

# Osteotomies around the Knee



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Head Joint Replacement  
Stolzalpe & Abu Dhabi



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# Consensus Paper

## AO Knee Expert Group

### Osteotomies Around the Knee

Siegfried Hofmann, Philipp Lobenhoffer, Alex Staubli, and Ronald Van Heerwaarden

⇒ not included complex 3-D deformities

# Key Points

- Current status
- Biomechanics principles
- Patient selection
- Planning
- Results



# Therapeutic Dilemma

- Active middle aged (40-60)
- Biological therapy ?  
    ⇒ NSAIDS, Suppl & Cartilage
- Arthroscopy ?  
    ⇒ Braces & Distraction
- Osteotomy
- Joint replacement  
    ⇒ Partial, UKA & TKA



# Osteotomy Classical Techniques

- Varus  $\Rightarrow$  Tibia
- Valgus  $\Rightarrow$  Femur
- Wrong dogma
- Correction not at site of deformity
  - $\Rightarrow$  new deformity
  - $\Rightarrow$  inclined jointline
  - $\Rightarrow$  disturbed biomechanics



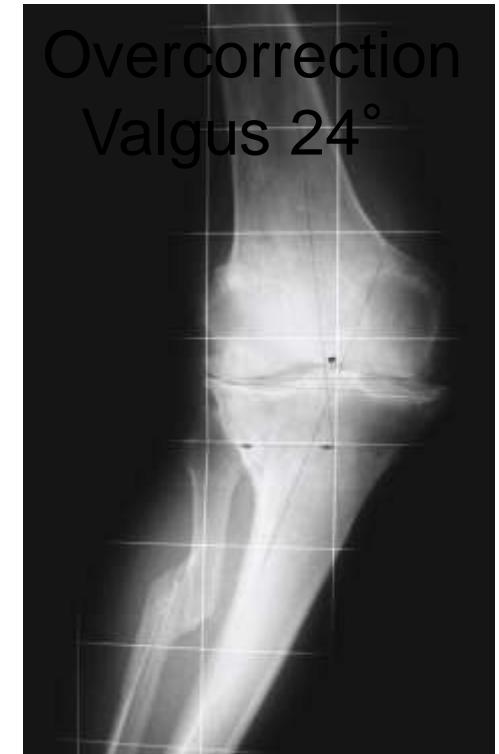
Varus lat  
subtractive



Valgus med  
subtractive

# Problems with Osteotomies

- Less predictable outcome
- Difficult surgical technique
- High complication rate
- 10 y survival  
    ⇒ 50 - 70 % only
- EBM - No evidence but recommendation
- Concept needs to be improved



Brouwer et al, Cochrane Data 2005

# New Concept for Osteotomies

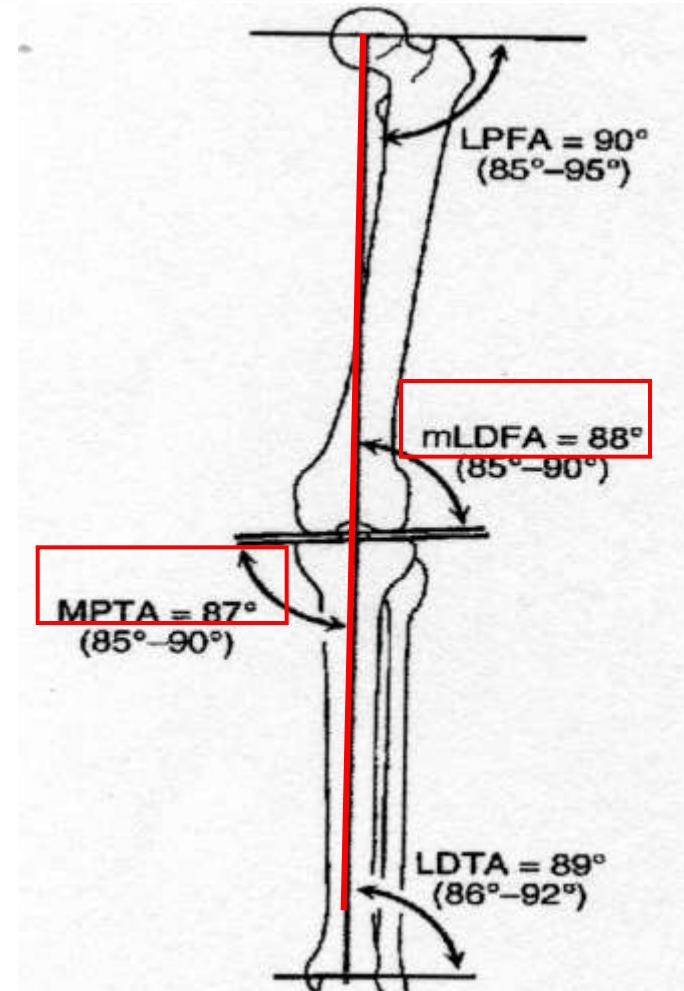
- Biomechanical understanding
- Deformity analysis
- Patient selection
- Planning
- Standardized surgical technique
- Early functional rehabilitation



