Ankle

Postoperative Imaging of Cartilage Repair

and

Lateral Ligament Reconstruction

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Imaging of Cartilage Repair

Why ?

- To assess the technical success of the procedure
- To evaluate the state of cartilage healing
- To identify potential complications

Imaging of Cartilage Repair

Recommendations MR-Imaging:

Same MR sequences as for the evaluation of native cartilage:

- High resolution images with extremity coils
- Intermediate- or T2-weighted FSE sequence
- 3D fat saturated gradient echo sequence
- Additionally fluid sensitive sequence for assessment of bone marrow edema (e.g. Stir-sequence)

Y. Choi et al./ RadioGraphics 2008**;** 28:1043–1059

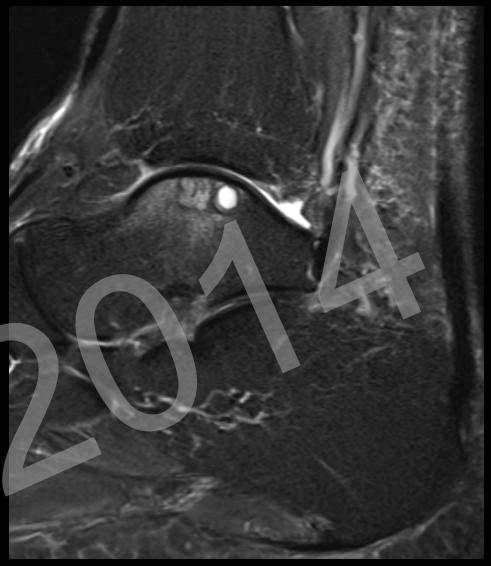
S. Marlovits et al. / European Journal of Radiology 57 (2006) 16–23

*S. Marlovits et al./*The American J of Sports Medicine 2012, Vol. 40, No. 10

Imaging of Cartilage Repair

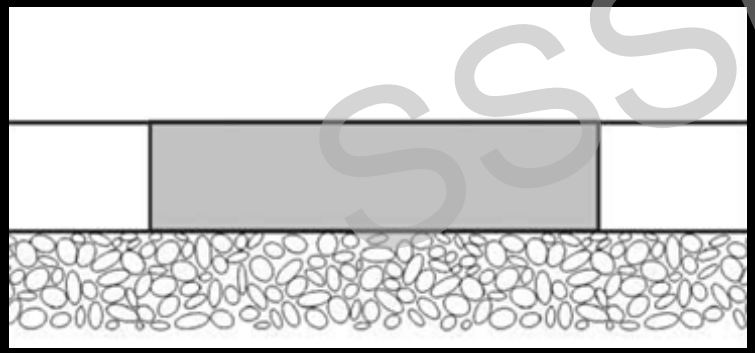
Postoperative cartilage assessment :

