

The **remains** of  
**ACL GRAFT TENSION**  
after cyclic knee motion

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# Successful ACL reconstruction

- **Mechanical factors**

- graft properties (mech., structural)
- graft preconditioning

- **initial graft tension**

- graft “isometry”
- graft fixation
- postop management

- **Biological factors**

- postop haemorrhage
- postop synovitis
- cytokines
- cell infiltration
- revascularisation



# Graft tension , knee stability

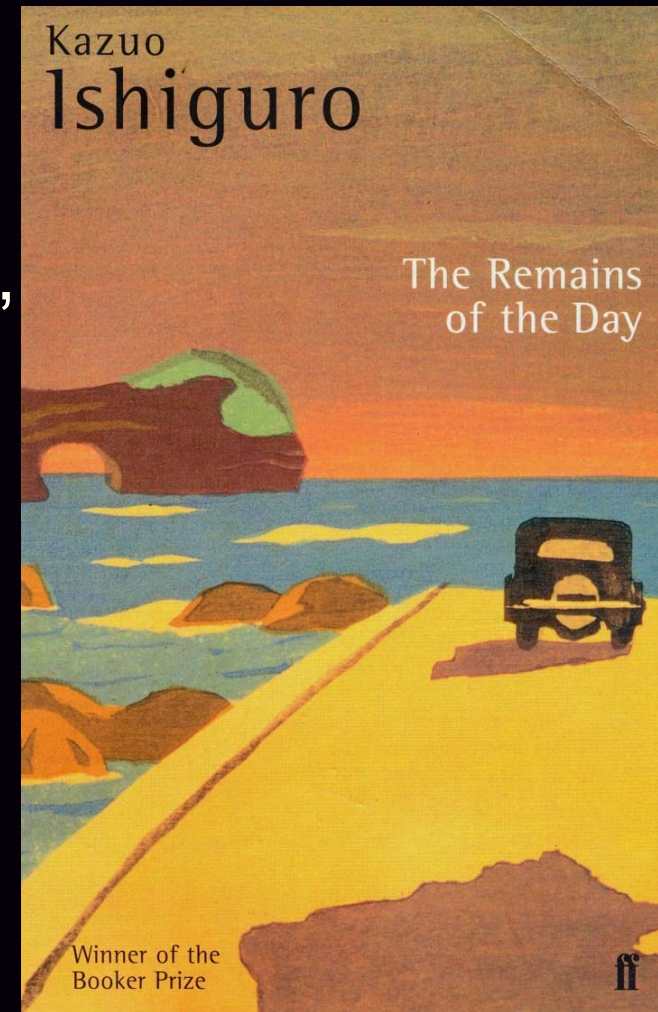
- Graft remodelling,  
“ligamentization”  
Amiel, JOR, 1986
- Graft tension affects  
remodelling
- Narrow range of ideal tension  
Tohyama, ESSKA Journal, Suppl., 1998
- Interrelation between graft  
tension and knee stability  
Friederich, ESSKA Journal, Suppl., 1998



# Remains of initial graft tension ?

- **Hypothesis :**
  - Identical endpoint for all grafts, end tension independent from start tension
  - Drop of graft tension early in rehabilitation