Hofmann et al, Orthopäde 2009  
Hofmann et al, European IC Lectures 2011

# Biomechanical Basics

- Deformity analysis
  - ⇒ LDFA & MPTA
- Location deformity
  - ⇒ femur and/or tibia
- Jointline
- Osteotomy not at
  - ⇒ right side - jointline
  - ⇒ CORA – translation

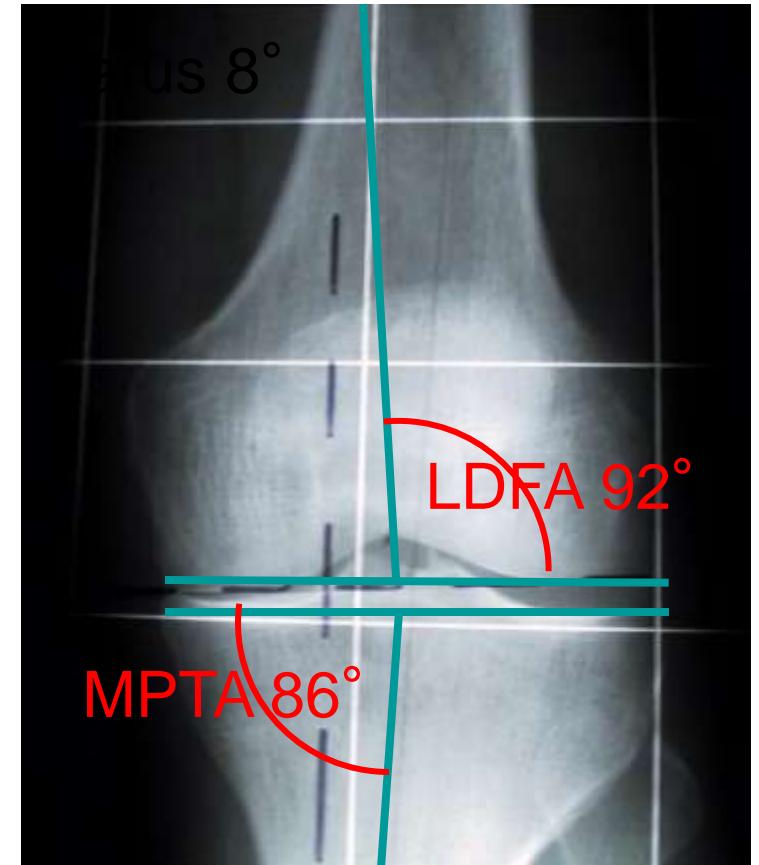


Paley, Orthop Clin NA 1994

# Deformity Analysis

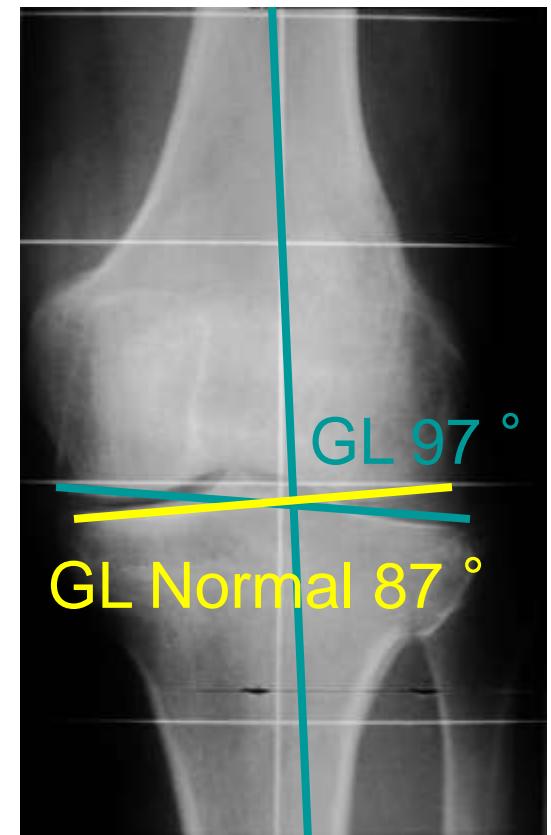
(100 consecutive cases)

