CQ HAND + UPPER LIMB
SPECIALIST ORTHOPAEDIC SURGEON

EVIDENCE SUMMARY

Septic arthritis of the knee

Overview

- Knee arthrodesis is usually the last option available to the surgeon to obtain a painless, stable knee when the knee is not amenable to reconstruction [4].
- Successful fusion is achieved in more than 90% of patients [4].
- Septic arthritis is a less common indication for knee arthrodesis [4].
- The most common indication for knee arthrodesis is the nonreconstructable TKA that has failed, usually because of infection and loss of the extensor mechanism [4].
- Bilateral knee involvement is a contraindication for knee arthrodesis [4].
- Ipsilateral hip arthrodesis is a contraindication for knee arthrodesis [4].
- External fixation, plates, intramedullary rods, and combined modalities are used in knee arthrodesis [4].
- If the limb-length discrepancy is less than 2 cm, the knee is placed in 5° to 7° of valgus and 15° of flexion [4].
- If the limb-length discrepancy is 2 to 4 cm, the knee is placed in extension to enable ground clearance [4].
- If the limb-length discrepancy is greater than 4 cm, bone grafting or a prosthetic spacer to limit gait abnormalities can be considered [4].
- Painful nonunion is the most common complication of knee arthrodesis [4].
- Infection is a complication of knee arthrodesis [4].
- Deep vein thrombosis is a complication of knee arthrodesis [4].
- Peroneal nerve palsy is a complication of knee arthrodesis [4].
- Wound dehiscence is a complication of knee arthrodesis [4].
- Long-term complications of knee arthrodesis include hip, spine, and ankle pain because of the altered gait pattern [4].

CQ HAND + UPPER LIMB
Dr Kieran Hirpara — Specialist Orthopaedic Surgeon
Suite 2, Level 1, Mater Private Hospital Rockhampton, 31 Ward Street, The Range, QLD 4700
Phone 07 4863 6556 · office@cqupperlimb.com.au · cqupperlimb.com.au

Anatomy & Pathophysiology

BONY ANATOMY

- The bones of the knee are the distal femur, the proximal tibia, and the patella [1].
- The medial femoral condyle is larger and projects farther posteriorly and distally than the lateral condyle [6].
- The lateral femoral condyle projects farther anteriorly and is wider in the medial-lateral direction than the medial femoral condyle [6].
- The tibial articular surface slopes 7° to 10° in the sagittal plane [6].
- The medial tibial plateau is larger than the lateral plateau and is concave in its frontal and sagittal planes [6].
- The lateral tibial plateau is smaller and more circular than the medial plateau, concave in the frontal plane and convex in the sagittal plane [6].
- The patella is the largest sesamoid bone in the body, averaging 2.5 cm in thickness [6].
- The patellar articular surface contains a vertical, central ridge that separates the broader lateral facet from the medial facet, and a smaller, more medial facet called the odd facet [6].
- The posterior slope of the medial tibial plateau is a mean of 10.7° and the lateral plateau is a mean of 7.2° [11].
- The fibular head is located a mean of 1.5 cm distal to the joint line, with a range of 6 to 32 mm [11].

LIGAMENTS

- The anterior cruciate ligament (ACL) prevents anterior translation and rotation of the tibia on the femur [1].
- The posterior cruciate ligament (PCL) prevents posterior subluxation of the tibia on the femur [1].
- The medial collateral ligament stabilizes the knee to valgus stresses [1].
- The lateral collateral ligament is the main stabilizer against varus stress [1].
- The ACL is composed of 90% type I collagen and 10% type III collagen [6].
- The mean length of the ACL is 33 mm and the mean midsubstance width is 11 mm [6].
- The femoral attachment of the ACL is a semicircular area on the posteromedial aspect of the lateral femoral condyle [6].
- The tibial attachment of the ACL is a broad, irregular, oval-shaped area slightly medial and anterior to the midline between the tibial spinous processes [6].
- The PCL is the largest of the intra-articular ligaments, with an average length of 38 mm and a mean diameter at the midpoint of 13 mm [19].
- The PCL has two distinct bundles: an anterolateral (AL) bundle comprising 85% of the cross-sectional area and a posteromedial (PM) bundle [19].

