ASSESSMENT OF A SUCCESSFUL TOTAL KNEE REPLACEMENT

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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/quadriceps)
- Heterotopic ossification
- Psychological disorder
- Others
  - Paget’s disease
  - Pigmented villonodular synovitis
  - Rheumatoid arthritis
  - Foot and ankle pathology
Some pointers of pain

<table>
<thead>
<tr>
<th>Early postoperative pain in full extension</th>
<th>knee effusion or hemarthrosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic pain in full extension</td>
<td>an overstuffed extension space</td>
</tr>
<tr>
<td>Pain with full flexion</td>
<td>impingement b/w posterior femoral osteophyte and tibial component, overstuffing of the flexion space.</td>
</tr>
<tr>
<td>Pain associated with stair climbing or descent</td>
<td>Dysfunction of the extensor mechanism. Patellar maltracking or subluxation</td>
</tr>
<tr>
<td>Rest pain and continuous postoperative pain</td>
<td>infection CRPS</td>
</tr>
</tbody>
</table>
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°.**
• 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
<table>
<thead>
<tr>
<th>Pain</th>
<th>None</th>
<th>Mild or occasional</th>
<th>Stairs only</th>
<th>Walking and stairs</th>
<th>Moderate</th>
<th>Occasional</th>
<th>Continual</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50</td>
<td>45</td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>10</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

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<tr>
<td></td>
<td>50</td>
<td>45</td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>10</td>
<td>0</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Range of Motion</th>
<th>(5 degrees = 1 point)</th>
<th>25</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Stability</th>
<th>Anteroposterior</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Maximal Movement in Any Position)</td>
<td>&lt;5 mm</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>5-10 mm</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>&gt; 10 mm</td>
<td>0</td>
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</table>

<table>
<thead>
<tr>
<th>Stability</th>
<th>Mediolateral</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;5 degrees</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>6-9 degrees</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>10-14 degrees</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>&gt;15 degrees</td>
<td>0</td>
</tr>
</tbody>
</table>
# Subtotal Deductions (minus)

<table>
<thead>
<tr>
<th>Flexion contracture</th>
<th></th>
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<tbody>
<tr>
<td>5-10 degrees</td>
<td>2</td>
</tr>
<tr>
<td>10-15 degrees</td>
<td>5</td>
</tr>
<tr>
<td>16-20 degrees</td>
<td>10</td>
</tr>
<tr>
<td>&gt;20 degrees</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extension lag</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10 degrees</td>
<td>5</td>
</tr>
<tr>
<td>10-20 degrees</td>
<td>10</td>
</tr>
<tr>
<td>&gt;20 degrees</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alignment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5-10 degrees</td>
<td>0</td>
</tr>
<tr>
<td>0-4 degrees</td>
<td>3</td>
</tr>
<tr>
<td>11-15 degrees</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
<td>20</td>
</tr>
</tbody>
</table>
# Function

<table>
<thead>
<tr>
<th>Walking</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlimited</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>&gt;10 blocks</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>5-10 blocks</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>&lt;5 blocks</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Housebound</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Unable</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stairs</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal up and down</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Normal up; down with rail</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>Up and down with rail</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Up with rail; unable down</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Unable</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

### Subtotal Deductions (minus)

| Single Cane                  | 5           |
| Two canes                    | 10          |
| Crutches or walker           | 20          |

Total deductions Function score
Instability

The patient is observed while ambulating and rising from a chair.

<table>
<thead>
<tr>
<th>A stiff-legged gait</th>
<th>Loss of flexion or guarding because of underlying instability</th>
</tr>
</thead>
<tbody>
<tr>
<td>shortened stance phase of gait</td>
<td>loss of extension on the affected side because the patient is unable to lock the knee in extension and must fire the quadriceps muscle to prevent the knee from buckling.</td>
</tr>
</tbody>
</table>

Normal foot progression angle. No abnormal rotation, No varus or valgus thrust.

Medial lateral stability - should not open more than 4°.

*Kuster MS Arch Orthop Trauma Surg. 2004*
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.

- **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**
Prosthetic joint line in relation to the native joint line is assessed.

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
Prosthetic joint line in relation to the native joint line is assessed.

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
Patella
Skyline view

Normal tracking

Maltracking
The 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.
Proper cementing of components
Knee Society Score (Radiological)

The lengths of the radiolucent lines were measured for each of the zones and for each component independently in mm.

For a seven-zone tibial component
- a score of 4mm or less probably is insignificant
- a score of 5mm to 9mm close follow-up for progression
- a score of 10mm or more possible /impending failure

Medio - Lateral stability

Varus stress

Neutral

Valgus stress
## Permissible Laxity Approximately 4°

<table>
<thead>
<tr>
<th>Author</th>
<th>Prosthesis</th>
<th>Varus</th>
<th>Valgus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draganich LF</td>
<td>TRAC PS mobile-bearing</td>
<td>4.0°</td>
<td>3.0°</td>
</tr>
<tr>
<td>Ishii Y</td>
<td>Genesis I PCLR</td>
<td>4.5°</td>
<td>4.8°</td>
</tr>
<tr>
<td></td>
<td>Genesis I PCLS</td>
<td>4.0°</td>
<td>4.6°</td>
</tr>
<tr>
<td>Matsuda M</td>
<td>LCS PCLR</td>
<td>3.5°</td>
<td>4.0°</td>
</tr>
<tr>
<td></td>
<td>LCS PCLSR</td>
<td>3.9°</td>
<td>3.8°</td>
</tr>
<tr>
<td>Kuster MS</td>
<td>Natural Knee &amp; LCS</td>
<td>4.3°</td>
<td>4.0°</td>
</tr>
</tbody>
</table>
Standing Knee x-rays as good as FLR
Effective measurement of knee alignment using AP knee radiographs

Alexandra N. Colebatch a,*, Deborah J. Hart b, Guangju Zhai b, F.M. Williams b, Tim D. Spector b, Nigel K. Arden a

a MRC Epidemiology Resource Centre, University of Southampton, Southampton, United Kingdom
b Twin Research and Genetic Epidemiology Unit, St Thomas’ Hospital, London, United Kingdom

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Epidemiology

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.
Evidence
Correlation between radiographic assessment and quality of life after total knee arthroplasty

Christian M. Bach, Eckart Mayr, Michael Liebensteiner, Michaela Gstöttner, Michael Nogler, Martin Thaler

From the Department of Orthopaedic Surgery, Medical University of Innsbruck, Anichstrasse 35, 6020-Innsbruck, Austria

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

<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></td>
<td>&gt;6</td>
</tr>
</tbody>
</table>

Alignment
Undesirable Radiological Features....

May contribute to undesirable results
Lucencies
Undesirable Radiological Features

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

**ESR** peak 5-7DAYS 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%, PP value of 58%, NP value of 95%.

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.

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.
A prospective study of 860 patients with TKR showed that those who had marked functional limitation, severe pain, a low mental health score and other comorbid conditions before operation were more likely to have a worse outcome after one and two years.

- In a study of 116 patients with psychological disorders and conditions such as diabetes mellitus, RA and fibromyalgia, significant pain was reported in 44.4%, 18.4% and 13.1% of patients at 1, 6 and 12 months, respectively.

- Pre-operative depression and anxiety were the best predictors of heightened pain.
Thank you