1. Defect filling
2. Integration to border zone
3. Surface
4. Structure
5. Signal intensity
6. Subchondral bone

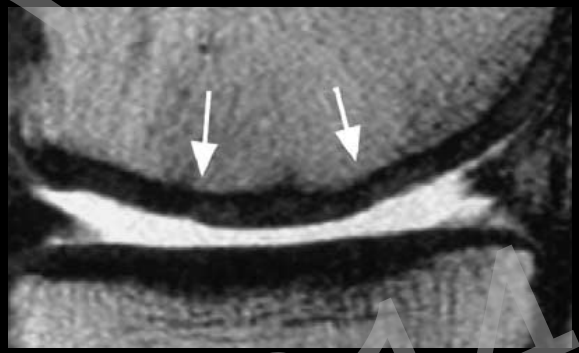


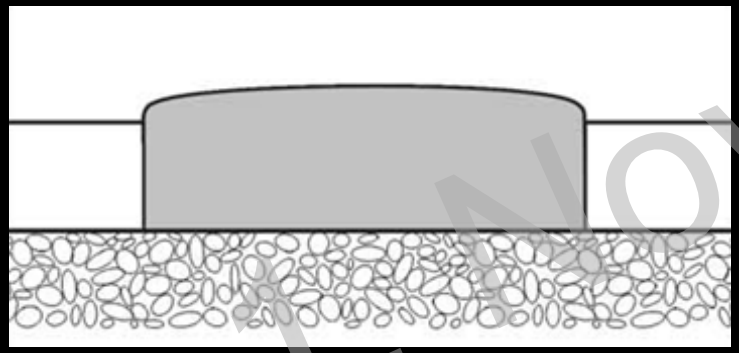
Cartilage Assessment

1. Defect Filling

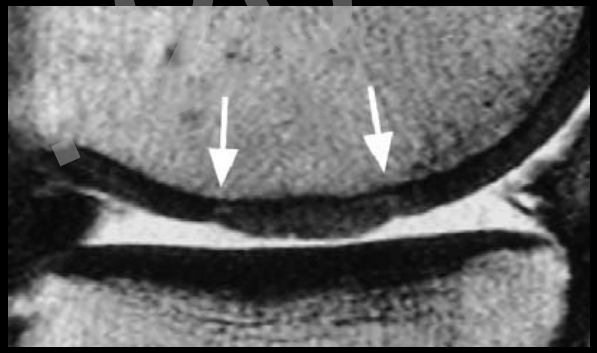


complete





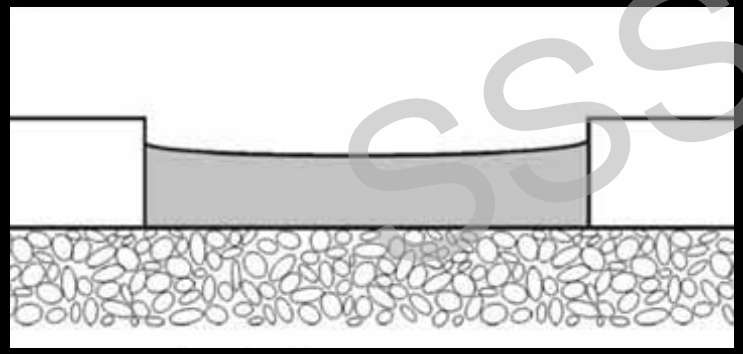
hypertrophy



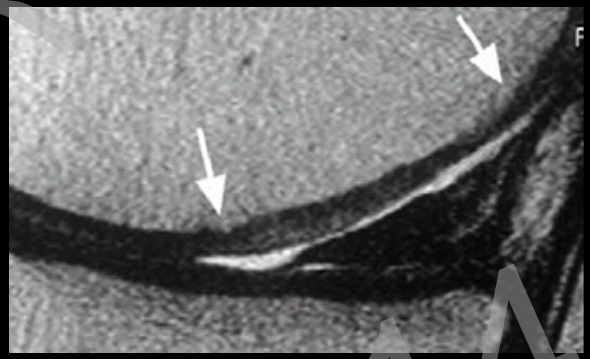
S. Marlovits et al. / European Journal of Radiology 52 (2004) 310–319
S.Trattnig et al. / European Journal of Radiology (2007)17:103-118