- Varus
  - 59 % Femur
  - 31 % Tibia
  - 10 % Combined
- Valgus
  - 45 % Tibia
  - 22 % Femur
  - 33 % Kombiniert



# Importance Joint line

- Normal 87° (85 – 90)  
(Paley, Orth. Clin NA 1994)
- Max deviation 10°  
(Coventry, JBJS 1987)
- Inclined joint line > 4°
  - ⇒ shear forces
  - ⇒ damage cartilage  
(Babis et al, JBJS Am 2002)



st. p. lat closed Tibia  
10° inclined joint line

# Patients selection

- Males < 65 & females < 55 y.
- Good joint functions  
    ⇒ ROM 0-10-100°
- Patients expectations
- Compliance
- Risk factors  
    ⇒ RA, DM, ON, smoker
- Preadarthrotic deformities



Adipositas per magna

Hofmann et al, Orthopäde 2009

# Pearthrotic deformities

- Malalignment > 4°
- Instabilities
- Cartilage defects
- Meniscal tears
- Stress bone marrow oedema
- Every knee with symptoms
  - ⇒ Check alignment !
  - ⇒ MRI



Stress oedema  
important risk factor

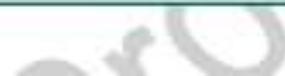
Felson et al, Ann Intern Med 2003

# Criteria Patient Selection

**Table 4** Patient selection for osteotomies in mono-compartment arthritis

Ideal candidate	Possible candidate	No candidate
Isolated pain medial/lateral at joint level	Infection history	Contra-lateral arthritis and st.p. lateral meniscectomy
Age 40–60 years	Age < 40 > 60	
BMI < 30	BMI 30–40	BMI > 40
Active patient but no running and jumping	Running and jumping sporting activities	
Mal-alignment < 15°	Mal-alignment > 15° possible double osteotomy	
Metaphyseal varus tibia and valgus femur	Metaphyseal varus femur and valgus tibia	Extra-articular deformity
Full ROM	Flexion contracture > 15°	Flexion contracture > 25°
No patello-femoral symptoms	Medium patello-femoral symptoms (grade 2–3)	Severe patello-femoral arthritis grade 4 and maltracking
Arthritis grade 1–3	Arthritis grade 4	
Stable joint	Insufficient ACL or PCL	Medio-lateral instability
No smoker	Smoker	

Source: Modified according to ISAKOS guidelines



# Example Planning

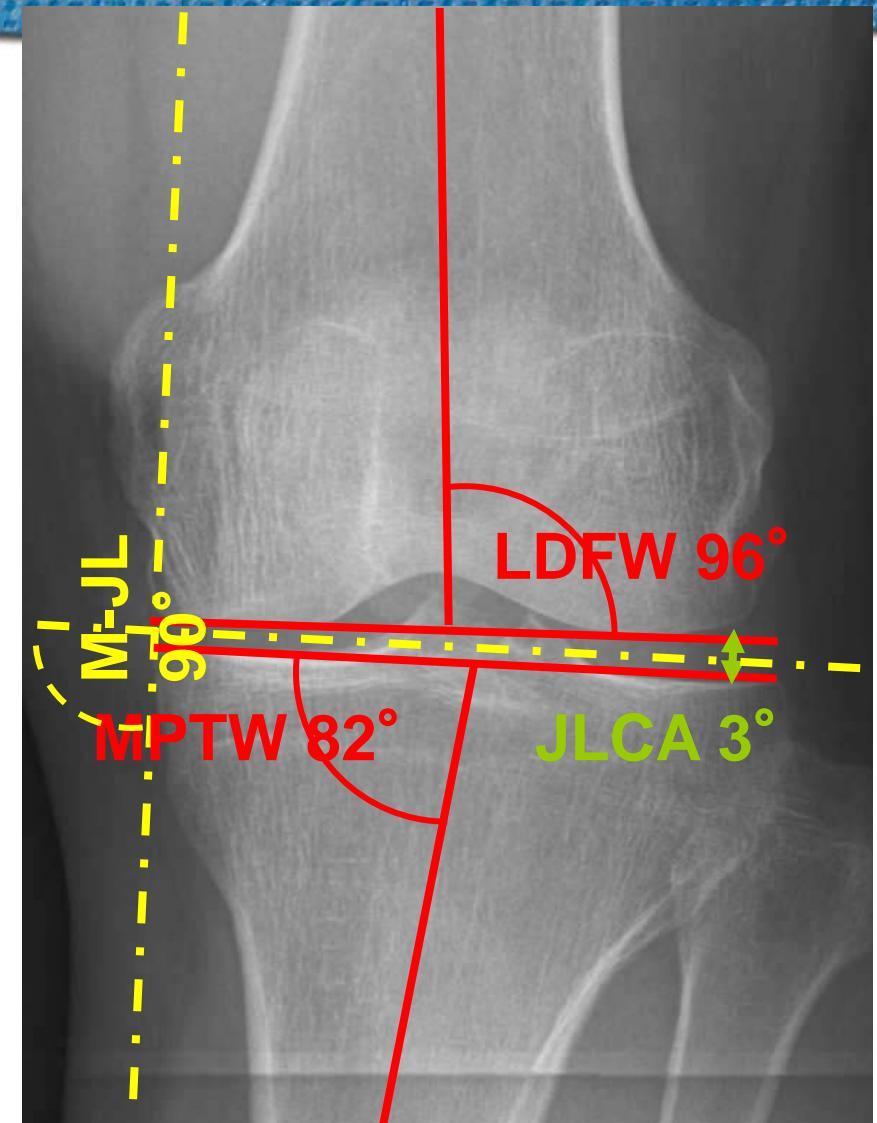
- R.A. 46 y male  
active & sports
- Progresssive pain
- Varus  $12^\circ$
- Arthrosis grade 2-3
- Med. cartilage defect &  
degenerative meniscus
- Therapeutic options?



