TOTAL KNEE ARTHROPLASTY

THE MEDIAL PIVOT PRINCIPLE IN TKA
11-16 YRS CLINICAL OUTCOME

Th. KARACHALIOS, MD, DSc
PROF IN ORTHOPAEDIC SURGERY
EDITOR IN CHIEF HIP INTERNATIONAL
UNIVERSITY OF THESSALY
HELLENIC REPUBLIC

DISCLOSURES
- RESEARCH FUNDS
  - SMITH & NEPHEW
  - WRIGHT MEDICAL TECHNOLOGY
  - AMGEN
- CONSULTANT
  - MICROPORT ORTHOPAEDICS

www.ortho-uth.org
TOTAL KNEE ARTHROPLASTY

- PATIENTS' SELECTION
- SURGICAL TECHNIQUE
  - ALIGNMENT
  - SOFT TISSUE BALLANCING
  - IMPLANTS SIZING AND PLACEMENT
- IMPLANT SELECTION

...SURGEONS CAN NOWADAYS SOLVE THE PAIN ISSUE FOR THE MAJORITY OF THE PATIENTS...

TOTAL KNEE ARTHROPLASTY

...RELIABLE PAIN RELIEF....
.....RESTORATION OF FUNCTION IS A GOAL OF A DIFFERENT ORDER....

- A MATTER OF OPTIMISED...
  - LOAD TRANSFER
  - KINEMATICS OF THE ARTIFICIAL JOINT
  - DESIGN ISSUES
  - SOFT TISSUE METABOLIC AND FUNCTIONAL STATUS
TOTAL KNEE ARTHROPLASTY

- MANY SUBJECTS DEMONSTRATE AN ANTERIOR SLIDING OF THE FEMUR ON THE TIBIA
  - A PHENOMENON NAMED PARADOXICAL MOTION
  - SIGNIFICANT IMPLICATIONS ON THE FUNCTIONAL RESULTS OF TKA

Dennis CORR 2003
Komistek Surgery of the Knee 2001

TOTAL KNEE ARTHROPLASTY

...IN LATE 90s...
...WE DO NEED A BETTER UNDERSTATING OF KNEE KINEMATICS... IN ORDER TO IMPROVE THE FUNCTIONAL OUTCOME OF A TKA....

...ANY NEW IDEAS ?????

www.ortho-uth.org
KNEE JOINT

- MODERN KNEE KINEMATICS
- MEDIAL PIVOT PRINCIPLE

Freeman, Pinskerova J Biomech 2005
Pinskerova JBJS 2004
Freeman, Pinskerova CORR 2003
Williams JBJS 2002
Iwaki JBJS 2001
www.ortho-uth.org

TOTAL KNEE ARTHROPLASTY

- ADVANCE MEDIAL PIVOT TKA
- WHICH HAS BEEN DESIGNED IN ORDER TO REFLECT CONTEMPORARY DATA REGARDING KNEE KINEMATICS

www.ortho-uth.org
PATELOFEMORAL JOINT
TOTAL KNEE ARTHROPLASTY

• ANATOMY OF FEMORAL TROCHLEA
  - SMALL VARIATION
  - DEPTH
  - LINEAR TRACK
  - LATERAL TO MEAN SAGITTAL LEVEL
  - BETWEEN MECHANICAL & ANATOMICAL AXIS (3.6°)

  - ANATOMICAL FEMORAL IMPLANT
  - DEPTH OF TROCHLER GROOVE
  - ELEVATION OF LATERAL FEMORAL LIP
  - 'PATELLA FRIENDLY' IMPLANTS

www.ortho-uth.org

FEMORAL DESIGN ADVANTAGES

ADVANCE
MEDIAL PIVOT

PATELLO-FEMORAL ADVANTAGES
  - RAISED LATERAL FLANGE
  - TROCHLEAR LENGTH AND DEPTH
  - 3.6° PATELLAR TRACK
    - REDUCES LATERAL RELEASE ????

