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RATIONAL IMAGING

Investigation of acute knee injury

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This series provides an update on the best use of different imaging methods for common or important clinical presentations. The series advisers are Fergus Gleeson, consultant radiologist, Churchill Hospital, Oxford, and Kamini Patel, consultant radiologist, Homerton University Hospital, London. To suggest a topic for this series, please email us at practice@bmj.com.

Radiography may be inadequate for evaluating the knee injury; other imaging techniques may be needed, especially magnetic resonance imaging

A 24 year old man, who was previously fit and well, presented to the emergency department after a footballing injury to his right knee. He had twisted his knee with his foot planted to the ground. He had felt a "pop" at the time of injury and experienced immediate pain and swelling. Clinical examination showed a swollen knee with tenderness over the fibular head. The patient was unable to flex to more than 90° and unable to weight bear. The results of the Lachman test (modified anterior drawer test) and the McMurray test were considered equivocal, but the degree of pain and swelling made examination difficult.

What is the next investigation?

Acute knee injury in adults is one of the most clinically challenging musculoskeletal disorders that present to emergency departments and general practitioners. A clear imaging rationale is important to avoid unnecessary radiography. Clinicians also need to know when to request further imaging and which modalities are most appropriate.

Initial imaging should be directed at detecting acute knee injuries that need immediate treatment, such as fractures and dislocations. Most soft tissue injuries, including internal derangements of the knee, although potentially disabling, do not usually need emergency treatment.

Radiography

Knee radiography has a low yield for showing fractures. In a retrospective review of 1967 patients with acute knee injuries, 74% of patients had knee radiography, although only 5% of these had fractures.[1] In most cases of internal derangement of the knee, radiographs are of limited value. As a result, several clinical prediction rules for knee fractures have been developed (Ottawa, Pittsburgh, Weber, Fagan-Davies), with the Ottawa rules being the most validated and widely used (box).

Meta-analysis has shown that the Ottawa knee rule accurately excludes fractures in adult patients presenting with an acute knee injury. A negative result on the Ottawa knee rule test is associated with a fracture probability of <1.5%.[3]

A minimum of two radiographs should be obtained in perpendicular anteroposterior and lateral planes. The lateral view is usually obtained with a horizontal beam to assess whether a layering fat-fluid level (lipohaemarthosis) is present, which would indicate an intra-articular fracture.

The radiographic findings associated with injuries of the anterior cruciate ligament are avulsion of the intercondylar tubercle, anterior displacement of the tibia with respect to the femur, and the Segond fracture (small vertical avulsion fracture of the proximal lateral tibia).[4] Avulsion of the fibular head corresponds to injury of the lateral collateral ligament or the biceps femoris tendon, which may be associated with injuries of the anterior cruciate ligament. Fractures of the posterior tibia may be the result of avulsion of the posterior cruciate ligament.

Further imaging studies

- When no fracture is evident on the radiograph, the further management will depend on the physical examination and on local policy:
  - If the physical examination suggests internal derangement, then further assessment is needed. In many institutions referral to an orthopaedic surgeon for magnetic resonance imaging (MRI) is the preferred course, rather than performing MRI directly
  - If the physical examination does not suggest internal derangement, conservative treatment is indicated. If symptoms persist for three to six weeks after injury, orthopaedic referral and MRI may be needed
  - If extensor mechanism injury is suspected, ultrasound scanning may be used to confirm the diagnosis.
- When a fracture is seen on the radiograph further evaluation will depend on the nature of the injury:
  - Avulsion fractures, such as those of the tibial spine, fibular head, or lateral capsule (Segond fractures), are invariably indicators of significant internal derangement, and MRI is indicated
  - Intra-articular femoral or tibial condylar fractures may need internal fixation and computed tomography is often indicated to evaluate the configuration and extent of the fracture.

LEARNING POINTS

Plain radiographs often show no fractures after acute knee injuries; even serious internal derangements of the knee may be occult on radiographs

The Ottawa rule is recommended for deciding whether to do radiography after knee injuries

Magnetic resonance imaging is the technique of choice for evaluating internal derangement of the knee

Computed tomography has an important role in evaluating fractures shown on radiographs, and for delineating fractures before surgery

The Ottawa clinical prediction rules for knee fractures[2]

The Ottawa rules recommend plain radiography if any of the following features are present in a patient:

- Age over 55 years (because of the risk of osteoporosis)
- Tenderness over the fibular head
- Discomfort confined to the patella upon palpation
- Inability to flex the knee to 90°
- Inability to bear weight, immediately and in the emergency department, for at least four steps