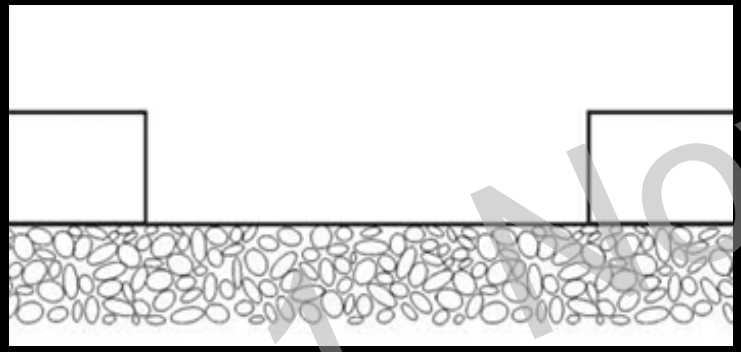
Cartilage Assessment

1. Defect Filling

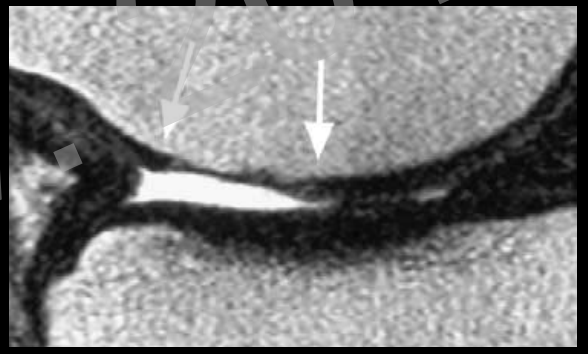


incomplete < 50%





incomplete > 50%



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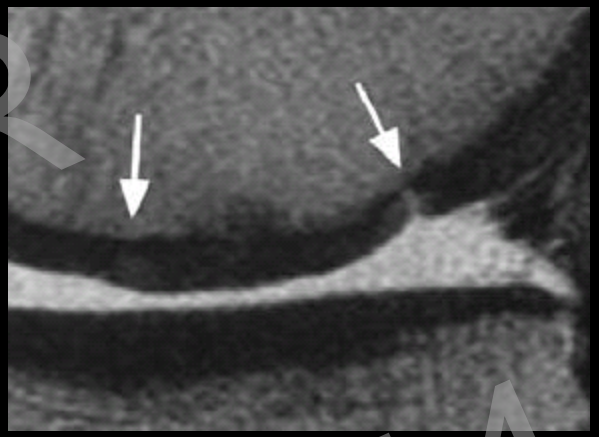
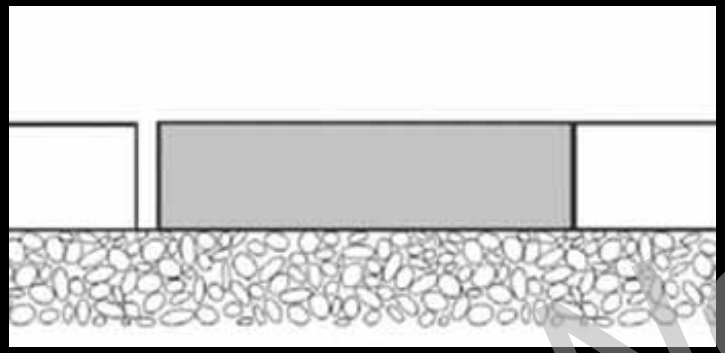
S.Trattnig et al. / European Journal of Radiology (2007)17:103-118

