

UPDATE on CARTILAGE

MSC Stimulation

CCOS Group

Dr Nicolas GRAVELEAU , Dr Philippe COLOMBET , Dr Nicolas BOUGUENNEC ,
Bordeaux-Mérignac, France

MERiSCIENCE



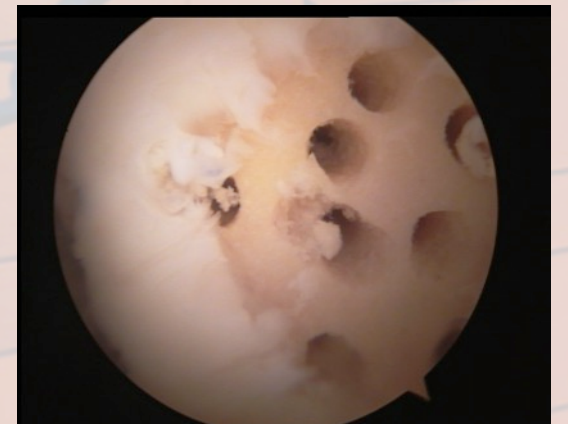
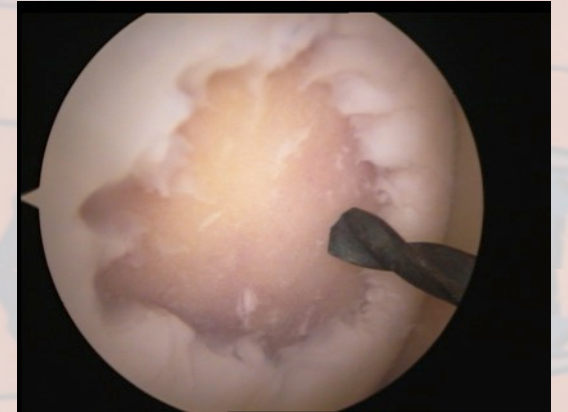
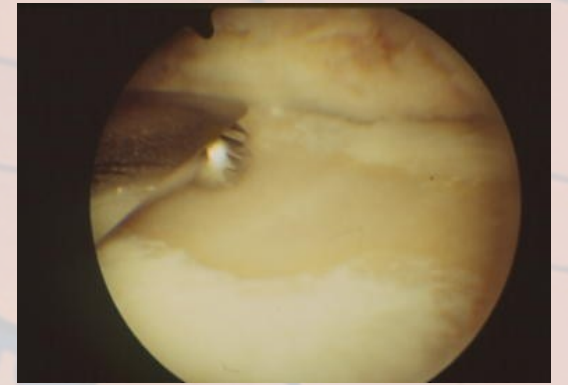
Centre de Chirurgie
Orthopédique et Sportive
Bordeaux Mérignac - Rocade sortie 12


CLINIQUE DU SPORT
BORDEAUX - MERIGNAC

MSC stimulation

Mesenchymal Stem Cell stimulation

Technique which could be performed by arthroscopy to « repair » some cartilage lesions



Localized full cartilage tear
+/-Large surface in WB area

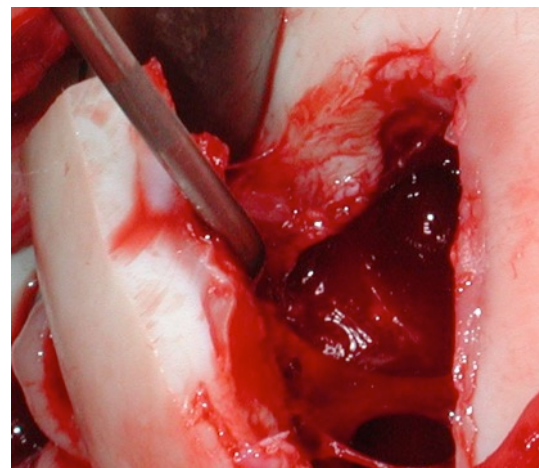
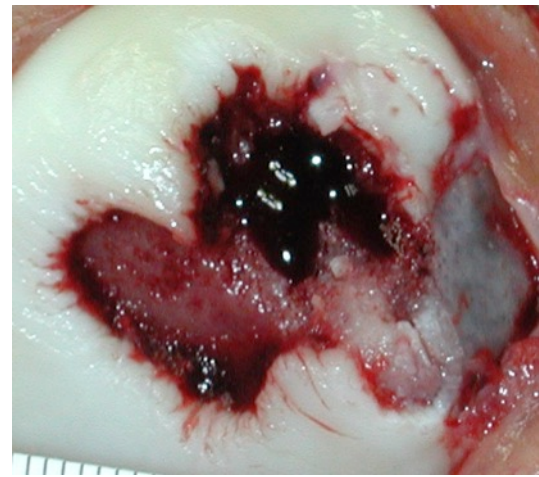
Chondral or osteochondral
Fracture

Osteochondritis



Possible etiologies

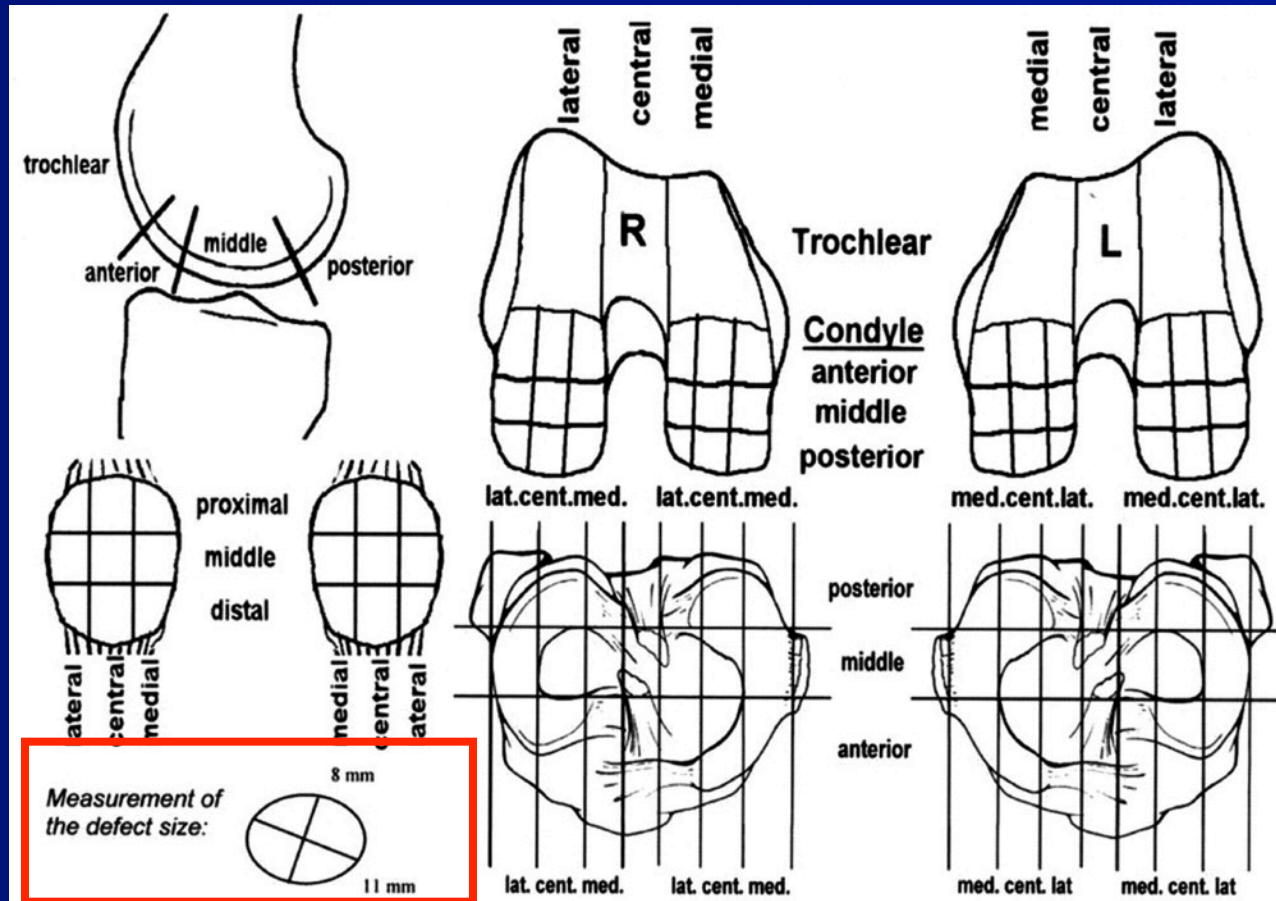
- Traumatic cartilage defects
- Osteochondritis dissecans
- Osteonecrosis
- Osteoarthritis



