were found to have 100% sensitivity and a specificity of 49%. There was a relative reduction in the use of radiography by 28%. In addition, physicians were able to interpret the rule accurately in 96% of cases.

Since the advent of these decision rules, studies have been conducted to validate their use in clinical practice. A systematic review of the Ottawa criteria from 2004 looked at 6 studies involving 4,249 adult patients.⁸ Pooled analysis showed that the mean sensitivity was 98.5% with a mean specificity of 48.6%. With a fracture prevalence of 7%, the

Table 1 Summary of the Ottawa and Pittsburgh knee injury rules

Ottawa criteria	Pittsburgh criteria
One or more of the following: <ul style="list-style-type: none"> • age ≥ 55 years • fibular head tenderness • patellar tenderness • knee flexion limited to 90° • inability to bear weight (4 steps) 	<ul style="list-style-type: none"> • Blunt trauma or fall as mechanism of injury <p>Plus either of the following:</p> <ul style="list-style-type: none"> • age <12 years or >50 years • inability to bear weight (4 steps)

Figure 1 Mechanism of presentation

probability of a false negative result was 0.37% in adults and 2% in children.

Several studies have attempted to compare the Ottawa and Pittsburgh rules directly. One of these was a multicentre study that prospectively validated these criteria in 934 patients with knee pain who required radiography.¹¹ Pittsburgh criteria were applicable in 745 patients, and findings showed a sensitivity of 99% and a specificity of 60%. Out of 91 fractures, there was 1 missed fracture. In comparison, 750 patients met the Ottawa criteria, which were found to have a sensitivity of 97% and 27% specificity. Three out of eighty-seven fractures were missed. The authors concluded that the Pittsburgh rules are more specific with similar sensitivity in comparison with the Ottawa rules.

In general, the Ottawa rules are better validated across a wider sample of adult patients. Whereas the Pittsburgh rules can be used for all ages, the Ottawa rules were not designed for use in patients under the age of 18 years. In a paediatric population, the Pittsburgh rules have been found to be more sensitive.¹²

Emergency departments and primary care services see a wide range of acute knee presentations regularly. A majority of patients are assessed clinically and referred for specialist review to fracture clinics. Decision rules for ordering radiography in the setting of acute knee injuries may help with reducing workload as well as providing optimum use of available resources.

The aim of this study was to analyse the use of the Ottawa and Pittsburgh knee injury rules for the radiographic assessment of patients referred to our acute knee clinic. The diagnostic accuracy of the Ottawa and Pittsburgh rules was studied in our cohort of patients to establish their usefulness and the need for ordering plain radiography.

Methods

This study was conducted in the acute knee clinic of our hospital, which is a tertiary referral centre for sports knee injuries. Patients requiring urgent specialist review are referred acutely both by the emergency department as well as by primary health care hospitals and district general hospitals. We reviewed all referrals to our acute knee clinic prospectively over a three-month period (October to December 2007). Patients were reviewed and their clinical records

Table 2 Breakdown of findings with ordering knee radiography for various clinical presentations		
	Ottawa rules	Pittsburgh rules
Criteria fulfilled + radiography	72	14
Criteria fulfilled, no radiography	11	2
Criteria not fulfilled + radiography	17	75
Criteria not fulfilled, no radiography	6	15

analysed to establish the indication for ordering plain radiography.

One hundred and thirteen patients were identified; seven patients were excluded from the study due to incomplete notes. Patient records were reviewed to assess whether the Ottawa and Pittsburgh criteria were fulfilled when plain radiography was being ordered. Information regarding further follow-up appointments or further investigations ordered was also collected. The data collected were analysed for diagnostic accuracy (sensitivity, specificity, positive predictive value and negative predictive value) of the Ottawa and Pittsburgh rules.

Results

One hundred and six patients were included in this study, aged between 12 years and 68 years (median: 29 years). The sex distribution was fairly equal with a female-to-male ratio of 1:1.3. The majority of presentations (42%) were in the 20–29 years age group. The most common diagnosis was an undiagnosed knee injury (22%), followed by meniscal (18%) or ligamentous injury (15%). Fractures accounted for only 6% of injuries.

Each patient’s notes were assessed to determine whether the Ottawa and Pittsburgh criteria were fulfilled, and whether radiography was performed (Table 2). More patients fulfilled the Ottawa rules ($n=72$) than the Pittsburgh rules ($n=14$). Eighty-nine patients out of a total of one hundred and six received plain radiography. It also appears that 11 patients did not have radiography despite fulfilling either the Ottawa or Pittsburgh criteria.