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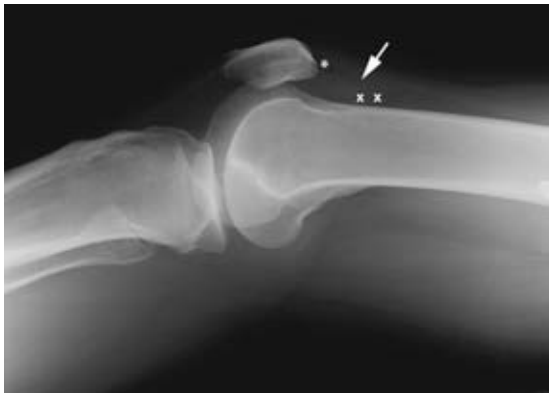

Fig 1 | Lateral radiograph showing an effusion in the suprapatellar pouch (arrow), with widening of the space between the prefemoral fat ("x x") and the suprapatellar fat pad (*)

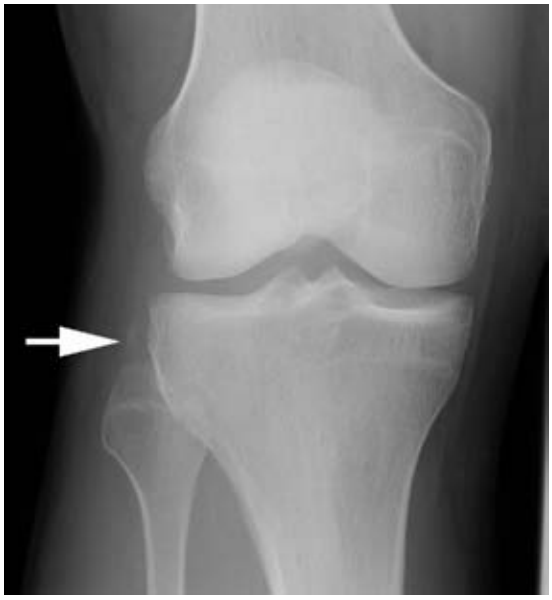

Fig 2 | Anteroposterior radiograph showing a small vertical fracture (arrow) from the lateral tibial condyle (Segond fracture), which indicates a lateral capsular avulsion and is highly indicative of rupture of the anterior cruciate ligament

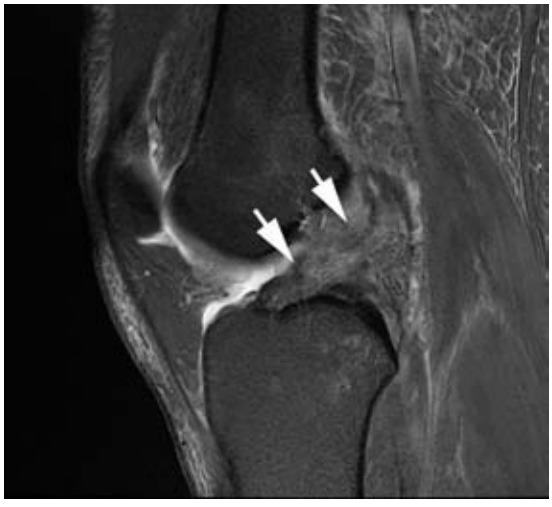

Fig 3 | Sagittal proton density, fat saturated sequence showing altered signal and blurring of the anterior cruciate ligament with loss of continuity of fibres, in keeping with an acute rupture (arrows)

Computed tomography

Computed tomography with multiplanar and three dimensional reformats is a rapid and effective tool for evaluating suspected knee fractures and for assessing complex fractures, particularly of the tibial plateau.[5] In the acute setting, computed tomography offers 80% sensitivity and 98% specificity for depicting osseous avulsions,[6] but the soft tissue resolution is poor compared with MRI. The role of computed tomography is therefore mainly confined to evaluating osseous injury. In one study, computed tomography enabled evaluation of the severity of tibial plateau fractures more accurately than radiography in 43% of cases and modified the surgical plan in 59% of cases.[7]

Magnetic resonance imaging

Magnetic resonance imaging, with its lack of ionising radiation, excellent soft tissue resolution, and multiplanar capability, is recognised as the technique of choice for evaluating traumatic internal derangements. The sensitivity of MRI is 75% to 87% for detecting meniscal tears and around 95% for cruciate ligament tears. The overall summary estimate of specificity is around 93%, indicating that patients without knee damage usually have a normal MRI scan.[8 9]

MRI has greatly influenced the diagnosis and management of acute knee injuries. Mackenzie and colleagues evaluated orthopaedic diagnoses before and after MRI in 332 patients.[10] Before imaging, clinicians were asked to indicate their clinical diagnosis, level of confidence, and their management proposal. For meniscal tears, 57 of 113 pre-imaging diagnoses were no longer considered after imaging, resulting in a change in management for 62% of patients. The proportion of patients for whom arthroscopy was being considered also changed considerably, with only 38% proceeding to arthroscopy after imaging.