Anthony Hopkins



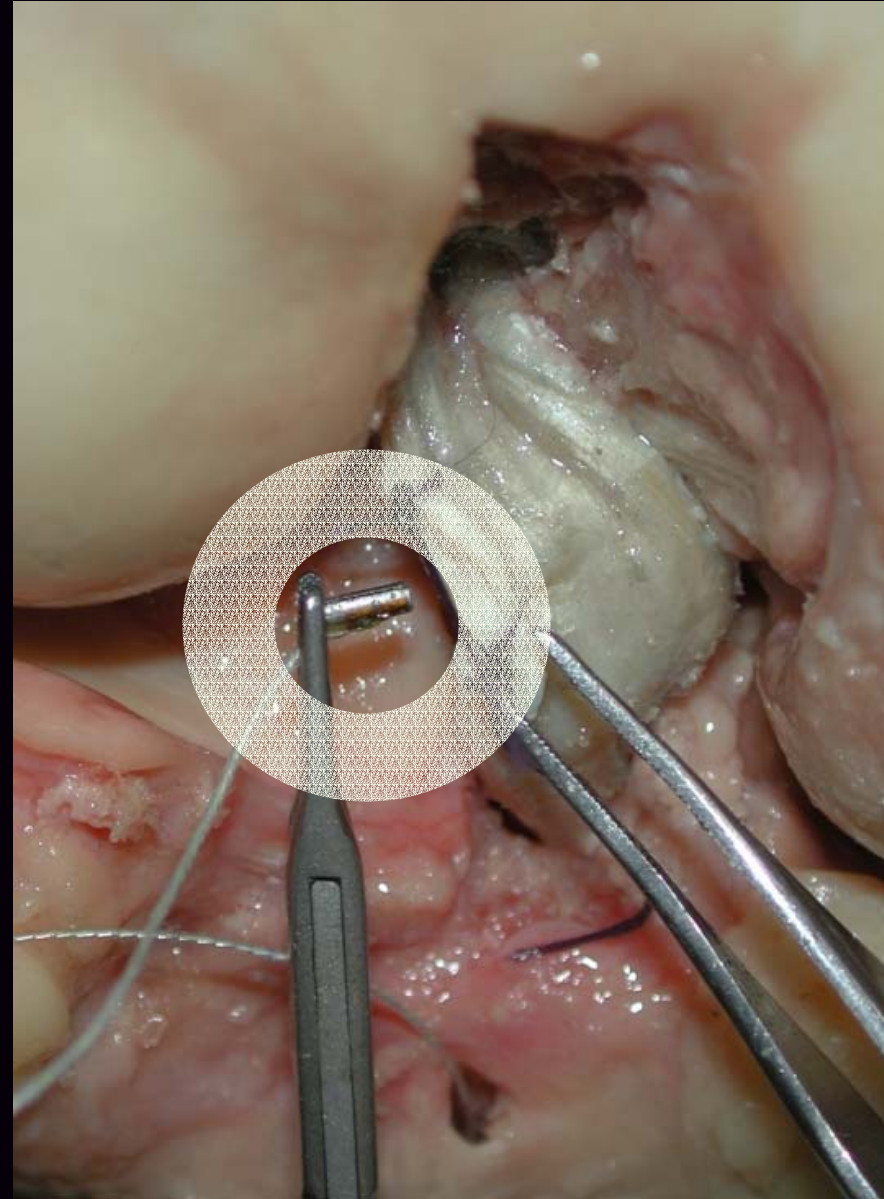
# M & M

- 8 Dutch knees
- Knee and graft preparation  
(Amis, JBJS Br, 1989, 819-24)
- Intact knee:  
Defined extension position  
(2 Nm femur)
- Instron: - laxity with  
- without ACL



# M & M

- **ACL reconstruction:**
  - femoral fixation with interference screw plus an external post
- **AIFP transducer:**  
(Arthroscopically Implantable Force Probe)
  - implant
  - calibrate (strain / graft force)
- **Strain:**
  - change in length divided by the original length  
 $\epsilon$  (Epsilon) =  $\Delta L / L_0$



# M & M

- Preconditioning of graft  
30N / 20 min
- Preconditioning knee with graft:  
20 cycles prior to calibration
- Calibration of graft and transducer  
0-70 N twice



# AIFP calibration

- **3 criteria for a functional transducer:**
  - Lachman
  - full extension
  - direct pull on graft