Applying the Ottawa rules, 83 patients fulfilled the criteria for plain radiography. Eleven of these did not go on to receive radiography. The most common reason for fulfilling the Ottawa criteria was the presence of limited knee flexion to 90° (58%), followed by patellar tenderness (27%), inability to bear weight (20%), fibular head tenderness (18%) and patient age (13%).

Using the Pittsburgh rules, 16 patients fulfilled the criteria for plain radiography, of whom 2 did not go on to receive radiography. Half the patients (50%) had a fall or blunt trauma as the mechanism of injury (Fig 1). Of these, 19% fell under the age criteria, 19% could not bear weight and 8% met both these criteria.

Figure 2 Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the Ottawa and Pittsburgh knee injury rules

Six patients from the study group were diagnosed with a fracture. All six fulfilled both the Ottawa and Pittsburgh rules. All six patients were managed conservatively and made an unremarkable recovery.

One hundred and one plain radiographs (95%) were ordered at acute presentation. In the vast majority of cases, the clinical rationale for ordering plain radiography was not established.

The various parameters of diagnostic accuracy for the Ottawa and Pittsburgh rules are shown in Figure 2. In our study, the Ottawa rules were found to be more sensitive than the Pittsburgh rules whereas the Pittsburgh rules were more specific. Both the Ottawa and Pittsburgh criteria were found to have a relatively low positive predictive value, of 7% and 19% respectively. However, both criteria were found to have negative predictive values close to 100%, thereby demonstrating the value of these decision rules as a test of exclusion when a fracture is suspected.

Using the Ottawa rules for knee radiography, 27 radiographs (25%) could have been avoided without missing a fracture. Using the Pittsburgh rules, 32 radiographs (30%) could have been avoided without missing a fracture.

Following discharge from the acute review, 69 patients went on to have magnetic resonance imaging (MRI), of which 44 had a condition that could be actively treated (meniscus tears, ligament injuries, loose cartilage fragments), usually with surgery.

Discussion

Our study shows that clinicians do not seem to be using any specific criteria for ordering plain radiography when acutely reviewing knee injuries. The Ottawa and Pittsburgh rules can indicate the need for radiography accurately.

Clinical decision rules potentially aid clinicians in ordering radiography in the emergency department, saving time and resources, and preventing unnecessary radiation exposure. In our study, the Ottawa rules were found to be twice as sensitive as the Pittsburgh rules with a detection rate of 100%. However, the Pittsburgh rules were more specific (87% vs 23%). If the Ottawa rules were followed exclusively, 17 radiographs could have been avoided, with no missed fractures. Similarly, using the Pittsburgh criteria, 72 radiographs could have been avoided.

Both the Ottawa and Pittsburgh criteria were found to have a relatively low positive predictive value, of 7% and 19% respectively. However, both criteria were found to have negative predictive values close to 100%, thereby demonstrating the value of these decision rules as a test of exclusion when a fracture is suspected.

The Ottawa and Pittsburgh rules used different definitions for the inability to bear weight. The Pittsburgh criteria were more stringent, requiring patients to take four full steps, applying weight to both the heel and toe pads. The Ottawa criteria, however, state that any weight transfer is considered bearing weight.

An interesting finding was that out of the six fractures, only two were identified with radiography. The remaining four were confirmed on further investigation using MRI. Following discharge from the acute review, 69 patients went on to further investigation (MRI).

After an acute knee injury, even if a radiograph is normal and a fracture has been excluded, there are still some important treatable injuries that require further investigation for diagnosis. Although expensive, if criteria for selective ordering of ultrasonography or MRI are implemented, many treatable ligamentous and meniscal injuries can be detected. More studies are needed to decide relevant criteria and determine the best way to make them cost effective.

Our study was conducted in a clinical setting and reviewed routine referrals from clinicians treating acute presentations. The grade or seniority of the clinician was not assessed. Furthermore, we did not compare results between doctors and trained practitioners.

Routine ordering of plain radiography is not necessary for all acute knee presentations. Our study suggests that it is possible to use the Ottawa and Pittsburgh rules to help guide the ordering of plain radiography prior to referral to acute knee clinics. Soft tissue injuries of the knee may require investigations such as ultrasonography or MRI. We believe that the key with acute knee injuries is to take a careful history and perform a thorough examination before deciding on the relevant path of investigation and management. It is possible that this approach is not always achievable in 'walk in' clinics or busy emergency departments, where resources and qualified personnel may be lacking. Having a high index of suspicion and referral to appropriate specialist clinics could be the solution to this. Early senior review, perhaps in an acute knee clinic, may be more cost effective.

Conclusions

Decision rules such as the Ottawa or Pittsburgh knee injury rules may be used by clinicians as a guide to ordering plain radiography prior to referral to specialist units.

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