- The PCL inserts onto a midline depression on the tibia, 10 to 15 mm below the level of the tibial plateaus [19].
- The meniscofemoral ligaments are present in at least one form in 93% of knees [19].
- The medial meniscus is firmly attached to the joint capsule along its entire peripheral edge [1].
- The lateral meniscus is attached to the anterior and posterior capsule but has a region posterolaterally where it is not firmly attached [1].
- The medial meniscus has less mobility than the lateral meniscus and is more susceptible to tearing when trapped between the femoral condyle and tibial plateau [1].
- The lateral meniscus is larger than the medial meniscus and carries a greater share of the lateral compartment pressure [1].

MENISCI

- The menisci are C-shaped fibrocartilaginous disks that provide shock absorption, increase joint congruency, enhance stability, and aid in synovial fluid distribution [1].
- The menisci provide a concave surface for the convex femoral condyles to articulate with [1].
- Absence of menisci decreases the surface area of contact and increases pressure on the articular cartilage, which may lead to rapid deterioration of the joint surface [1].
- Menisci consist of type I collagen fibers arranged obliquely, radially, and vertically [11].
- Vascular supply to the menisci is derived from geniculate arteries, penetrating 20% to 30% of the peripheral medial meniscus and 10% to 25% of the peripheral lateral meniscus [11].

VASCULAR AND NERVE ANATOMY

- The blood supply to the knee is formed from an anastomosis including the descending geniculate artery, superior and inferior geniculate arteries, middle geniculate artery, and anterior tibial recurrent arteries [6].
- The middle geniculate artery supplies both the anterior and posterior cruciate ligaments [6].
- The knee is innervated by branches of the femoral nerve (L2, L3, L4), obturator nerve (L2, L3, L4), and sciatic nerve (L4, L5, S1, S2) [6].
- The posterior articular branch of the tibial nerve is the largest nerve providing innervation to the intra-articular knee [6].
- The popliteus artery travels through the adductor hiatus where it is relatively immobile and distally through the fibrous arch deep to the soleus muscle [16].
- The common peroneal nerve travels along the posterior edge of the biceps femoris and continues distally around the fibular neck [16].

SYNOVIAL ANATOMY

- The knee joint forms embryologically from three synovial compartments that normally fuse into a single synovial cavity [18].

- Synovial plicae represent unresolved remnants of these partitions, including suprapatellar, infrapatellar, medial patellar, and lateral patellar plicae [18].
- The medial patellar plica has an incidence ranging from 10% to more than 50% in normal knees [18].
- A median septum may separate the posterior aspect of the knee into two compartments, with the PCL projecting anteriorly in the septum [21].

KINEMATICS

- The knee is a hinge joint that incorporates both gliding and rolling motions [7].
- The "screw-home" mechanism involves tibial external rotation of 5 degrees in the final 15 degrees of extension [7].
- The greatest range of motion occurs in the sagittal plane, approximately 160° [23].
- Knee rotation ranges from 45° in external rotation to 30° in internal rotation [23].
- In the frontal plane, the range of motion in both abduction and adduction reaches a maximum of 10° [23].
- During walking, knee range of motion in the sagittal, frontal, and transverse planes reaches approximately 70°, 15°, and 10°, respectively [23].
- The normal instant center of the knee joint follows a semicircular path related to the tibiofemoral surface and ligaments [23].
- Rupture of cruciate ligaments or disruption of the tibiofemoral surface causes a major change in the path of the instant center, leading to articular dysfunction [23].
- The screw home mechanism occurs as the knee slightly hyperextends with slight tibial external rotation, tightening collateral and cruciate ligaments to lock the knee in extension [24].
- Flexion is initiated by the popliteus muscle pulling the lateral femoral condyle backward while the medial femoral condyle slides forward, resulting in tibial internal rotation [24].

Clinical Presentation

HISTORY

- A detailed history for knee pain diagnosis includes onset, quality, duration, tempo, and location of symptoms [33].
- The history should include modifying factors, ability to bear weight, and history of trauma [33].
- Key historical information includes current medications, history of injury or prior surgery, instability, and mechanical symptoms [34].
- The history should document medical comorbidities, location of pain (unicompartmental or global), and response to previous treatments [34].
- Symptom duration, temporal nature of pain, swelling, and distance able to ambulate are key historical elements [34].