give immediate and adequate response
- **Re-calibration after tests**



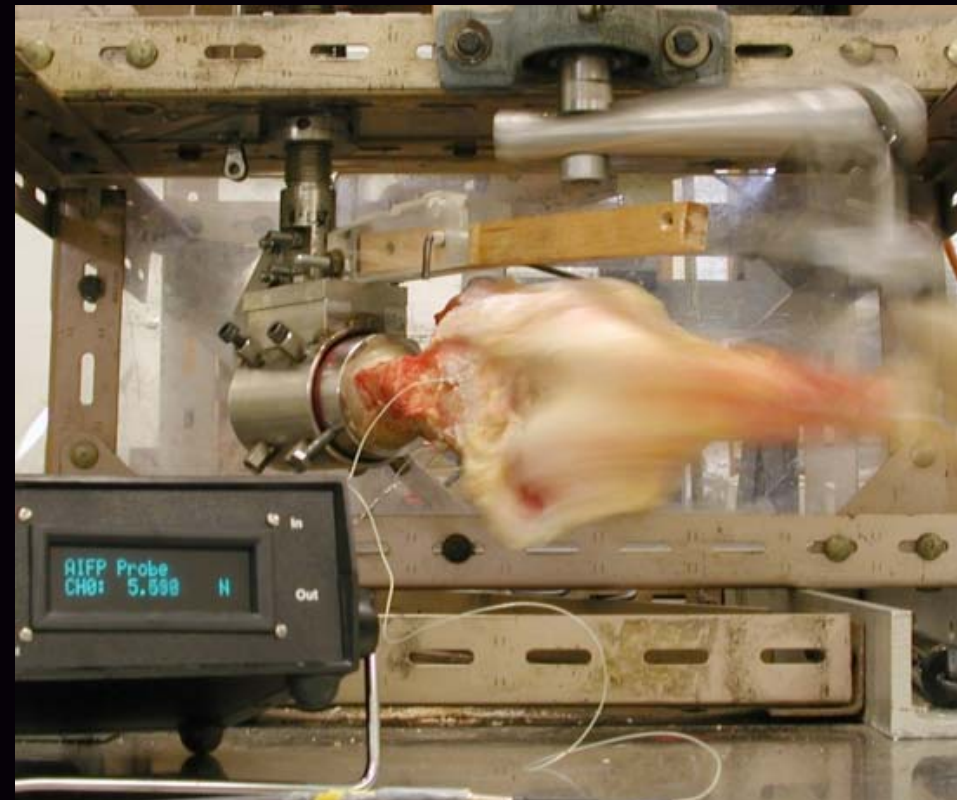
# With and without Instron

- Each knee 2 grafts
- Graft 1: without
- Graft 2: with Instron
- the pure effect of cyclical graft loading ?
- drop in graft tension, increase in laxity ?



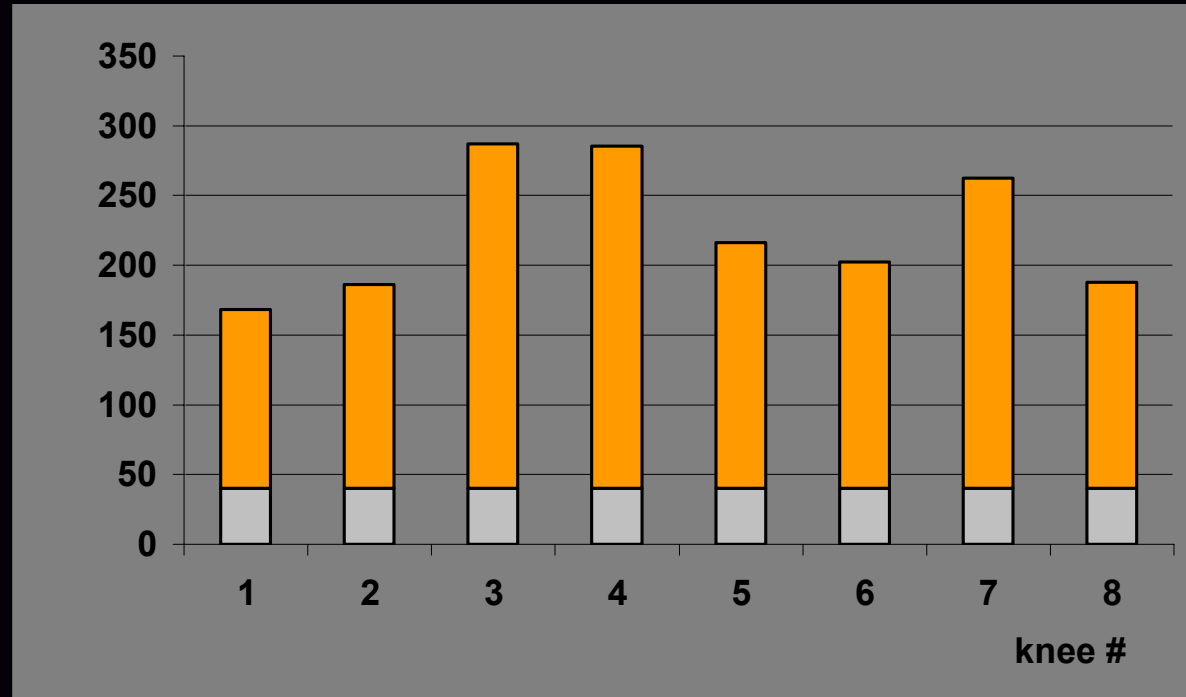
# Pretension , Tests

- **Startpoint** : 40N / 20 degrees
- Cyclical loading:  
Flexion-extension rig  
50 cycles / minute
- Strain / Tension after  
0, 20, 50, 100, 200, **500**, 1000  
and **1500** cycles  
(Instron in graft 2)
- Recalibration of transducer