Cartilage lesions

Arthroscopic classification ICRS :

descriptive analysis, size



20 cts 1 euro
 3.80 cm² 4.52 cm²



1 centime 10 centimes
 2.01 cm² 2.83 cm²

Cartilage lesions

Arthroscopic classification ICRS : 4 Grades

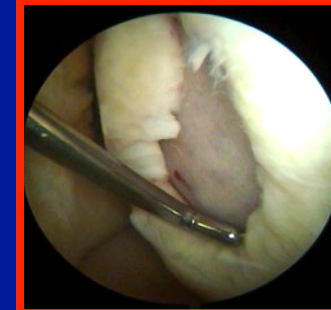
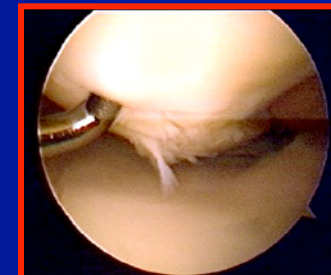
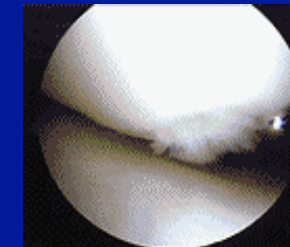
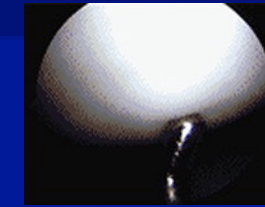
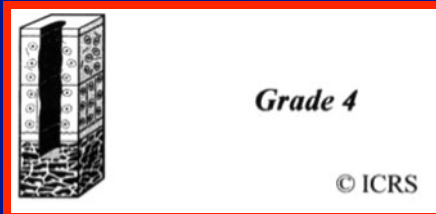
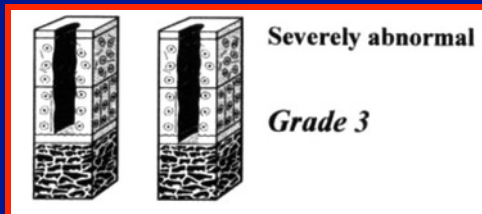
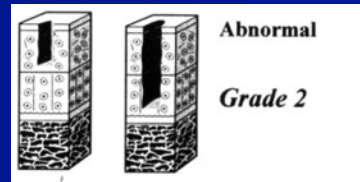
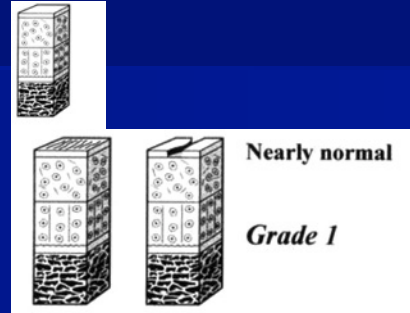
➤ Normal