FEMORAL DESIGN ADVANTAGES
  - CONSTANT RADIUS
    - BETTER FLEXION AND EARLIER REHABILITATION
    - GREATER MID-FLEXION STABILITY WITH TIBIAL ARTICULATING SURFACE

PCL IRRELEVANT IMPLANT

• CONCISE FOLLOW UP, AT A MINIMUM 11 YRS, OF PREVIOUS REPORTS
• A RETROSPECTIVE EVALUATION OF PROSPETIVELY COLLECTED DATA
• OBJECTIVE AND SUBJECTIVE RATING SCALES (PROMs) ???

www.ortho-uth.org

PATIENTS

• TIME PERIOD
  - JAN 2000 – APRIL 2004
  - AVG FOLLOW-UP:
    12.3 YEARS (10-15 YRS)

• 225 PATIENTS
  - 41 MALES (18.2%)
  - 184 FEMALES (81.8%)

• 284 KNEES (OUT OF 1838 PERS CASES)
  - 149 RIGHT
  - 135 LEFT

• MEAN AGE AT OPERATION
  - 71.1 (52-84) YRS

www.ortho-uth.org
PATIENTS

- **DIAGNOSIS**
  - OSTEOARTHRITIS 168 (74.6%)
  - RHEUMATOID ARTHRITIS 29 (12.8%)
  - SERONEGATIVE ARTHRITIS 10 (4.4%)
  - POST-TRAUMATIC 12 (5.3%)
  - MISCELLANEOUS 2 (1.2%)

  - CHARNLEY: A: 73.7%
    B: 22.6%
    C: 3.6%

METHODS

DAVIES, RATING SYSTEMS FOR TOTAL KNEE REPLACEMENT, KNEE 2002

- **PRE AND POST OPERATIVE DATA COLLECTION**
  - (Both objective and subjective clinical criteria)
  - Radiological evaluation
  - Orthowave software

- **TIME INTERVALS**
  - Pre-op, 3W, 6W, 3M, 6M, 1YR, every year thereafter

- 10 (4.4%) patients were lost to follow-up - one found

- 20 (9%) patients died for reasons unrelated to the operation

- 82% compliance in time interval follow-up evaluation
TECHNICAL ISSUES

- ANTERIOR MIDLINE APPROACH
  - ANTERIOR MEDIAL PARAPATELLAR

- SOFT TISSUE RELEASES
  - PCL RELEASE - SUCRIFICE 77 (27.11%) WHEN NECESSARY

- MODERN CEMENTING TECHNIQUE
  - LMWH FOR 30 DAYS

PATELLOFEMORAL JOINT

- NO REPLACEMENT
- DIFFERENT OA •••
- PATELLAR APONEUROSIS
- RESTORATION OF PATELLAR SHAPE
- ANATOMICAL FEMORAL IMPLANT (PATELLA FRIENDLY DESIGN)
ADVANCE MEDIAL PIVOT
TOTAL KNEE ARTHROPLASTY

- IMAGING
  - AP BEARING VIEW OF THE LOWER LIMB
  - AP AND LATERAL VIEW
  - MERCANT VIEW
  - CT SCAN FOR ROTATIONAL PLACEMENT OF THE COMPONENTS
    - MODIFIED TECHNIQUE
    - ACCURACY cv:0.87 (p<0.05)

Berger Orth Clin North Am 2001
Jazarwi J Arthroplasty 2000
Berger and Rubash Clin Orthop 1998

RESULTS
OBJECTIVE

- KNEE SCORE (0-100)
  - PAIN (50)
  - STABILITY (25)
  - ROM (25)

- PREOP AV: 31.6(1-70)
- 10 YRS F-UP AV: 91.13 (60-100)
- 15 YRS F-UP AV: 89.1 (58-98)
**RESULTS**

**FUNCTION SCORE**

FUNCTION SCORE (0-100)
- PREOP AV: 71.92 (9-80)
- 10 YRS F-UP AV: 82 (45-100)
- 15 YRS F-UP AV: 78 (45-96)