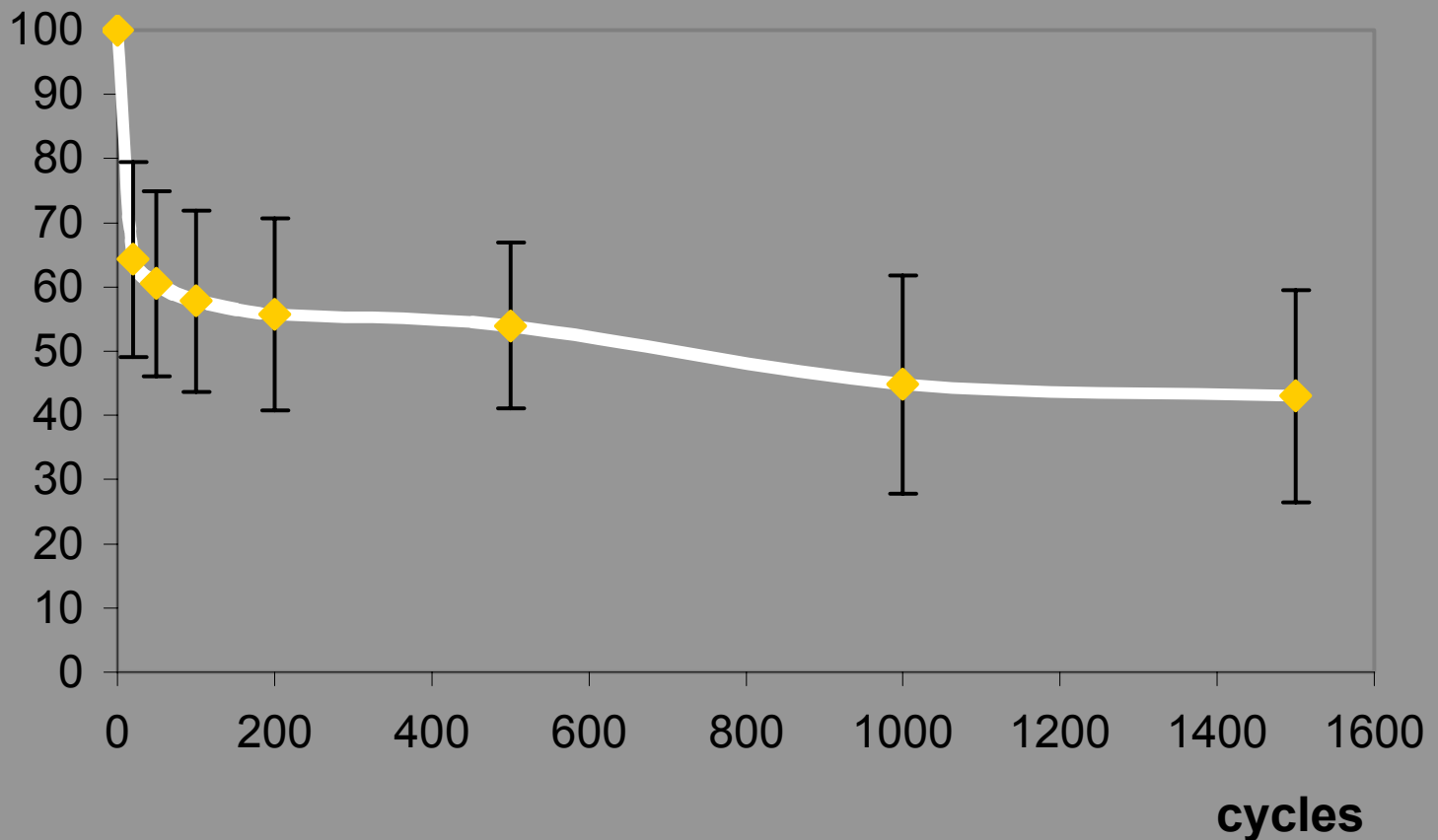
# Results

- Graft tension in “extension”
- Calibration: linear correlation strain / N
- No graft slippage