➤ Grade 1 : Nearly normal
Chondromalacia
Superficial crack

➤ Grade 2 : Abnormal
Depth < 50 %

➤ **Grade 3 : Severly abnormal**
Depth > 50 %

➤ **Grade 4 : erosion to
subchondral bone**



Incidence of lesions $> 2 \text{ cm}^2$

➤ 993 consecutives arthroscopy

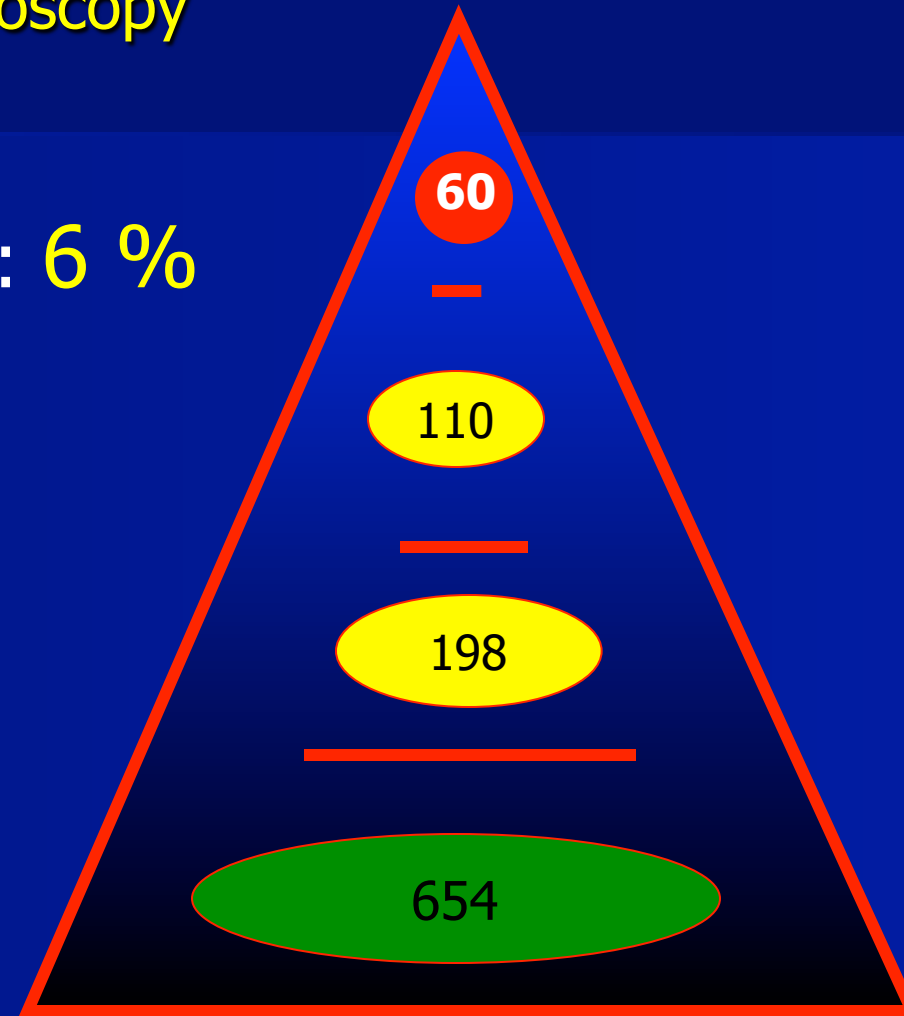
Localized defect

ICRS grade 3 & 4 $> 2 \text{ cm}^2$: 6 %

ICRS grade 3 et 4 localized : 11 %

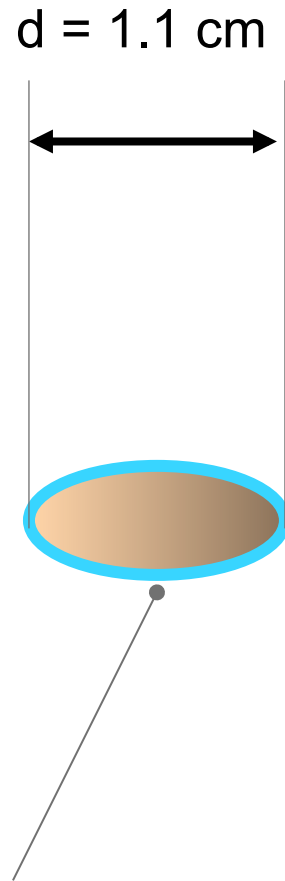
Localized defect : 20 %

Cartilage lesion: 66 %



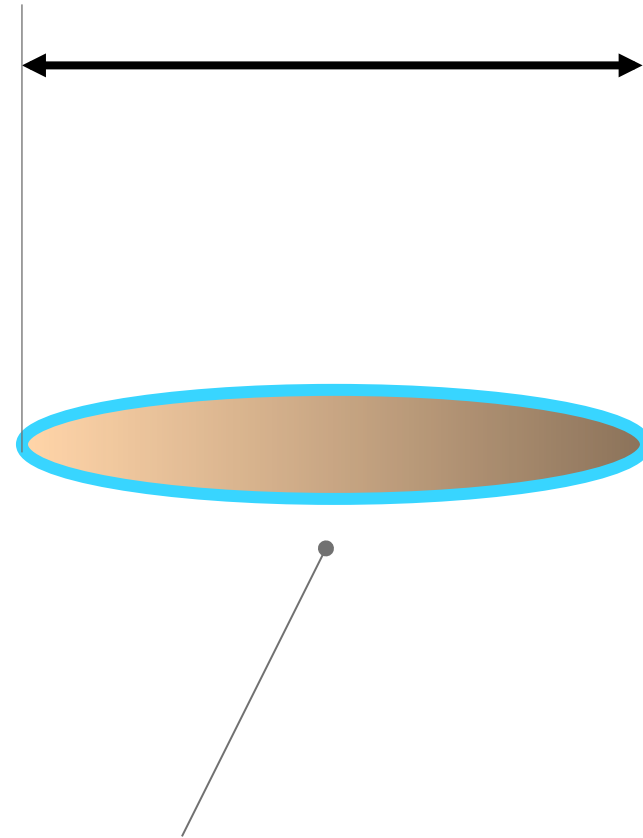
Size matter

Small...



$$A = 1.0 \text{ cm}^2$$

$d = 2.3 \text{ cm}$



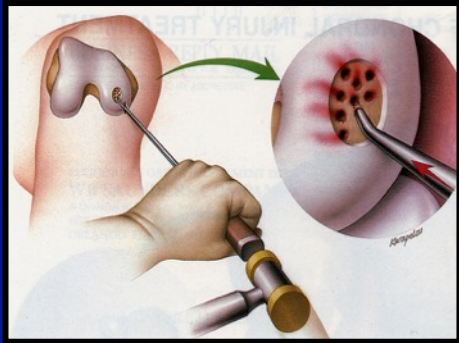
$$A = 4.0 \text{ cm}^2$$

Large...

Techniques of cartilage repair

Bone marrow stem cell stimulation

- Pridie perforations (*Pridie JBJS B 1959*)
- Abrasive chondroplasty (*L. Johnson Arthroscopy 1986*)
- Microfractures (*J. Steadman O. Technique 1997*)
- Promotor (*Steadman, Arthroscopy 2003, Mithoeffer JBJS ...*)
- Comparatives studies :
 - Knutsen JBJS A 04
 - Gudas Arthroscopy 05
 - Alford AMJSM 05



Indication & techniques

Communication with bone marrow

Focal perforation of the cement line

awls (microfracture)

drill bits (subchondral drilling)

generalised abrasion (1-2 mm²) (abrasion arthroplasty)

Mesenchymal cells migrate into defect

Smillie *J Bone Joint Surg Br* 1957

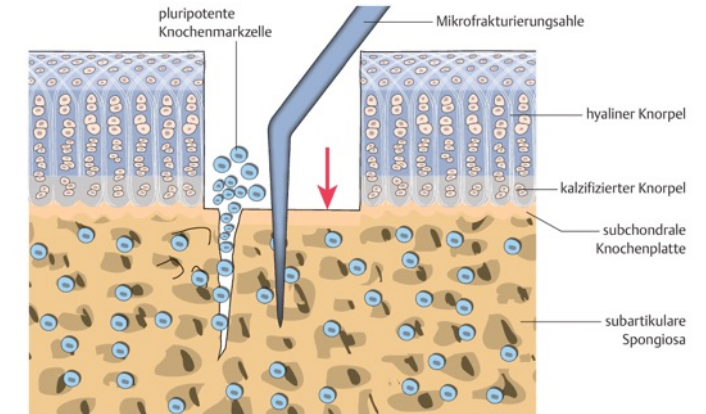
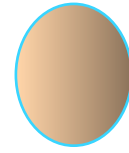
Pridie *J Bone Joint Surg Br* 1959

Steadman et al. *Arthroscopy* 2003

Johnson *Arthroscopy* 1986

< 20 year-old patients

Small defects



Source: Madry *Expertise Knie - Operative Therapie* 2015

Microfracturing

Chondral

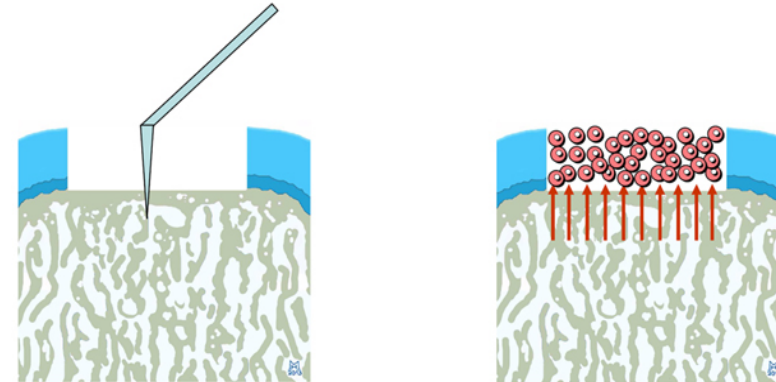
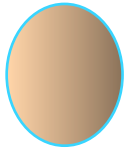
- Marrow-stimulation
 - Microfracturing

Osteochondral

- Refixation of osteochondral fragment
- Osteochondral transplants

< 20 year-old patients

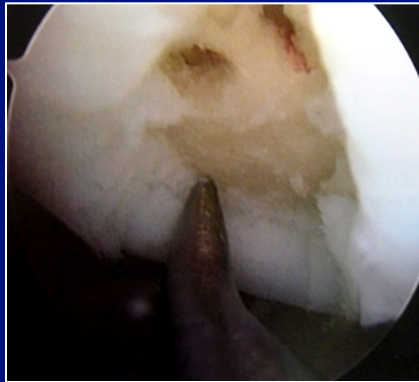
Small defects



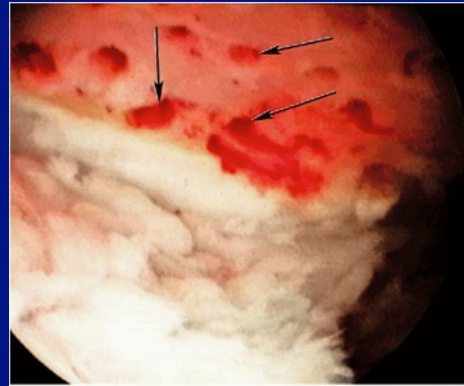
● Mesenchymal stem cell

Microfractures : Principles

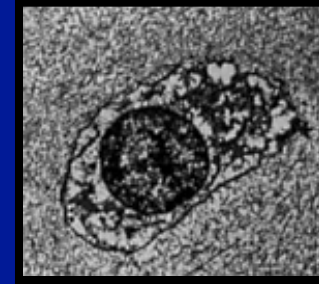
Subchondral perforation



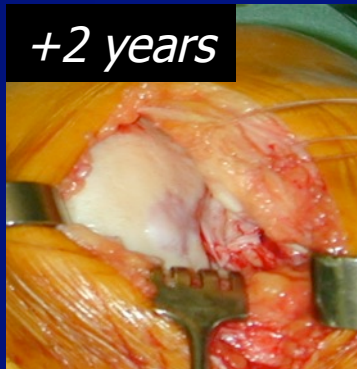
Cloats



Stimulation, Migration, Multiplication & Diferenciation
Multi-**P**otential mesenchymal cells