Long standing x-ray &  
arthroscopy

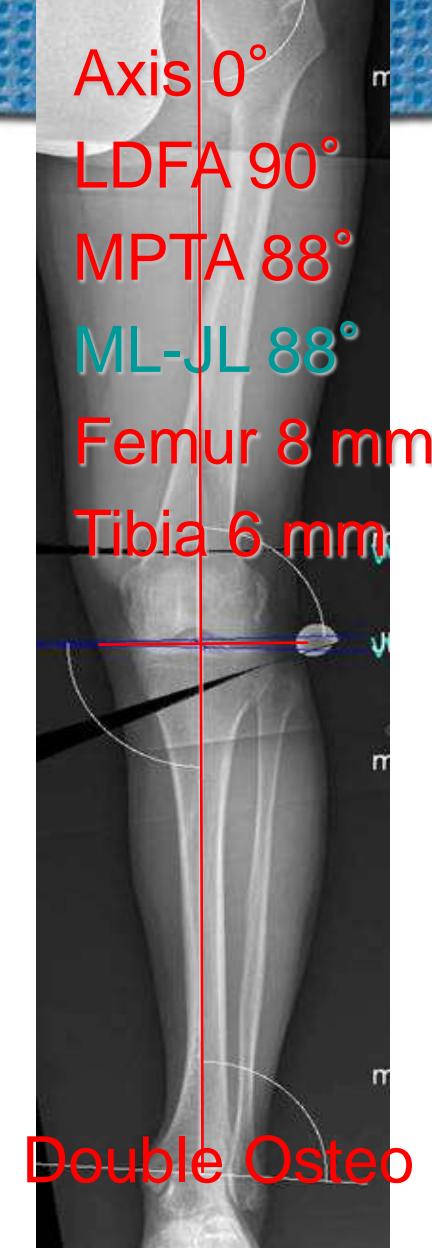
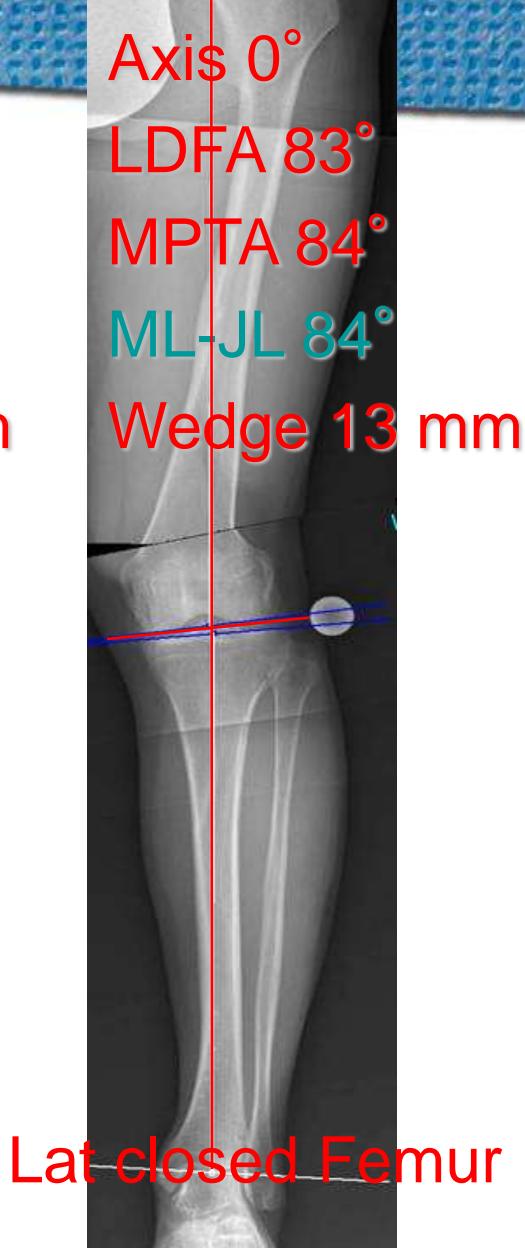
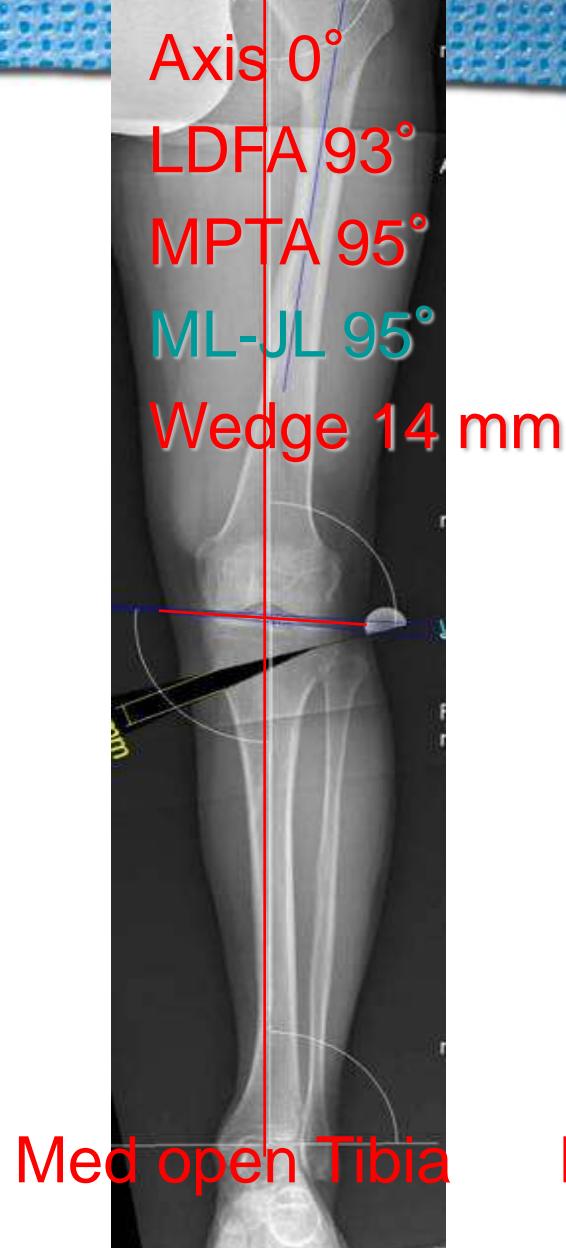
# Analysis Frontal Alignment

- Varus 12°
- LDFA 96°
- MPTA 82°
- Tibiaplateau point 0°
- M-Joint line 90°
- JLCA 3°