Ultrasonography

Ultrasonography is not used routinely for acute knee injury but may have a role in the detection of knee effusions and the assessment of the integrity of the extensor mechanism. In the context of acute trauma, a joint effusion may be highly indicative of internal derangement. In patients with haemarthrosis without bony abnormality, ultrasonography has been shown to be highly accurate in the diagnosis of rupture of the anterior cruciate ligament (sensitivity 91%, specificity 100%).[11] The presence of a lipohaemarthrosis on an ultrasound scan strongly suggests an intra-articular fracture.

Outcome

The patient was unable to weight bear or flex his knee more than 90° and therefore had plain radiography, which showed an effusion with a Segond fracture (figs 1 and 2). Magnetic resonance imaging was requested in view of the Segond fracture seen on radiographs. MRI confirmed an acute rupture of the anterior cruciate ligament and also showed a lateral meniscal tear; there was no posterolateral corner injury (figure 3). The patient had an initial period of conservative management and an elective reconstruction of the anterior cruciate ligament.

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GUIDELINES

Management of an acute painful sickle cell episode in hospital: summary of NICE guidance

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This is one of a series of *BMJ* summaries of new guidelines based on the best available evidence; they highlight important recommendations for clinical practice, especially where uncertainty or controversy exists.

Further information about the guidance, a list of members of the guideline development group, and the supporting evidence statements are in the full version on bmj.com.

Sickle cell disease comprises a group of lifelong, inherited conditions of haemoglobin formation. Although the sickle gene is found in all ethnic groups, most people affected with sickle cell disease are of African or African-Caribbean origin. In the United Kingdom 12 500 to 15 000 people have sickle cell disease,[1] and its prevalence is increasing because of immigration into the UK, new births, and diagnostic screening programmes.[2] Acute painful sickle cell episodes (vaso-occlusive episodes) occur as a result of changes in the red blood cells that may cause tissue ischaemia and pain. These painful episodes may be triggered by factors or conditions such as dehydration, fever, or hypoxia, but can occur unpredictably, with variable intensity and frequency, and at times the pain can be excruciating. Although most episodes can be successfully managed at home, patients with uncontrolled pain may need to seek hospital care. However, the management of such episodes in hospital is thought to vary throughout the UK, and common problems include unacceptable delays in receiving analgesia, insufficient or excessive doses, inappropriate analgesia, and stigmatising the patient as drug seeking.[3 4] This article summarises the most recent recommendations from the National Institute for Health and Clinical Excellence (NICE) on the management of an acute painful sickle cell episode in hospital.[5]

Recommendations

NICE recommendations are based on systematic reviews of best available evidence and explicit consideration of cost effectiveness. When minimal evidence is available, recommendations are based on the Guideline Development Group's experience and opinion of what constitutes good practice. Evidence levels for the recommendations are in the full version of this article on bmj.com.

Individualised assessment of all patients with sickle cell disease presenting with acute pain

- Treat the episode as an acute medical emergency. Follow locally agreed protocols for managing an acute painful sickle cell episode and/or an acute medical emergency that are consistent with this guideline.
- Throughout the episode, regard patients (and/or their carers) as experts in their condition, listen to their views, and discuss with them the planned treatment regimen for the episode; treatment received during previous episodes; any concerns they may have about the current episode; any psychological and/or social support they may need.
- Assess pain and use an age appropriate pain scoring tool.
- Offer analgesia within 30 minutes of presentation (see next section too).
- Clinically assess all patients, including monitoring of blood pressure; pulse rate; respiratory rate, oxygen saturation on air (if oxygen saturation is ≤95%, offer oxygen therapy); temperature.
- Assess all patients with sickle cell disease who present with acute pain to determine whether their pain is being caused by an acute painful sickle cell episode or whether an alternative diagnosis is possible, particularly if pain is reported as atypical by the patient.

