

# Instructional course lecture # 25



Old and new approaches to meniscal repair.

Regency Ballroom I

Thursday April 7; 7:00-8.30 a.m.

## Questions:



"You loose your time !"

"You loose the patient's time !"

"You have more complications !"

"The techniques are complicated !"

"New repair techniques are expensive !"

"You are not even sure that it protects the patient from further cartilage damage."

- Why do we suture a meniscus ?

## Participants & topics:

- Romain Seil - Luxembourg:

Biomechanics of meniscal repair (15 ')

- Mark Clatworthy - Auckland, New Zealand:

Meniscal sutures: indications, techniques and results (15 ')

- Uffe Jorgensen - Copenhagen, Denmark:

New repair techniques: indications, techniques and results (15 ')

- Dilworth Cannon - San Francisco, California:

Meniscal repair: what have we learned and where do we go from here ? (15 ')

- Discussion (25 ')



# Biomechanics of meniscus repair

Romain Seil, M.D.

Dept. of Orthopaedic  
Surgery



Centre Hospitalier  
de Luxembourg

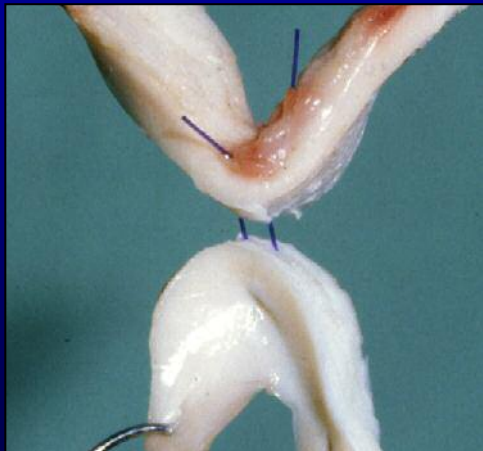
# Literature

1989	Kohn D & Siebert W
1995	Rimmer MG
1997	Post WR, Albrecht-Olsen PM, Asik M, Dervin GF,
1999	Boenisch UW, Song EK
2000	Barber FA, Seil R, Song EK,
2001	Arnoczky SP, Becker R, Fisher SR, Seil R, Walsh SP
2002	Asik M, Becker R, Bellemans J, Fisher SR, Karaoglu S, Rankin CC
2003	Borden P, Dürselen L, Mc Dermott ID, Seil R
2004	Zantop T
2005	Zantop T



28 studies

**Goal: To evaluate & improve  
mechanical factors  
of meniscus repair complex**



# Evaluation criteria

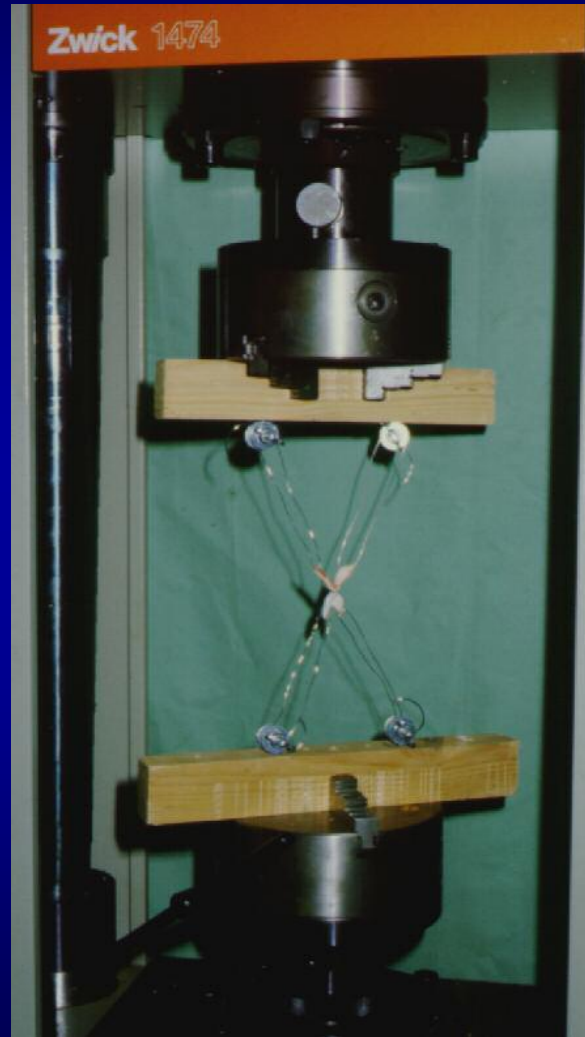
## Tensile fixation strength / stiffness

- Anatomy of the meniscus
- Type of tissue
- Type of test
- Type of implant / suture material
- Implantation technique / suture type
- Animal experiments



# Biomechanical testing

↑  
uniaxial loading  
↓

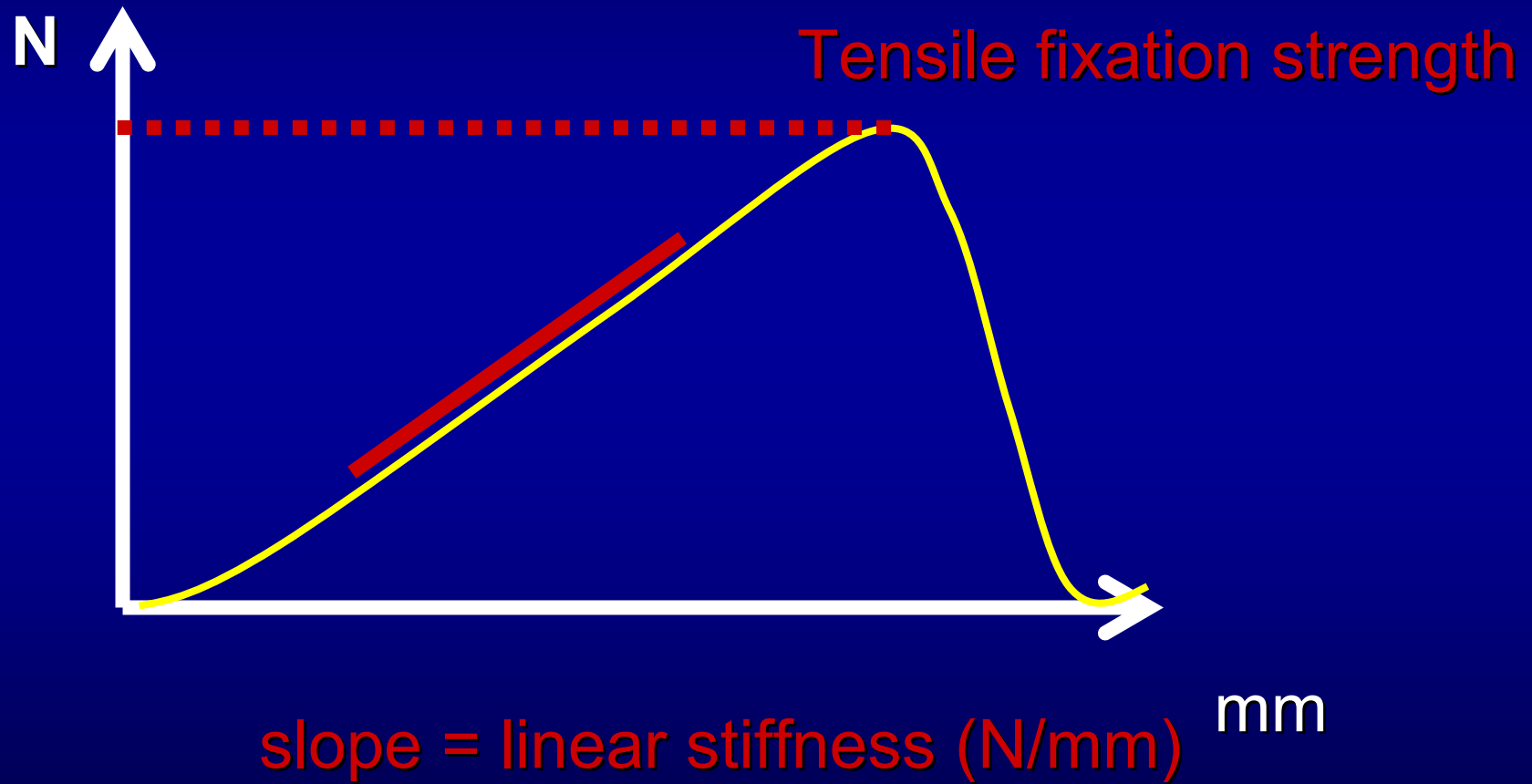


cross-head  
speed  
(mm / min)

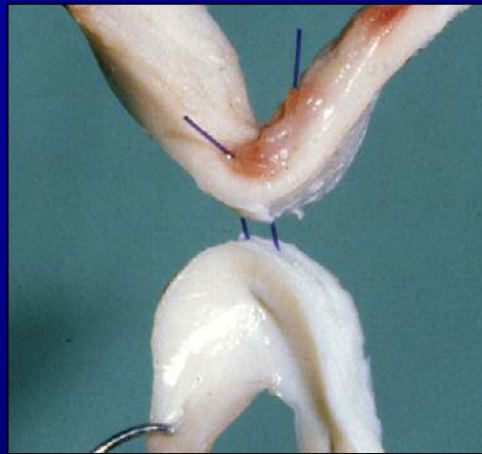


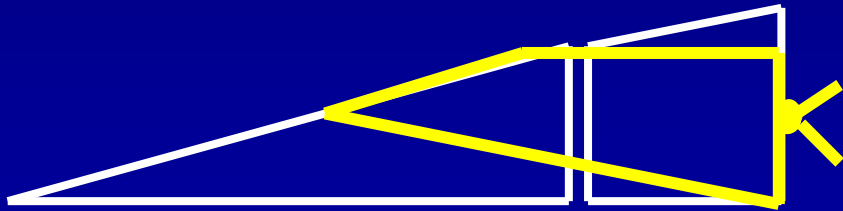


# Load-displacement curve



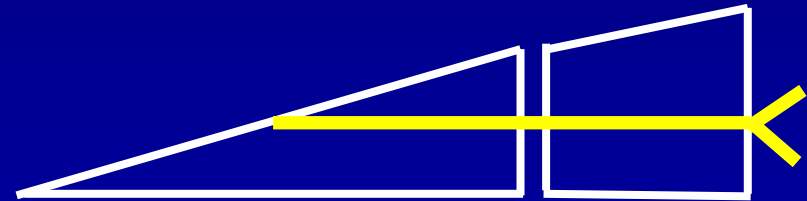
# Sutures





**vertical sutures**

**>**

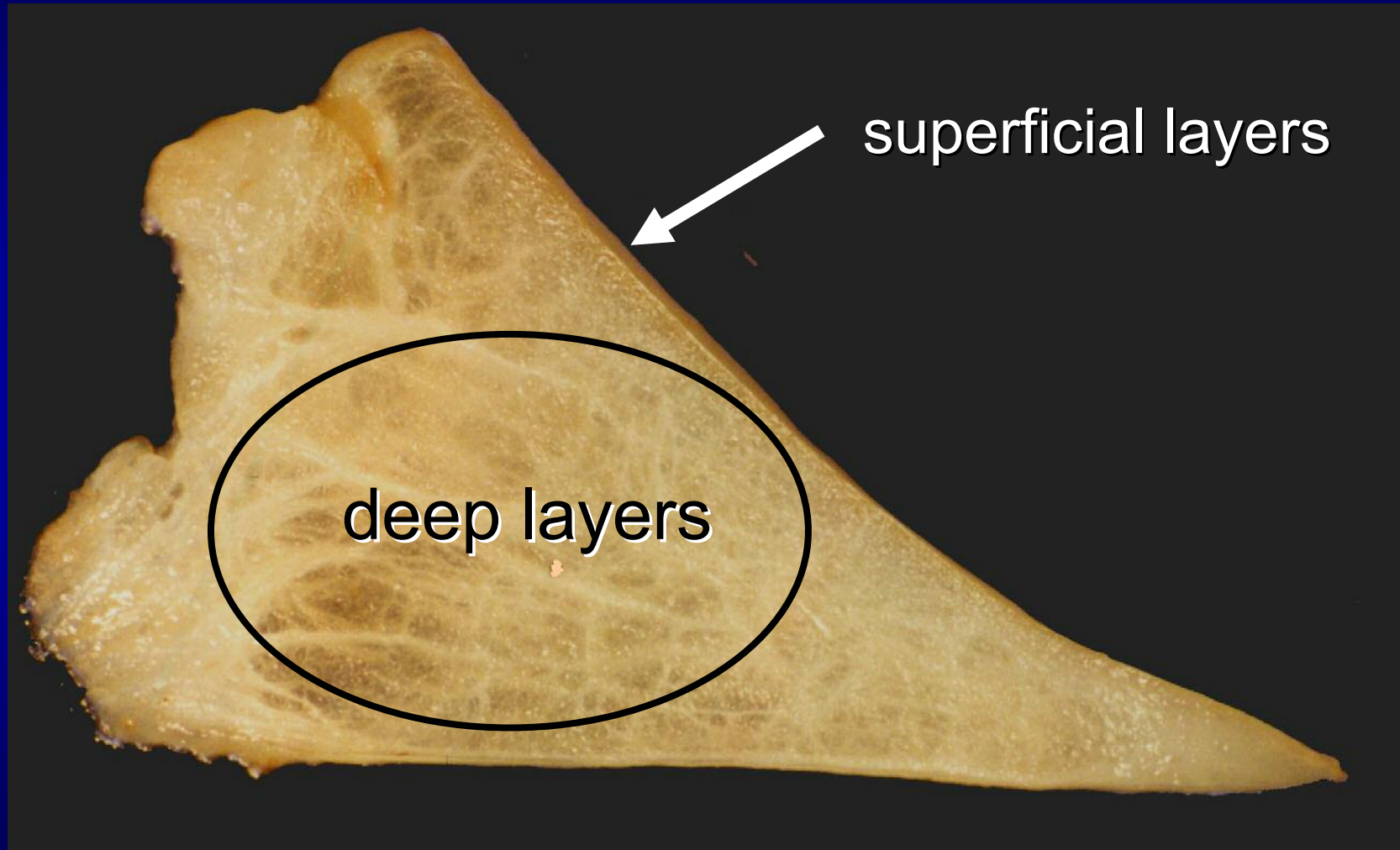


**horizontal sutures**



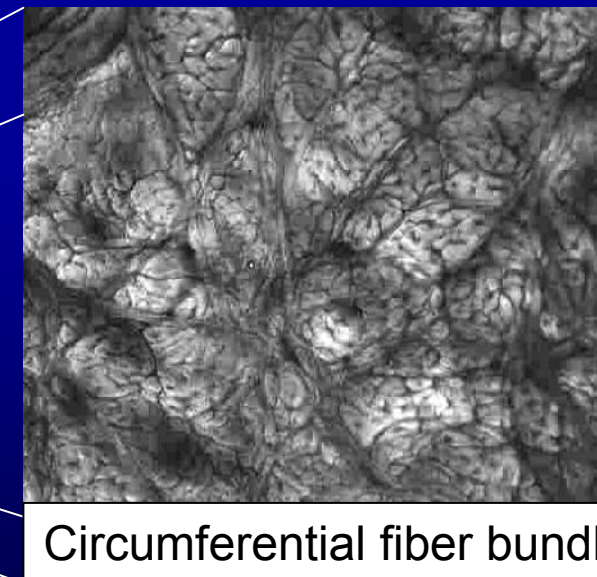
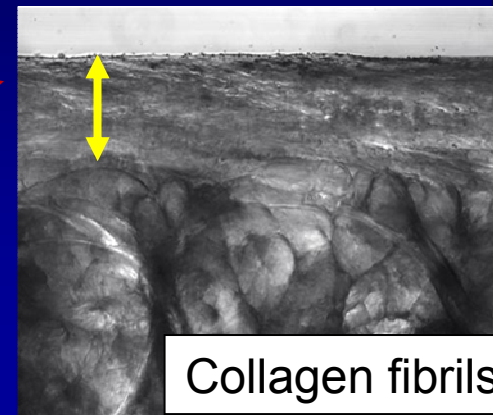
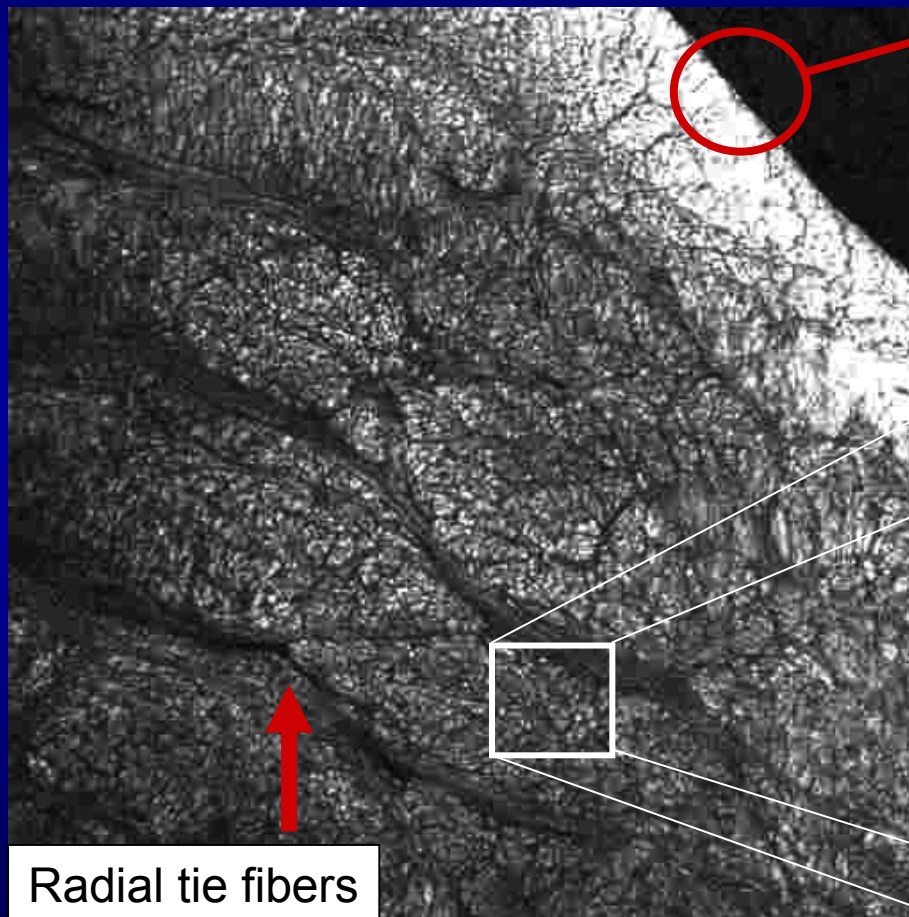
Kohn D, Siebert W, 1989

# Collagen fiber orientation



Courtesy of Prof. C. Fink, Innsbruck

# Microscopic anatomy

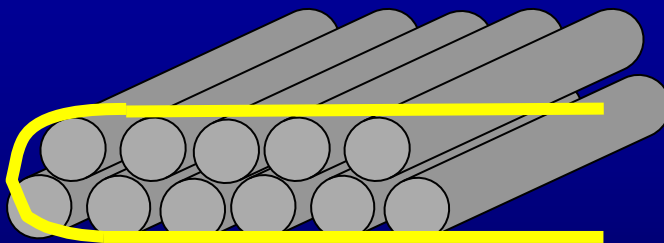
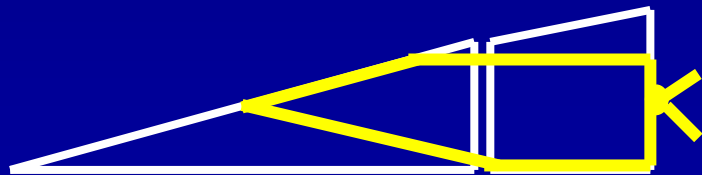


Courtesy of Prof. C. Fink, Innsbruck

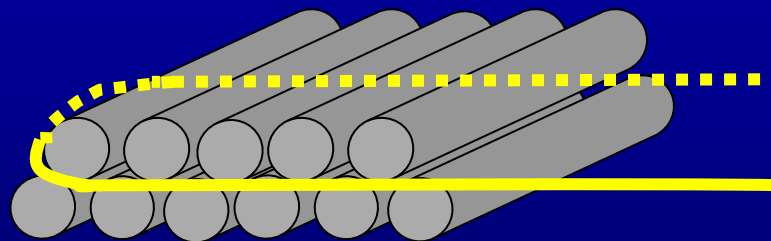
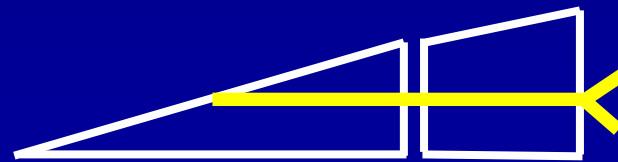