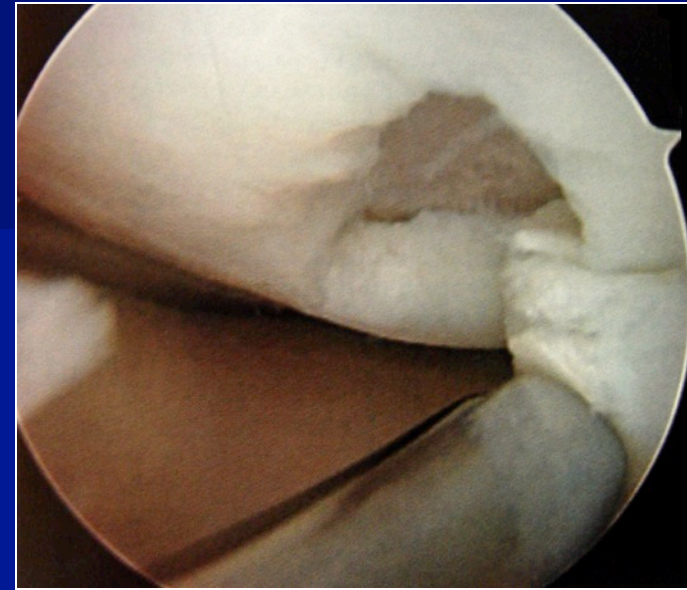


« repaired » fibro cartilage 6 to 8 sem (collagène Type I)
Differente from normal cartilage (Mecanichal & Compo)



Microfractures : Technique

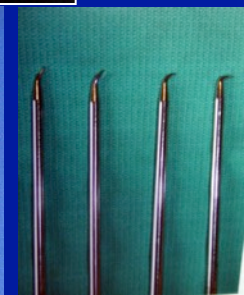
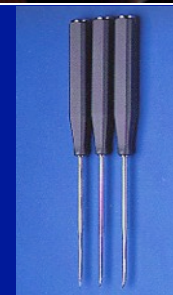
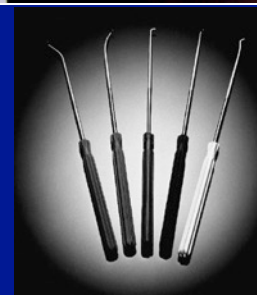
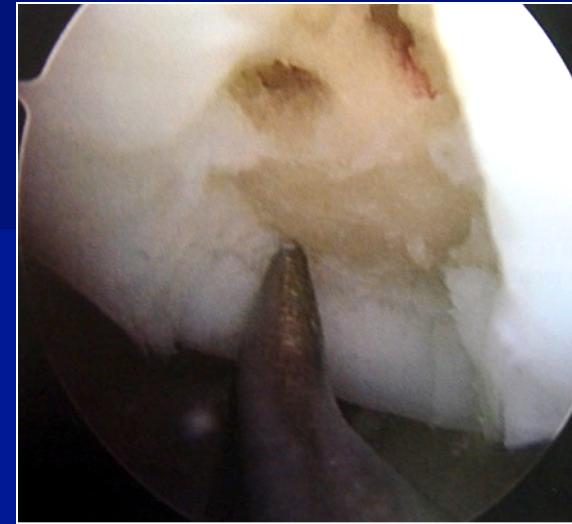
- Arthroscopy :
- Size assesment
- Debride cartilage flaps and damaged cartilaged to the « calcidied » cartilage with sharp periphery



Microfractures : Technique

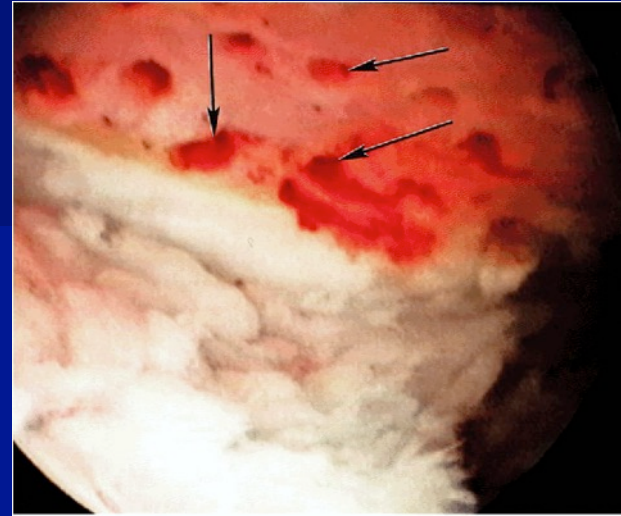
Arthroscopy :

- Preparation with debridement to the calcified cartilage
- Perforations sub-chondral bone
- *Every 2 to 3 mm*
- *3 à 4 mm of depth*
- **Periphacal : angulated device**

