Causes and Mechanisms of Failed Total Knee Replacement

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Ideal TKR

• Components ideally aligned in CAS plane
• With the femoral component matched to the tibial in rotation
• With a joint line at the appropriate level
• With balanced soft tissue
  • In flexion and extension
  • Stability
  • Does not restrict movements
• With the patella tracking in the correct plane.
Common Causes of TKR Failure

- Infection
- Instability
- Extensor mechanism problems
- Aseptic / Mechanical loosening
- Osteolysis
- Wear of articular bearing surface
- Peri-prosthetic fracture
- Implant Failure
Symptoms of the failed total knee

- Pain
- Limping
- Painful restriction of daily activities
- Stiffness
- Edema
- Effusion
- Instability
Failed
TKR

- Pain
- Postop stiffness
- Instability
- Infection
Ideally the pain should be largely relieved in most of the cases by 3 months postoperatively.

*Study involving more than 8000 patients reported that 19.8% had persistent pain one year after operation.*

A visual analogue scale (VAS) is helpful in documenting.
PAIN

Intrinsic factors

Infection

Instability
  Mediolateral
  Anteroposterior
  Flexion/extension

Malalignment

Soft-tissue impingement
  Patellar clunk
  Fabellar impingement
  Popliteus impingement
  Component overhang
**Intrinsic factors**

**Arthofibrosis**

**Wear, osteolysis and aseptic loosening**

**Extensor mechanism problems**

- Patellar maltracking
- Extensor mechanism disruption
- Unresurfaced patella
- Undersized patellar button with lateral facet impingement
- Oversized patellar button with overstuffing of patellofemoral joint
- Patella baja + alta

**Recurrent haemarthrosis**
## Extrinsic factors

- Hip pathology
- Neurological
- Vascular - DVT
- Pes anserinus bursitis
- Stress fracture and peri-prosthetic fracture
- Tendinopathy (patellar/quadriceps)
- Heterotopic ossification
- Psychological disorder
- Others
  - Paget’s disease
  - Pigmented villonodular synovitis
  - Rheumatoid arthritis
  - Foot and ankle pathology
Pain - Characteristics

**Pain on weight bearing**
- Improves on sitting.
  - = Mechanical

**Start-up pain**
- Initial weight bearing and improves after several steps.
  - = Instability
- Continued start-up pain is suggestive of loosening of the tibial component.

**Chronic pain in full extension**
- Overstuffed extension space.
Pain - Characteristics

**Pain with full flexion**
- Impingement between posterior femoral osteophyte and tibial component
- Overstuffing of the flexion space.

**Pain associated with stair climbing or descent**
- Dysfunction of the extensor mechanism.
- Patellar maltracking or subluxation

**Rest pain and continuous postoperative pain that never improves**
- Infection or CRPS.
Pain - Characteristics

Early post-operative pain

- Acute Infection
- Instability
- Inadequate balancing of the soft tissues
- Prosthetic malalignment
- Soft-tissue impingement.
Pain - Characteristics

Delayed onset

- Looseing of a component,
- Wear of the polyethylene
- Late Ligamentous instability
- Late haematogenous infection
- Stress fracture.
Neuroma

• Injury of the infrapatellar branch of the saphenous nerve

Complex Regional Pain Syndrome

• Uncommon cause
• Cutaneous hypersensitivity is common,
• Swelling and stiffness
• Radiographs may show localized patchy osteoporosis.

The role of pain and function in determining patient satisfaction after total knee replacement

DATA FROM THE NATIONAL JOINT REGISTRY FOR ENGLAND AND WALES

P. N. Baker, J. H. van der Meulen, J. Lewsey, P. J. Gregg

A postal questionnaire was sent to 10,000 patients more than one year after their total knee replacement (TKR). They were assessed using the Oxford knee score and were asked whether they were satisfied, unsure or unsatisfied with their TKR. The response rate was 87.4% (8,231 of 9,417 eligible questionnaires) and a total of 81.8% (6,625 of 8,095) of patients were satisfied. Multivariable regression modelling showed that patients with higher scores relating to the pain and function elements of the Oxford knee score had a lower level of satisfaction ($p < 0.001$), and that ongoing pain was a stronger predictor of this. Female gender and a primary diagnosis of osteoarthritis were found to be predictors of lower levels of patient satisfaction. Differences in the rate of satisfaction were also observed in relation to age, the American Society of Anesthesiologists grade and the type of prosthesis.