# Collagen fiber orientation

**Vertical sutures**

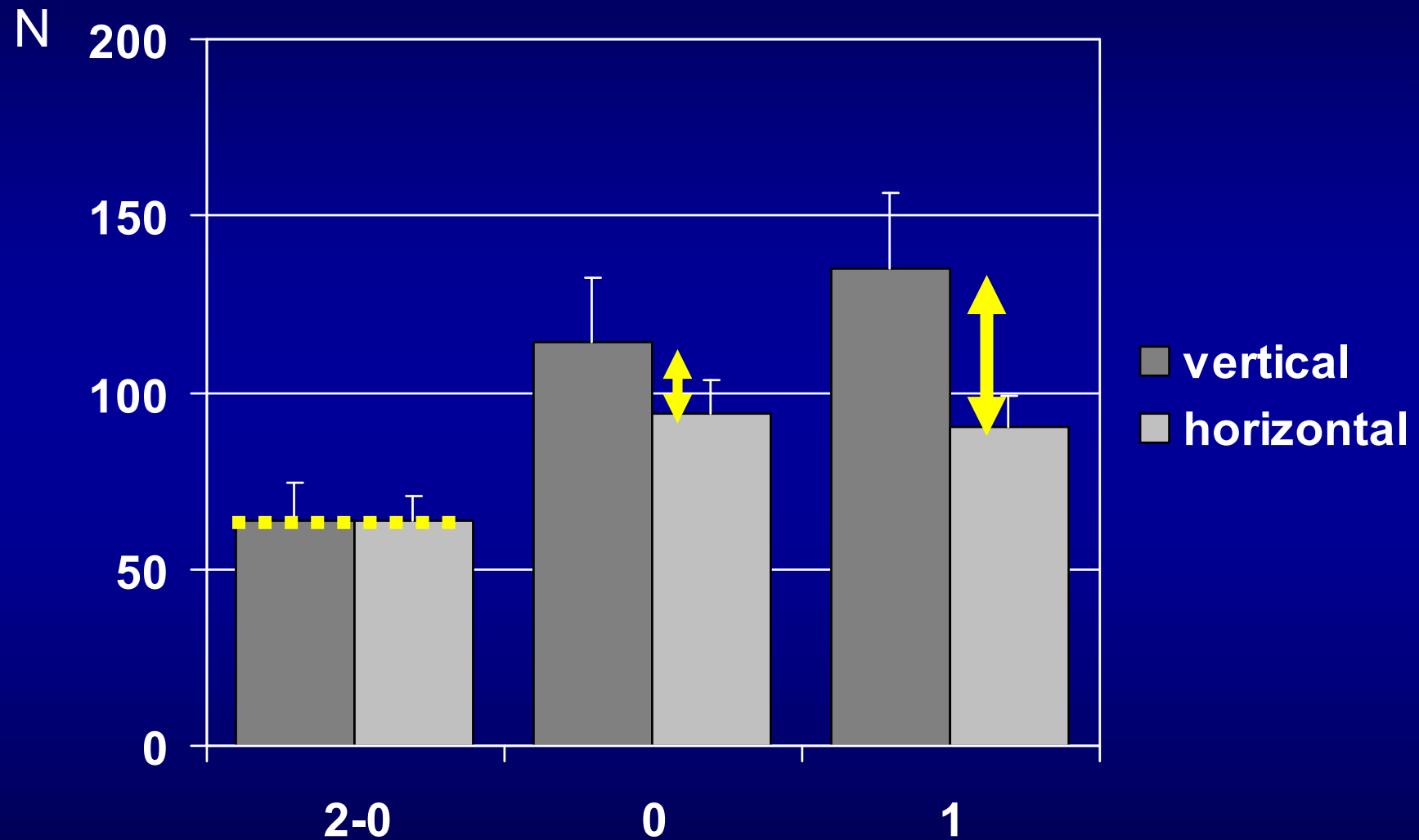


**Horizontal sutures**



Kohn D, Siebert W, 1989

# Suture material



Mattress sutures

Seil R, 2001

# New repair devices



1st generation



2nd generation

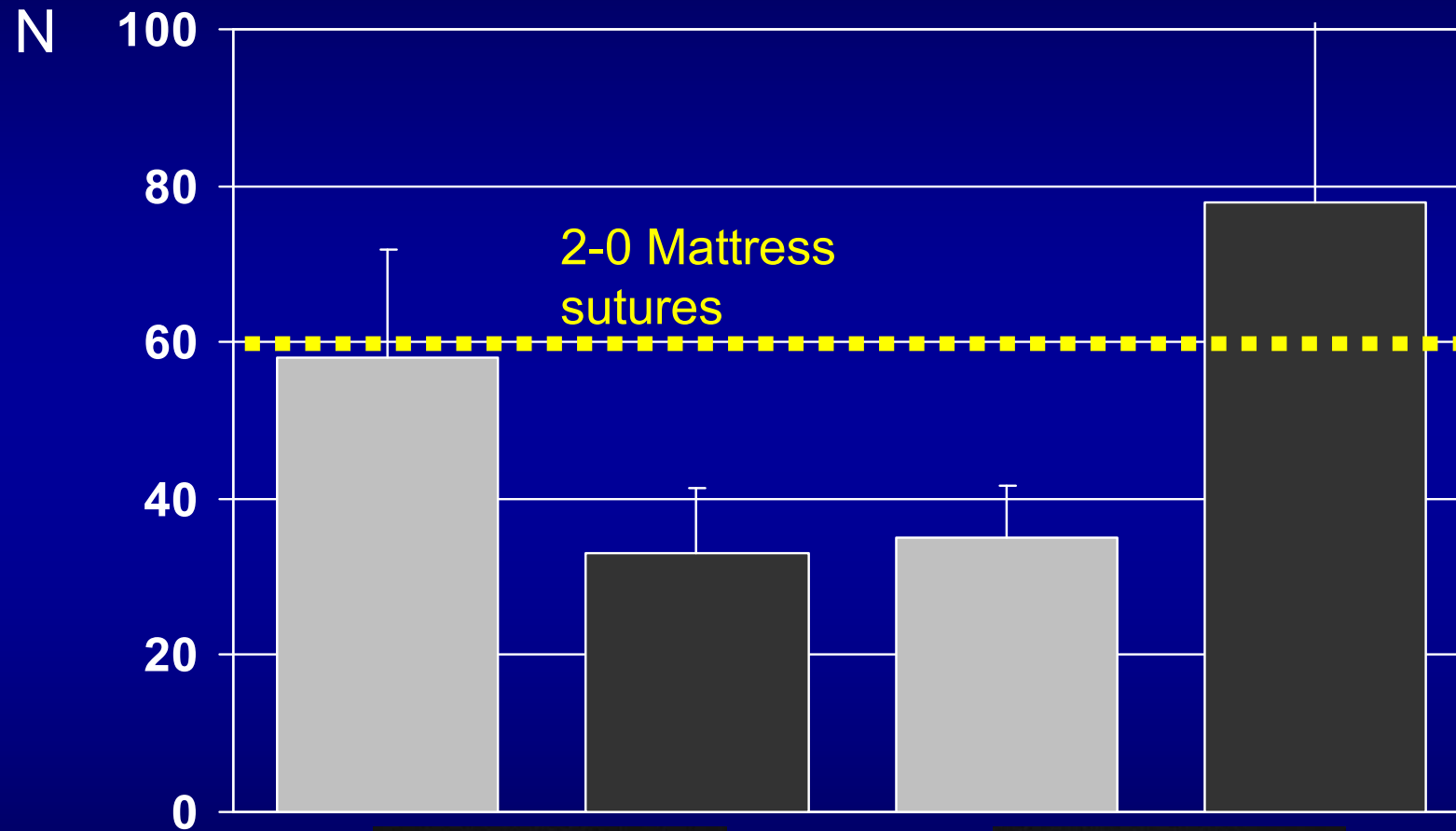


3d generation





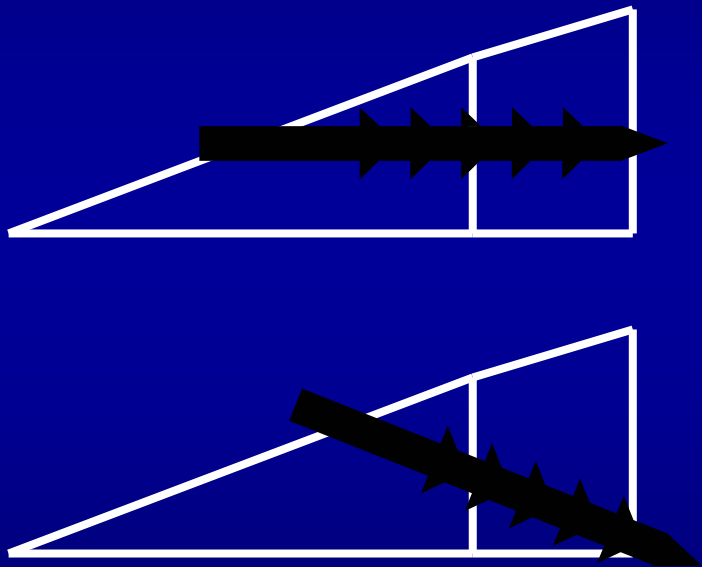
# Tensile fixation strength



■ Arnoczky SP, 2001

■ Barber FA, 2000

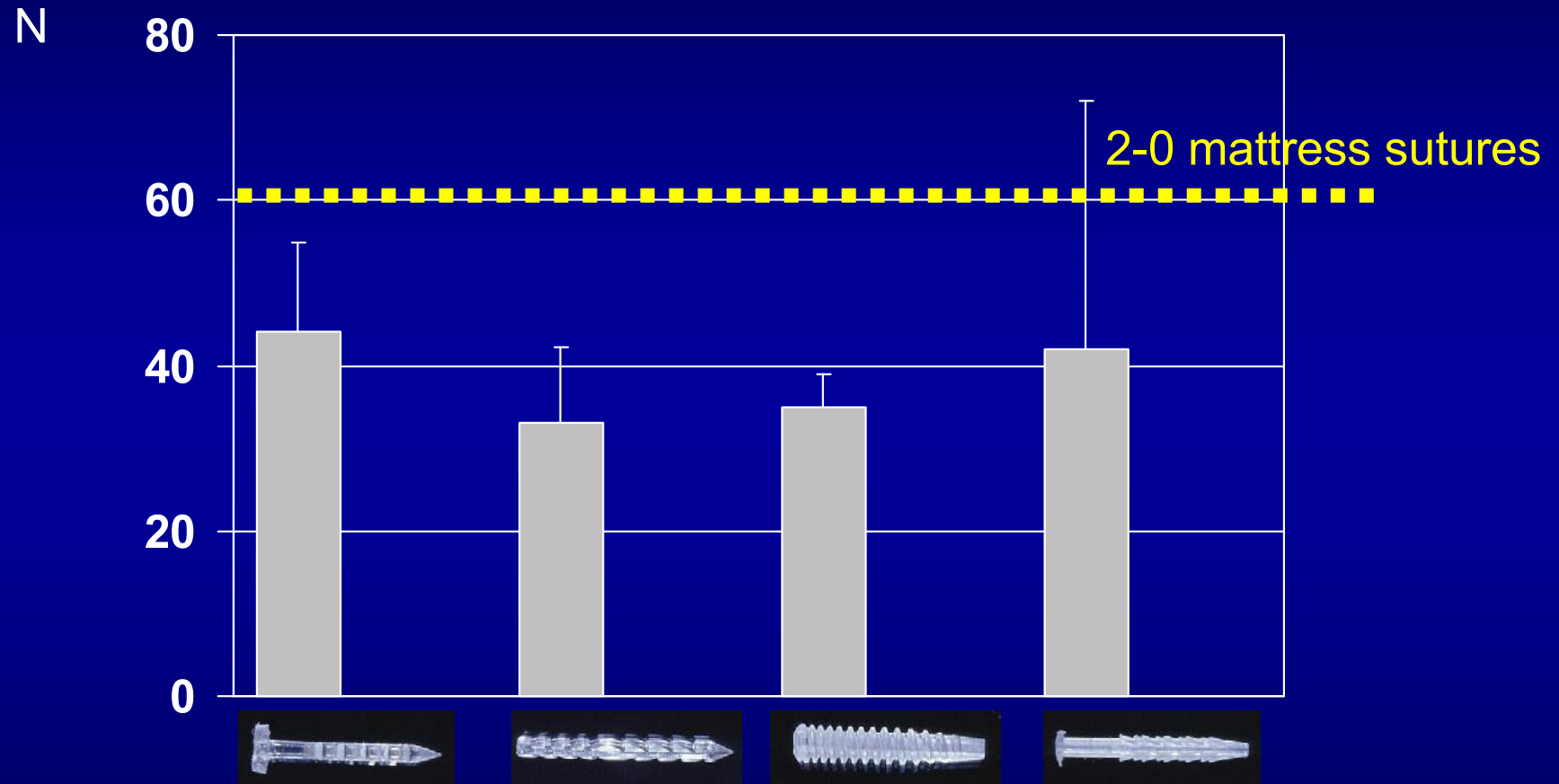
# Importance of insertion angle



Failure strength ↘ 66%

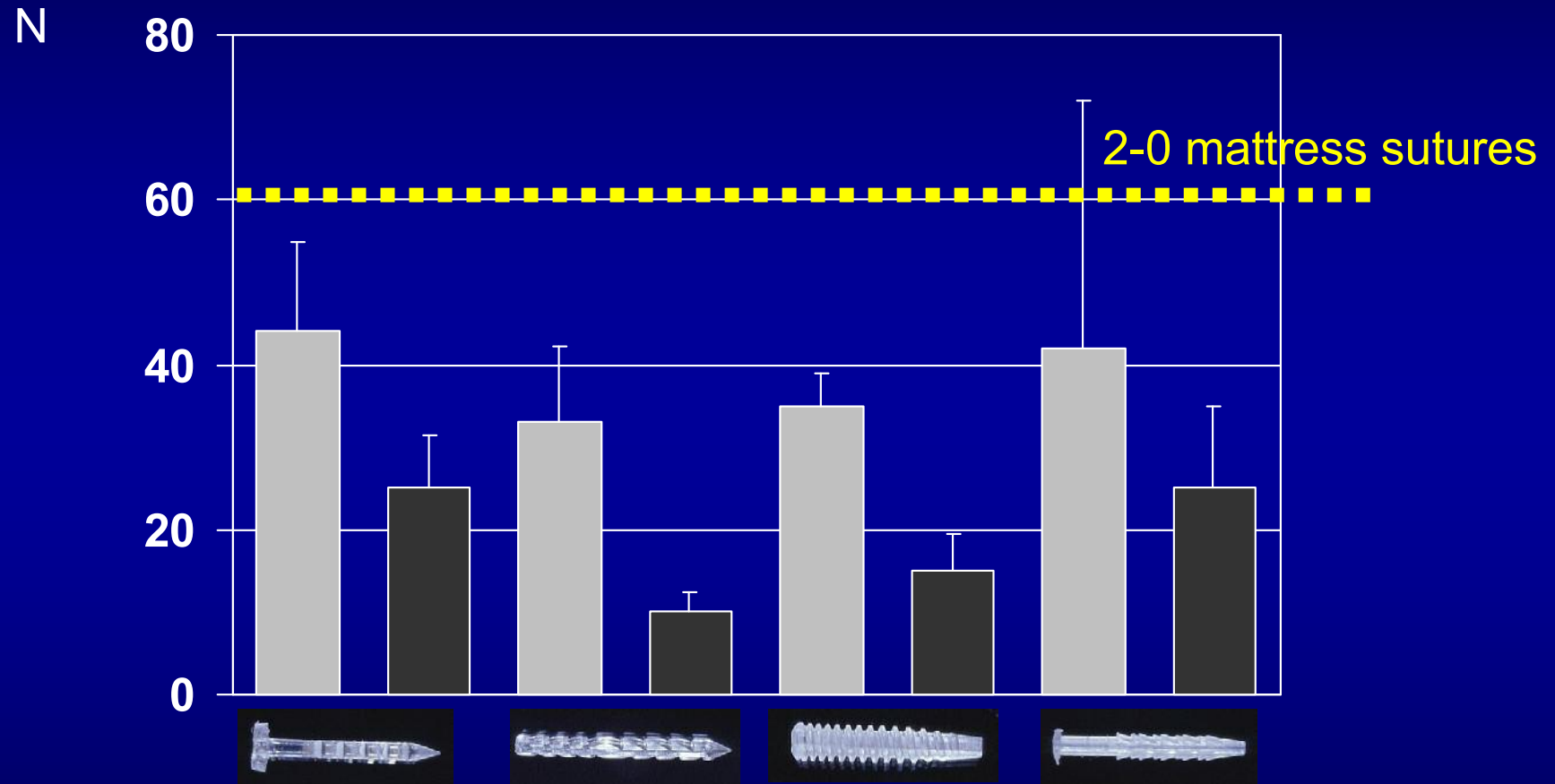


# Importance of donor tissue



■ Porcine  
Seil R, 2003

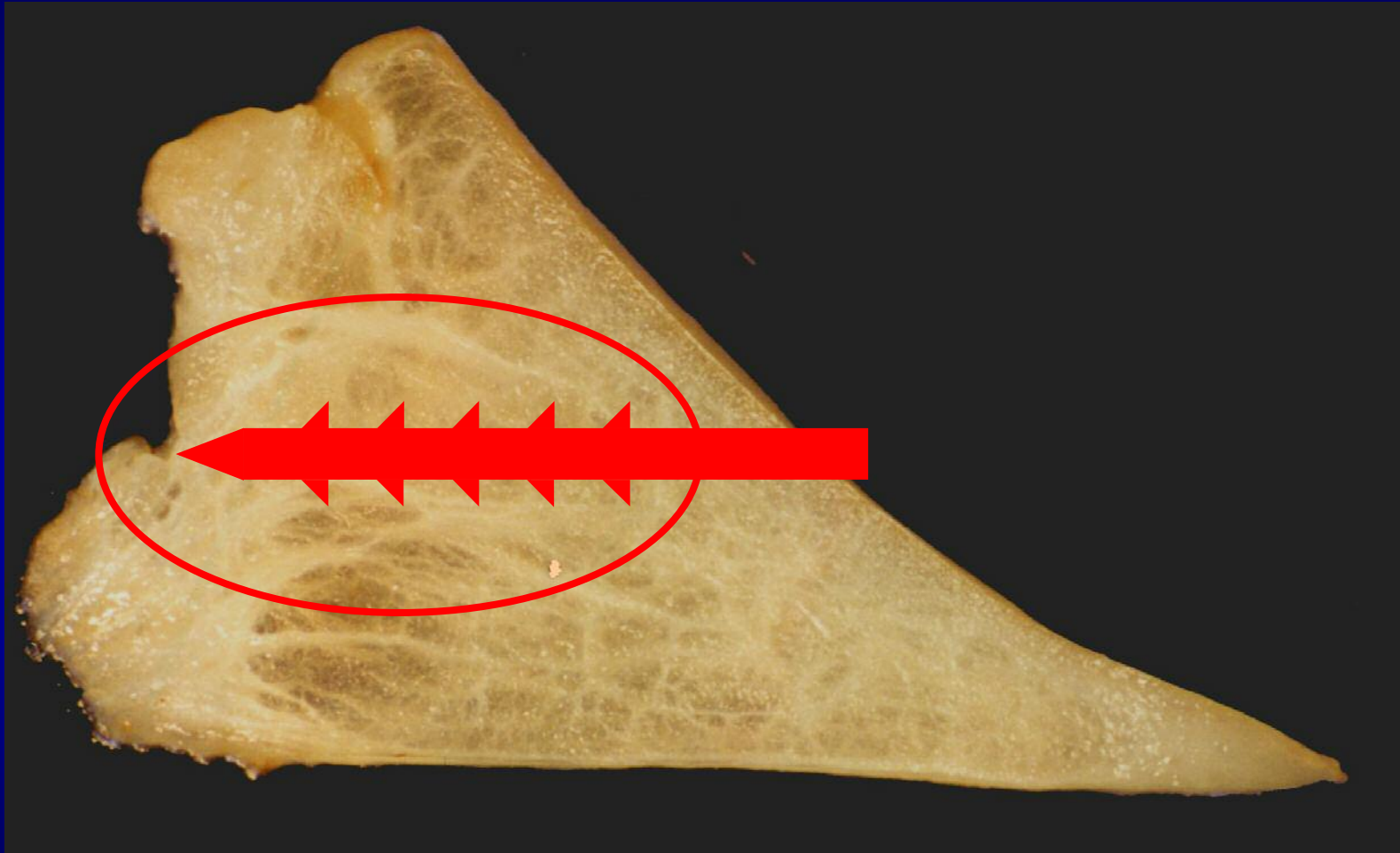
# Importance of donor tissue



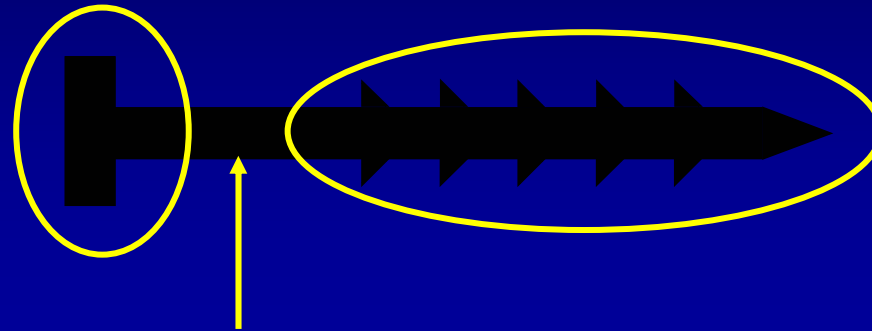
■ Porcine  
Seil R, 2003

■ Human > 60  
Becker, R 2002

# Central tissue degeneration ?



# Other biomechanical factors



## Design & material properties

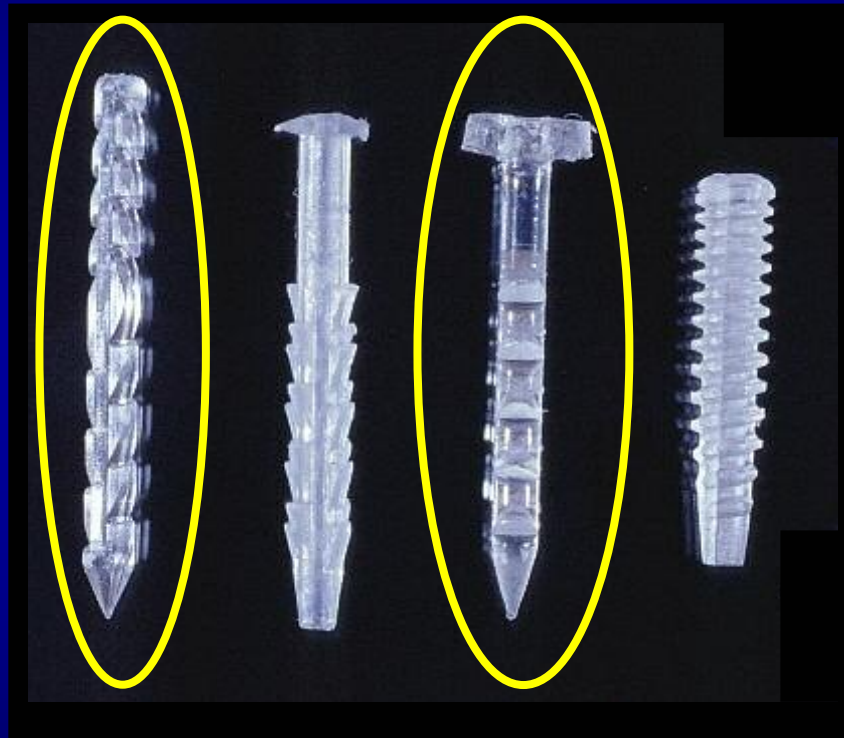
**Thickness / Elasticity**

**Form / Head / Barbs**



# Thickness / elasticity

## Maximum failure test: fractures



**40 %**

**17 %**

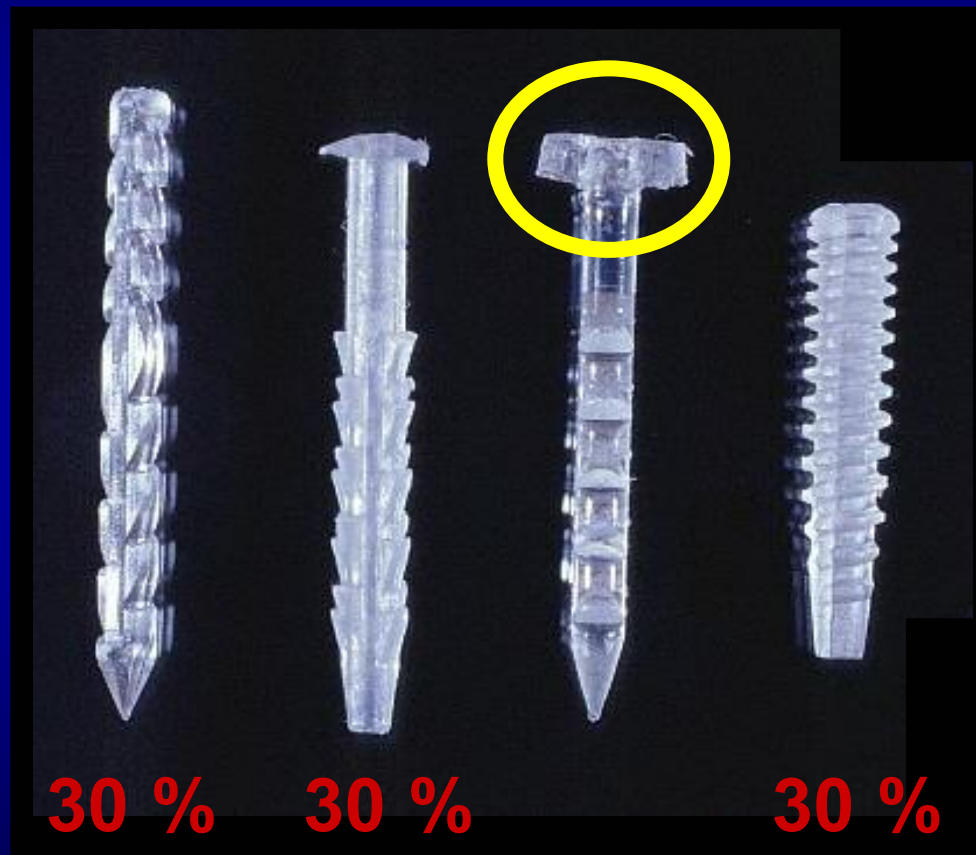
Arnoczky SP, 2001

Seil R, 2003



# Design: Head

## Cyclic loading: Failures





# Design: Barbs

Cyclic loading: Gapping



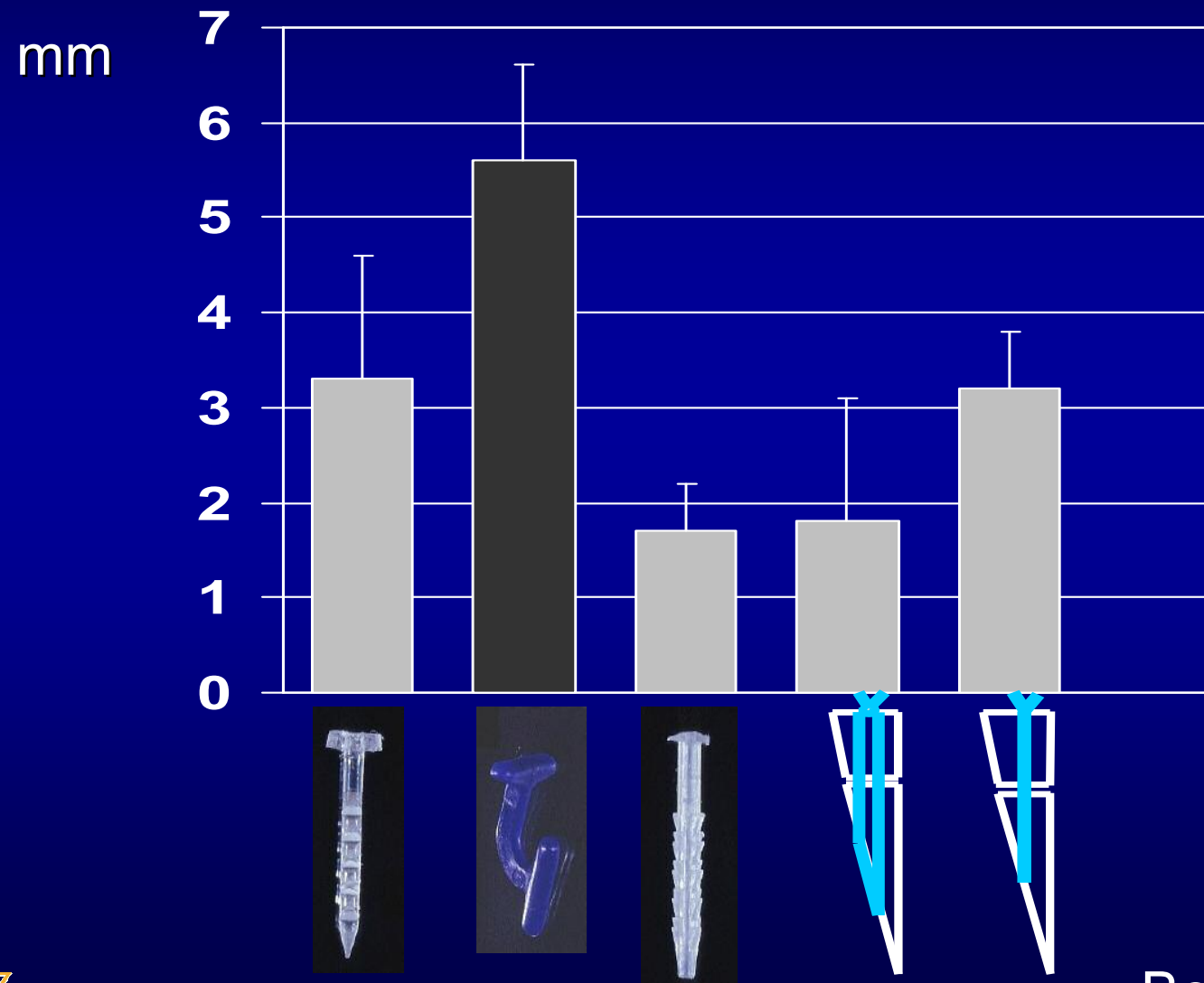
100 %



30 %



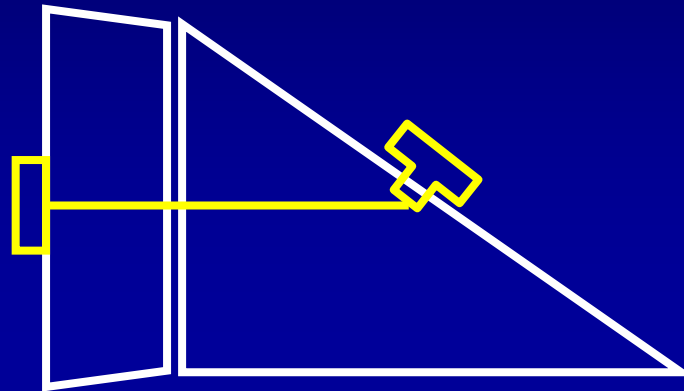
# Design: displacement



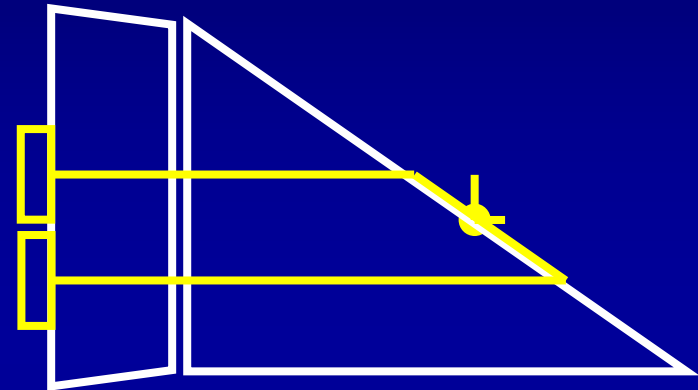
Becker R, 2002

# Design: displacement

Rapid Loc



FasT Fix



1000 cycles:

NO FAILURES !

NO FAILURES !

failure strength:

+

+++