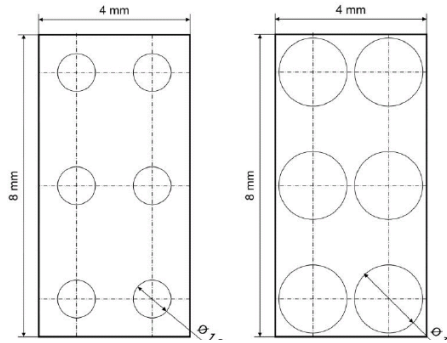


Microfractures : Technique

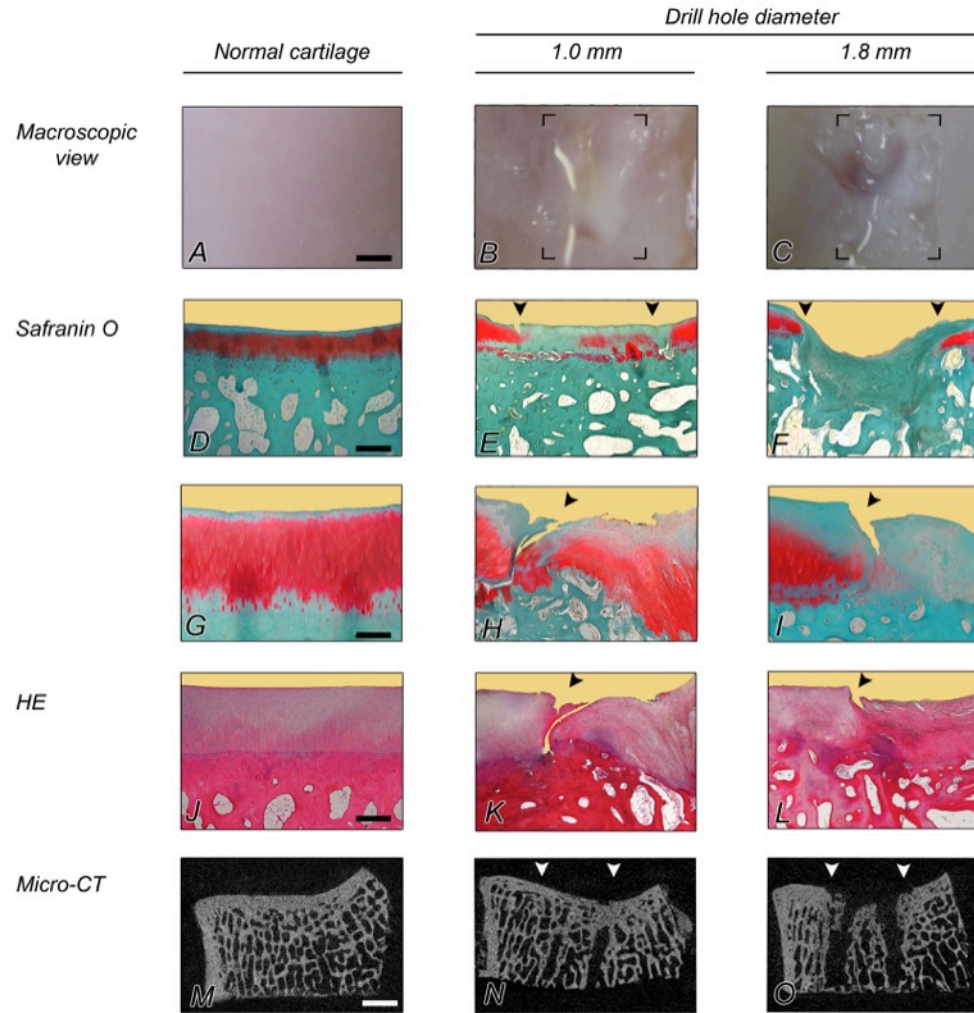
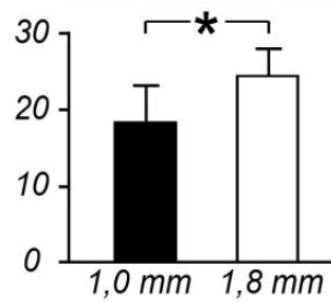
- Peripheral : with a angulated peak
- *Check for bleeding (remove tourniquet)*
- **C**loot fibrino-cruoric