Primary analgesia

- When offering analgesia, ask about and take into account any analgesia taken by the patient for the current episode before presentation; ensure that the drug, dose, and administration route are suitable for the severity of the pain and the age of the patient; refer to the patient's individual care plan if available.
- Offer a bolus dose of a strong opioid by a suitable administration route, in accordance with locally agreed protocols for acute painful sickle cell episodes, to all patients presenting with severe pain and to all patients presenting with moderate pain who have already had some analgesia before presentation.
- Consider a weak opioid as an alternative to a strong opioid for patients presenting with moderate pain who have not yet had any analgesia.
- Offer all patients regular paracetamol and non-steroidal anti-inflammatory drugs by a suitable administration route, in addition to an opioid, unless contraindicated.[6]

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- Longer term management of self harm: summary of NICE guidance (*BMJ* 2011;343:d7073)

- Do not offer pethidine to treat pain in an acute painful sickle cell episode. [*Based on the experience and opinion of the GDG*]

Reassessment and continued management of pain

- Assess the effectiveness of pain relief:
  - Every 30 minutes until satisfactory pain relief has been achieved, and at least every four hours thereafter
  - Using an age appropriate pain scoring tool, and
  - By asking questions such as "How well did that last painkiller work?" and "Do you feel that you need more pain relief?"
- If the patient has severe pain on reassessment, offer a second bolus dose of a strong opioid (or a first bolus dose if they have not yet received a strong opioid).
- Consider patient controlled analgesia if repeated bolus doses of a strong opioid are needed within two hours. Ensure that patient controlled analgesia is used in accordance with locally agreed protocols for acute painful sickle cell episodes.
- Offer all patients who are taking an opioid laxatives on a regular basis; antiemetics as needed; antipruritics as needed.
- Monitor patients taking strong opioids for adverse events, and carry out a clinical assessment (including sedation score) every hour for the first six hours and at least every four hours thereafter.
- If the patient does not respond to standard treatment for an acute painful sickle cell episode, reassess him or her for a possible alternative diagnosis.
- As the acute painful sickle cell episode resolves, follow locally agreed protocols for acute painful sickle cell episodes to step down drug treatment, in consultation with the patient.

Possible acute complications

- Be aware of the possibility of acute chest syndrome (the presence of a new pulmonary infiltrate in combination with clinical signs and symptoms)[7 8] in patients with an acute painful sickle cell episode if any of the following are present at any time from presentation to discharge:
  - Abnormal respiratory signs and/or symptoms
  - Chest pain
  - Fever
  - Signs and symptoms of hypoxia (oxygen saturation ≤95% or an escalating oxygen requirement).
- Be aware of other possible complications seen with an acute painful sickle cell episode, at any time from presentation to discharge, including acute stroke; aplastic crisis; infections; osteomyelitis; splenic sequestration.

Management of underlying disease

- Do not use corticosteroids in the management of an uncomplicated, acute painful sickle cell episode as there may be a risk of long term toxicity and there is little evidence of benefit outweighing possible harm.

Non-drug interventions

- Encourage patients to use their own coping mechanisms (for example, relaxation techniques) for dealing with acute pain.

Settings and training

- All healthcare professionals who care for patients with an acute painful sickle cell episode should receive regular training on pain monitoring and relief; identification of potential acute complications; and attitudes towards and preconceptions about patients presenting with such episodes.
- Where available, use daycare settings in which staff have specialist knowledge and training for the initial assessment and treatment of patients presenting with an acute painful sickle cell episode.
- All healthcare professionals in emergency departments who care for patients with an acute painful sickle cell episode should have access to locally agreed protocols and specialist support from designated centres.
- Patients should be cared for in an age appropriate setting.
- For pregnant women with an acute painful sickle cell episode, seek advice from the obstetrics team and refer when indicated.

Discharge information

- Before discharge, provide patients (and/or their carers) with information on how to continue to manage the current episode, including how to obtain specialist support; how to obtain additional medication; and how to manage any potential side effects of the treatment they have received in hospital.

Overcoming barriers

The main aim of this short clinical guideline is to ensure that all patients who present to hospital with an acute painful sickle cell episode are offered appropriate, safe, and prompt pain management. Although healthcare professionals may be cautious in their use of strong opioids, we recommend that this is the primary analgesia for patients presenting with severe pain and those with moderate pain who have already received analgesia. Patients presenting to hospital with an acute painful episode should initially have their pain monitored every 30 minutes until the pain is under control. Although this may be considered time consuming, this extent of observation is imperative to identify any complications that can arise.

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