stiffness:

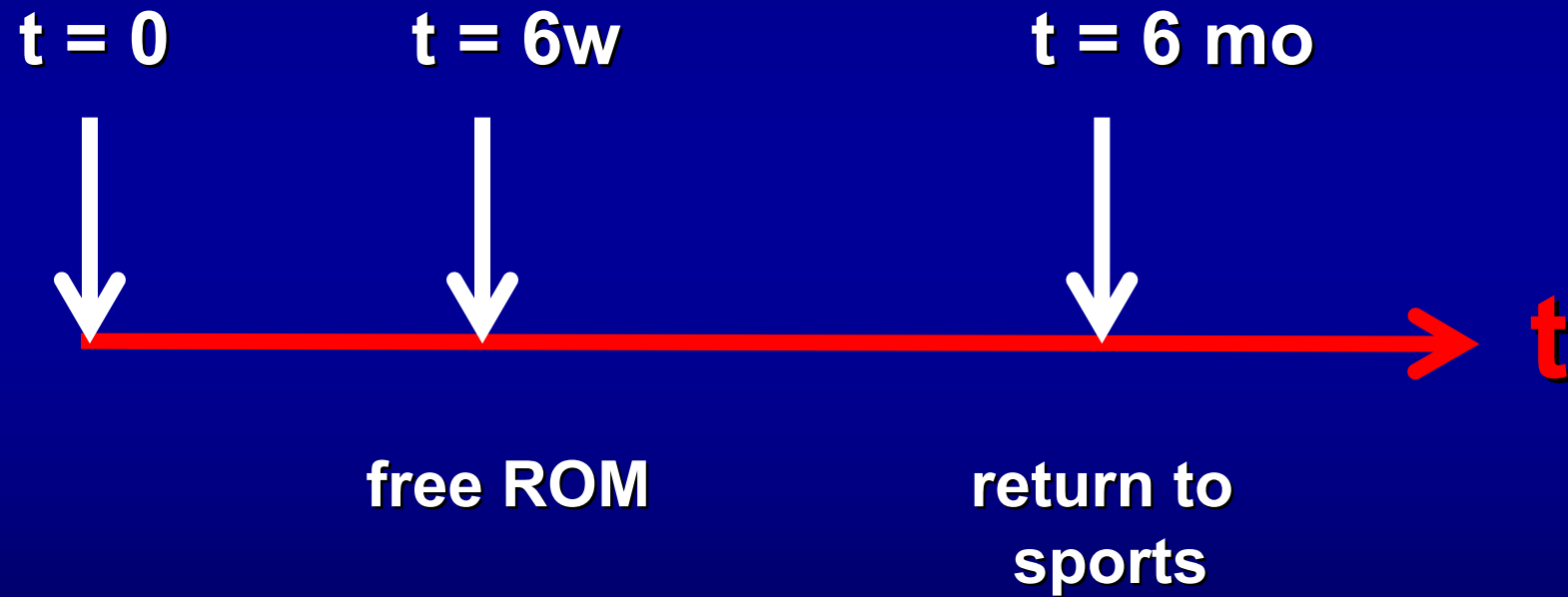
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Zantop T, 2004 & 2005

# Repair over time ?



# Fixation strength over time ?



**In vitro**

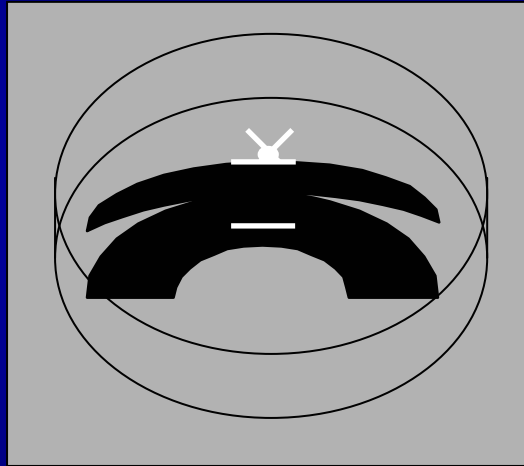
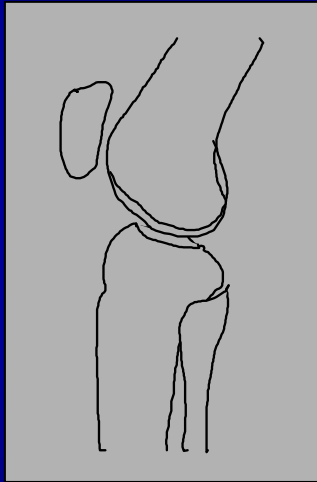


**Animal experiments**



# Effect of hydrolysis time

## Incubation



2 – 24 weeks



Arnoczky SP, 2001  
Dienst M, AANA 2001

# Failure strength over time



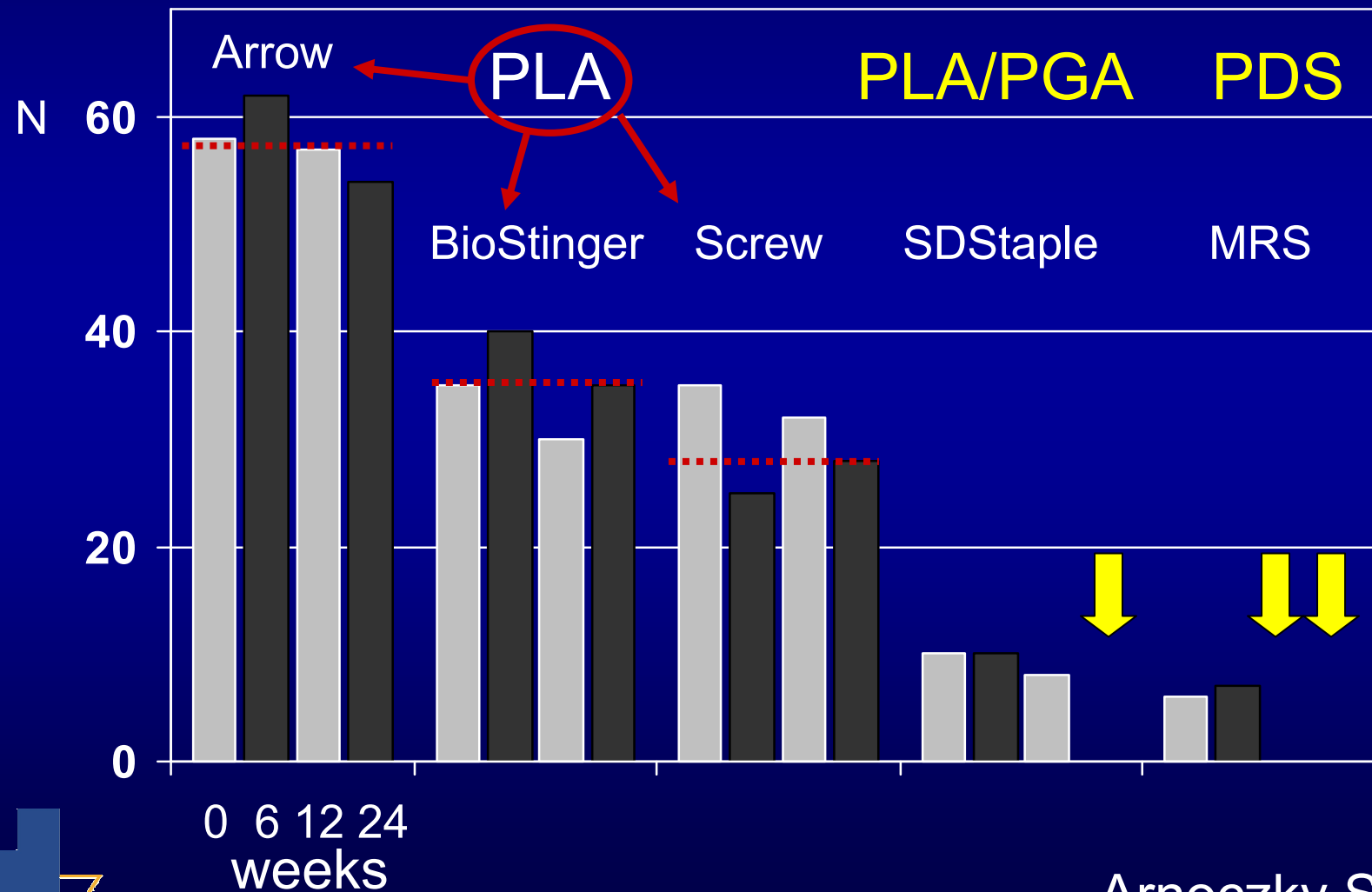
Incubation for 6 weeks

**Nonabsorbable sutures:** =

**Absorbable sutures:** ↓ 50 %



# Failure strength over time



Arnoczky SP, 2001



# **Failure strength over time: Animal experiments**

- tensile fixation strength of scar tissue:**

**4 months: 30 % of normal tissue (goats)**

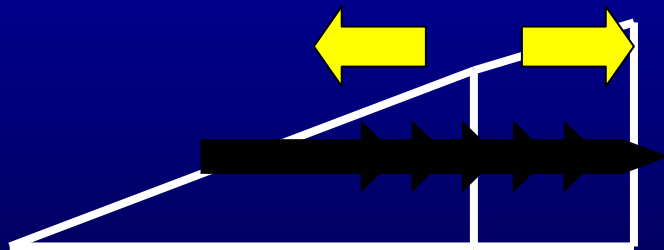
(Port J, 1996)

**1 year: sutures < controls (dogs)**

(Koukoubis TD, 1997)



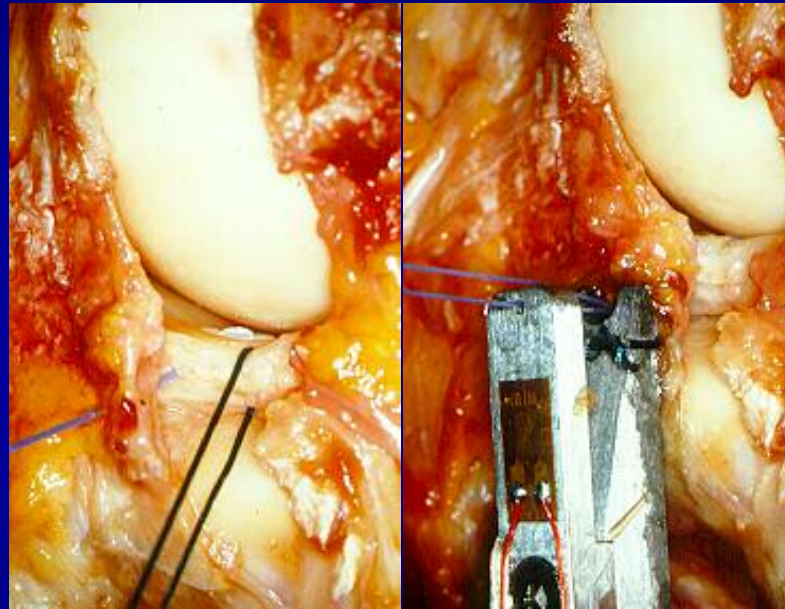
# Forces acting in vivo on meniscus repair ?



**Tensile forces**



# Forces acting in vivo

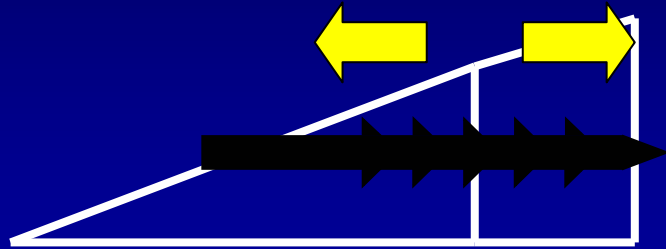


Tensile forces  $< 10$  N

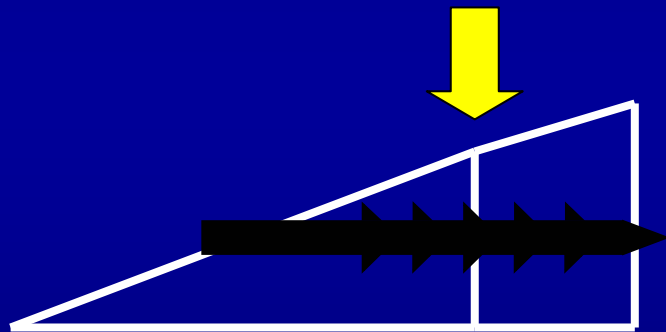


Kirsch, J Biomech 1999

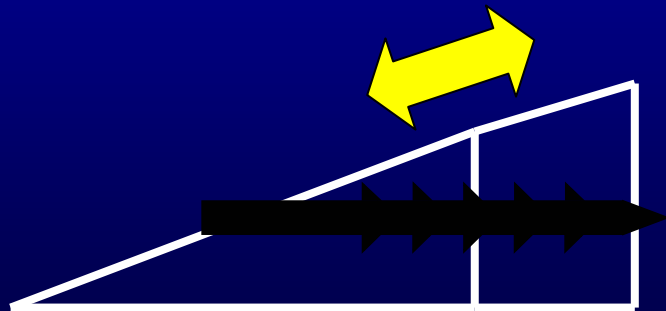
# Forces acting in vivo



**Tensile forces**



**Compressive forces**



**Shear forces**

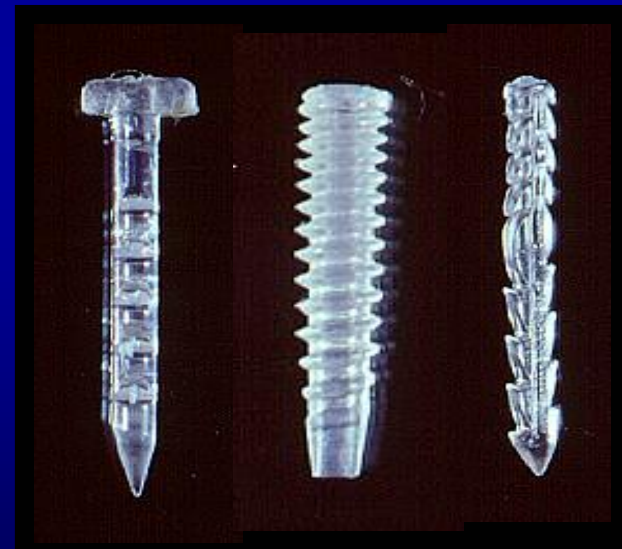
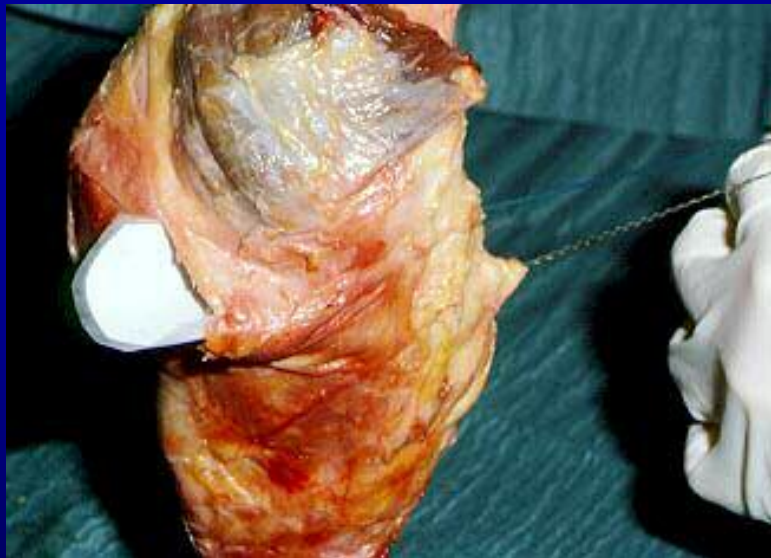
# Complications



Anderson MW, 2000  
Ross G, 2000

Seil R, 2000  
Ménétrey J, 2002

Meniscoefemoral contact areas  
and stresses before and after  
implantation of devices.