Small diameter bone cutting devices improve repair

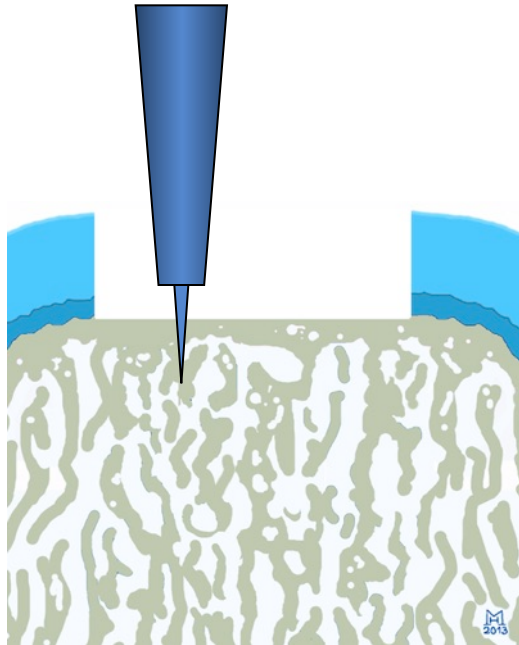


Sellers score

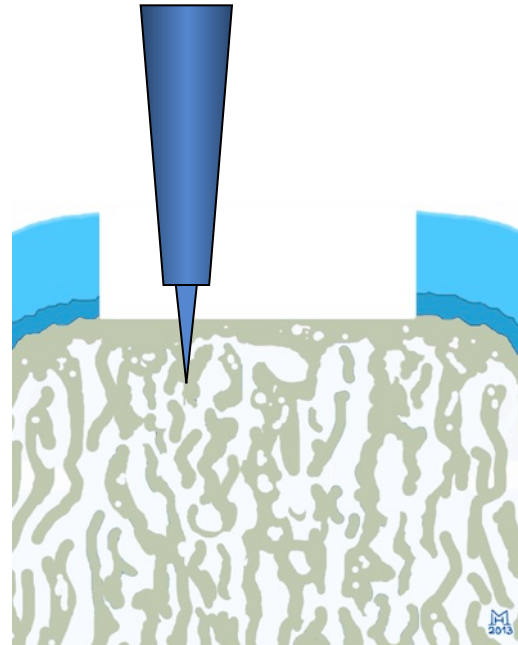


Effect of Awl Diameter

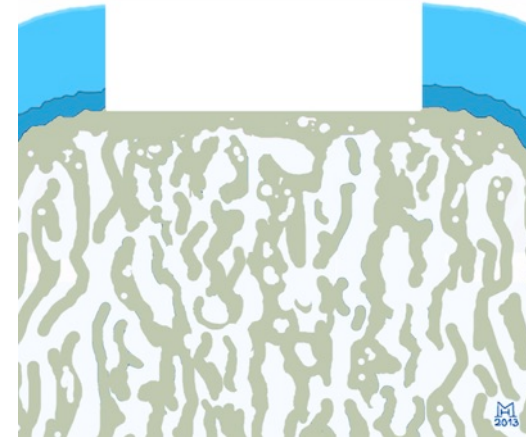
Group 1
1.0 mm diameter



Group 2
1.2 mm diameter

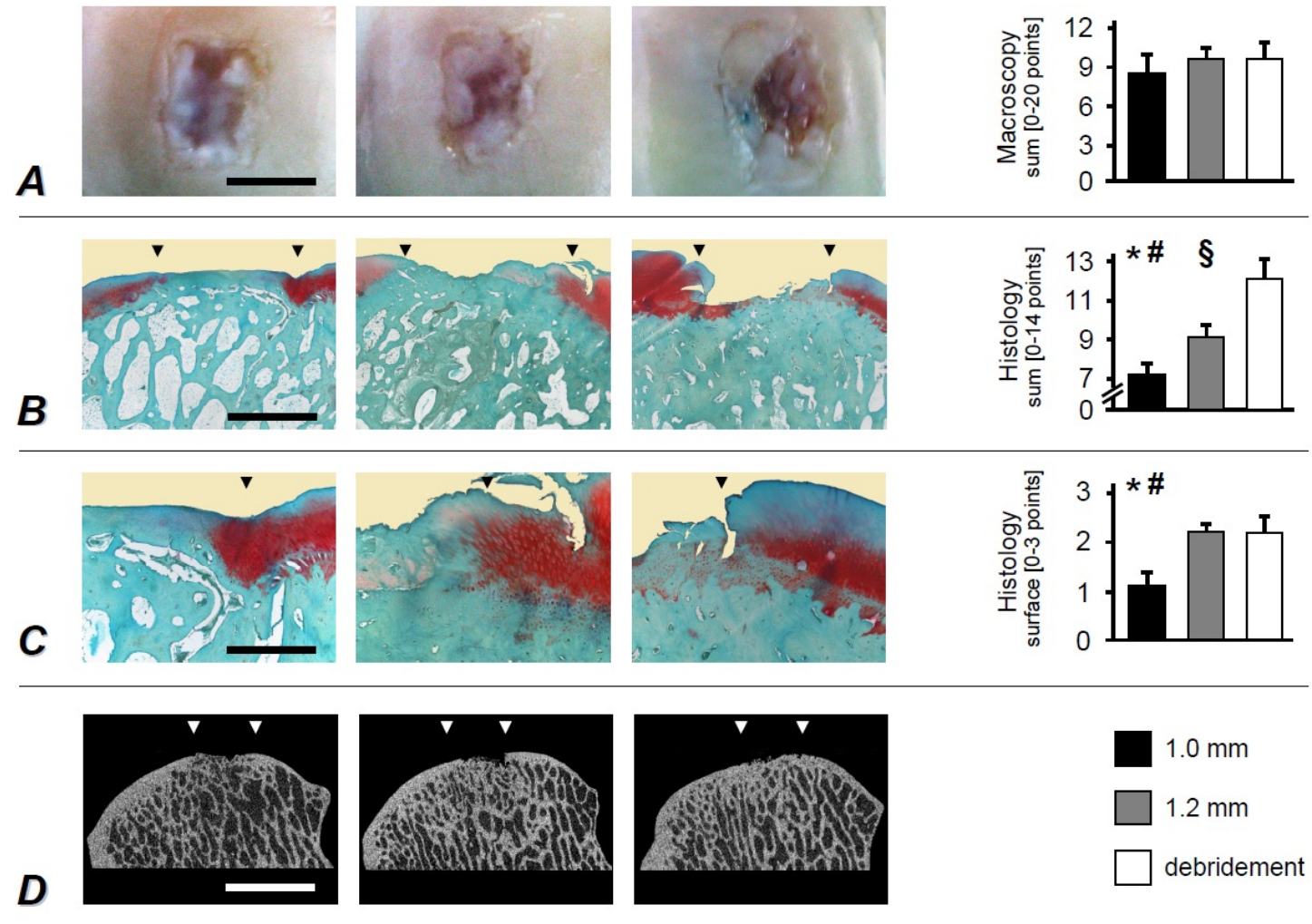


Group 3
debridement control



- *chondral defects*
- *subchondral drilling*
- *sheep model - 6 months postop*

Small Diameter Awls Improve Repair Following Microfracture



Microfractures : Post operative management

Objectifs :

Protect the cloats

Promote proliferation & diferenciation of MSC

Maturation to cartilage

Condyles :

non WB 6-8 s. depending of lesion size

continued mob. passive

ROM? controversy

Patella & trochlea :

sling

Full WB

0-30° for 4 w

out of the microfracture zone

Run & jump > 3 / 4 months



Microfractures : Results

Promoted by **Steadman**

CORR 2001, Arthroscopy 03, J Knee Surg 04

71 cases, FU 11 ans

Isolated cartilage lesions (**pain, MRI**)

No meniscal or ligament tears

Average age 30 y.o. (13-45), **< 45yo**

Localisation

MFC : 21

Trochlea : 20

LFC : 12

Patella : 8

Average SIZE: 2,77 cm²

Microfractures : Results

Promoted by **Steadman**

CORR 2001, Arthroscopy 03, J Knee Surg 04

Evaluation PROMS

(Personnel, Tegner, Lysholm, Womac, SF 36)

Objective evaluation ?

Anatomical control (MRI)?

10 % failure

2 failure

5 arthroscopy for persistante pain

Microfractures : Results

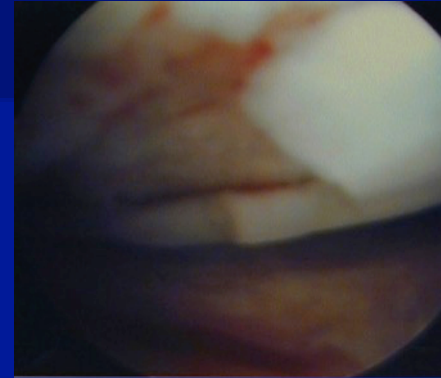
Promoted by **Steadman**

CORR 2001, Arthroscopy 03, J Knee Surg 04

Significant increase in questionnaire
86 % normal function / sub normal
STABLE results for 2 to 7 ans

Major pronostic factor : **age < 35y**

NO influence : lesion size , duration
of symptomes ; localization



Microfractures : Results

Gobbi KSSTA 2005 Niveau IV

Prospective : 53 **athlètes** (26 comp, 27 loisirs)

Average age: 38 yo (19-55)

Sport activities

IKDC **s**ubjective et **o**bjective

Average FU **6 ans**

Localization :

MFC : 61 %

LFC : 13 %

Tibial plateau: 11%

Average size : 4 cm²

Microfractures : Results

Gobbi KSSTA 2005

IKDC subjective : 70 pts/ 100

Pain free : 62 %

80 % diminution sport level compare to preop

But, 55 % still have sport activity

IKDC Obj : 70 % A & B

Failure : 10 % (2 infections, 3 ACI)

Microfractures : Results

Mithöfer JBJS 2005 Niveau IV

Prospective : 48 cases, age : 41 ± 12

MRI evaluation specific/cartilage :

T2-echo gradient

T2-Fat Spin Echo + fat-sat (coupes coronales et sagittales)

Average FU **41 ± 7 months**

LocaliZation :

MFC : 54 %

LFC : 23 %

Traumatic : 56 %

Average size : 4,8 cm²

Microfractures : Results

Mithöfer JBJS 2005

Results : SF 36, IKDC subjectif

Excellent : 67 %

Mild : 29 %

Poor 17 %

But **deterioration** after 24 months +++

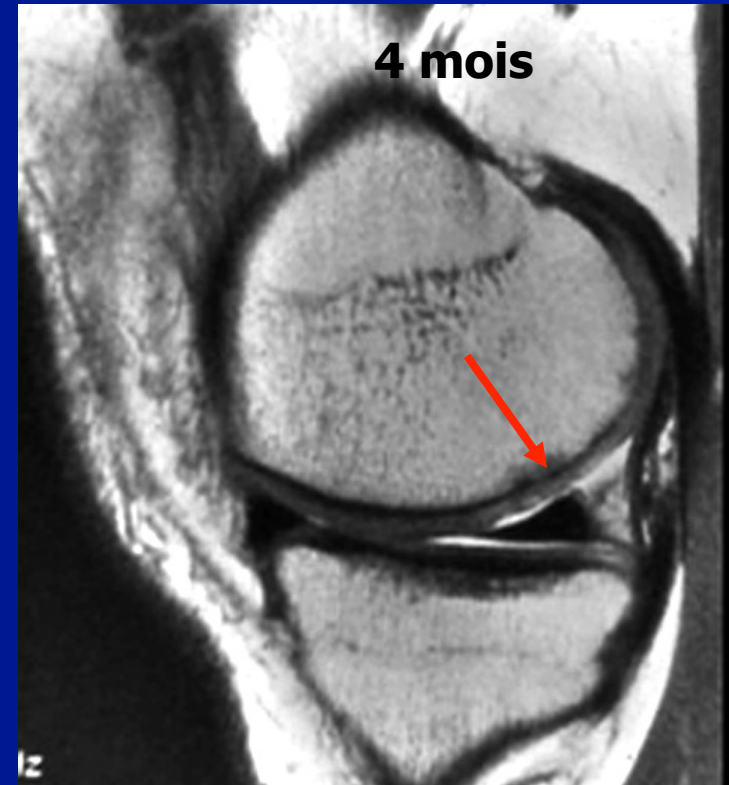
Bad pronostic factor :