**KNEE SCORE - PAIN**

**PREOP PAIN:**
- SEVERE: 85.4%
- MODERATE CONTINUAL: 4.9
- MODERATE OCCASIONAL: 9.8

**POSTOP PAIN:**
- NO PAIN 57.1%
- MILD OCCASIONAL 37.5%
- MODERATE OCCASIONAL 5.4%
KNEE SCORE - ROM

• FLEXION
  - PREOP AV 101 (80-125)
  - FINAL F-UP AV 117 (85-135)

• EXTENSION
  - PREOP
  - FINAL F-UP

QUESTION

• DO YOU FEEL ANY PAIN IN YOUR KNEECAP ???
• 3.4% MODERATE TO SEVERE
**PATELLA SCORE**

- **ANTERIOR KNEE PAIN**
  - 0, 1, 2
- **PAIN ON CLIMBING STAIRS**
  - 0, 1, 2
- **PATELLA TENDERNESS (WHILE FLEXING THE KNEE)**
  - 0, 1, 2
- **PATELLA CREPITUS**
  - 0, 1, 2
- **RADIOLOGICAL TILT, SUBLUXATION AND DISLOCATION OF THE PATELLA**
  - 0, 1, 2

Karachalios, Newman, Ackroyd Knee 2000

- **PREOP AVERAGE VALUE:** 3.82
- **POSTOP AVERAGE VALUE:** 9.93
- **SS DIFFERENCE** p~0.001

www.ortho-uth.org

---

**ABILITY TO PERFORM REGULAR ACTIVITIES**

**SUBJECTIVE PARAMETER**

- **61.4% EXCELLENT**
- **29.8% VERY GOOD**
- **3.5% GOOD**
- **5.3% FAIR**

www.ortho-uth.org
ABILITY FOR HEAVY WORK OR SPORT ACTIVITIES

SUBJECTIVE PARAMETER
• 12.2% EXCELLENT
• 15.8% VERY GOOD
• 47.4% GOOD
• 17.5% FAIR
• 7% POOR

PATIENT’S EXPECTATIONS

SUBJECTIVE PARAMETER
• 59.6% EXCELLENT
• 29.8% VERY GOOD
• 7.0% GOOD
• 3.5% FAIR
Repeate the operation on another joint

- 69.6% DEFINETELY YES
- 26.8% POSSIBLY YES
- 0% PROBABLY NOT
- 3.6% CERTAINLY NOT

- SUBGROUP ANALYSIS
  - SATISFACTORY OBJECTIVE EVALUATION
  - EARLY OA

Results

- SF-12
- PHYSICAL CRITERIA
  - PREOP AV: 26.63 (18.94-40.55)
  - 10 YRS F-UP AV: 46.98 (34.98-56.58)
  - 15 YRS F-UP AV: 45.80 (33.82-55.91)

- MENTAL CRITERIA
  - PREOP AV: 49.85 (38.05-63.27)
  - 10YRS F-UP AV: 50.12 (39.61-62.19)
RESULTS

• WOMAC (SUBJECTIVE)
  - PREOP AV:
    • Pain  7  (3–14)
    • Motion 2.72 (0–4)
    • Function 20.09 (9–37)
    • Total 30.81 (14–54)
  - 10 YRS F-UP AV:
    • Pain 17.57 (12–20)
    • Motion 7.8 (4–8)
    • Function 53.85 (23–67)
    • Total 70.23 (43–95)

• OXFORD 12
  - PREOP AV: 44.35 (36–53)
  - 10 YRS F-UP AV: 22.56 (15–40)
  - 15 YRS F-UP AV: 25.43 (15–36)
11-16 YRS OUTCOME BJJ in press
Th Karachalios, S Varitimidis, M Hantes, K. Bargiotas, N. Roidis, KN Malizos
EMEA APPROVAL