## Uniaxial loading



0, 45, 90°

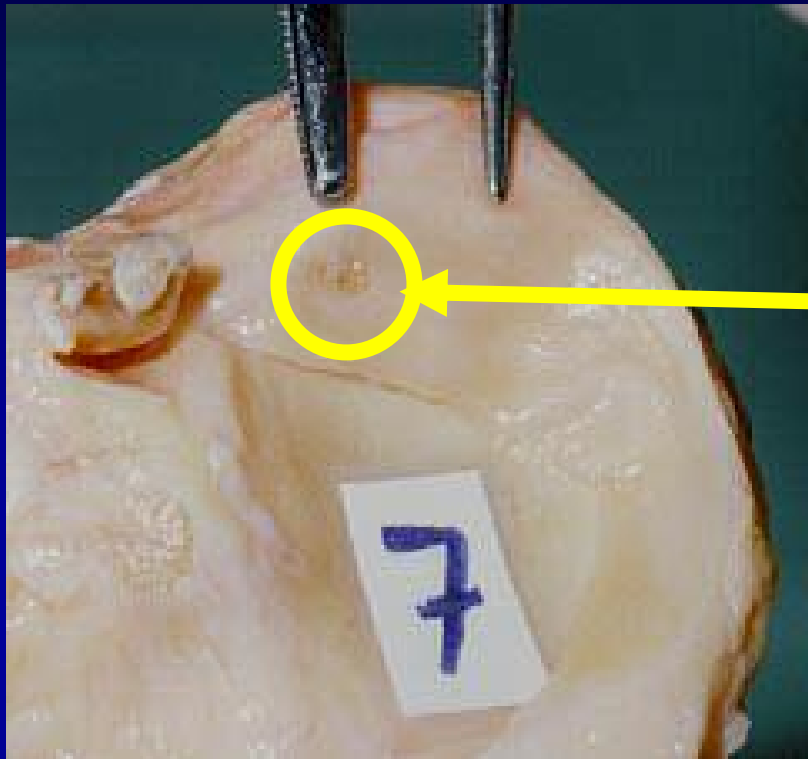
## „Passive motion“



0-120°





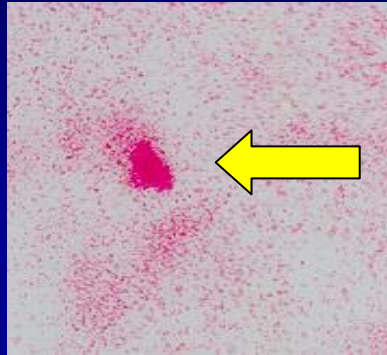


Meniscus Arrow	89 %
Clearfix Screw	54 %
Meniscal Dart	29 %



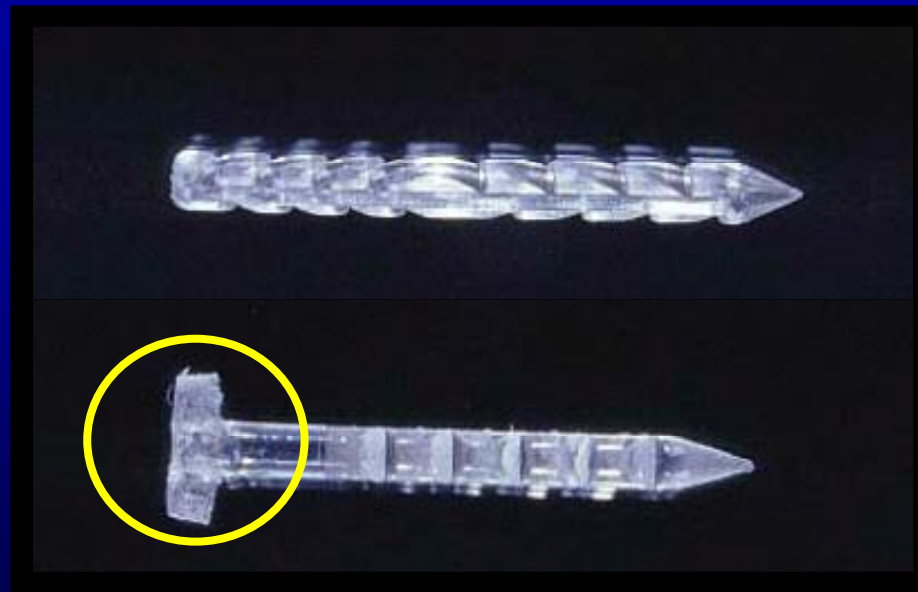


# Contact areas / stresses



Even „without weightbearing“

Head



# Summary

**t = 0 (immediately after repair)**

- Sutures > new fixation devices
- Tensile fixation strength of sutures ↑ with stronger suture materials



# Summary

t = 0 – 12 weeks (early healing period)

- Repetitive loading  
    ➔ failures of devices
- Hydrolysis weakens absorbable sutures,  
    but not PLA devices or  
    nonabsorbable sutures



# Summary

t > 12 weeks (healed tissue)

- Tensile fixation strength far from normal



# Conclusions

## 1. Biomechanics:

In vivo forces unknown

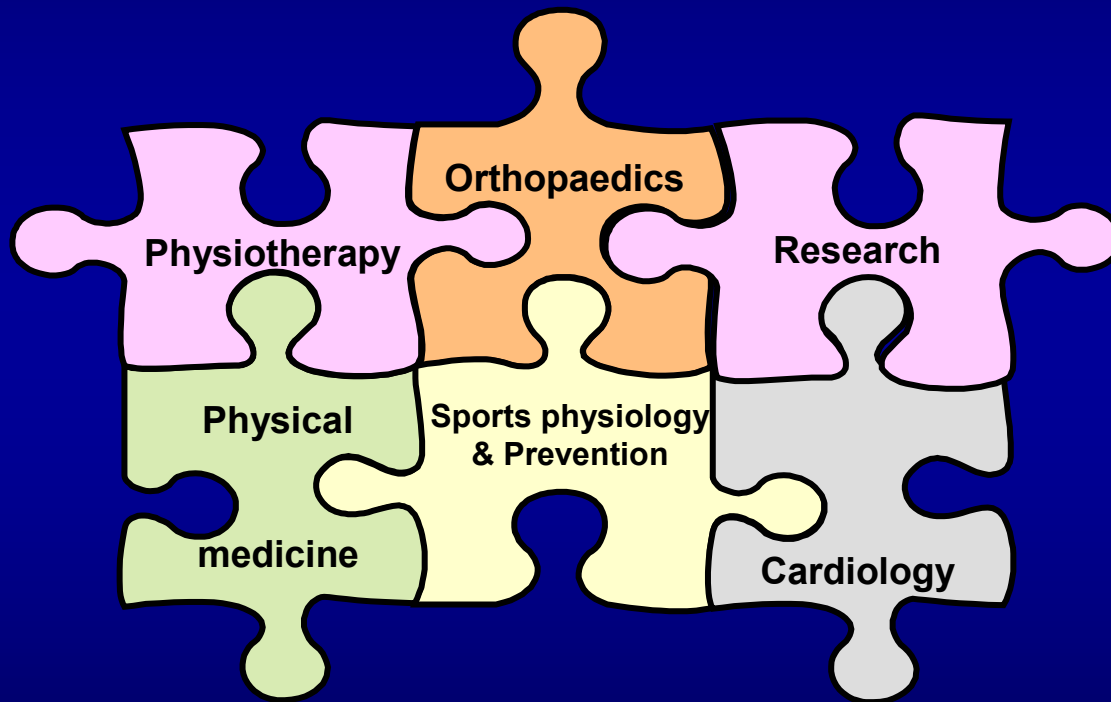
TFS of fixation devices < sutures

Horizontal sutures not necessarily weaker than vertical sutures

Biomechanical properties of scar tissue unknown

## 2. Complication potential of new devices must be evaluated further

Centre de l'Appareil Locomoteur,  
de Médecine du Sport et de Prévention  
Centre Hospitalier de Luxembourg –  
Clinique d'Eich



[www.sportsmedicine-chl.lu](http://www.sportsmedicine-chl.lu)

# Meniscal Suturing

## Indications, Techniques & Results

Mark Clatworthy



# Indications

For a meniscal repair to heal  
the torn meniscus must  
communicate with its  
peripheral blood supply



# Meniscal Vascularity

- The inferior and superior medial & lateral geniculate arteries give rise to a perimeniscal capillary plexus

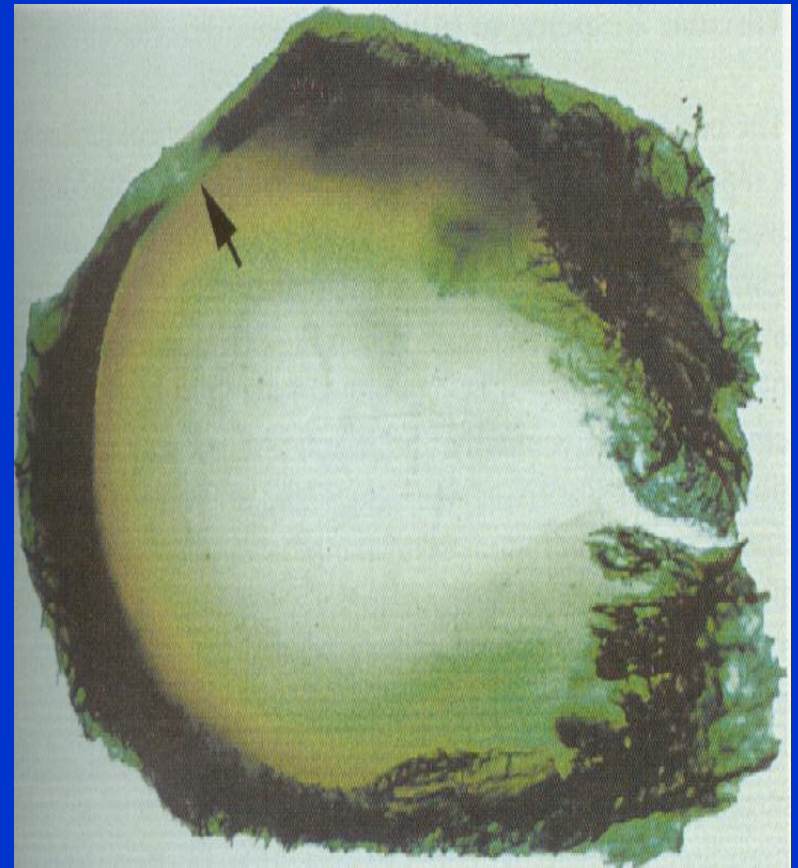


# Meniscal Vascularity

- The peripheral vascular penetration is:

10% - 30% for the medial meniscus

10% - 25% for the lateral meniscus



# Meniscal Vascularity

- A small reflection of vascular synovial tissue extends a short distance over articular surfaces containing small terminally looped vessels

## Synovial fringe

- Contributes markedly to the reparative response



# Meniscal Healing

- After a meniscal tear/repair a fibrin clot forms that is rich in inflammatory cells
- A fibrin scaffold is formed which the perimeniscal capillary plexus proliferates with undifferentiated mesenchymal cells
- Repair site is filled with a cellular fibroblastic scar that glues the meniscus.
- Followed by a marked inflammatory response providing vascular ingrowth from capillary plexus and synovial fringe

# Classification of Healing Zones

- Red on Red



- Red on White



- White on White



# Repair Indications

- Location - red/red, red/white  
Young patient white/white – enhance
- Tear type – longitudinal  
Do not repair horizontal cleavage, degenerative, flap or mid meniscus radial tears.  
Can repair posterior radial tears with purse string technique
- Tear stability <3mm displacement - stable

# Repair Indications

- Time to Surgery  
Earlier the better. Henning < 2 months
- Meniscal Quality – Shelbourne AJSM 2003  
Non degenerative repairs similar to results of ACL reconstruction with normal meniscus  
Degenerative repairs no better than meniscectomy

# Repair Indications

- Patient Age  
Recommended < 45. Studies documenting good results in older patients
- Knee Stability  
Poorer results in unstable knees
- Patient Compliance  
Patient must abide post operative instructions



# Mensical Repair History

- First repair 1883 – Thomas Annadale
- First arthroscopic repair Hirosho Ikeuchi - 1969
- Open meniscal repairs - De Haven - 1981
- Arthroscopic meniscal repairs Henning – 1983
- Bioabsorbable arrows – Albrecht–Olsen - 1993

# Meniscal Repair

- Inside – Out using Zone Specific Technique
- Outside – In Repair
- Open
- Repair Enhancement techniques
- All Inside – Uffe Jorgensen

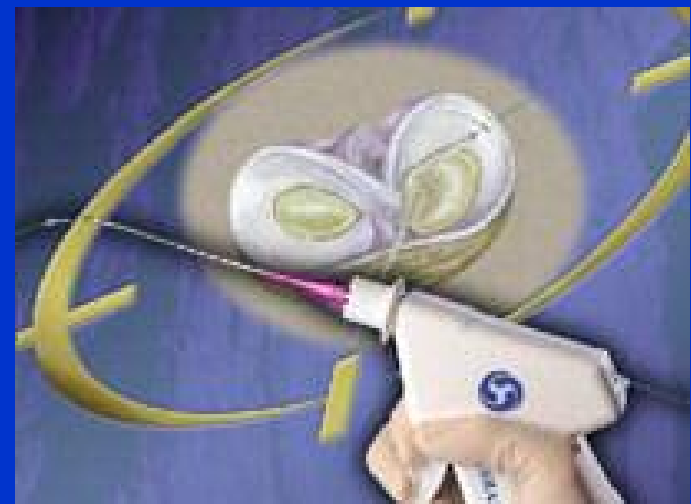
# Inside - Out Zone Specific Repair Technique

- Operative leg is placed in a leg holder and flexed off the end of the bed
- Contralateral leg is placed in a ski boot and abducted to allow easy access to the knee for the surgeon and an assistant



# Zone Specific Cannulas

Zone Specific cannulas are used allowing vertical or horizontal placement of sutures in either the superior or inferior margin of the meniscus



# Posteromedial Incision

- A 3-6 cm vertical incision is made posterior to MCL, 1/3<sup>rd</sup> above the joint line
- Presartorial fascia is incised and the pes retracted to protect the saphenous nerve
- A retractor is placed deep to the medial head of gastrocnemius.



# Posterolateral Incision

- A 3-6 cm vertical incision is made posterior to the LCL. 1/3<sup>rd</sup> above the joint line
- Divide the interval between the anterior border of biceps and ITB to protect peroneal nerve
- Place a retractor deep to the lateral head of gastrocnemius





# Portals

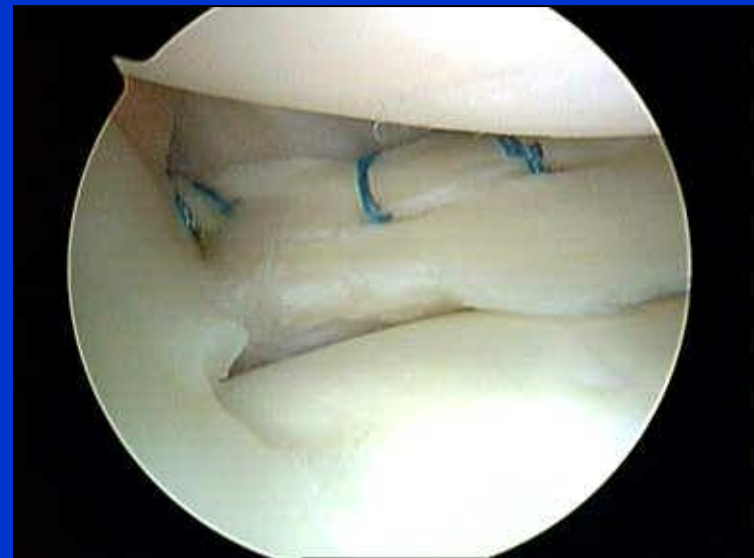
The sutures can be passed through the ipsilateral portal for more posterior suture placement

Through the contralateral portal for more anterior suture placement



# Sutures

- Non absorbable 2/0 sutures are passed with 10 inch needles through the cannula and tied over the capsule of the knee. A posteromedial or posterolateral incision is made to protect neurovascular structures
- Sutures are placed approx 5 mm apart





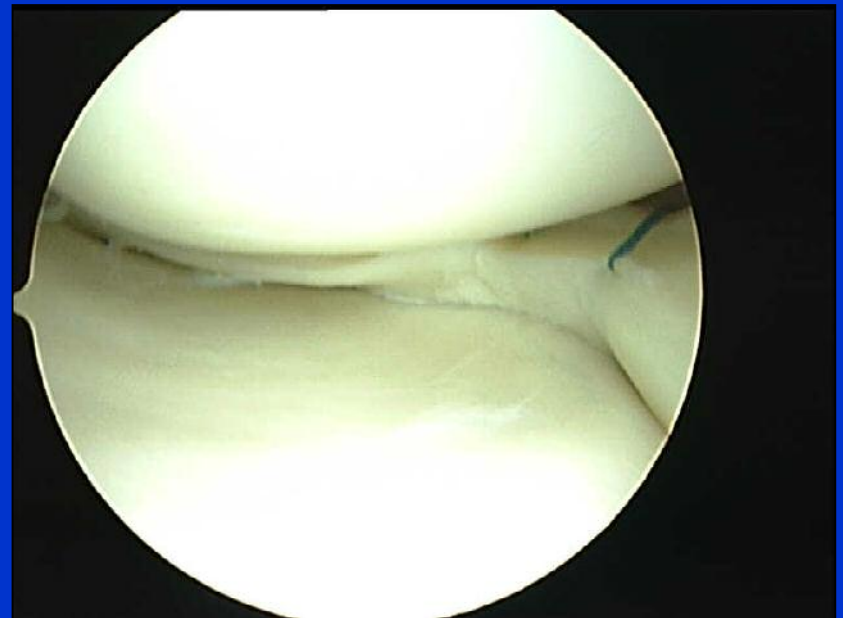
# Posterior Suture Placement

- Unable to place posterior sutures due to risk of damaging neurovascular structures and technically being able to retrieve sutures
- Elkoursky & Higgins Am J Orthop 2005  
Unable to reach the posterior 15mm of medial meniscus and 11mm of lateral meniscus



# Suture Tying

- Sutures should be tied under arthroscopic vision to ensure the tear is well opposed but not over tight
- The knee should be placed in 30° to prevent the capsule being captured



# Results

Cannon 1999 172 cases - re-look arthroscopy or arthrography

- 75% healed with ACL
- 53% isolated meniscal repair
- More peripheral tears healed better
- Lateral meniscus better than medial meniscus

Rosenberg Arthroscopy 1994 - re-look arthroscopy

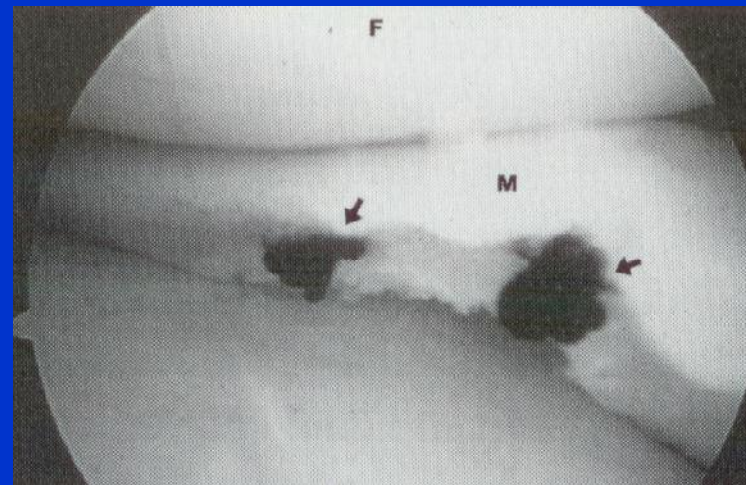
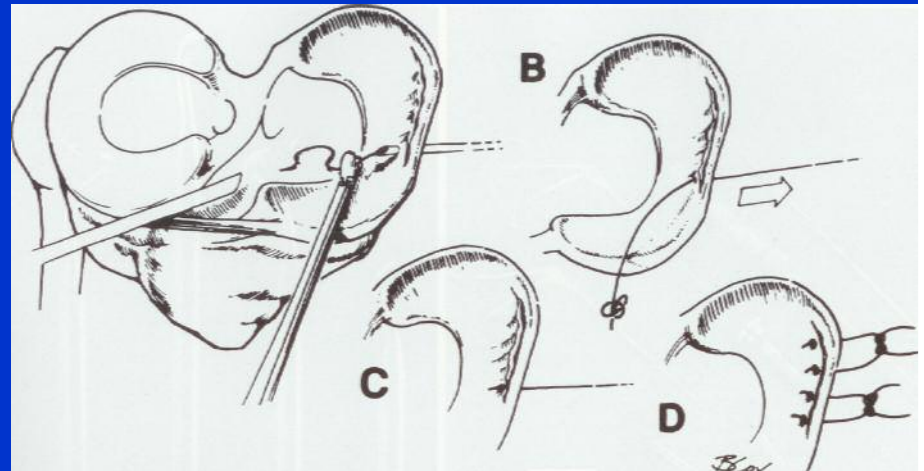
- 83% healed
- 80% failures ACL deficient