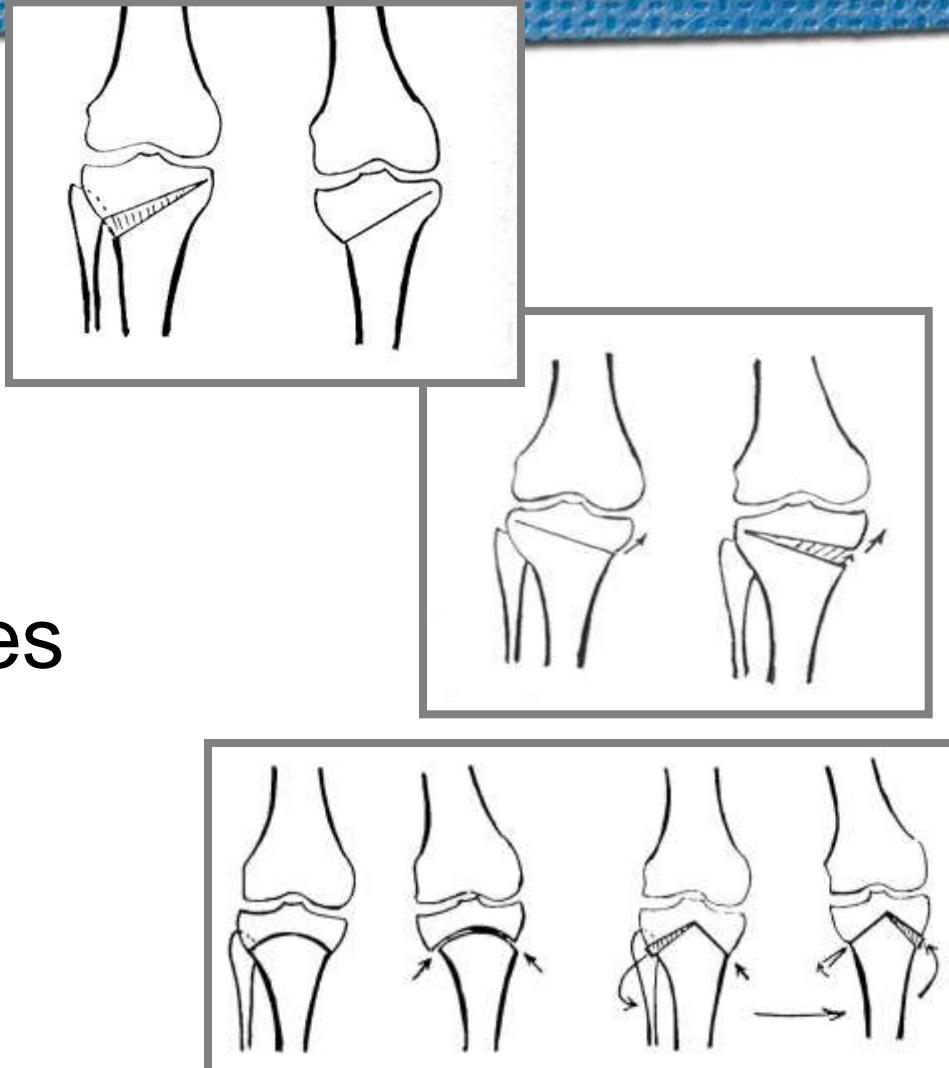
Long standing x-ray

# Planning Joint Line



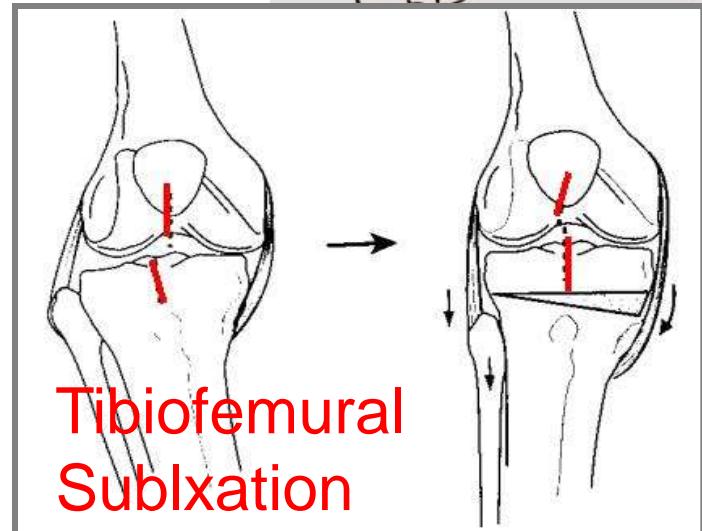
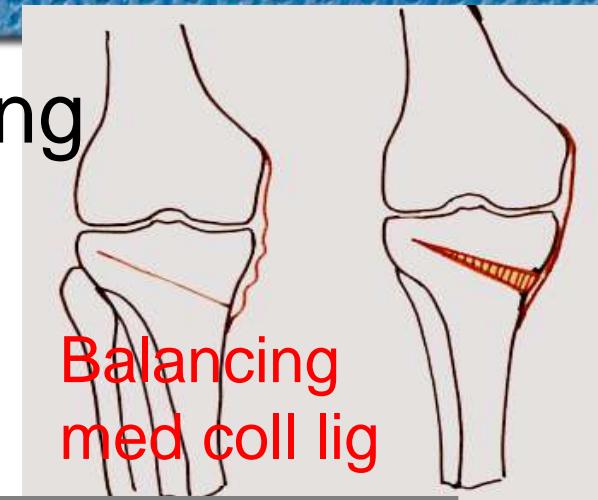
# Surgical Options