- The specific type of intra-articular knee injection used and the patient's response, including length of pain relief and magnitude of improvement, should be noted [34].
- Patients who do not have temporary relief from an intra-articular injection should be evaluated for other pathology external to the knee joint [34].
- Overweight patients should be asked about recent weight gain or loss and current weight-maintenance strategy [34].
- Comorbidities such as renal or peptic ulcer disease may preclude oral anti-inflammatory medication use [34].
- Social factors such as occupation or residence in a nursing home can affect the treatment strategy [34].

PHYSICAL EXAMINATION

- A detailed physical examination of the knee includes inspection, palpation, gait assessment, range of motion testing, stability testing, neurovascular assessment, hip examination, and special tests [33].
- Inspection of the knee can reveal skin abnormalities, evidence of trauma, malalignment, and swelling [33].
- Inspection of the patient's gait may reveal abnormalities that suggest either intra-articular or extra-articular causes [33].
- Palpation of the knee with a focus on points of tenderness can alert the clinician to focal pathologies such as joint line tenderness, patellar tendon tenderness, or pes anserine bursa tenderness [33].
- Palpation of the peripatellar tissue can reveal the presence of effusion and/or synovitis [33].
- Overall knee alignment (varus, valgus, or neutral) should be assessed in both supine and standing positions, as bearing weight may change alignment dynamically [33].
- Range of motion testing is divided into active range of motion (patient's ability to move the knee) and passive range of motion (examiner's ability to move the knee) [33].
- Flexion contractures and hyperextension should be noted during range of motion testing [33].
- Blocks to motion can be pain-related or mechanical, and differences between active and passive ranges of motion require differentiation between pain-related, mechanical, or neuromuscular causes [33].
- Hip range of motion should be examined because it may reveal resultant knee pain indicating referred pain from intra-articular hip pathology [33].
- Stability testing of the knee can reveal ligamentous competency or deficiency [33].
- Basic varus and valgus stability testing should be performed at 0° and 30° of flexion [33].
- Firm end points indicate ligament competence, while pronounced laxity can indicate ligament deficiency [33].
- Testing at 30° of flexion isolates the MCL and LCL best, as testing in full extension also engages some secondary stabilizers [33].
- ACL competence can be tested using the Lachman test, which involves flexing the knee to 30°, holding the femur firmly, and translating the tibia anteriorly on the femur [33].
- A positive Lachman test is indicated by no firm end point and significant translation [33].

- PCL competence can be tested using the posterior drawer test, which involves flexing the knee to 90° with the patient supine, stabilizing the distal tibia, and translating the tibia posteriorly on the femur [33].
- A positive posterior drawer test is indicated by no firm end point and significant translation [33].
- Patellar maltracking can be assessed using the J-sign, which involves bringing the knee from full extension into flexion to observe a visible patellar shift from lateral to medial in a J-shaped path [33].
- Lateral meniscus tears can be assessed using the McMurray test, which involves flexing the knee, internally rotating the tibia, extending the knee, and applying pressure to the lateral joint line [33].
- Medial meniscus tears can be assessed using the McMurray test, which involves flexing the knee, externally rotating the tibia, extending the knee, and applying pressure to the medial joint line [33].
- A positive McMurray test is indicated by pain or click with the maneuver [33].
- PLC deficiency can be assessed using the dial test, which involves placing the patient prone with the knee flexed to 30° and externally rotating both tibiae [33].
- PLC plus PCL deficiency can be assessed using the dial test, which involves placing the patient prone with the knee flexed to 90° and externally rotating both tibiae [33].
- A positive dial test is indicated by greater than 10° difference from the contralateral side [33].
- The patient's gait, lower body alignment, range of motion, and ligamentous stability should be assessed and documented [34].
- Catching or locking, instability in the coronal and/or sagittal plane, or an effusion can signal the presence of a mechanical pathology warranting surgical treatment [34].
- The lumbar spine and hips should be examined because pathology in one of these locations can present as referred pain to the knee [34].
- The lower extremities should be examined for evidence of muscular atrophy or weakness, with particular attention to hip abductor and quadriceps strength [34].
- Distal sensation and vascular perfusion (peripheral pulses) should be assessed in all patients, and any abnormalities should be documented [34].
- Key physical examination findings include previous incisions, effusion, range of motion, joint line tenderness, ipsilateral hip examination, lower extremity strength (quadriceps, gluteus), peripheral pulses and sensation, alignment (varus/valgus/neutral, and if deformity, rigid or flexible), and gait [34].
- Hip osteoarthritis can refer to the knee via the obturator nerve [34].