IMC > 30 kg/m²

Microfractures : Results

Mithöfer JBJS 2005

Hyper signal intensity : 92 %



N = 48

Microfractures : Results

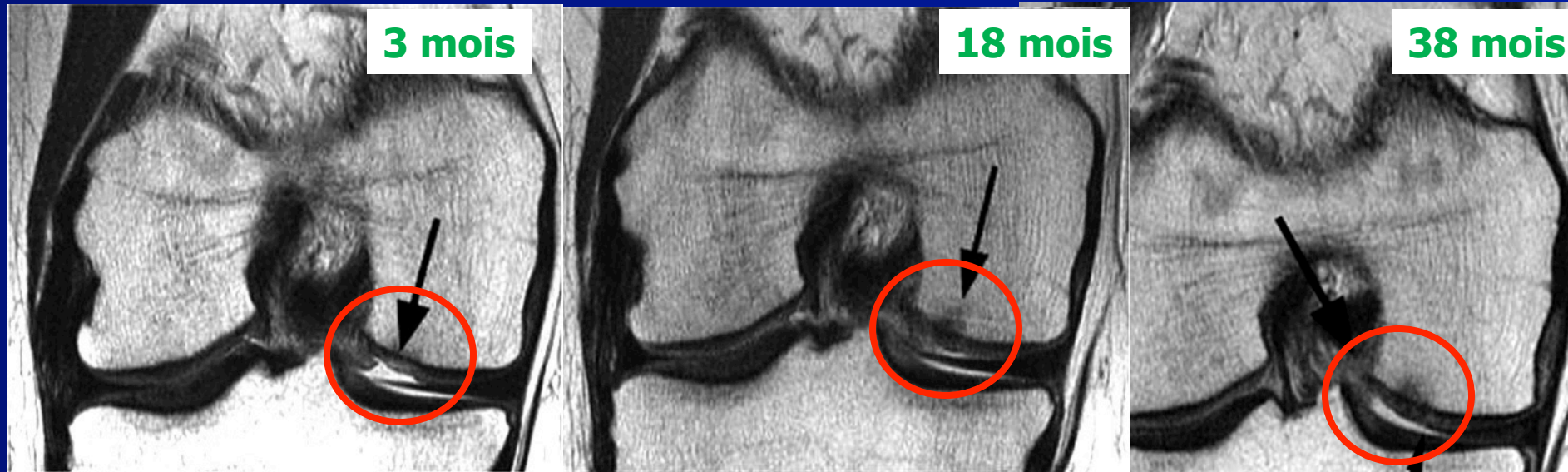
Mithöfer JBJS 2005

Defect filling:

Good (>66 %) **54 %**

Mild (33-66 %) 29 %

Bad (0- 33 %) 17 %



N = 48

Micro fractures : results

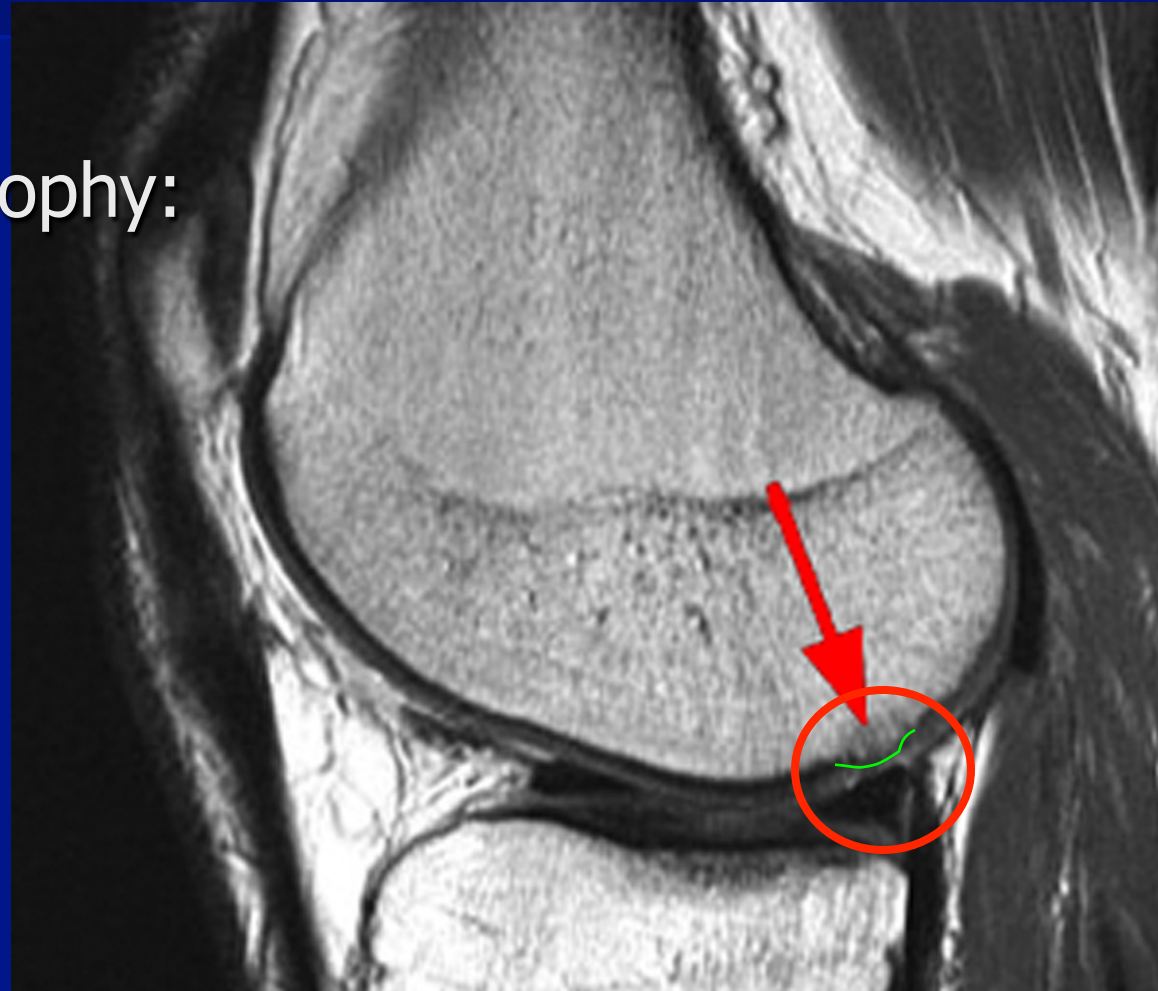
Mithöfer JBJS 2005

Subchondral bone hypertrophy:

25 %

Thin superficial cartilage

Biomechanich behavior ?



N = 48

Microfractures : Results

Knutsen JBJS 2004

MF versus chondrocytes graft

Prospective randomized, Niveau I 1A

Average age: **32 yo**

Isolated Grade 3 et 4 lesion

Average size 4,5 et 5,1 cm²

Arthroscopic control w. biopsies

Subj questionnaire & ICRS

Minimal FU **2 years**

Microfractures : Results

Knutsen JBJS 2004

MF versus chondrocytes graft

Significant improve of SF 36 in the two cases but,
MF > chondrocytes graft

Lysholm identic : 75 % increase

Biopsy : 39 % hyaline cartilage & 43 % of
fibrocartilage

Arthroscopy for controle : 25 % CG, 10 % MF

Prognostic factors :

Age < 30 y.

Size < 4 cm²

Microfractures : Results

Gudas Arthroscopy 2005

MF versus Mosaicplasty chez **jeunes** sportifs

Prospective randomized, Level I 1A

Average age: **24 yo**

Isolated lesion Grade 3 et 4

Average size lesion 2,8 cm² (< 4)

Arthroscopic controle w. biopsies

Questionnaire HSS & ICRS

Minimal FU **3 ans**

Microfractures : Results

Gudas Arthroscopy 2005

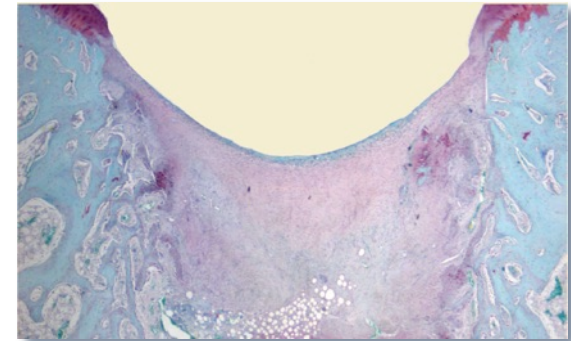
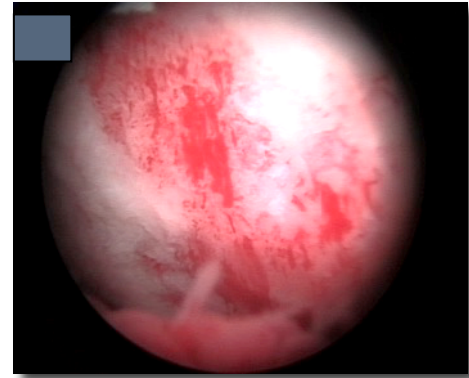
MF versus Mosaicplasty in young athletes

