Total Knee Replacement: An Insight

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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.
Assessment of a successful Total Knee Replacement
Successful TKA

CLINICAL  RADIOLOGICAL  SEROLOGICAL  PATIENT’S SATISFACTION
Clinical Parameters
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

**Arthrofibrosis**

**Wear, osteolysis and aseptic loosening**

**Recurrent haemarthrosis**

**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
PAIN
Extrinsic factors

- Hip pathology
- Neurological
- Vascular - DVT
- Pes anserinus bursitis
- Stress fracture and peri-prosthetic fracture
- Tendinopathy (patellar/quadricep)
- Heterotopic ossification
- Psychological disorder
- Others
  • Paget’s disease
  • Pigmented villonodular synovitis
  • Rheumatoid arthritis
  • Foot and ankle pathology
Suggested Functional and Clinical milestones during recovery

Post-Op Day 1

- All bedside exercises which include ankle pumps, Quadriceps and gluteal sets, and heel slides.
- Sit at the edge of bed with necessary assistance.
- Ambulate with standard walker with moderate assistance.
- Sit in a chair for 15 minutes.
- Actively move knee 0-70°.
Suggested Functional and Clinical milestones during recovery

Post-Op Day 3

- Bed mobility and transfers with contact guarding.
- Ambulate with standard walker **with supervision**.
- **Negotiate 4 steps with necessary assistance.**
- Standing hip flexion and knee flexion exercises.
- Sit in a chair for most of the day
- **Use bathroom with assistance**
- Actively move knee 0-90°.
Suggested Functional and Clinical milestones during recovery

Post-Op Day 5

- Perform bed mobility and transfers independently.
- Ambulate with walking aid independently.
- Negotiate 4-8 steps with railing and support safely.
- Perform Home Exercise Programme independently.
- Actively move knee 0-100°.
- Discharge from the hospital to home
PHASE II: PROGRESSIVE FUNCTION (WEEKS 2-5)

Weeks 2-3

- **Monitor incision site and swelling.**
- Continue with Home Exercise Programme.
- **Ambulation** (increase 1/2 to 1 block each day)
- Supervised stationary bicycle for 5-10 minutes.
- Static and dynamic balance exercises.
- **Active ROM 0-115°.**
PHASE II: PROGRESSIVE FUNCTION (WEEKS 2-5)

Weeks 3-4

- Practice with straight cane indoors.
- Increase stationary bicycle endurance to 10-12 min.
- **Unilateral stance on the involved leg** and side stepping.
- **Gentle semi-squat concentrating on control of quadriceps.**
- **Attain Active ROM 0-120°.**
PHASE II: PROGRESSIVE FUNCTION (WEEKS 2-5)

Weeks 4-5

- Ambulate with straight cane only.
- Stationary bicycle to 15 minutes, twice per day.
- Gentle lateral exercises, i.e. lateral stepping,
- Attain Active ROM 0-125°.
PHASE III: ADVANCED FUNCTION (WEEKS 6-8)

WEEKS 6-7

- **Ambulate indoors WITHOUT device.**
- Exercises on strength and eccentric control of muscles.
- Focus on unilateral balance activities.
- Aggressive Active ROM to promote knee ROM 0-135°

WEEKS 7-8

- Advance exercises for strength and endurance training
- **Ambulate without straight cane**
Knee Society Score (clinical)

- **Clinical Knee score** with 50 points for pain, 25 points for range of motion, and 25 points for stability.
  Points are deducted for flexion contracture, extension lag, and malalignment.
- **Function score** assigns 50 points for walking distance and 50 points for stair climbing, with deductions for requirement of walking aids.

**Patient Category**
A. Unilateral or bilateral (opposite knee successfully replaced)
B. Unilateral, other knee symptomatic
C. Multiple arthritis or medical infirmity
Radiological Parameters
Radiographs

Weight bearing AP

• The femoral component should be in 4° to 7° of valgus (Alpha angle).

• The tibial component should be perpendicular to the long axis of the tibia on the AP radiograph (Beta Angle).  Centralised.

Lateral

- **Femoral Component**: Perpendicular to long axis of femur.

- Flush with anterior cortex

- Should not be flexed.
• **Tibial plate** should be perpendicular to its long axis or tilted posteriorly down 3-5 degrees.

• The tibial component should be placed **centrally or posteriorly** on the tibia.

• **Components should be of appropriate size**
AP View - Roughly one fingerbreadth above the proximal tip of the fibula.