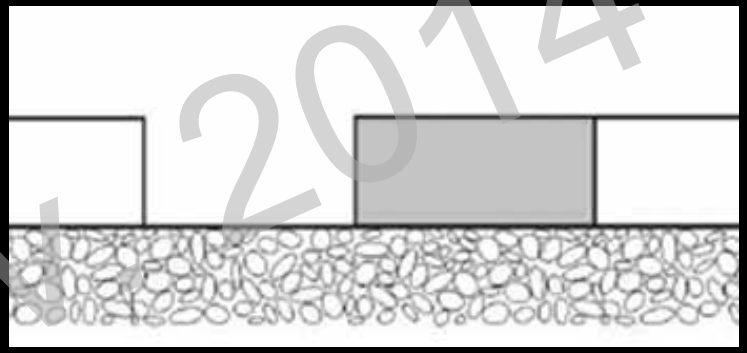
Cartilage Assessment

2. Integration to border zone
   - complete or incomplete ?
   - visible defect ?





incomplete with split like border



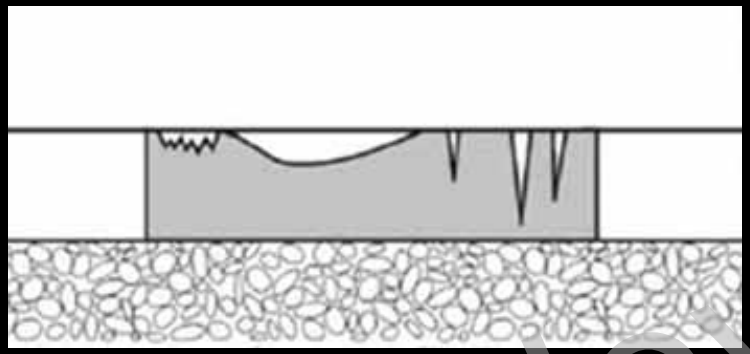
incomplete with visible defect

S. Marlovits et al. / European Journal of Radiology 52 (2004) 310–319
S.Trattnig et al. / European Journal of Radiology (2007)17:103-118

Cartilage Assessment

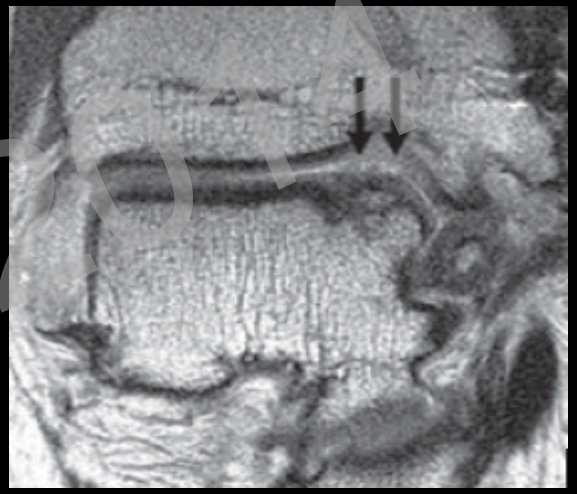
3. Surface

- Intact Surface
- Damaged Surface



damaged surface with fibrillations,

ulcerations and fissures

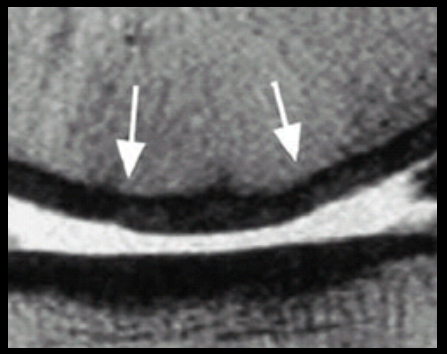


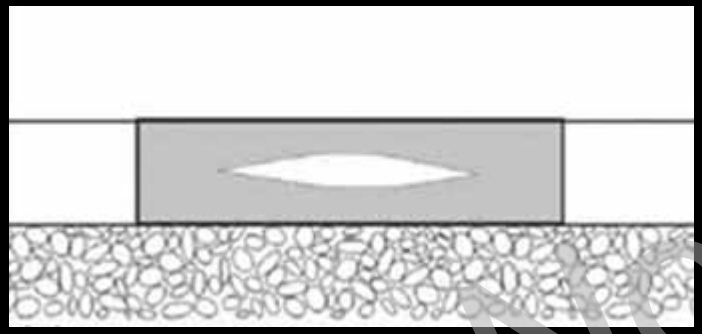
S. Marlovits et al. / European Journal of Radiology 52 (2004) 310–319
K. Lee et al. /Orthopedics 2011; Vol 34, No. 8