- SURVIVAL RATE...
  - 15 YRS SURVIVAL RATE 97.2% - ANY REASON
  - 15 YRS SURVIVAL RATE 98.6% - AS LOOSENING
- 11-16 YRS FOLLOW UP STUDY
  - THREE PATIENT RELATED FAILURES
  - THREE SURGEON RELATED FAILURES

Karachalios et al Knee 2009
Karachalios et al BJJ in press

RADIOLOGICAL EVALUATION

- 16 YEARS FOLLOW-UP
- 14 YEARS FOLLOW-UP
- 12 YEARS FOLLOW-UP
  - NON-PROGRESSIVE LUCENT LINES
- PATELLOFEMORAL JOINT
**RADIOLOGICAL EVALUATION**

- 92 YRS OLD FEMALE PATIENT
- OSTEOPOROTIC
- 15 YRS FOLLOW UP
- SOUND INTERFACE

[Image of X-rays]

**FAILURES-COMPLICATIONS**

- **INFECTION**: 2 (0.7%) TWO STAGE REVISION
  - 1.1% OVERALL FOR JOINT REPLACEMENT SURGERY
- **ASEPTIC LOOSENING**: 3 (1.1%) (REVISION)
  - POOR PATIENT SELECTION
- **TRAUMATIC DISLOCATION**: 1 (0.35%)
- **INSTABILITY**: 1 (0.35%)
- **ANTERIOR KNEE PAIN**: 3.4%
  - THREE REVISIONS
- **10 MUA** (3.55)

- DVT: 12 (6.7%) PE: 0%
- WOUND HEALING PROBLEMS: 4 (2.59%)
- MISCELLANEOUS: 8 (4.52%)
- THE FATE OF THE 4 DROP-OUTS ???

[Image of X-rays]


**MANIPULATION OF RESULTS**

- LEVEL 1 STUDY
- SHORT F-UP (2-3 YRS)
- KS AND HSS SCORES ???
- MORE TIME SPEND IN BALANCING PFC’s ???
- HIGH RATE OF INFECTION IN AMP ???
- PATIENTS DISSATISFACTION WAS BASED ON INFECTION REOPERATION RATES
- AMP INCREASING ROM UP TO 115
- PFC EARLY ROM (124) BUT THEN DECREASING
- POPULATION BIAS

www.ortho-uth.org
**TKA FAILURE MODES**

- WEAR/LOOSENING
- INSTABILITY
  - LIGAMENT BALANCE
  - DESIGN RELATED ISSUES
- PATELLA PROBLEMS
  - PAIN
  - TRACKING

**ADVANCE MEDIAL PIVOT**

- CONTEMPORARY KINEMATICS PRINCIPLE
- ASYMMETRIC PE
- STABILITY WITH MOBILITY
- WEAR PATTERN ?????
**PE LINER RETRIEVAL STUDY**

- **SIX PE LINERS**
  - R/Size 3/10mm: Aseptic Loosening, 5Y FU
  - R/Size 5/10mm: Infection, 3Y FU
  - R/Size 2/12mm: Traumatic Dislocation, 6Y FU
  - L/Size 3/10mm: Aseptic Loosening, 7Y FU

  [www.ortho-uth.org](http://www.ortho-uth.org)

**PE LINER RETRIEVAL STUDY**

- **PRELIMINARY REPORT**
  - Comparable Dimensional Study
  - Retrieved Liner
    - New Liners of Equal Size and Thickness