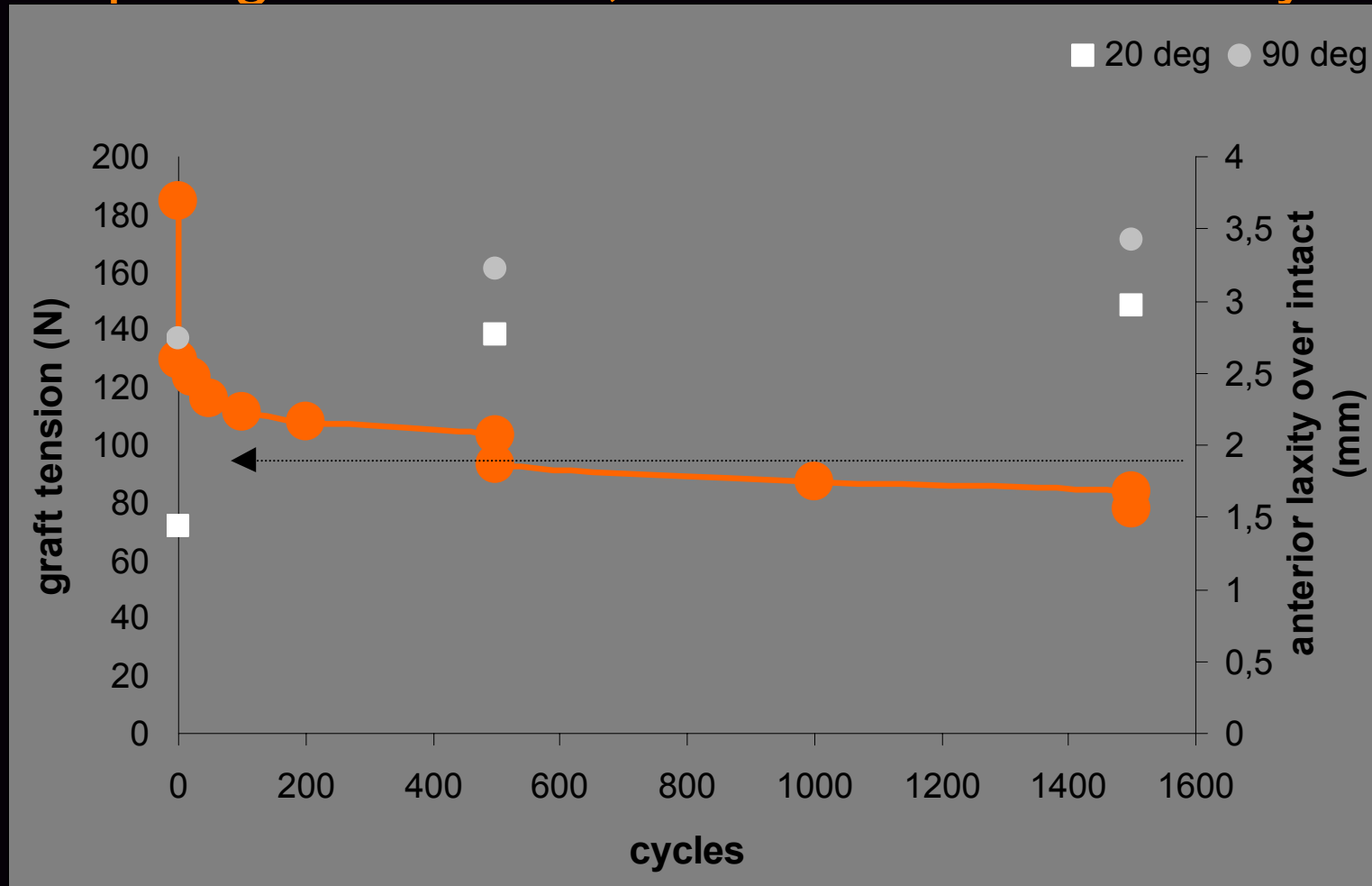
# Results

## Graft tension without Instron - test



# Results

Drop in graft tension, increase of knee laxity



# Discussion

- AIFP transducer: reliable but difficult to handle  
Fleming, J Biomech, 2000 / Markolf, JOR 1998
- Tension in a part of a bundle measured, not the whole graft
- Reliability confirmed by recalibration
- Significant graft tension losses despite thorough preconditioning protocol

# Conclusion

- **50%**

- of the initial tension in a b-pt-b graft remain after 1500 cycles

- the large drop happens in the first 100 cycles



**merci**