This study has provided data on the Oxford knee score and the expected levels of satisfaction at one year after TKR. The results should act as a benchmark of practice in the United Kingdom and provide a baseline for peer comparison between institutions.
Postoperative Stiffness

Average knee motion required

- Climbing stairs normally $83^\circ$;
- Sitting, $93^\circ$;
- Tying a shoe, $106^\circ$;
- Lifting an object, $117^\circ$.

- ROM of $<90^\circ$
- Pain or functional disability

Stiffness

Lack of extension

- Improper correction of a preoperative flexion deformity with a tight PCL or posterior capsule
- Inadequate resection of the distal femur
- Impingement of posterior osteophytes on the posterior capsule
- Component malposition (e.g., flexed femoral component, too much posterior sloping of the tibial component),
- Overstuffing of the extensor space (e.g., undersized femoral component, thick tibial insert),
Stiffness

Lack of flexion

- Tight PCL
- Lack of tibial posterior slope
- Patella baja
- An overstuffed patellofemoral compartment
- Suprapatellar heterotopic ossification
- Quadriceps contracture and adherence.
Late-onset knee stiffness

- Infection
- Patellar tendinitis
- Synovitis resulting from particulate wear debris
- Loosening or breaking of the implant
- Component failure
- Rheumatoid arthritis.
Stiffness - Other Causes

• Poor pre-operative range of movement,
• Previous knee surgery
• Infection
• CRPS
• Uncontrolled pain > Reduced ROM > Adhesions in the suprapatellar pouch.


Medio - Lateral stability

Varus stress  Neutral  Valgus stress
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<th>Author</th>
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<td>TRAC PS mobile-bearing</td>
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<td>J Arthroplasty. 2000</td>
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<td>Ishii Y</td>
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<td>Matsuda M</td>
<td>LCS PCLR</td>
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<td>LCS PCLS</td>
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<td>Arch Orthop Trauma Surg. 2004</td>
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Instability

- Early post-operative period
  - Uncorrected pre-operative ligamentous imbalance
  - Improper intra-operative ligamentous balancing
  - Mismatch of the flexion-extension gap
  - Iatrogenic injury to the ligaments during surgery
  - Pre-existing neuromuscular pathology

- Late instability
  - Malalignment leading to progressive stretching of ligaments
  - Wear of polyethylene
  - Loosening of the component and collapse

Instability - Characteristics

- **Valgus instability**
  - Incomplete correction of a valgus deformity.

- **Medial-lateral instability**
  - Usually apparent in midflexion.
    - Incorrect placement of the femoral component too anteriorly and proximally,
    - Very thick tibial insert

- **Instability in the AP plane**
  - Generally results in posterior translation of the tibia in flexion
    - Overresection of the posterior femoral condyles,
    - Undersizing of the femoral component.
    - Excessive tibial slope.
Instability - Characteristics

- Patients are symptomatic when
  - going up and down stairs and can have
  - start-up pain and
  - even locking of the knee

- Global instability occurs when the flexion-extension spaces are balanced but a polyethylene insert of insufficient thickness

- Premature loosening, instability, and fractures about a TKA can be associated with a Charcot joint.
Infection

**Acute infection**
- up to 2 months after surgery
- usually presents with swelling, erythema and persistent drainage

**Intermediate infection**
- 2 to 24 months after surgery
- Painful, warm, stiff, swollen, and tender joint.
- Pain typically is not related to activity and can occur at night.

**Late infection**
- More than 2 years after the index arthroplasty.
- Usually is hematogenous seeding associated with a distant infection (urinary tract infection, pneumonia, skin abscess, dental procedure).