Cartilage Assessment

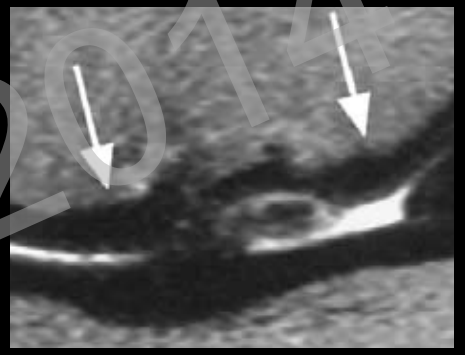
4. Structure

- Homogenous
- Inhomogenous or cleft formation





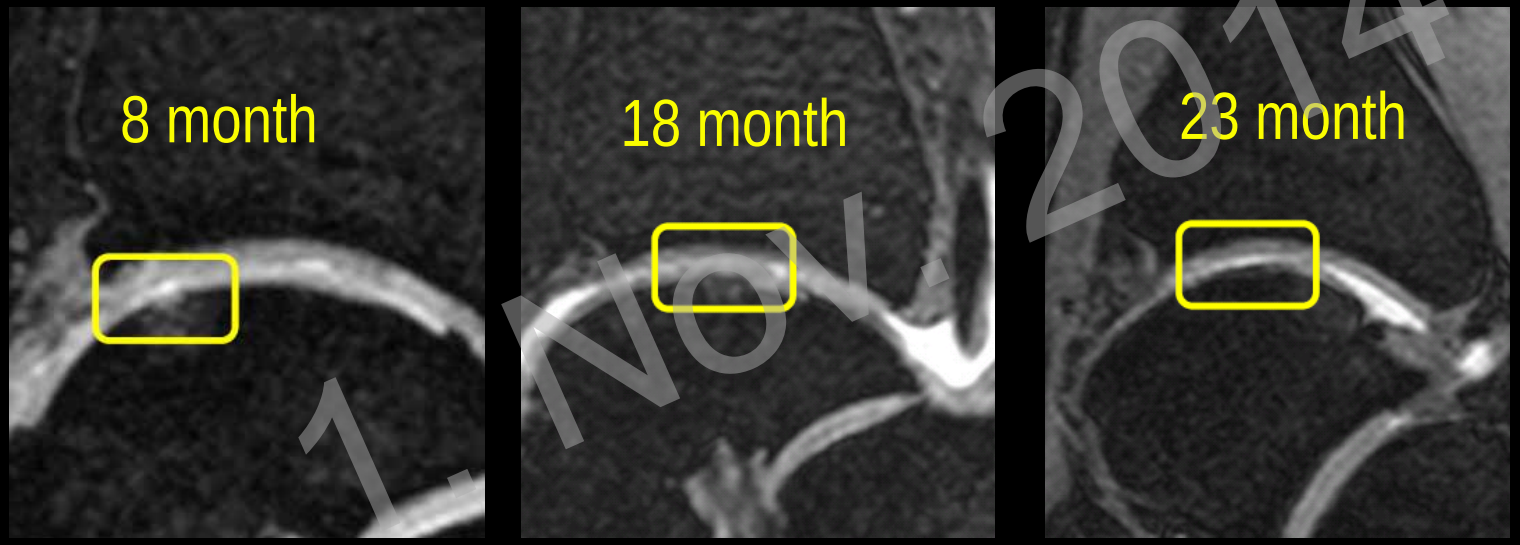
inhomogenous structure of cleft formation



S. Marlovits et al. / European Journal of Radiology 52 (2004) 310–319
S.Trattnig et al. / European Journal of Radiology (2007)17:103-118

Cartilage Assessment

- In the early postoperative period, the repair tissue may appear thin and indistinct
- The thickness of the repair tissue increases during 24 month
- 1–2 years postop the surface should appear smooth and well defined



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Y. Choi et al. / RadioGraphics 2008; 28:1043–1059
H. Tao et al. / Eur Radiol (2014) 24:1758–1767