- Closed Wedge  
    ⇒ subtractiv
- Open Wedge  
    ⇒ additiv
- Theoretical 10 possibilities
  - ⇒ 4 x Femur (2+2)
  - ⇒ 4 x Tibia (2+2)
  - ⇒ double osteotomy
  - ⇒ dome or pendulum



# Advantages Open Wedge Tibia

- No prox deformation & leg shortening
- No fibula problems
- No opening lat compartment
- No irritation lig patallae
- Only one osteotomy
- Balancing MCL
- Re-centration tibia



Lobenhoffer et al, Thieme 2007  
Osteotomies around the knee

# Open vs Closed Tibia

Criteria	Closed	Open
Technique	Two correction cuts	One correction cut only
Precise correction	Difficult	Simple
Fibula problem	Yes	No
Detachment of muscles	Tibialis loge	No
Nerve damage	Peroneal possible	No
Slope change	Reduction possible	Increasing possible
Ligament balancing	No	Medial possible
Patella baja	Secondary possible	Primary possible
Deformity proximal tibia	Possible	No
Bone transplant	No	Exceptional cases only

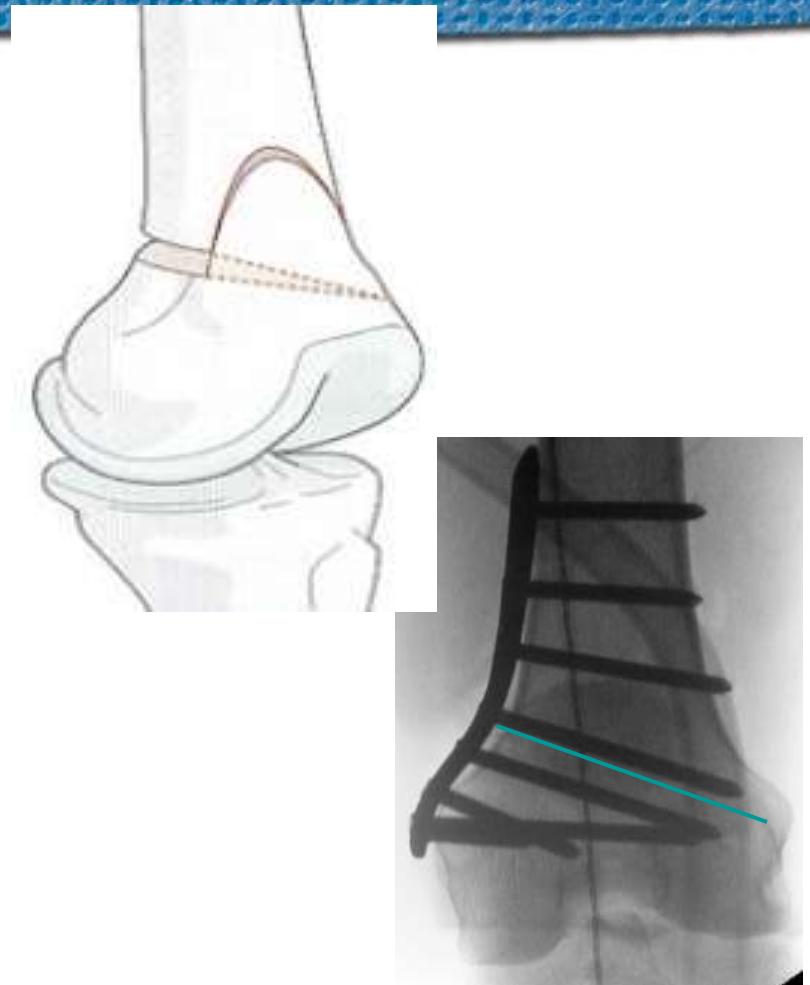
# Femur Osteotomy

- Closed wedge (medial & lateral)
  - ⇒ Standard
- Open wedge (medial & lateral)
  - ⇒ exceptional cases only
- Osteotomy
  - ⇒ outside ligaments
  - ⇒ anatomical # mechanical axis
- Fixation
  - ⇒ angle stable plates