	Microfractures		Mosaicplasty	
HSS ICRS	52 % Excellents	<	96 % Excellents	
Sport level	52 % same	<	93 % same level	
Grade ICRS 1 et 2	45 %	<	78 %	
Surface aspect MRI	52 %	<	96 %	
Arthroscopy	9 failure	<	1 failure	Diff sign

Indication

- first-line treatment, symptomatic small ($< 4 \text{ cm}^2$) focal chondral defects in young patients
- degenerative focal cartilage lesions with intact adjacent articular cartilage in middle-aged patients
- juvenile patients: important even for large defects
- in the elderly: relative indication

Chondrogenesis

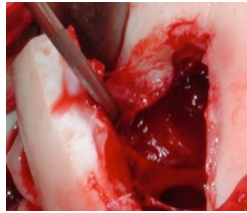


Adult
mesenchymal
stem cells

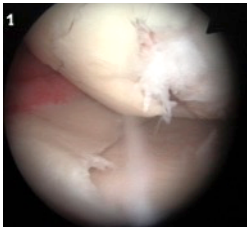
Possible etiologies



- Traumatic defect



- Osteochondritis dissecans



- Osteonecrosis



- Osteoarthritis

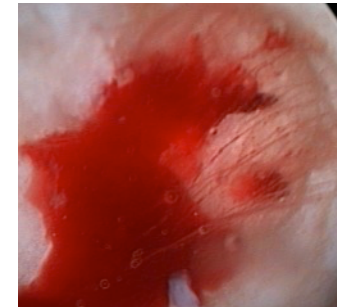
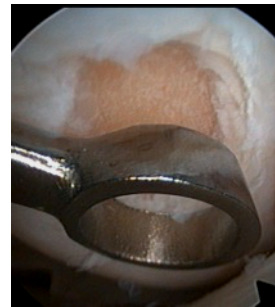
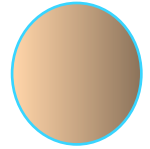
Indication

20-60 year-old patients

Chondral

- Marrow-stimulation
 - Microfracturing

Small defects



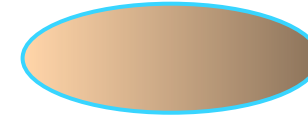
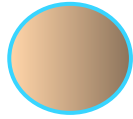
Osteochondral

- Refixation of osteochondral fragment
- Osteochondral transplants

Adachi et al. *J Bone Joint Surg Br* 2009

Mandelbaum et al. in: *Cartilage Repair: Current Concepts* 2010

Take home message (chondral defects)



Small defects

Large defects

< 20 year-old patients

Marrow stimulation

Osteochondral transplants

(Refixation)

Marrow stimulation

Refixation

(ACI)

20 – 60 year-old patients

Marrow stimulation

Osteochondral transplants

ACI

Clinical Results

- fibrocartilagenous repair tissue
- good to excellent results in 60-80%
- physically active patients better
- adult patients: younger 30-40 years better
- femoral condyle better
- **15 years comparison with ACI : similar**

Kaul, Madry + *KSSTA* 2011

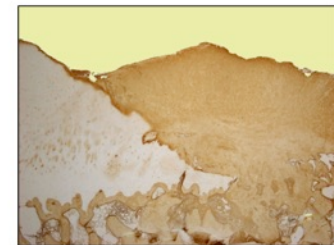
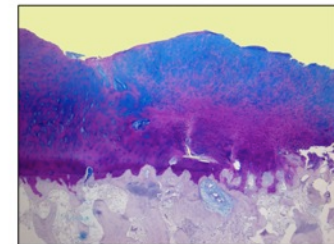
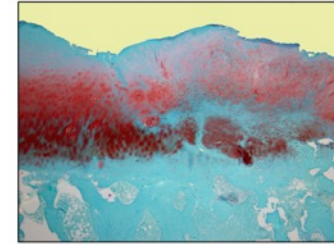
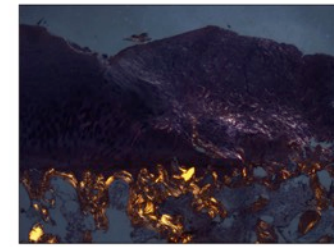
Kreuz + *Osteoarthritis Cartilage* 2006

Kreuz + *Arthroscopy* 2006

Mithoefer + *Am J Sports Med* 2009

Bekkers + *Am J Sports Med* 2009

Knutsen *ICRS Chicago* 2015



Conclusion

Ideal candidate

Young patient < 35 - 40 ans, non competitive sport activities

Traumatic lesion , acute < 3 mois

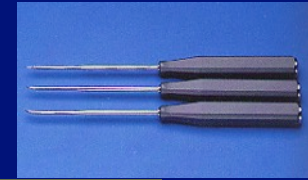
Straight alignment , no associated lesions

IMC < 30 kg/m²

Taille : < 3 cm²



Conclusion



MSC Stimulation : Microfractures

Repair technique

Simple **arthroscopic** technique

Various localisation

Carrefull preparation

Stricte compliance to rehab protocole

No big morbidity

Cheap

Not a « cutting bridge » technique

High rate of **succes** at short and mid FU

10 % failure



Conclusion

MSC Stimulation : Microfractures

Drawbacks :

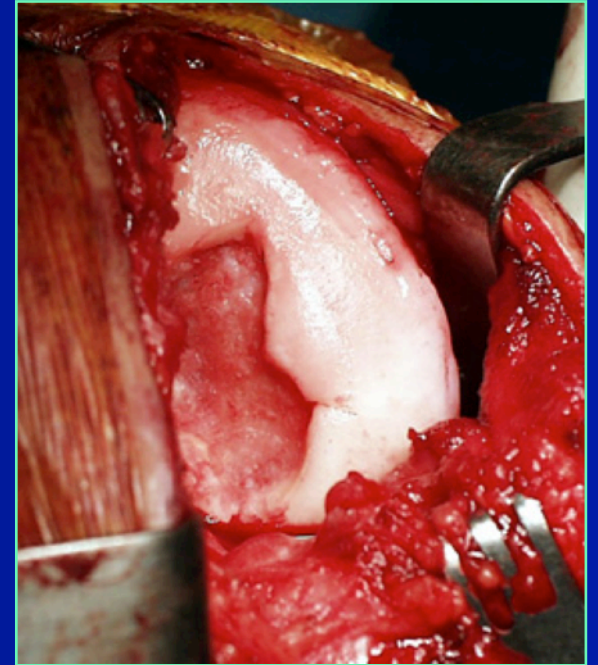
Not for athletes

Do not fit for large lesion

Variability of healing response

Long term effect questionable

Quality and futur of the fibrocartilage



SFA



2018

STRASBOURG

PALAIS DES CONGRÈS

13 > 15 DÉCEMBRE

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Conflit postéro-supérieur. *J. Grimberg (Paris), Y. Lefebvre (Strasbourg)*

Traitement arthroscopique de l'arthrose du coude. *Y. Carlier (Mérignac), P. Desmoineaux (Versailles)*



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Renseignements et Inscriptions :
MCO Congrès - Tel : +33 (0)4 95 09 38 00
mary.abbas@mcocongres.com