IMAGING

- Baseline weight-bearing radiographs of the knee should be obtained in all patients with symptomatic osteoarthritis of the knee [34].
- A standing PA view obtained with the patient's knee in 45° of flexion is often preferred over the standard standing AP view [34].
- The 45° flexion view allows better evaluation of the posterior femoral condyles and earlier detection of subtle joint-space loss than the AP view [34].

- Additional radiographs should include a lateral view of the affected side and a Merchant or sunrise view of the patellofemoral joint [34].

Investigations

PLAIN RADIOGRAPHY

- Plain radiographs are appropriate initial imaging studies for most knee conditions because they allow the assessment of traumatic injury, arthritis, patellofemoral alignment, osteochondral injury, bone neoplasm, and surgical implants [3].
- Radiographic studies help confirm the clinical diagnosis of a joint disorder determined using the patient's history and physical examination [3].
- Imaging studies should include at least two perpendicular views: AP and lateral [3].
- Weight-bearing AP (extension) views are used to assess cartilage loss from the distal femur and tibial plateau [3].
- Weight-bearing PA (Rosenberg; flexion) views are used to assess cartilage loss from the posterior femur and tibial plateau [3].
- Patellofemoral views are used to assess patellofemoral alignment (tilt/subluxation), patellar and trochlear morphology, osteochondral injury, and patellofemoral arthritis [3].
- A notch view is used to assess posterior femoral cartilage, notch width, and osteophytes [3].
- Radiography may identify subchondral sclerosis, joint space narrowing, subchondral cysts (variable), osteophytes (variable), and joint subluxation in osteoarthritis [3].
- Radiography may identify joint space loss and peripheral bone erosion in inflammatory arthropathy [3].
- Radiography may identify subchondral radiolucency in osteochondral defects, which is most common in the medial femoral condyle [3].
- Radiography may identify linear radiolucency or radiodensity in stress fractures, which are most common in the proximal medial tibia [3].
- Radiography may identify a mixed sclerotic pattern with a subchondral, epiphyseal, or metaphyseal location in osteonecrosis [3].
- Radiography may identify malalignment, osteophytes, cysts, and joint space loss in patellofemoral disease [3].
- Non–weight-bearing radiographs may identify acute injury without the risk of fracture displacement in trauma [3].
- Lateral capsular avulsion (meniscotibial ligament) is pathognomonic but not essential for ACL injury, and hemarthrosis is frequently present [3].
- Avulsion of the medial femoral epicondyle (Pellegrini-Stieda lesion) may appear within a few weeks of proximal MCL avulsion injury [3].