# Technique Closed Wedge Femur

- Biplanar osteotomy
  - ⇒ rotational stability
  - ⇒ more bone contact
- Descending osteotomy
  - ⇒ better fit fragments
  - ⇒ more spongy bone
- Preserves suprapatellar fat pad and recessus
- Angle stable plates



Brinkmann et al, KSSTA 2011

# Outcomes of osteotomy

- Cochrane – Silver Evidence  
    ⇒ 70% benefit 10 years
- Classical survival rates  
    ⇒ 5 years 73 %  
    ⇒ 10 years 52 %
- Selected patients  
    ⇒ Survival 10 y 90%
- New concept  
    ⇒ promising results

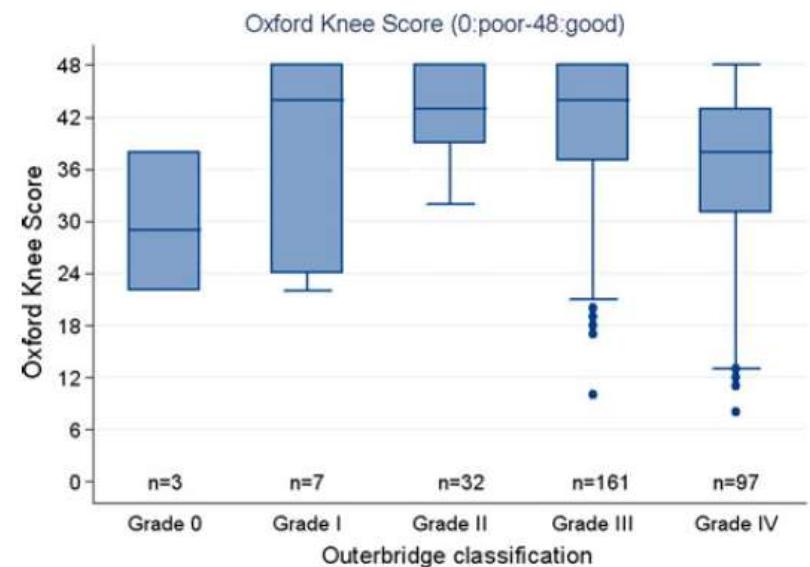
Table 2  
Results of Select Recent Series of High Tibial Osteotomy to Manage Varus Gonarthrosis

Study	Number	Mean Follow-up In Years (range)	Mean Age (yr)	Technique	Outcomes
Niemeyer et al <sup>26</sup>	43 pts	2 (6-24 mo)	47.3	Opening wedge, using plate and autologous iliac crest bone graft	68% good or excellent
Omori et al <sup>26</sup>	37 pts (48 knees)	17 (14-24)	59	Closing wedge using threaded pins and figure-of-8 wiring	77% good or excellent
Akizuki et al <sup>24</sup>	132 pts	16 (16-20)	63	Closing wedge using a plate	98% survival at 10 yr, 90% survival at 15 yr
Gstöttner et al <sup>27</sup>	111 pts (134 osteotomies)	12 (1-25)	54	Closing wedge using a staple	80% survival at 10 yr, 66% survival at 15 yr
Chiang et al <sup>29</sup>	16 pts (19 knees)	15 (13-16)	58	Dome-shaped, using external fixation	68% good or excellent
Polyzois et al <sup>30</sup>	95 pts	8 (5-11)	69	Closing wedge using plate	61% good/excellent
Tang and Henderson <sup>25</sup>	67 knees	6.5 (1-21)	49	Closing wedge using plate or staple	75% survival at 10 yr, 67% survival at 15 yr

Feeley et al, J Am Acad Orthop Surg 2010

# Results New Concept

- Prospective multicenter (3)  
369 knees @ 49 y (18-84)
- FU 3.6 years (2-5)
- 6 % Complications
- 98% Survival (3-5 years)
- No correlation OA stage
- Oxford Score 43 (8-48)
  - ⇒ UKA 39
  - ⇒ TKA 35-40



Floerkemeier et al, KSSTA 2013

# Treatment Concept Stolzalpe

- All patients pre arthritic deformities
  - ⇒ long x-rays
  - ⇒ Deformity analysis
- Malalignment  $> 4^\circ$ 
  - ⇒ osteotomy ?
- Patellofemoral joint ?
- Tibia open & femur closed wedge angle stable plates
- 10% double osteotomies



# Summary

- Osteotomy still „golden standard“
  - ⇒ young & active patient
- Better understanding of
  - ⇒ biomechanics & planning
  - ⇒ patient selection
- Proper surgical technique & stable osteosynthesis allows early mobilisation
- Combined with cartilage & ligament repair
- New concept mid term results promising