Insall J, Vince K, Booth R: Revision knee arthroplasty surgical guidelines, Warsaw, 1992
CAMPBELL OPERATIVE ORTHOPAEDICS
Lateral view - one fingerbreadth distal to the inferior pole of the patella.

Insall J, Vince K, Booth R: Revision knee arthroplasty surgical guidelines, Warsaw, 1992
CAMPBELL OPERATIVE ORTHOPAEDICS
Distance of the joint line in relation to the lower pole of the patella is normally between 10 and 40 mm in 20 degree flexion.

A distance <10 mm is indicative of patella baja.
Patella
Skyline view

Normal tracking  Maltracking
Proper cementing of components
Medio - Lateral stability

Varus stress  Neutral  Valgus stress
Tricompartmental Replacement
Standing Knee X-rays as good as FLR
Effective measurement of knee alignment using AP knee radiographs

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ABSTRACT
The gold standard for measuring knee alignment is mechanical axis determined using full-limb radiographs (FLR). Measurement of joint alignment using antero-posterior (AP) knee radiographs is more accessible, economical and involves less radiation exposure to the patient compared with using full-limb radiographs. The aim of this study was to compare and assess the reproducibility of knee joint axial alignment on full-limb radiographs and conventional AP knee radiographs.
Knee alignment was measured in 40 subjects (80 knees) from the TwinsUK registry. Measurement of mechanical knee alignment was from FLR, and anatomic knee alignment from weight-bearing AP knee radiographs. Reproducibility was assessed by intra-class correlation coefficients and kappa statistics. Reproducibility of knee alignment for both methods was good, with intra-observer ICC's of 0.99 for both FLR and AP radiographs. The mean alignment angle on FLR was 178.9° (SD 2.1, range 173–183°), and 179.0° (SD 2.1, range 173–185°) on AP films. 58.8% of knees on FLR and 66.3% on AP films were of varus alignment. Good correlations were seen between results for FLR and AP radiographs, with ICC ranging from 0.87–0.92 for left and right knees, and kappa statistics of 0.65–0.74.
Standard AP knee radiographs can be used to measure knee alignment with good reproducibility, and provide comparable results to those obtained from FLR. This will facilitate measurement of knee alignment in existing cohort studies to assess malalignment as a risk factor of incident OA, and in clinical practice.
Correlation between radiographic assessment and quality of life after total knee arthroplasty

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ABSTRACT

The correlation between radiographic and clinical outcome was investigated for total knee arthroplasty. One hundred three total knee arthroplasties in 98 patients were investigated at an average follow-up of 10.8 years (range, 2–17 years). For radiographic evaluation the Radiographic Evaluation System of the Knee Society was used. For assessment of clinical outcome four disease-specific scores, and the Nottingham Health Profile were applied. A significant correlation was found between the extent of radiolucent lines of the tibial component and the Nottingham Health Profile (correlation coefficient: 0.61, p<0.0001). For the disease-specific scores the correlation was low (correlation coefficient: 0.30–0.50). For the prosthetic alignment no significant correlation was found (p<0.05). The current results show that a correlation was found between radiological assessment and several clinical scores. We suggest that a quality-of-life score should be included in the follow-up evaluation of total knee arthroplasty.

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Good Alignment After Total Knee Arthroplasty Leads to Faster Rehabilitation and Better Function

Lee M. Longstaff, MA, FRCS, Karen Sloan, MSc, Nikki Stamp, MB, BS, Matt Scaddan, MB, BS, and Richard Beaver, FRCS

Abstract: The aim of this study was to identify what aspects of implant alignment and rotation affect functional outcome after total knee arthroplasty (TKA). One hundred and fifty-nine total knee arthroplasties were performed at the authors’ institution between May 2003 and July 2004. All patients underwent an objective and independent clinical and radiological assessment before and after surgery. A computed tomography scan was performed at 6 months. The alignment parameters that were measured included sagittal femoral, coronal femoral, rotational femoral, sagittal tibial, coronal tibial, and femorotibial mismatch. The cumulative error score, which represents the sum of the individual errors, was calculated. Functional outcome was measured using the Knee Society Score. Good coronal femoral alignment was associated with better function at 1 year ($P = .013$). Trends were identified for better function with good sagittal and rotational femoral alignment and good sagittal and coronal tibial alignment. Patients with a low cumulative error score had a better functional outcome ($P = .015$). These patients rehabilitated more quickly and their length of stay in hospital was 2 days shorter. Key words: total knee arthroplasty, alignment, function, rehabilitation.