- Supine AP knee radiographs are most frequently used but do not adequately estimate the joint space width needed to estimate the degree of osteoarthritis progression [29].
- Plain frontal radiographs of the knee may not accurately display the actual joint space due to different cartilage wear patterns, meniscal integrity, or variances in tibial slopes [29].
- A 45° standing flexion view was introduced by Rosenberg et al. to better evaluate joint space [29].
- A fixed flexion view (FFV) technique has been introduced with improved reproducibility and good evaluation of the joint space [29].
- The Lyon Schuss view (LSV) uses the same posture as the FFV but requires fluoroscopic adjustment of the irradiation angle relative to the medial tibial plateau, which is more accurate for measuring actual joint space width [29].
- The radiation exposure dose for the Lyon Schuss view is higher and positioning is more complex and time-consuming than for the FFV [29].
- Goniometer readings of long limb alignment or measured on an FFV correlated well with the angle measured on long limb radiographs, providing an alternative imaging source if long limb radiographs are not available [29].
- Radiographs are still the standard for initial evaluation of knee pain [25].
- Images for initial evaluation should include weight-bearing AP and lateral views, a view of the weight-bearing knee flexed at 45-degree angle imaged posterior to anterior, a sunrise view (Merchant view), extension and flexion lateral views, and a standing full-length AP radiograph [25].
- A standing full-length AP radiograph from hip joint to ankle joint is used to evaluate limb alignment and knee deformity and to identify femoral and/or tibial bone deformity [25].
- The Kellgren-Lawrence (KL) rating grades extent of OA based on review of AP knee radiograph [25].
- Primary features used for KL rating include osteophytes (periarticular and tibial spine), joint space narrowing, subchondral sclerosis with or without subchondral cysts, and altered shape of periarticular bones [25].
- KL Grade 0 indicates normal knee features with no OA [25].
- KL Grade 1 indicates OA possibly present [25].
- KL Grade 2 indicates OA present with minimal severity [25].
- KL Grade 3 indicates OA present with moderate severity [25].
- KL Grade 4 indicates OA present with severe severity [25].
- Knee arthroplasty is recommended when Grade 4 findings are present [25].

COMPUTED TOMOGRAPHY

- Computed tomography is a three-dimensional study performed with ionizing radiation that provides enhanced bone detail [3].
- Imaging in the axial, sagittal, and coronal planes may help visualize fracture lines and displacement, osteolytic lesions around joint arthroplasty, and cortical disruption in cases of infection or neoplasia [3].

- Three-dimensional reconstructions may help with preoperative planning for complex intra-articular fractures, multiplanar osteotomy for limb malalignment, and reconstitution of bone loss in joint arthroplasty [3].
- Axial plane imaging of the hip and knee can help assess the rotational alignment of components of a total knee arthroplasty in cases of patellar maltracking [3].
- Three-dimensional CT with remodeling is used for preoperative planning for reconstruction associated with dysplasia, post-trauma planning, and complex total knee arthroplasty (TKA) planning [25].

MAGNETIC RESONANCE IMAGING

- Increasing strength of the magnetic field (measured in Tesla units) increases the resolution of images [3].
- An injected contrast agent (intravenous or intra-articular) may help delineate specific tissues of interest [3].
- MRI may suggest cruciate ligament injury through the presence of edema, intra-articular fluid, disruption of ligament fibers, and an atypical ligament contour [3].
- MRI can identify patterns of meniscal injury by location (anterior, midbody, posterior, peripheral, articular), pattern (horizontal, longitudinal, radial, complex), and displacement [3].
- MRI may identify the degree of articular cartilage injury (chondrosis, full-thickness cartilage loss), the presence of associated bone marrow edema, and the location (medial condyle, lateral condyle, trochlea, patella; anterior, posterior) [3].
- MRI may identify edema, avulsion, or discontinuity for the MCL/lateral collateral ligament (LCL) or associated posteromedial and posterolateral ligamentous complexes [3].
- MRI may be used to assess the continuity of the quadriceps or patellar tendon [3].
- MRI may be used to assess the margin of resection for a neoplasm, identify vascular malformation, or define the location of nerves or vessels relative to popliteal cysts [3].
- MRI is the most useful study for differentiating osteonecrosis from other conditions [31].
- Bone edema on MRI is a common feature of OA, osteonecrosis, cartilage injury, and transient regional osteoporosis [31].
- Serpentine lesions within a well-demarcated border is a specific finding on MRI for osteonecrosis [31].
- MRI is grossly overused in the arthritic patient population [25].
- If the joint space is significantly narrowed on radiograph, then MRI is not indicated [25].
- MRI is used when osteonecrosis is suspected [25].
- Radiographic evaluations are essential when diagnosing an OCD lesion of the knee and elbow; however, important aspects of the OCD lesions may be better seen with MRI [28].
- A systematic review quantified the accuracy of MRI for detection of meniscal injury and ACL tear [22].
- Compositional MRI techniques (T1ρ, T2*, dGEMRIC, gagCEST) are used for early recognition of cartilage degeneration [22].