Brown Am J Knee Surg 1996

- 92% success if rim < 4mm

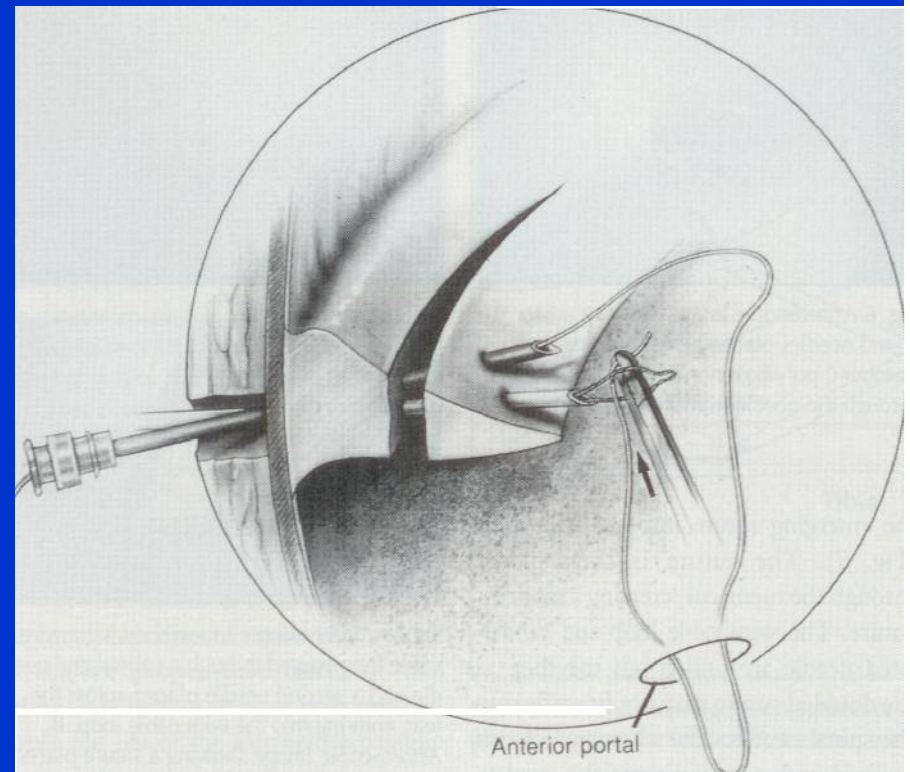
# Outside – In Technique

- PDS sutures are passed through an 18 gauge needle from outside in
- A mulberry knot can be tied and introduced through the opposite portal to the scope portal and the ends are tied over the capsule



# Outside In Technique

- Sutures may also be passed through the spinal needle and retrieved through a loop to create a vertical or horizontal mattress suture



# Outside In Technique

- Small incisions are made to tie over the capsule
- Ideal for anterior tears



# Results

## Morgan AJSM 1991

- 74 meniscal repairs evaluated by second look arthroscopy
- 65% completely healed, 19% incompletely healed and 16% failed - 11/12 ACL deficient

## HSS Experience - Warren - 1991

- 62% asymptomatic / healed
- 18% slightly symptomatic / partially healed
- 13% failed – 40% of these unstable

## HSS Experience AJSM 1998

- Lower healing rate in posterior horn of medial meniscus thought to be due to obliquity of sutures

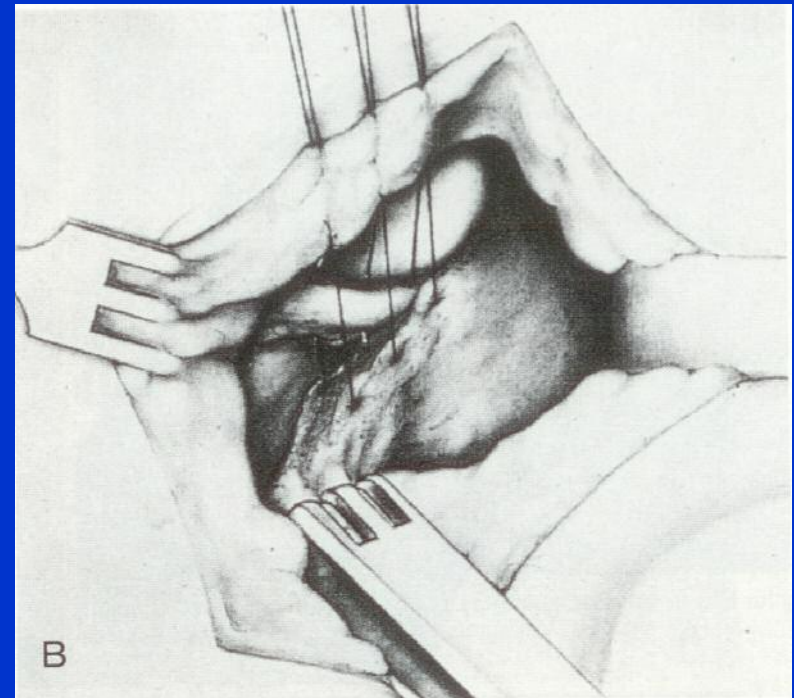


# Open Technique

Developed and popularized by De Haven JBJS  
1981

## Medial Repair

- 5cm posteromedial incision
- Oblique capsular incision posterior to MCL
- Meniscal rim & capsule rasped
- Vertical sutures 3-4 mm apart

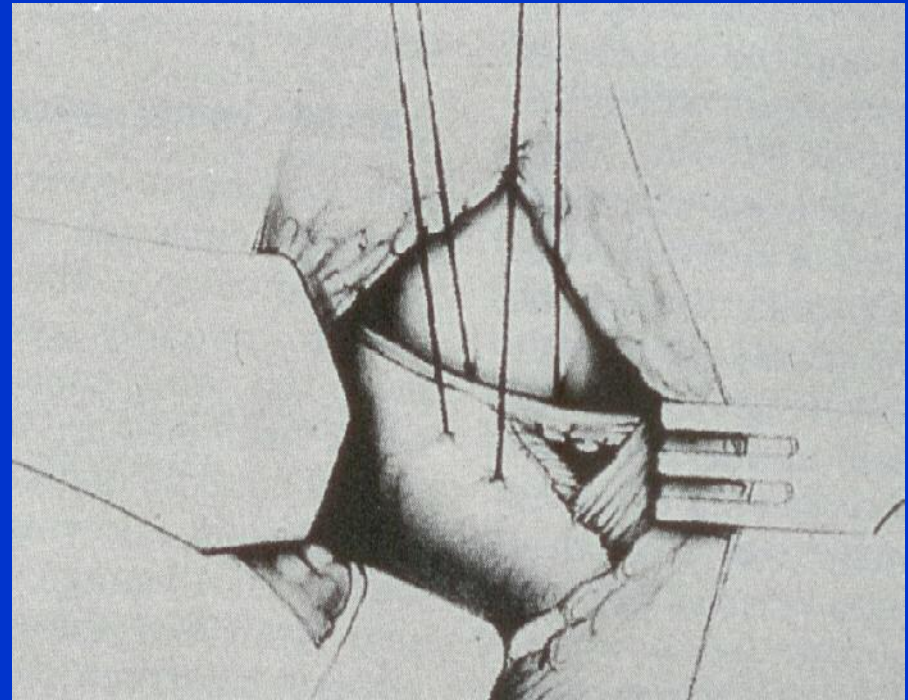




# Open Technique

## Lateral meniscal repair

- 5cm incision post to LCL
- ITB split
- Oblique posterolateral capsular incision post to popliteus
- Vertical sutures 3-4mm apart



# Results

## De Haven AJSM 1995 – Long term results

- 79% survival at mean 10.9 years
- ACL deficient knees failed
- Degenerative radiographic changes  
15% of successful repairs, 57% re-torn  
menisci

## De Haven AJSM 1989

- 80 meniscal repairs 2 – 9 years mean 4.6  
years
- 89% success  $\frac{2}{3}$  failures ACL deficient

# White on White Avascular Repairs

## Noyes AJSM 2002 < 20 years

- 71 patients 45 with ACL reconstruction
- 25% failure rate overall, 13% with ACL

## Noyes Arthroscopy 2000 > 40 years

- 30 patients 22 with ACL reconstruction
- 87% asymptomatic better with ACL

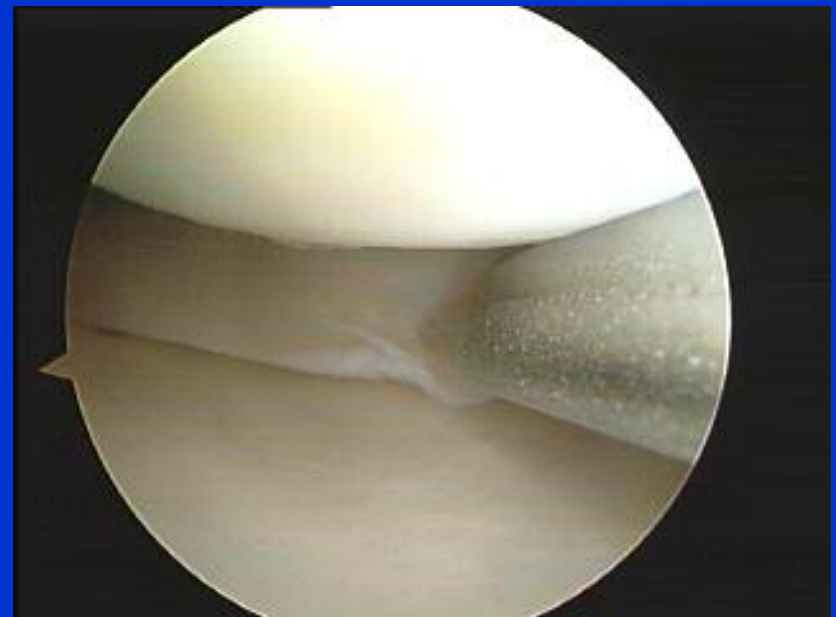
## Rubman AJSM 1998

- 198 tears 72% ACL reconstruction, 80% asymptomatic
- 91 evaluated arthroscopically 25% were classified as healed, 38% as partially healed, and 36% as failed.
- Worthwhile in young patients especially with ACL

# Repair Enhancement Techniques

## Vascular Access Channels & Trephination

- Creation of small channels with penetration to vascular supply also allows cell passage
- Increased healing in animal studies compared with suture alone



# Repair Enhancement Techniques

- **Synovial Abrasion**  
Stimulation of synovial fringe with a rasp

Shown to increase tensile strength vs control in rabbit



# Repair Enhancement Techniques

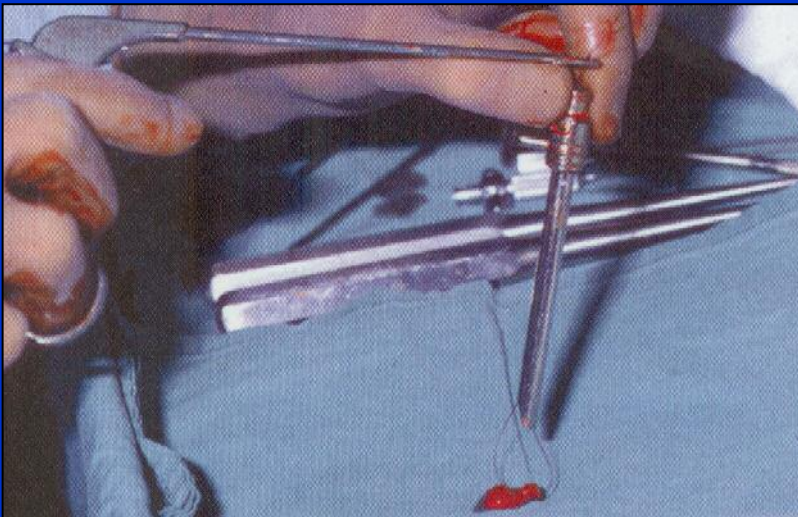
## Fibrin Clot

- Provides scaffold for cellular ingrowth and growth factors
- 60 mls blood in a plastic container stirred with a glass rod for 5 minutes.
- Well organized clot sutured pass thru cannula



# Fibrin Clot

- Henning et al CORR 1990  
The isolated tear failure rate was 41% without the exogenous fibrin clot versus 8% with the exogenous clot



# Rehabilitation

- Weight bearing status
- Range of motion
- Return to Sport

Huge variation in recommended protocols



# Rehabilitation – Basic Science

- Menisci relatively immobile from 15° - 60°  
Extremes of motion result in significant translation  
5.1mm medial meniscus, 11.2 mm lateral  
Significant increase in load in posterior horn > 90°
- Immobilization decreases collagen formation and maturation. Aggrecan expression reduced 2-5 times and 2-4 fold decrease in glycosaminoglycan production
- Structures heal faster and better under load – Wolff's law
- Animal meniscal healing time  
50% 3-4 weeks, 76% at 8 weeks - dog, 62% 6/12 rabbit

# Rehabilitation – Clinical Studies

## Barber Arthroscopy 1994

- Conservative - braced, NWB 6/52, No sport 6/12  
19% failure rate
- Aggressive – no brace , full WB, return to sport once  
no effusion ROM 0-120°  
10% failure rate

## Shelbourne - Accelerated Rehab Clin Sports Med 1996

## Mariani - Accelerated Rehab - Arthroscopy 1996

- Not comparative studies however show similar  
results to more conservative regimes

# Rehabilitation Recommendations

- If concurrent ACL no alteration in standard ACL protocol

- If displaced bucket handle tear  
ROM 15° - 60° 6 weeks  
Protected weight bearing 6 weeks  
Return to sport 6 months



- If tear is reduced at time of arthroscopy  
ROM limited to 0° - 90° for 6 weeks  
Weight bearing as tolerated  
Return to sports 4 months



# Meniscus repair

Uffe Jørgensen  
MD, PhD

[UJ@parkensprivathospital.dk](mailto:UJ@parkensprivathospital.dk)

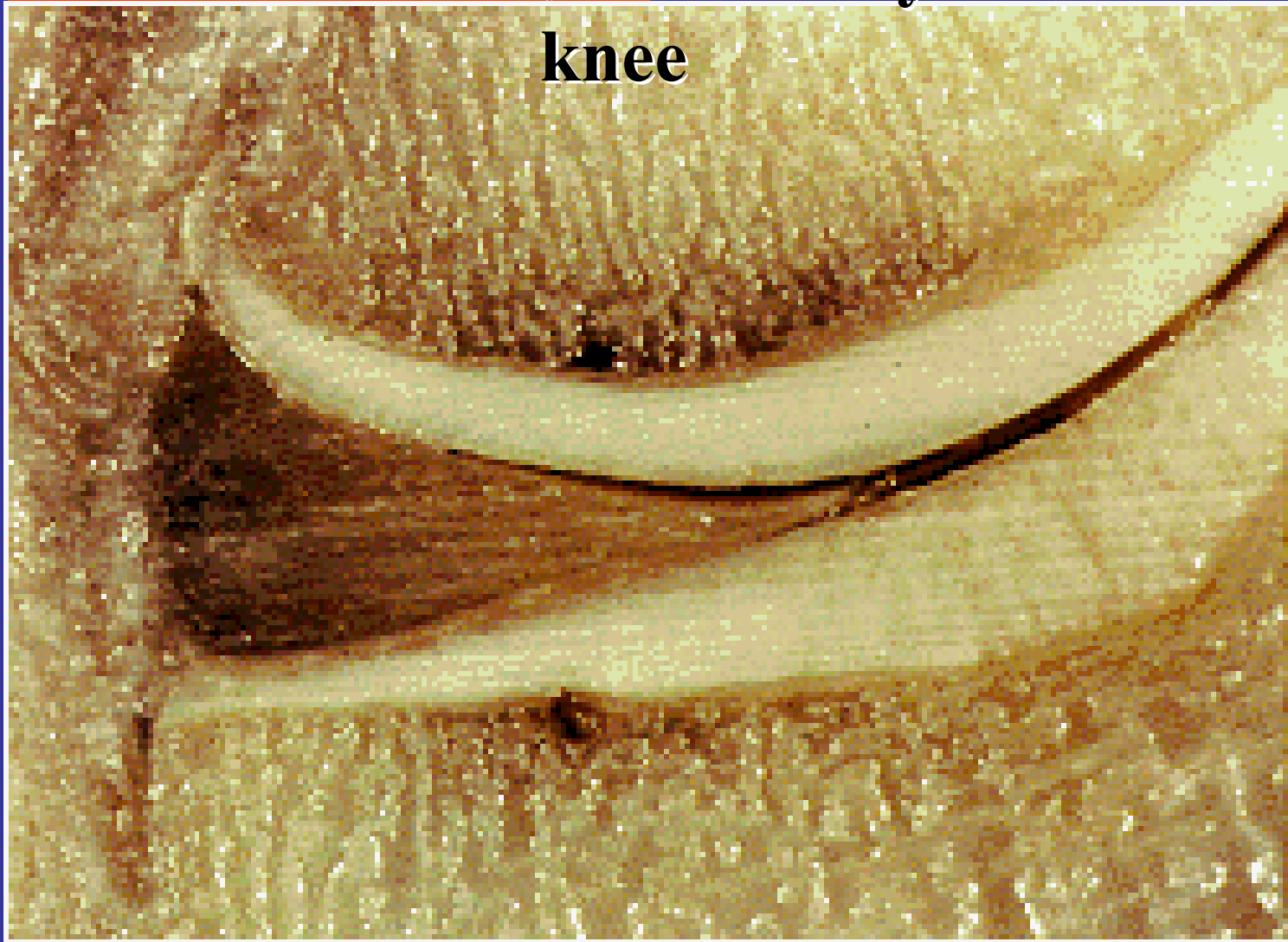
ISAKOS 2005

# Scandinavian Sports Medicine Center

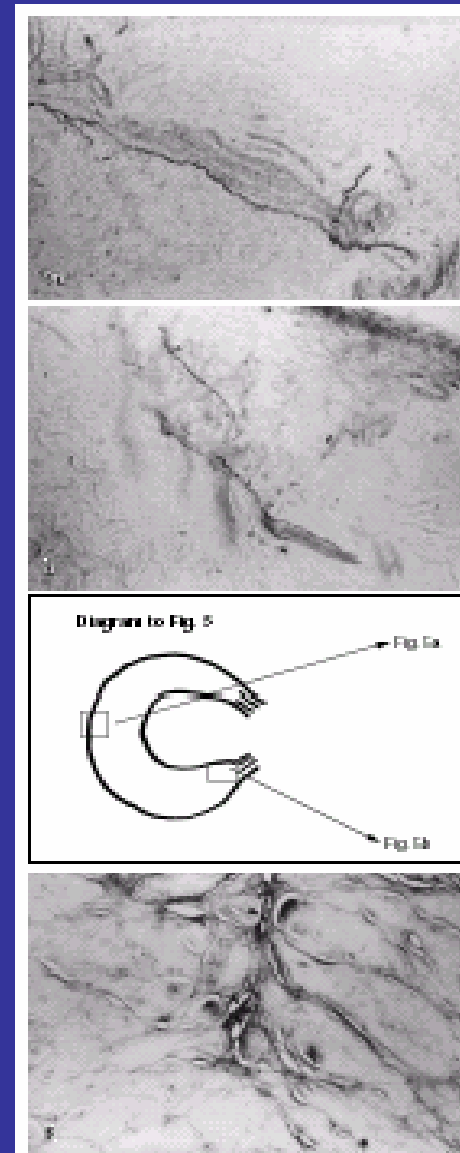
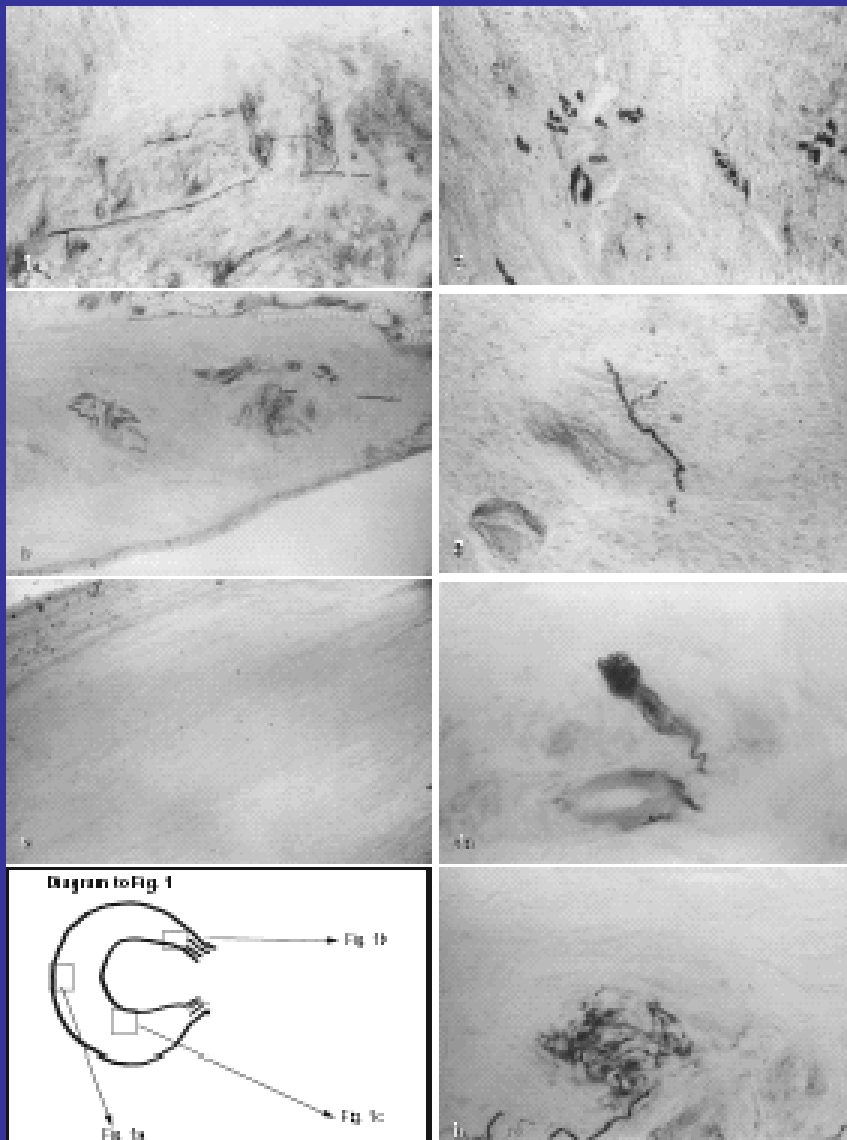
## Parkens Private Hospital Copenhagen, Denmark



**Menisci fills the empty space between  
the femoral and tibial condyle in the  
knee**



# Meniscus nerve supply

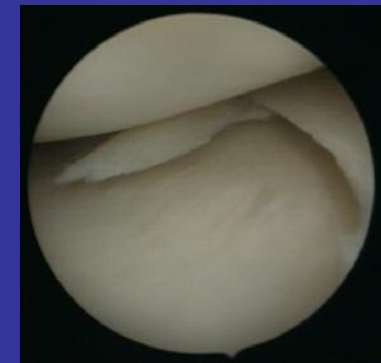
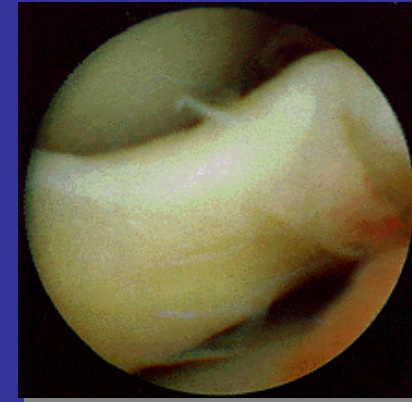
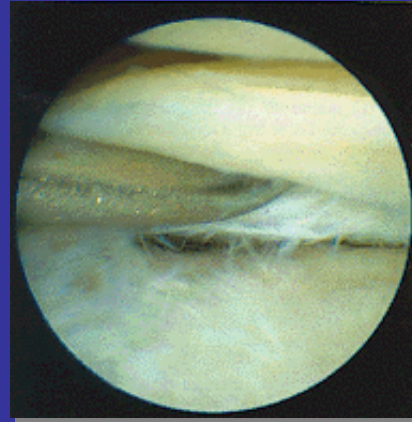
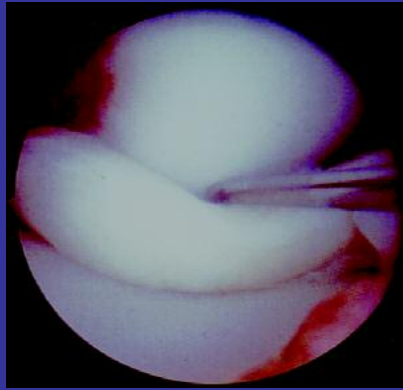




# ????? Treatment ????????







**Treatment depends on type of lesion**

# Consequence

## Total meniscectomy

- 80% deg. after 12 years. ( Jørgensen 1987 )

## Partial

- 40% deg. after 10 years ( Faunø 1991 )
- 54% deg. after 13 years ( Rockborn 2000 )

## Meniscus sutures

- 36 % deg. after 13 years ( Rockborn 2000 )

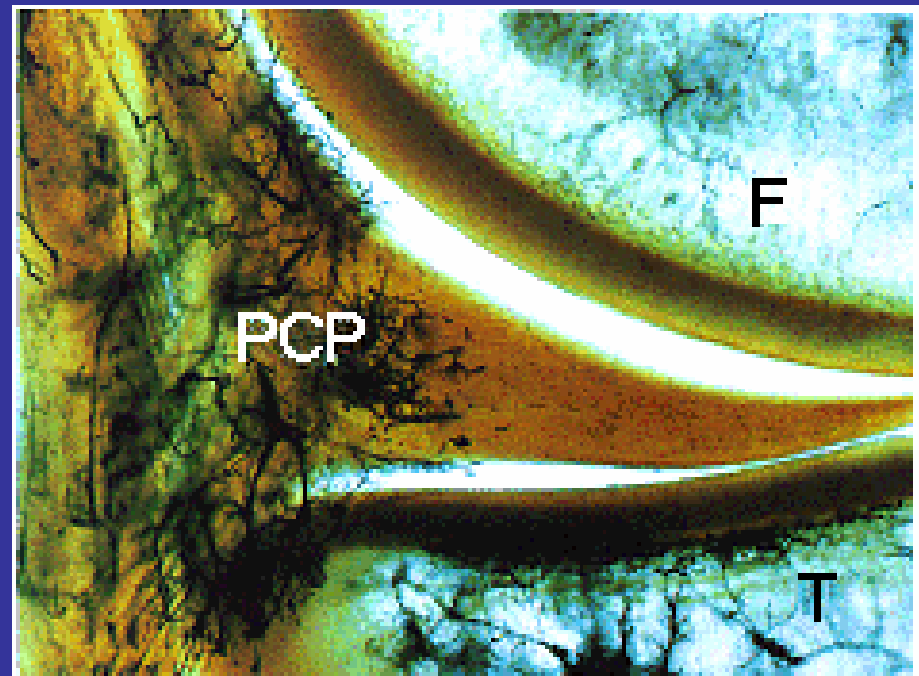
# Which menisci should be repaired ?