- A Destructive Structural Study in Progress

  [www.ortho-uth.org](http://www.ortho-uth.org)
TRAUMATIC DISLOCATION
6 Y FU

- MEDIAL COMPARTMENT
- SAGITAL PLANE
  - 100 μm WEAR
  MIDDLE SECTION

TRAUMATIC DISLOCATION
6 Y FU

- LATERAL COMPARTMENT
- SAGITAL PLANE
  - 300-400 μm WEAR
  ANTERIOR SECTION
TRAUMATIC DISLOCATION
6 Y FU

• BOTH COMPARTMENTS
• FRONTAL PLANE
  - 200–400 μm
  - 200 μm POSTERIOR ELEVATION !!! OF THE LINER

ASEPTIC LOOSENING 7 Y FU
VARUS TIBIAL TRAY

• MEDIAL COMPARTMENT
• SAGITAL PLANE
  - 100 μm WEAR
ASEPTIC LOOSENING 7 Y FU

- LATERAL COMPARTMENT
- SAGITAL PLANE
  - 500 μm ELEVATION POSTERIORLY

ASEPTIC LOOSENING 7 Y FU

- BOTH COMPARTMENTS
- FRONTAL PLANE
  - 100 μm WEAR MEDIAL COMP
  - UP TO 800 μm POSTERIOR ELEVATION !!! OF THE LINER
TOTAL KNEE ARTHROPLASTY
ROTATIONAL PLACEMENT OF THE COMPONENTS

- Placement of the femoral component within 3 ± 2°
  - 92% of the cases
  - 3% lateral retinaculum release
  - 20-40% in historical controls

- Optimal rotational placement
  - Improved range of movement ???
  - Less pain ???

RADIOLOGICAL EVALUATION

- Concentric patella
  - 170 (96%) TKA’s

- Patella tilt
  - 7 (4%) TKA’s
COMPARATIVE STUDY
Karachalios et al submitted

- RANDOM SELECTION
  - PERSONAL DATABASE
  - 50 PTS WITH AMP
  - 50 PTS GENESIS II
  - 50 PTS AGC NON ANATOMIC
  - MATCHED
    - FOR AGE, SEX, DIAGNOSIS AND F-UP
  - 10-15 YRS F-UP
  - SS DIFFERENCES * BETWEEN GROUPS AT FINAL F-UP

PATELLA SCORE

www.ortho-uth.org

COMPARATIVE STUDY

- PARTS OF THE SCORE
  - CREPITUS, TILT
  - PAIN, TENDERNESS
  - SS DIFFERENCES ★ BETWEEN GROUPS AT FINAL F-UP

www.ortho-uth.org
Foam Metal ADVANCE® Tibial Implant Designs

- Cementless (Foam Metal) with and without screw option
- Next Generation Tibial Instruments

Two Tibial Plate Options

- Keel for Stem Extenders
- Standard Keel

4 holes
Additional screw fixation

No holes
(4 Fixed Spikes)

CLINICAL TRIAL BIOFOAM IMPLANT

- INITIAL SERIES
- LEARNING CURVE
  - 60 OA PATIENTS (VOLUNTEERS)
  - ETHICAL COMMITTEE APPROVAL
  - AVERAGE AGE 57 (45-60) YRS
  - GOOD BONE QUALITY
  - SEVEN YEARS F-UP
  - FIRST EUROPEAN CENTER

- CLINICAL TRIALS
  - CEMENTED VS CEMENTLESS
  - ADVANCE MEDIAL PIVOT TKA
  - CLINICAL OUTCOME STUDY
CLINICAL OUTCOME

- AT 7 YEARS FOLLOW-UP
  - NO FAILURES WERE OBSERVED
    - IMPLANT RELATED
    - PATIENT RELATED
    - SURGEON RELATED

ADVANCE KNEE SYSTEM

- SHORTCOMINGS
  - RELATIVE SMALL NUMBER OF PATIENTS
  - RELATIVE SHORT FOLLOW-UP ????
  - NO GAIT ANALYSIS

- STRENGTHS
  - LOW NUMBER OF DROP-OUTS
  - PREOP AND POSTOP DATA
  - BOTH OBJECTIVE AND SUBJECTIVE PARAMETERS
ADVANCE KNEE SYSTEM

- Satisfactory Clinical Results
- Satisfactory ROM and Function
- Improvement of all scores up to four years
- Satisfactory Cumulative Success Rate
- No implant related failures
- A different knee design

www.ortho-uth.org