NUCLEAR MEDICINE

- Nuclear medicine involves labeled radionuclide injection followed by delayed imaging of gamma radiation [3].
- Areas of increased radionuclide concentration appear bright or "hot" [3].
- Nuclear medicine provides a nonspecific study that does not define the etiology of an abnormality but rather the presence of an abnormality that may correlate with a clinical concern [3].
- Increased radionuclide activity in bone may be a normal postoperative finding for up to 6 to 12 months after a fracture repair or arthroplasty [3].
- Technetium-99 (Tc-99) is a radionuclide that may help identify infection, neoplasia, occult fracture, bone healing, active phases of heterotopic ossification, implant loosening, or failure of osseointegration [3].
- Gallium-67 (Ga-67) is a radionuclide that may help differentiate between aseptic and septic prosthetic loosening; 24 to 72 hours are needed for a complete study [3].

PHYSICAL EXAMINATION

- The physical examination begins with observation of the patient's gait [1].
- The uninjured knee is examined as a basis of comparison with the injured knee [1].
- Any swelling or effusion should be noted during physical examination [1].
- A small effusion will cause obliteration of the recesses on the medial and lateral aspects of the patellar tendon [1].
- With a larger effusion, diffuse swelling is present in the region of the suprapatellar pouch [1].
- A fluid wave can be palpated on the sides of the patella [1].
- Active and then passive range of motion is tested carefully [1].
- The knee is palpated to define areas of localized tenderness [1].
- The joint lines are located at the level of the inferior pole of the patella when the knee is flexed to 90 degrees [1].
- Patient assessment of knee pain includes a physical examination and diagnostic radiographic modalities [25].
- Pain with weight bearing is aggravated by stairs, inclines, and transition from sit to stand [25].
- Bowing deformity and instability are seen later in the clinical presentation of knee pain [25].
- Knee thrust is seen later in the clinical presentation and indicates ligament stretch-out on the convex side of the thrust [25].
- Varus thrust occurs when the knee pushes outward during stance phase of gait, overloading the medial compartment and accelerating cartilage degeneration in the medial compartment [25].
- Valgus thrust occurs when the knee pushes inward during stance phase of gait, overloading the lateral compartment and accelerating cartilage degeneration in the lateral compartment [25].
- Assessment of the joint must combine physical examination along with radiographic (including full-length alignment views) and MRI findings [32].

Treatment

ARTHRODESIS

- The most common indication for knee arthrodesis is the nonreconstructable total knee arthroplasty (TKA) that has failed, usually because of infection and loss of the extensor mechanism [4].
- If the limb-length discrepancy (LLD) is less than 2 cm, the knee is placed in 5° to 7° of valgus and 15° of flexion for arthrodesis [4].
- If the LLD is 2 to 4 cm, the knee is placed in extension to enable ground clearance for arthrodesis [4].
- If the LLD is greater than 4 cm, bone grafting or a prosthetic spacer to limit gait abnormalities can be considered for arthrodesis [4].
- Complications of knee arthrodesis include infection, deep vein thrombosis, peroneal nerve palsy, and wound dehiscence [4].

GENERAL MANAGEMENT PRINCIPLES

- Infection of the knee can be a devastating process, and rapid surgical and antibiotic appropriate care should be facilitated by orthopaedic surgeons [36].
- Rapid and appropriate surgical and antibiotic care should be facilitated by orthopaedic surgeons to prevent further cartilage destruction in cases of knee infection [36].
- Recent or current knee sepsis is an absolute contraindication to total knee arthroplasty (TKA) [5].
- A remote source of ongoing infection is an absolute contraindication to total knee arthroplasty (TKA) [5].

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CQ HAND + UPPER LIMB
Dr Kieran Hirpara — Specialist Orthopaedic Surgeon
Suite 2, Level 1, Mater Private Hospital Rockhampton, 31 Ward Street, The Range, QLD 4700
Phone 07 4863 6556 · office@cqupperlimb.com.au · cqupperlimb.com.au

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CQ HAND + UPPER LIMB
Dr Kieran Hirpara — Specialist Orthopaedic Surgeon
Suite 2, Level 1, Mater Private Hospital Rockhampton, 31 Ward Street, The Range, QLD 4700
Phone 07 4863 6556 · office@cqupperlimb.com.au · cqupperlimb.com.au