## Healing rates

- **Traumatic tears** 73 %.
- **Atraumatic meniscus** tears 42 %
- The isolated atraumatic medial meniscal tear only 33% healing
- may be better treated by meniscectomy ?

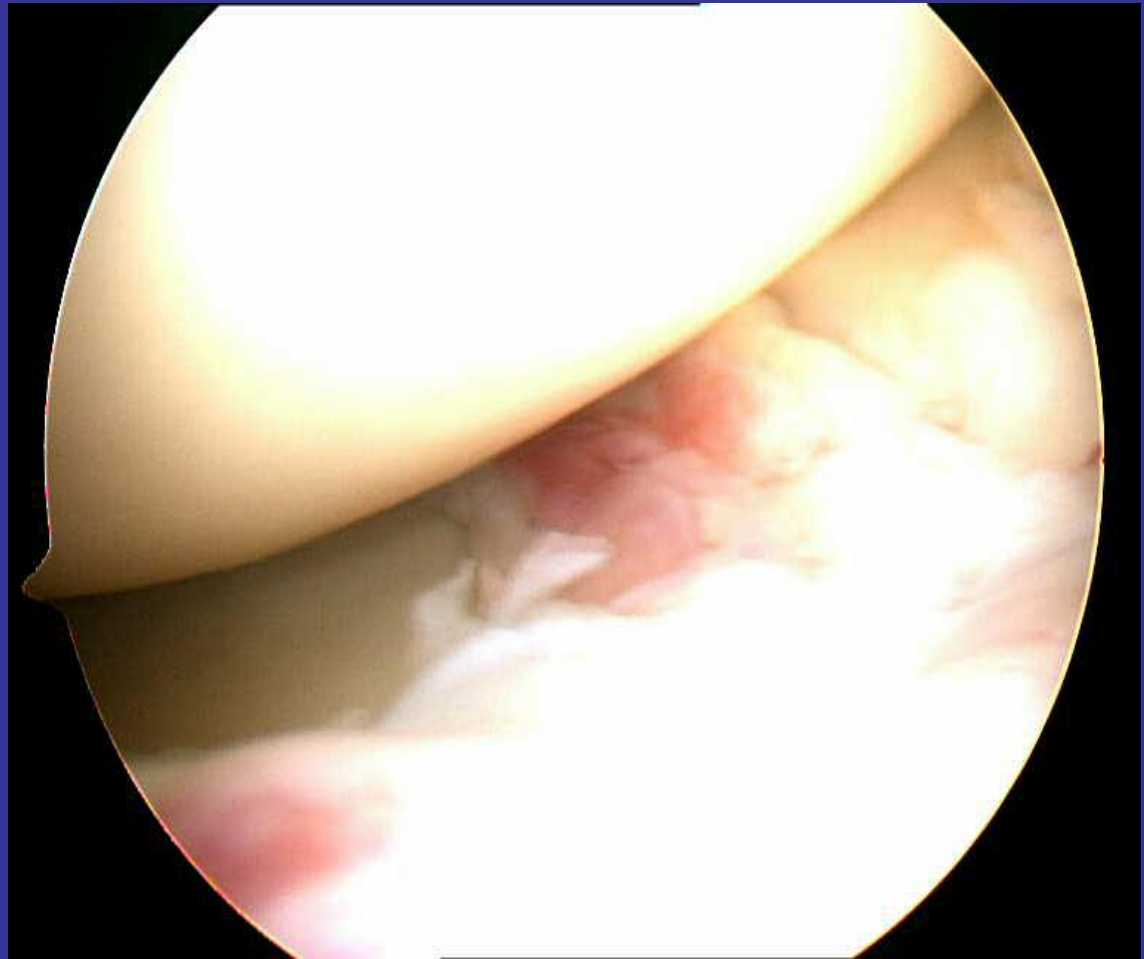
# Indications for repair

- Vertical, longitudinal lesions (fresh/old)
- Red/red or red/white area
- Reducable without tension
- No or minor intrameniscal degenerative changes



# Bucket-handle tears ?

- Localisation
- Shrinkage
- Quality of the capsular part
- Look for horizontal lesions



# ARTHROSCOPIC MENISCUS FIXATION

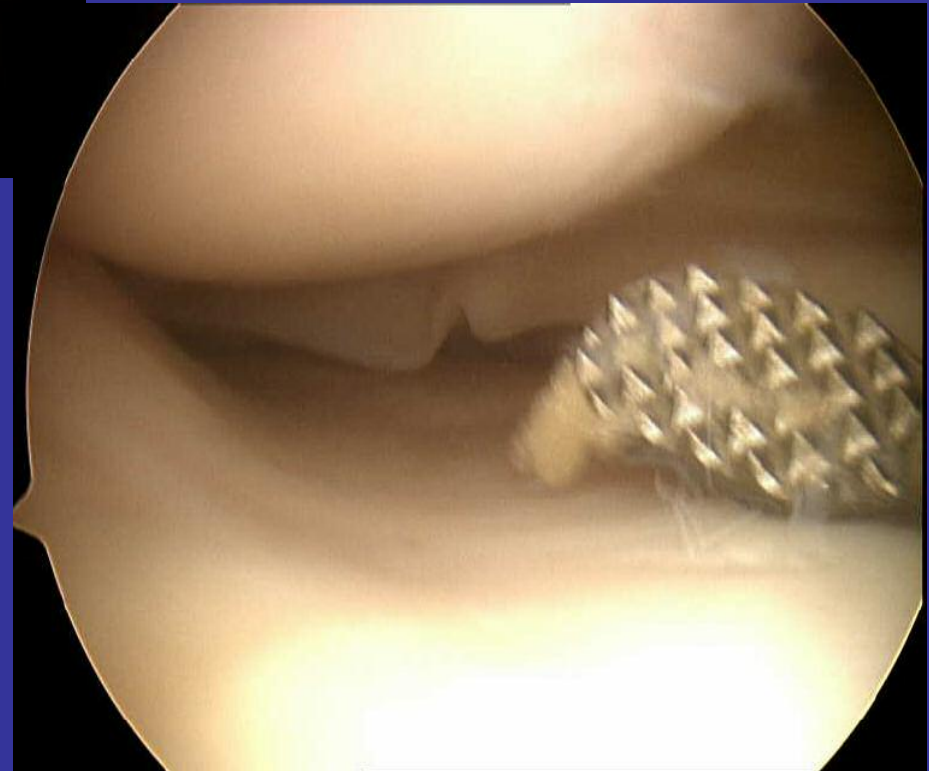
## ABSORBABLE TACKS



**1:**

**Freshen the lesion with a rasp  
- including synovial surroundings.**

gk-93



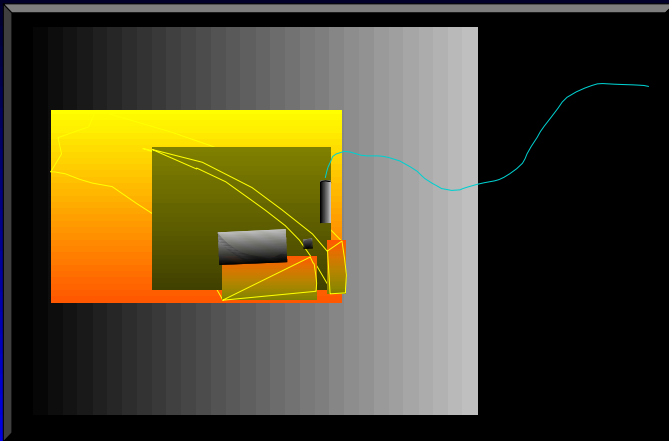
**The cytokine network on the rasped meniscal surface appears to be the key to explaining the mechanism of vascular induction and meniscal healing by meniscal rasping.**

**Ochi M et al Arthroscopy 2001 Sep;17(7):724-31**

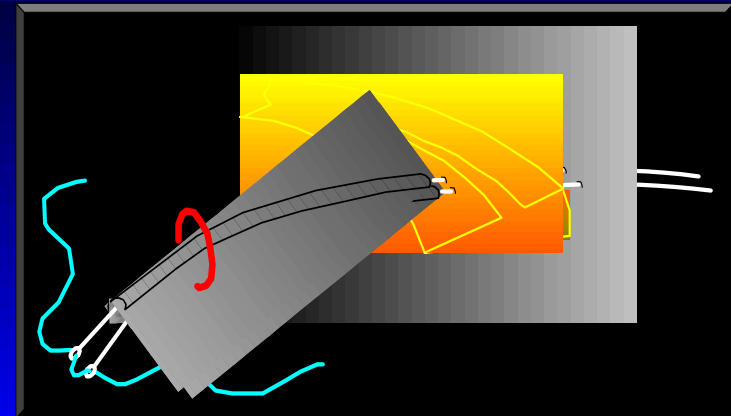
# Suture



## Meniscus repair - open suture

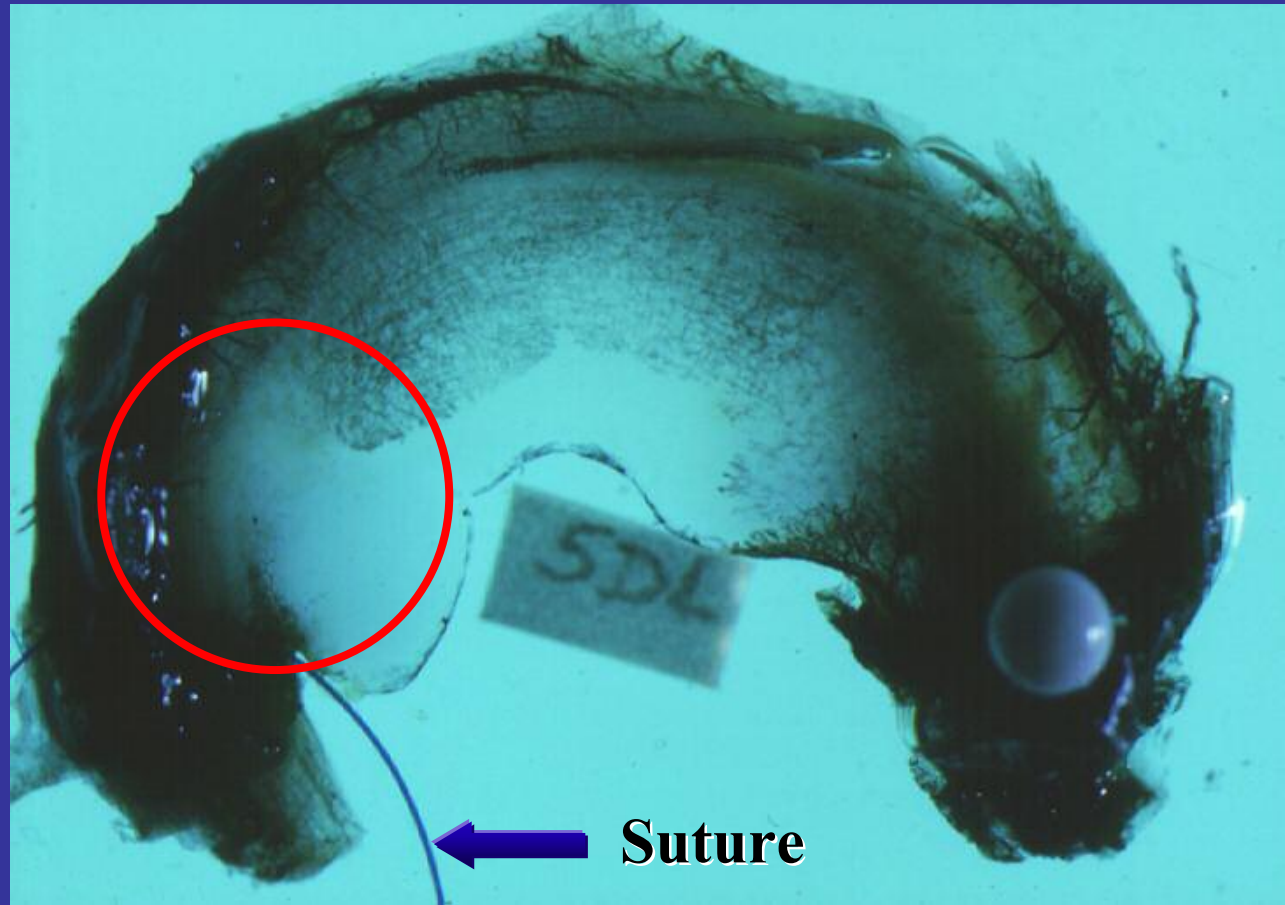


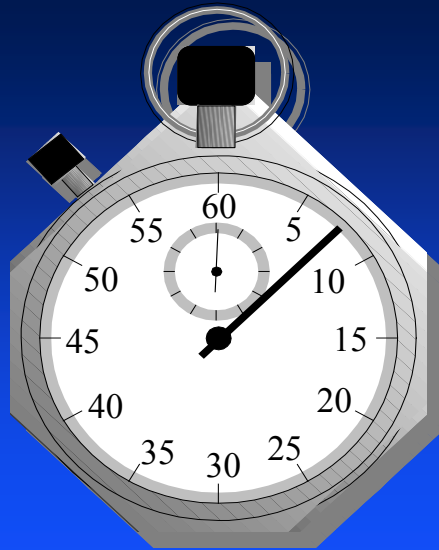
## Meniscus repair - Inside-out Arthroscopically assisted



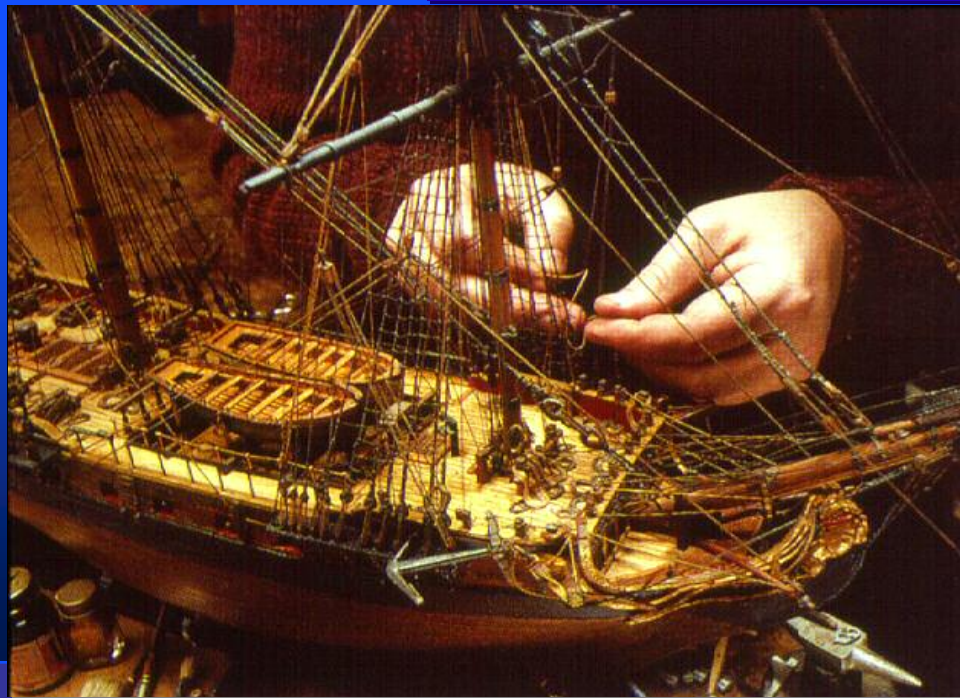


**Vascular supply to the meniscus is affected by vertical sutures (Albrecht-Olsen – a study in pigs – personal communication)**





**Meniscus repair  
with sutures is a  
time-consuming  
procedure!**



# **Different surgical "devices" for meniscus repair**



Clean  
MENISCAL  
screw



MENISCAL  
darts



Low profile, counter-sunk head minimizes condylar contact



Curved and straight instruments allow easy access to all zones



11311 Concept Boulevard, Largo, Florida 33773-4908  
Customer Service: (800) 925-4255

- Sterile, disposable, and reloadable instruments lower cost as implants can be loaded and used as needed
- Window on end of cannula allows viewing of implant during insertion