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Influence of positioning of prosthesis in total knee replacement

PA Lotke and ML Ecker


**Abstract:** The early clinical results of geometric total knee arthroplasty were compared with the position of the prosthetic device by a roentgenographic score system. It was noted that there is a statistically significant positive correlation between a good clinical result and a well positioned prosthesis. In addition, it was appreciated that perfect positioning of the device was difficult to obtain. We believe that the long-term clinical results, wear resistance, and resistance to prosthetic failure depend on correct positioning of the devices.
Alignment

<table>
<thead>
<tr>
<th>Alignment (deg)</th>
<th>Well Aligned</th>
<th>Badly Aligned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronal femoral</td>
<td>−2 to +2</td>
<td>Outside of this range</td>
</tr>
<tr>
<td>Sagittal femoral</td>
<td>−2 to +2</td>
<td>Outside of this range</td>
</tr>
<tr>
<td>Femoral rotation</td>
<td>−2 to +2</td>
<td>Outside of this range</td>
</tr>
<tr>
<td>Coronal tibial</td>
<td>−2 to +2</td>
<td>Outside of this range</td>
</tr>
<tr>
<td>Sagittal tibial (posterior slope)</td>
<td>+1 to +5</td>
<td>Outside of this range</td>
</tr>
<tr>
<td>Femorotibial mismatch</td>
<td>−2 to +2</td>
<td>Outside of this range</td>
</tr>
<tr>
<td>Cumulative error</td>
<td>Up to 6</td>
<td>&gt;6</td>
</tr>
</tbody>
</table>

COMPONENTS IN LESS THAN 2 DEGREES OF DEVIATION FROM THE NORMAL ARE CONSIDERED WELL ALIGNED
Undesirable Radiological Features....

May contribute to undesirable results
Large femoral component causes overstuffing of anterior compartment and produces anterior knee pain.
Notched anterior femur cortex increases risk of periprosthetic fracture.
Femoral component in flexion can restrict full extension of the knee.
Lucencies
Medial overhang of tibial component can cause persistent pain over medial side.
Laboratory Parameters
Laboratory Parameters

**ESR** peak 5-7 Days of operation, **pre-operative levels in 3 months.**

ESR can remain elevated for as long as one year.

An **ESR > 30** mm per hour has a sensitivity 82%, specificity of 85%

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 for infection
74% PPV
99% NPV

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.

Patient Satisfaction

- Patient satisfaction is an important factor in TKA, and it was used as an endpoint in outcome analysis.

- It appears that 73% of the patients have a satisfactory outcome 5 years after TKA.

A Comparison Between Subjective and Objective Outcome Assessments
Pieter H. J. Bullens, Corne J. M. van Loon, Maarten C. de Waal Malefijt, Roland F. J. M. Laan, and Rene P. H. Veth,
The Journal of Arthroplasty Vol. 16 No. 6 2001
A study showed only a poor correlation between the objective physician-assessed knee score and the subjective patient-assessed satisfaction VAS score. This finding suggests that the concerns and priorities of patients and surgeons are different. Surgeons usually focus on range of motion, alignment, and stability, whereas patients focus on the functionality of the knee as a whole.

Causes and Mechanisms of Failed TKR
Common Causes of TKR Failure

- Infection
- Instability
- Extensor mechanism problems
- Aseptic / Mechanical loosening
- Osteolysis
- Wear of articular bearing surface
- Peri-prosthetic fracture
- Implant Failure
Failed TKR

- Pain
- Postop stiffness
- Instability
- Infection
Symptoms of the failed total knee

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

- Wear of the polyethylene
- Loosening of a component
- 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.

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

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),
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 $\rightarrow$ Reduced ROM $\rightarrow$ Adhesions in the suprapatellar pouch.

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

- 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).

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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 99m-HDT Scan

- Sensitive but not very specific
- First two phase 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 even after 1 year.**
- 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
- **Infected Focus** - **POSITIVE** Indium and **NEGATIVE** SC Scan

- **CONGRUENT** Scan- Both Positive-Less likelihood of Infection
- **INCONGRUENT** Scan- 90% chance of Infection
INFECTION

• Aspiration
  – Smear
  – Gram’s Stain
  – Culture

• Synovial Biopsy
Revision Knee
Septic
Aseptic / Mechanical Loosening

- Incomplete cementation
- Poor component alignment
- Inadequate ligamentous balancing
- Osteolysis and wear
- Rheumatoid arthritis
- TKR with Neurological Disorders
Revision Knee - Aseptic Loosening
Peri-Prosthetic Fracture

**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

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.
Selective Compartment Replacements
Thank You