Diagnosis: Radiological

- Early Lysis/Lucencies
- Progressive lucent lines
- Lytic area(s)
- Prosthesis position
- Stem movement
- Cortical perforation
Scintigraphy

- Triple phase Technetium 99-m- HDT Scan
- Indium-111 leucocyte Scan
- Technetium Sulphur Colloid Bone Marrow Scan
Triple phase Technetium 99-m-HDT Scan

• Sensitive but not very specific
• First two phases may be positive up to 1 year
• Third phase may persist positive indefinitely
• The characteristic findings with an infected TKR are increased uptake in all three phases of the scan.
• The lack of increased uptake in the first two phases is an important negative finding that would mitigate against the diagnosis of infection.
Indium-111 Leucocyte Scan

- 95% Sensitive
- 100% Negative PV
- Positive Scan - Limited Value
- Negative Scan - Strong Predictor of absence of Infection
Technetium Sulphur Colloid Bone Marrow Scan

- Sulphur Colloid accumulates in RE system
- Hyperplastic Marrow- Positive Indium and SC Scan
- **Infective Focus** - POSITIVE Indium and **NEGATIVE SC Scan**
- **CONGRUENT Scan** - Both Positive-Less likelihood of Infection
- **INCONGRUENT Scan** - 90% chance of Infection
Laboratory Parameters

**ESR** peak 5-7 days after operation, pre-operative levels in 3 months. Studies showed that the ESR can remain elevated for as long as one year.

An **ESR > 30** mm per hour has a sensitivity 82%, specificity of 85% for infection, PP value of 58%, NP value of 95%.

**Moreschini O, Greggi G, Giordano MC, Nocente M, Margheretini F.**
Postoperative physiopathological analysis of inflammatory parameters in patients undergoing hip or knee arthroplasty. 
CRP

level is a better indicator early peak 2-3 days after surgery, usually normal - 3 wks after operation.

CRP value > 10 mg/l

96% sensitivity
92% specificity
74% PPV
99% NPV

for infection

ESR and CRP together

Sensitivity 0.95
NPV 0.97

Interleukin 6 (IL-6)

elevated (> 10 pg/mL )
peri-prosthetic infection, higher predictive value

Interleukin-6 levels
peak - first 6 to 12 hours
baseline- 48 to 72 hours.

A combination of CRP and IL-6 has recently been shown to provide excellent sensitivity in the assessment of infection after TKR.

Infection

- Aspiration
  - Smear
  - Gram’s Stain
  - Culture

- Synovial Biopsy
Aseptic / Mechanical Loosening

- Incomplete cementation
- Poor component alignment
- Inadequate ligamentous balancing
- Osteolysis and wear
- Rheumatoid arthritis
- TKR with Neurological Disorders
Aseptic/Mechanical Loosening

Patellar loosening

- Incorrect resection of patella
- Lateralization of the patellar component
- Patellar maltracking
- Malposition of the femoral or tibial component
Patellar Dysfunction

Patellar subluxation

- Tight lateral retinaculum
- Weakness/dehiscence of VM
- Increased Q angle
Patellar Dysfunction

• Tibial / Femoral component
  - Excessive Valgus
  - Medialization
  - Internal rotation

• Anterior placement of femoral component

• Asymmetric patellar resection

• Lateral positioning of the patellar component

• Raising the joint line (artificial patella baja)
**Supracondylar Femoral Fractures**

Risk factors include
- Osteopenia
- Femoral notching
- Rheumatoid arthritis
- Poor flexion.

**Periprosthetic tibial fractures**
Less common than patellar or supracondylar fractures.

- Generally component remains well-fixed
- Undisplaced fractures may be treated nonoperatively.
Problems of the Extensor Mechanism

• Patellofemoral maltracking and instability

• Disruption of the extensor mechanism

• The patellar clunk syndrome

• Peripatellar adhesions

• Wear of polyethylene

• Osteonecrosis

Patellar Fracture

Predisposing intra-operative factors

- Excessive lateral Release
- Over-reaming of the patella
- Slippage of the reamer
- Aggressive bone resection
- Malpositioned implant
- Maltracking of the patella.
- Single Peg Fixation
- Thermal injury

Risk – Postoperative period > Intraoperative period
Rupture of the patellar tendon

Quadriceps tendon rupture

- Quadriceps turndown
- Over-resection of patella with damage to the quadriceps tendon.
- Manipulation or an extensive lateral release.
Thank you