SD-Sorb

# MENISCAL STAPLER

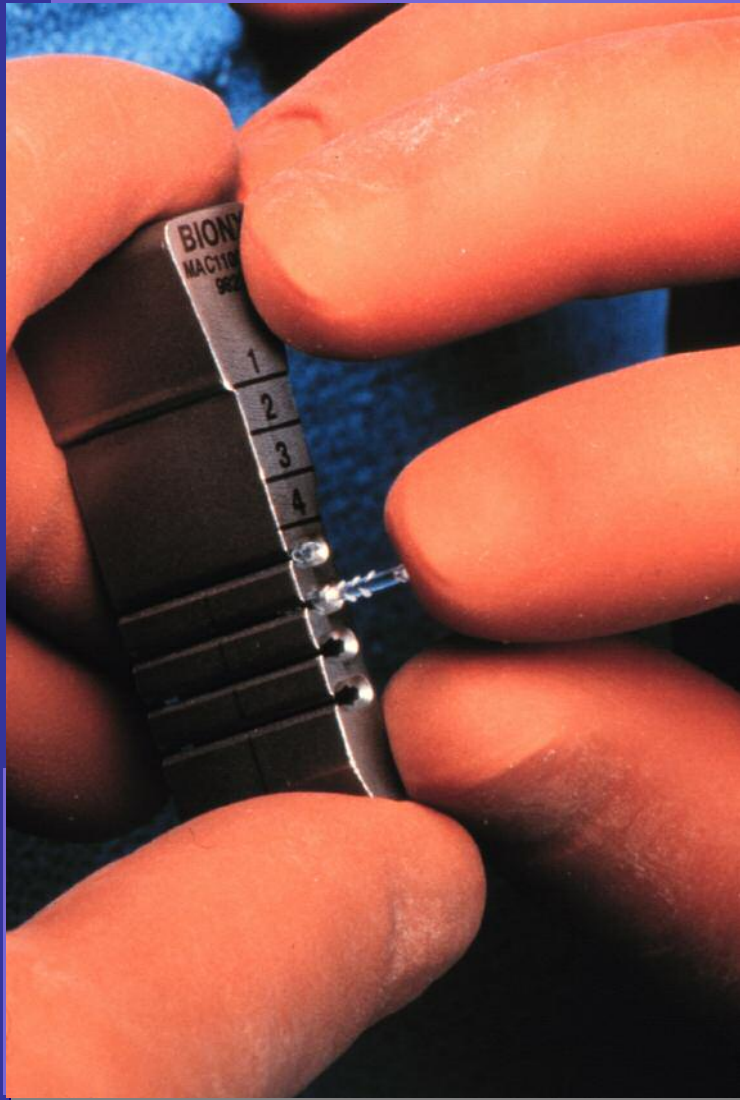
LINVATEC BIOSTINGER™

VERTICAL SUTURE



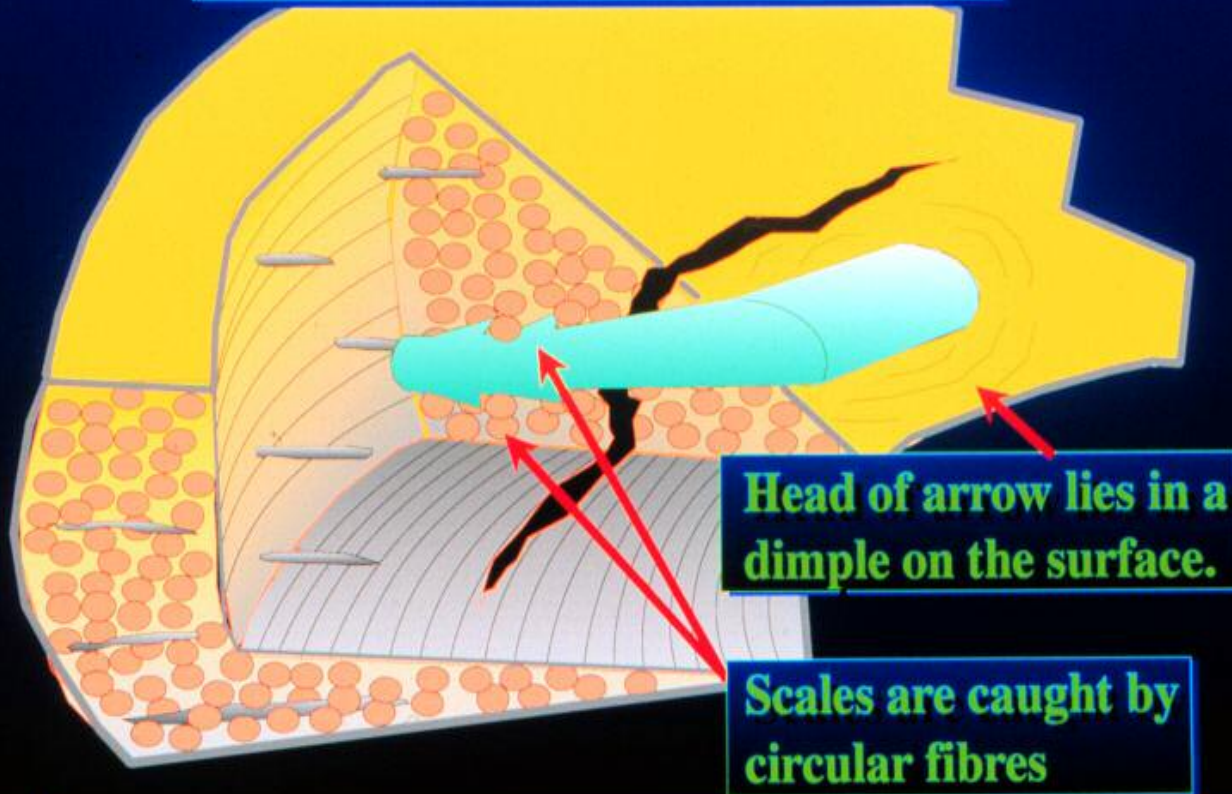


**Bionx Meniscus Arrow, made of selfreinforced polylactic acid, diameter 1.1 mm, length: 10, 13 and 16 mm.**



## MENISCUS ARROW

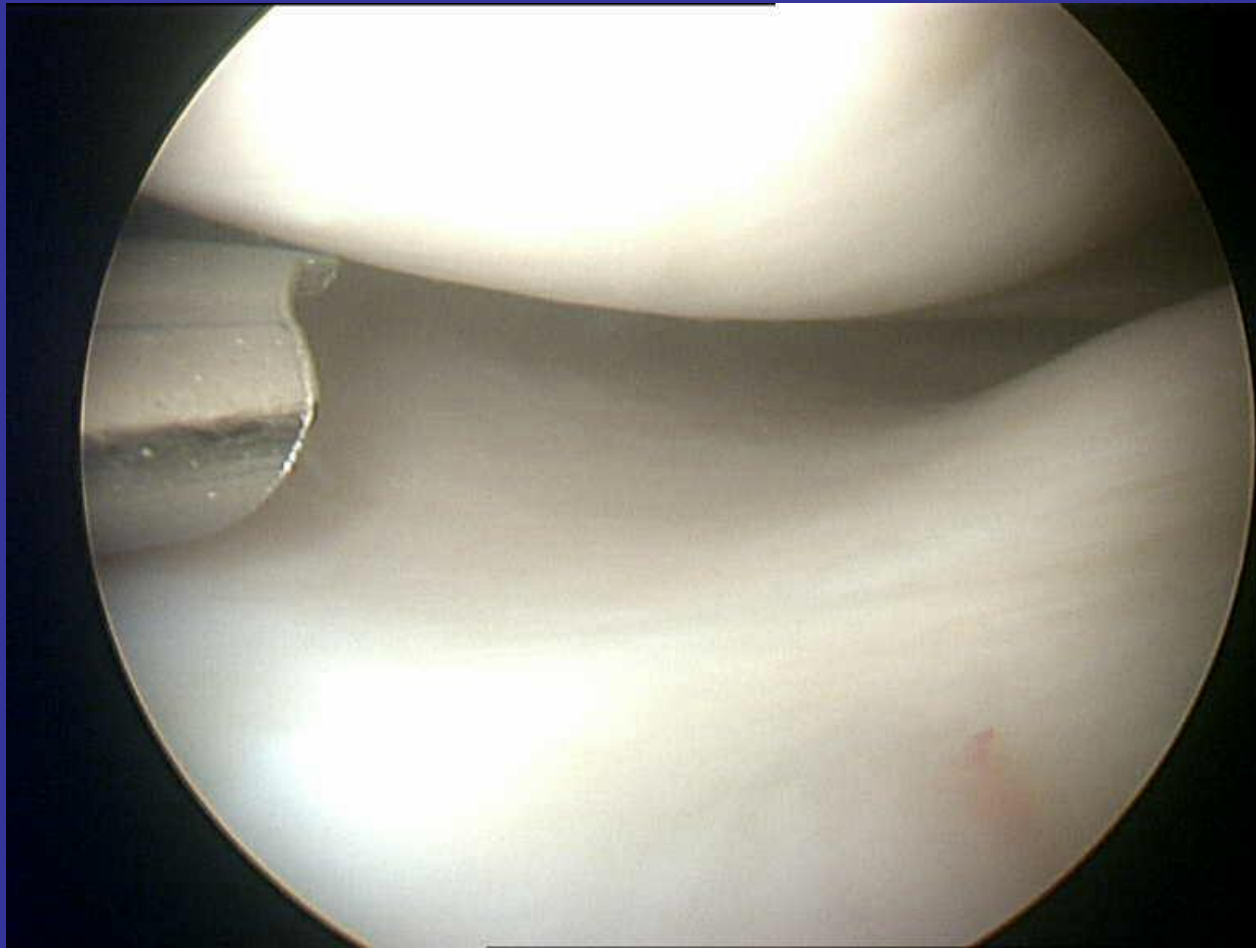
### *Principles of fixation*



gk/pao-96

Not to long !!

Meniscus arrow – Space for the  
tube



# ARTHROSCOPIC MENISCUS FIXATION

## ABSORBABLE TACKS



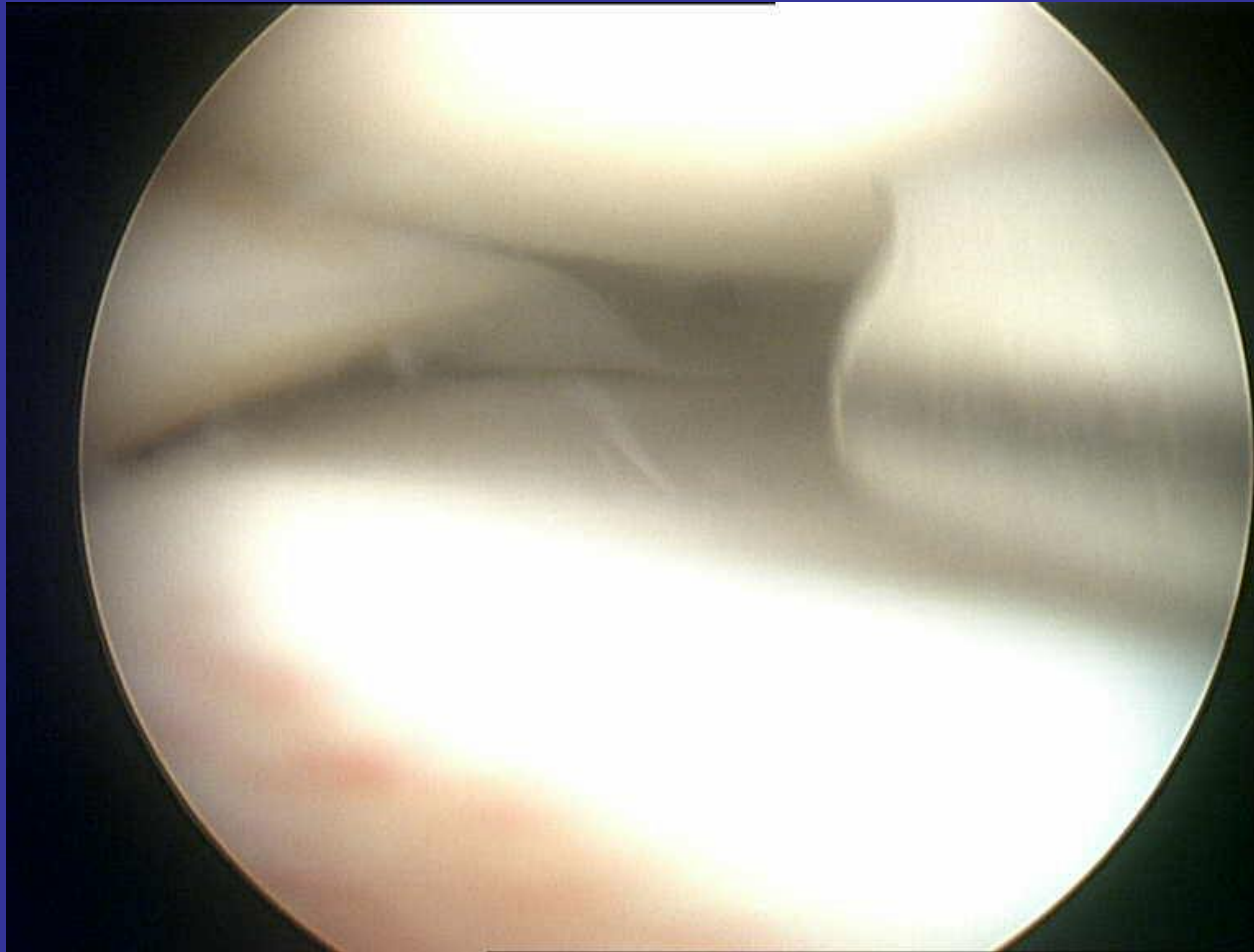
**3:**  
**Insert the**  
**tack delivery tube**  
**and keep the lesion**  
**reduced**

gk-93

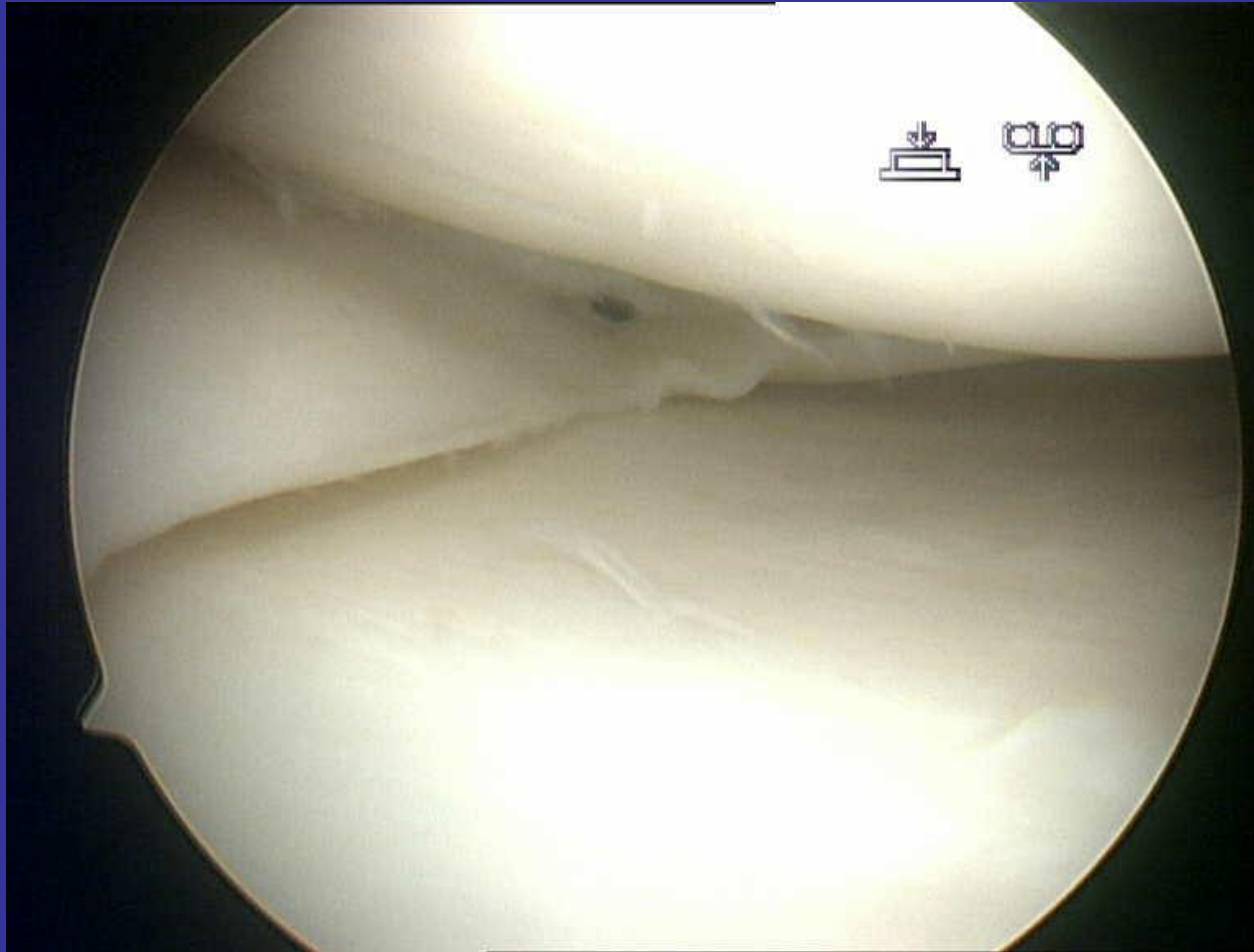




Change portals – and get  
perpendicular to the tear



# At least two point fixation



# Average maximal tensile strengths (meniscus Arrow) :

- 38.3 +/- 4.3 N in **one-point** fixation
- 56.5 +/- 3.5 N in **two-point** fixation

*53.9 +/- 6.4 N in knot-end suture,*

**Song EK.** Arthroscopy 1999 Oct;15(7):726-32

# ARTHROSCOPIC MENISCUS FIXATION

## ABSORBABLE TACKS

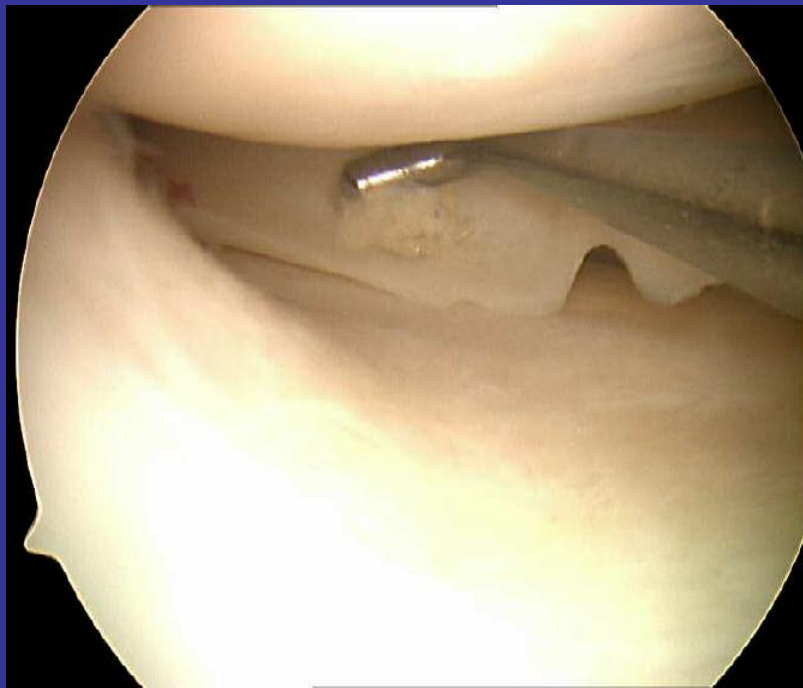


**Absorbable tacks can be inserted both on the upper and the lower surface of the meniscus.**

gk-93



Arrows and Fast fix – easy to use  
in the posterior half of the meniscus



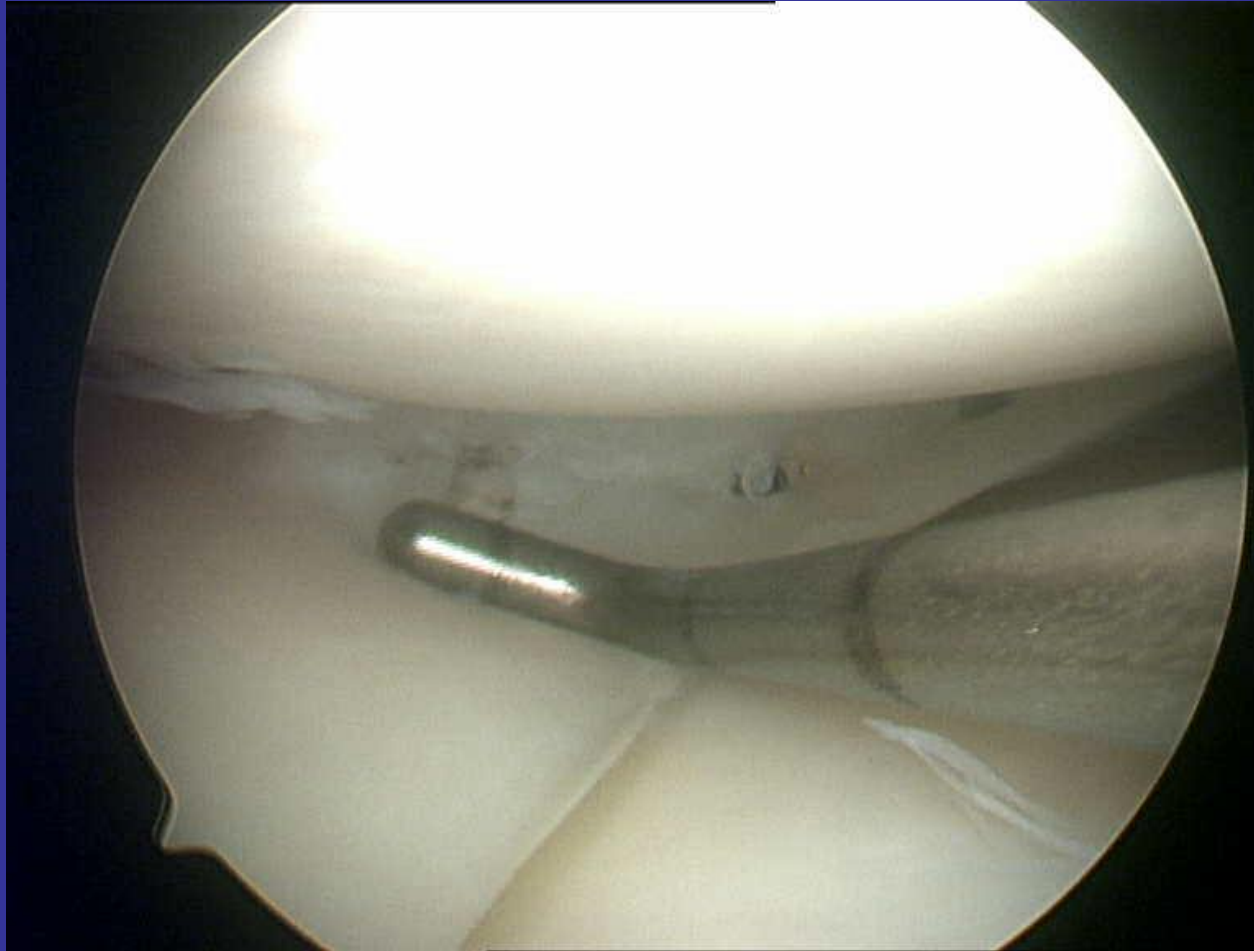
	Clinical	Biomech.	Review	Case reports
Biostinger (Linvatec)	0	3	3	1
Clearfix screw (Mitek)	3	4	3	3
Fastfix + (T-fix) (S & N)	6	1(9)	2(3)	0
Arrow Linvatec	15	18	5	15
Meniscal Viper -Arthrex	0	0	1	0
Mitek Meniscal Repair System	1	5	3	0
Meniscal Stapler	0	1	1	0
Rapidloc (Mitek)	0	1	1	1
Dart (Arthrex)	0	4	3	0

# Healing Rate

- Arrow: 82 % to 93 %
- Fast-fix: 80 % to 91 %
- Clearfix: 75 % to 88 %

Medline march 2005

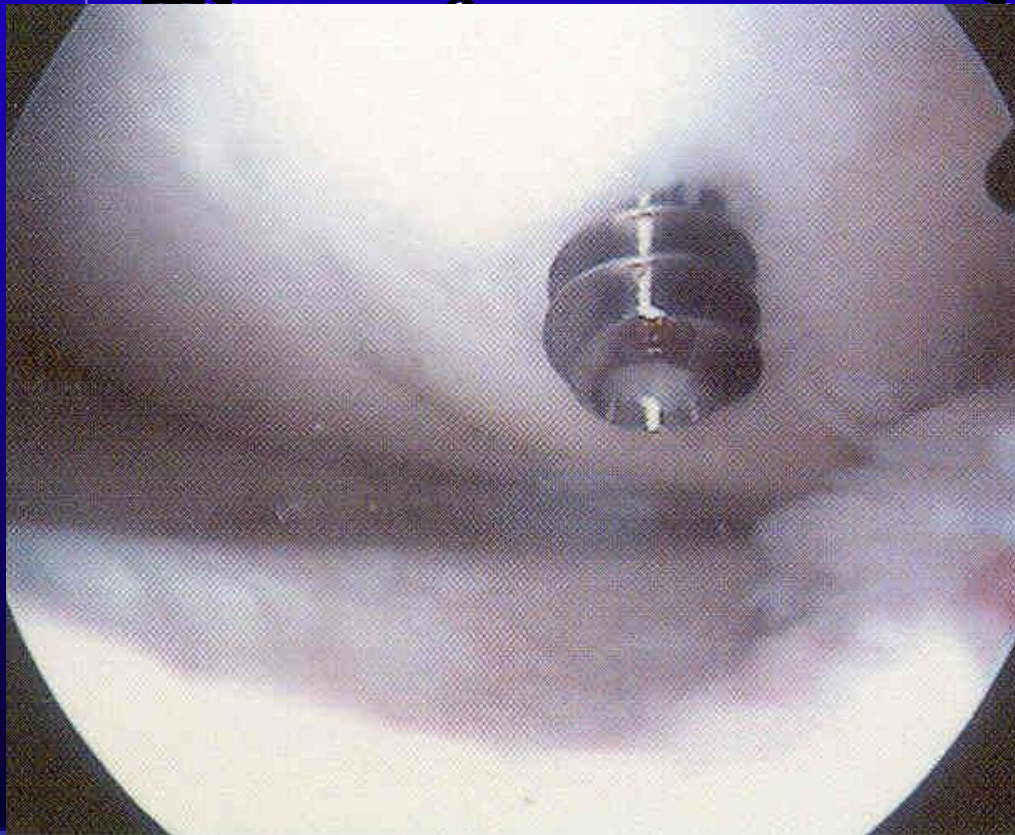
Be carefull





# Complications to absorbable devices

- Case reports



**All implants  
have  
complications  
if not used  
properly on the  
right indication**

# Meniscus Arrow - Complications

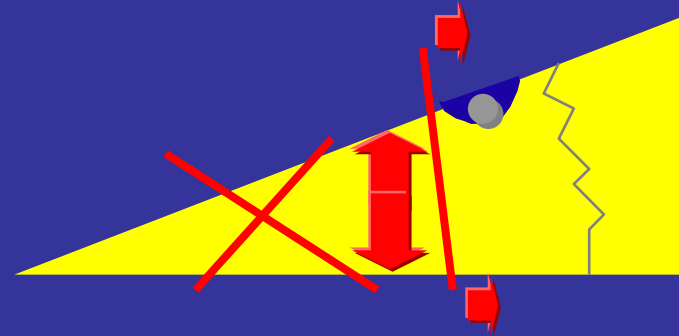
- Protusion of the arrow tip
- Inflammatory response
- Femoral cartilage damage

**2/113 consecutive patients**

**Ellermann A. Knee Surg Sports Traumatol Arthrosc 2002  
Sep;10(5):289-93**

# How to avoid cartilage damage?

- Insert **ARROWS** perpendicular to the tear
- Be parallel to tibial surface
- Be close to the lesion (avoid placing arrowheads in the central  $\frac{1}{2}$  of the meniscus)



# Clearfix - Complications

Tsai AM, McAllister DR, Chow S, Young CR, Hame SL

*Arthroscopy* Jul 2004; **20(6)** :586-90

**18 patients.**

- **Migration** of an implant.
- One patient noted a painless mild **prominence** on the medial aspect of the knee approximately 8 weeks after surgery. This prominence resolved completely over 6 months.
- Transient **inflammatory responses**

# Fast-fix - Complications

**42 meniscal tears in 37 patients**

- No articular scuffing from the knots.
- **8 relook arthroscopies; 5 for failures and 3 for other procedures**
- Removal of a device at the time of surgery was necessary in 5 instances for failure of engagement of the T-Fix bar.

# Complications are without doubt underreported

In 2 prospective randomised studies

- Low complication rate
- No difference between sutures and arrows
  - Albrect Olsen et al 1998
  - Kirkley et al 2004
- So this is not a big concern

# Postoperative rehabilitation

- **Limitation of motion**  
**stability of the fixation ?**
- **Loading ?**  
**Full weight bearing**
- **Sports ? - 3 weeks / months.**

# **No** - immobilization

- **Prolonged immobilization decreases collagen formation in healing menisci.**

**Dowdy PA.** Am J Sports Med 1995 ;23(6):721-8

**There were no complications or deleterious effects from immediate knee motion or early weightbearing on the meniscal repairs**

**Buseck MS, Noyes FR.**

Am J Sports Med 1991 Sep-Oct;19(5):489-94



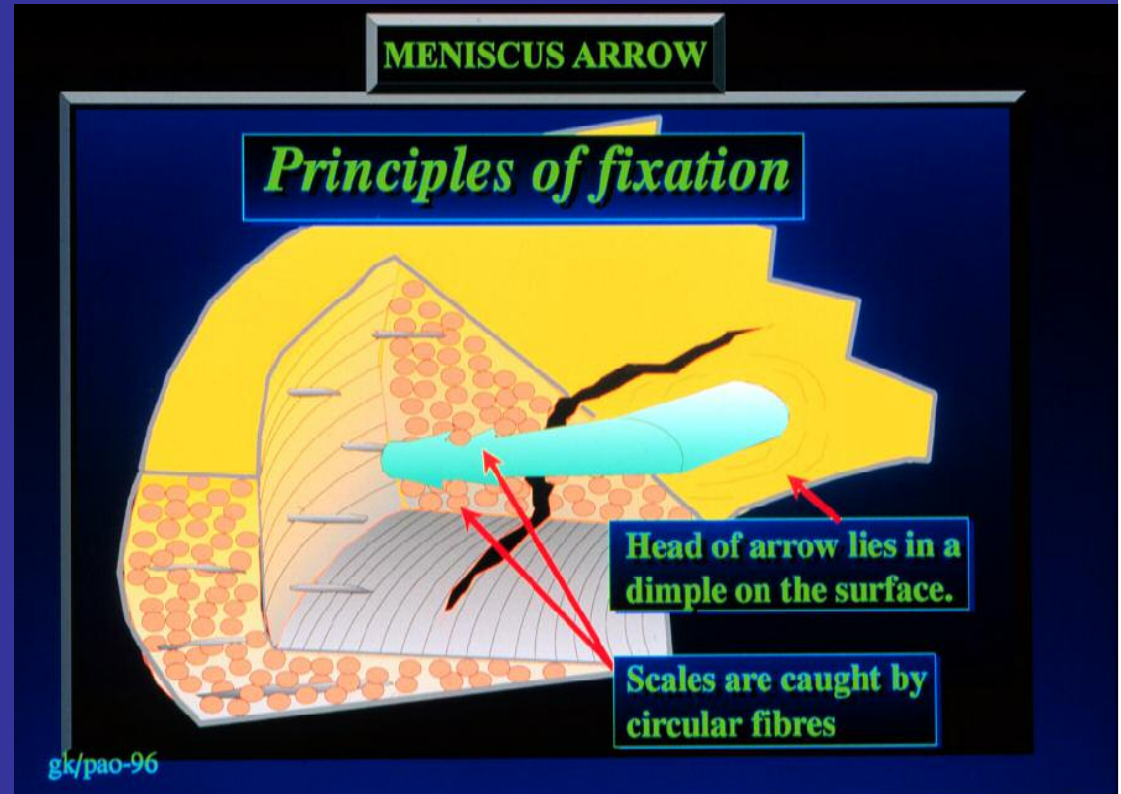
# Conclusion - repair

- Good quality meniscus heals with repair
- Always freshen up the defect
- Posterior half – arrows is a simple solution
- Use at least two arrows
- Combinations with sutures is a possibility
- Possible improvement by adding: trepination and hyaluronan.
- Weightbearing and limited motion

# Tacs inferior to sutures

- When the circular fibres are defect
- Degenerative tears

**The challenge is to  
Improve our results  
With degenerative tears**



# The most important

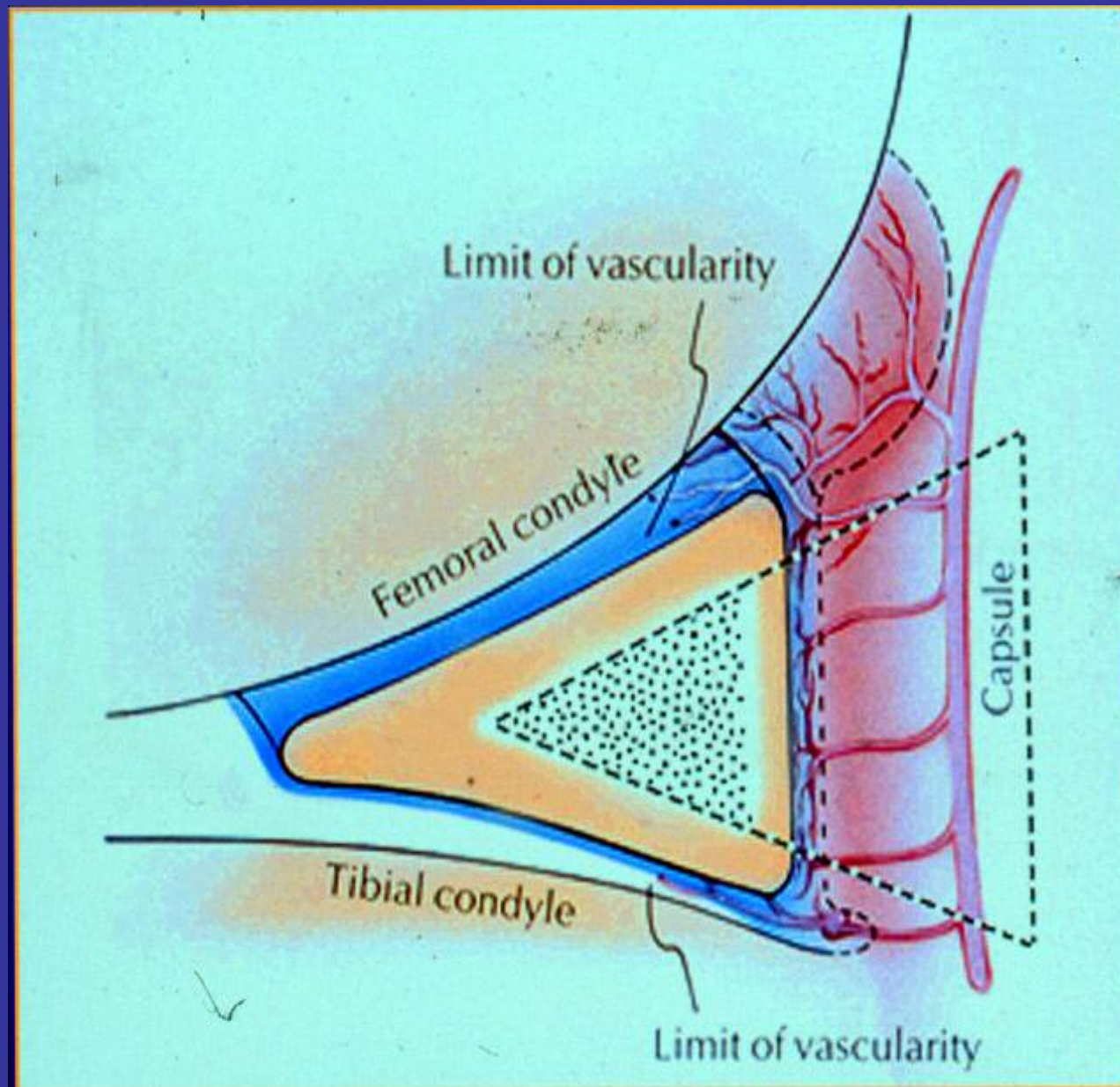
- The right indication
- Familiarity with the procedure
- Match rehabilitation to the repair
  - The quality of the meniscus
  - The size of the tear
  - The strenght of the fixation

**Thank you**

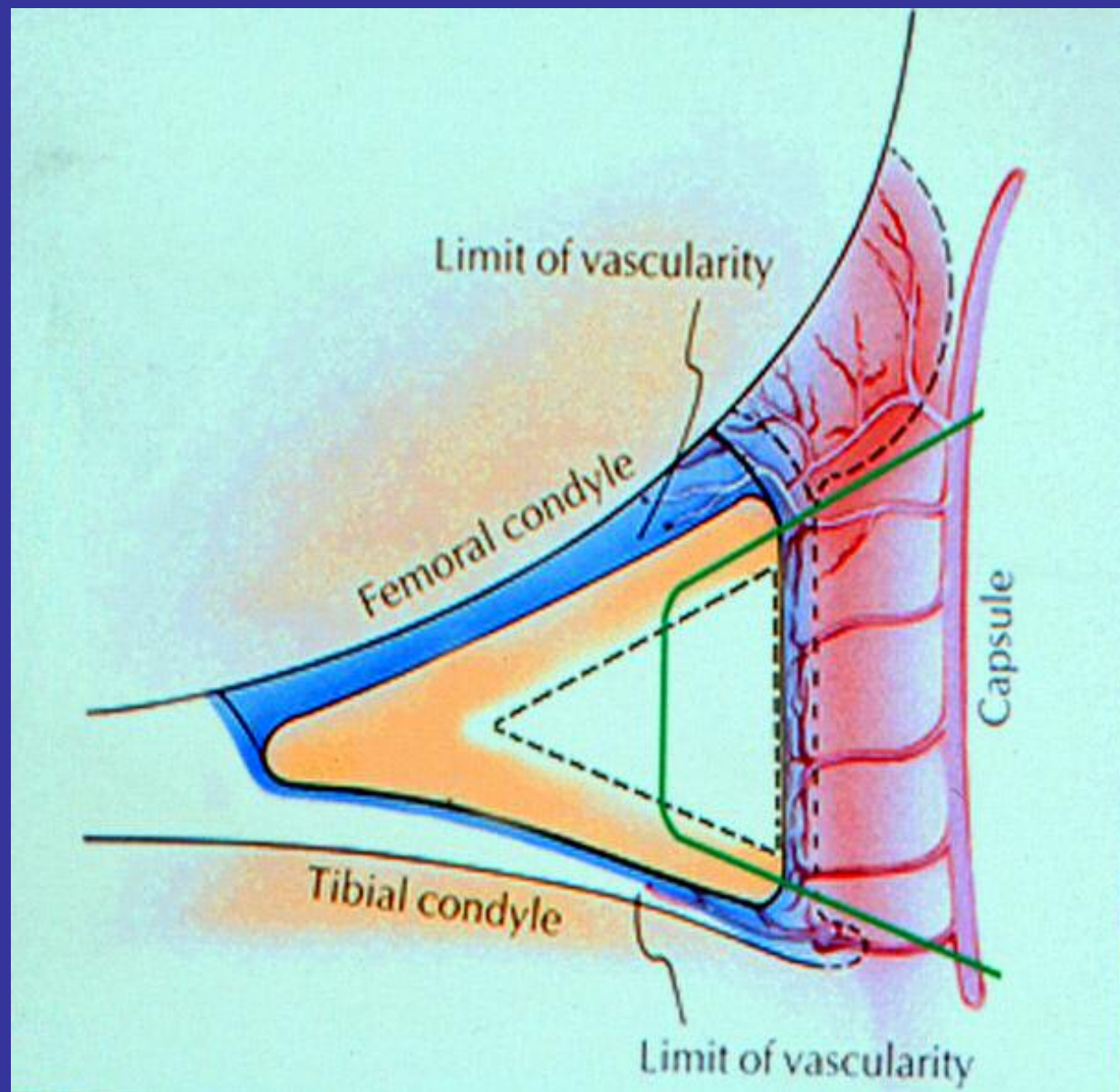
# Intramensical lesion

- The lesions we all have looked at – and overlooked !









# Results

- 10 patients ( Lysholm 83 (mean))
- Re-arthroscopy / Open OP one year after arthroscopy
- 3 break through of lesion- **resection**
- 7 open wedge resection and suture
- One year follow up: Lysholm 93 ( mean )
- Two years                      Lysholm 91 ( mean )
- MRI at one year: regained hight –still changes



# **Discussion – degenerative tears**

- **The degenerative meniscus**
- **A sign of degeneration of the knee ?**
- **Can we do something to change the situation ?**
- **Surgery (repair / transplantation / scaffold )**
- **Glucosamin / Hyalyronan**
- **Genetherapy?**
- **Training ?**

# Meniscus transplantation

## Animal experience

- **Primary > secondary**

(Ågaard 1999)

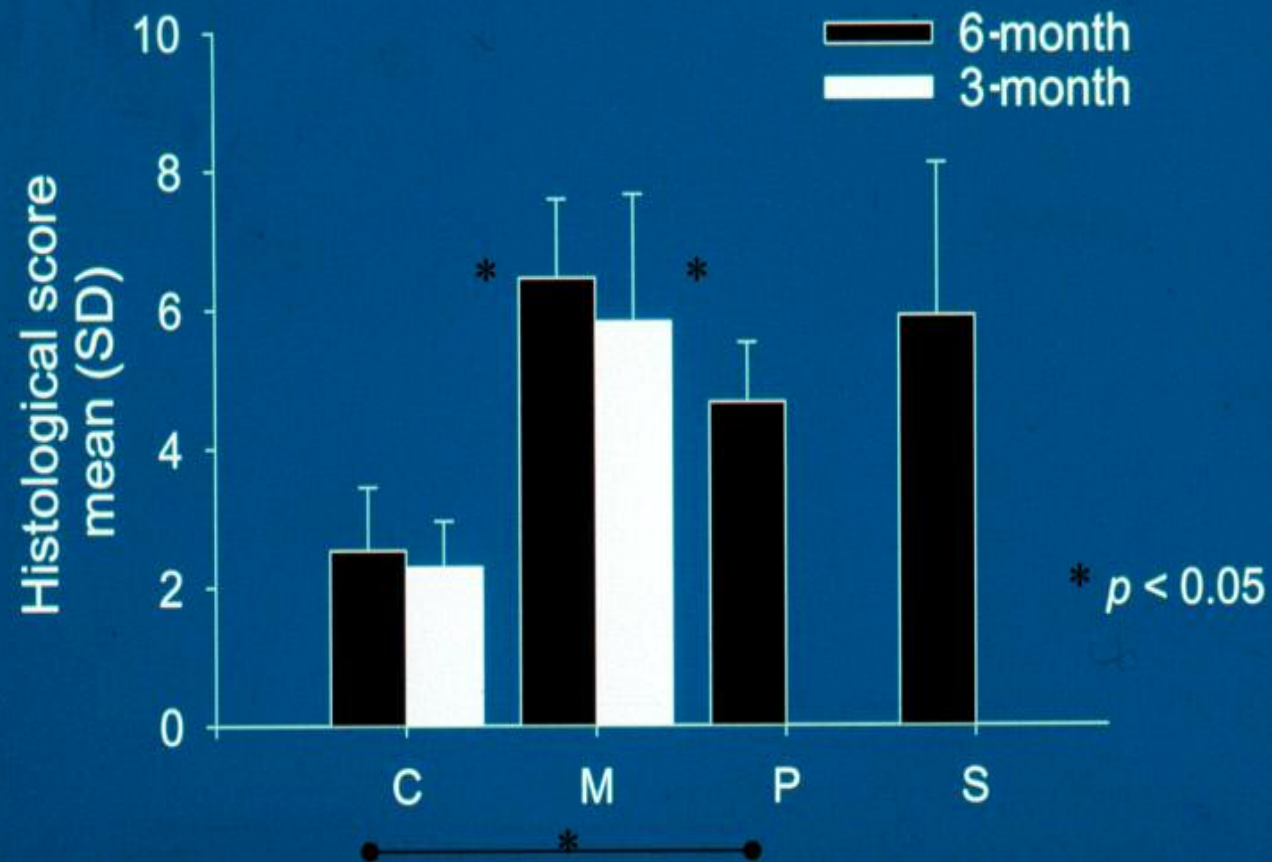
- **Still degeneration**

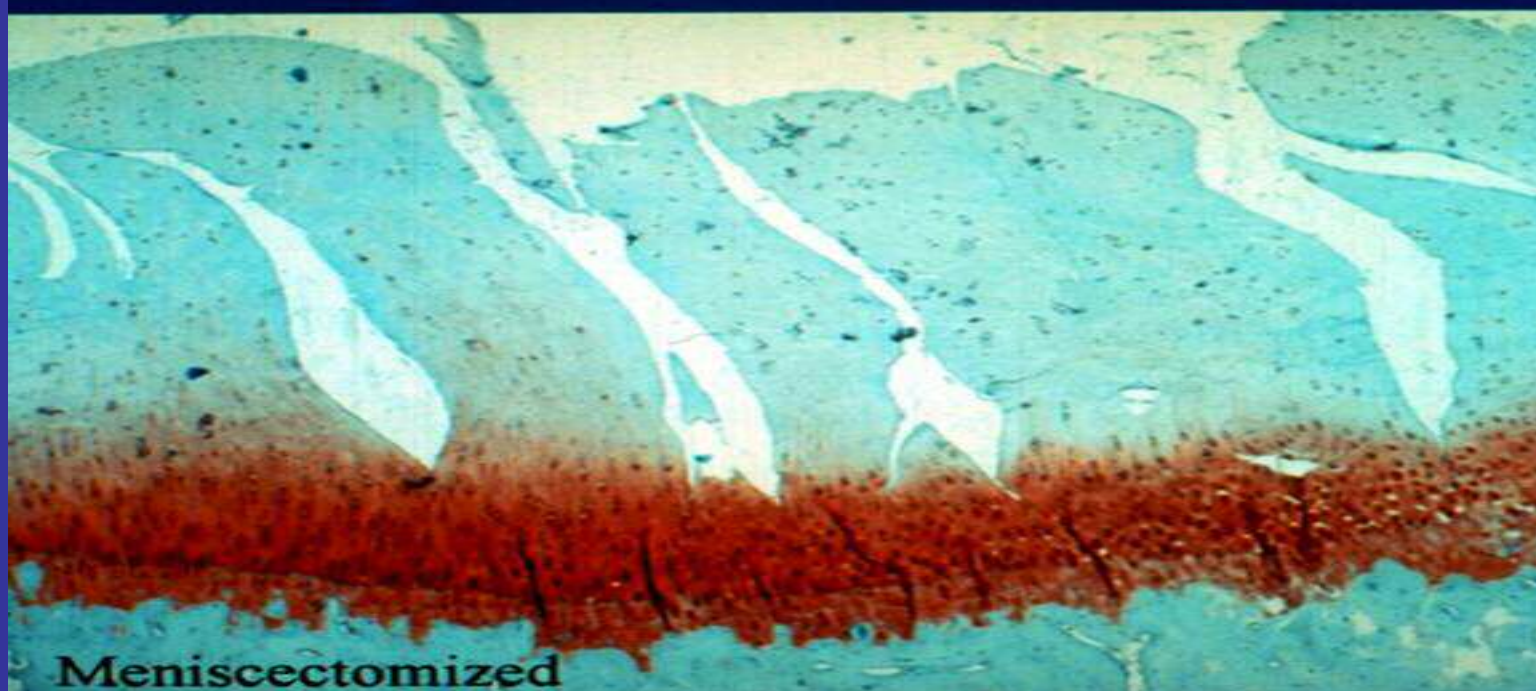
## Human experience

- **Pain reduction** (Verdonck 1999)

# Articular cartilage changes

## histological score









# The future

## Stimulation of meniscus healing

- Gene transfer - repair ?

## New meniscus

- Scaffold
- Autologous meniscus cell implantation
- Growth factors

# Meniscus repair

## Suture

- Inside out - outside in
- Notch technic
- All inside

## Fast-fix

## RapidLock

## Tacs

- Meniscus arrow
- Dart
- Fastener

## Cannulated

- Biostinger
- Clearfix screw