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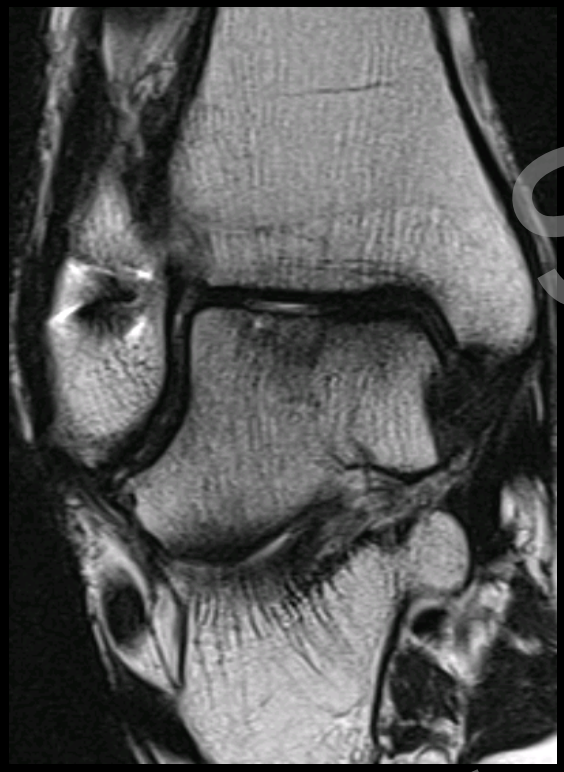
Cartilage Assessment



before AMIC

before AMIC

6 weeks after AMIC

47 years, female

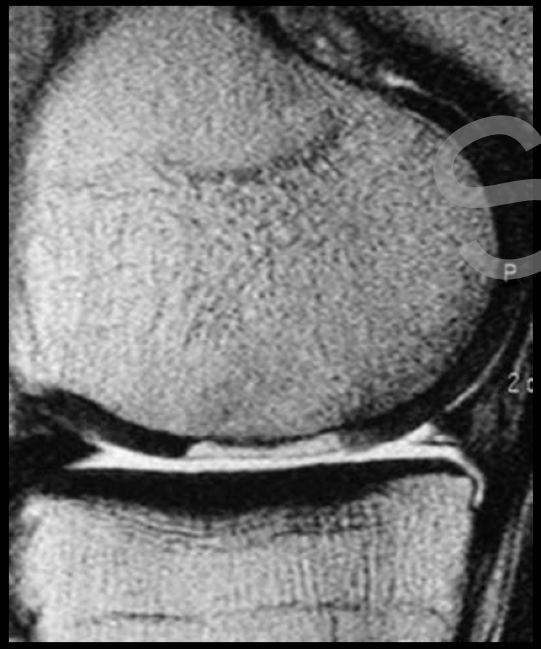
Cartilage Assessment

5. Signal intensity:

	Early postop	Late postop
T2-TSE	hyper-intense	iso-intense
3D-GE-FS	hypo-intense	iso-intense

Cartilage Assessment

5. Signal intensity



1 month

6 month

1 year

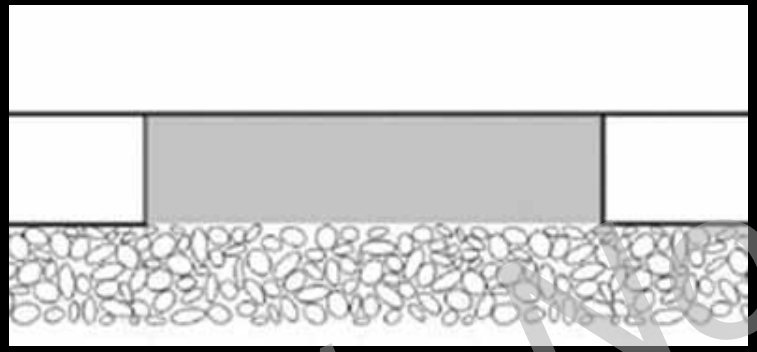
The signal intensity of the reparative decreases as the tissue matures.

Cartilage Assessment

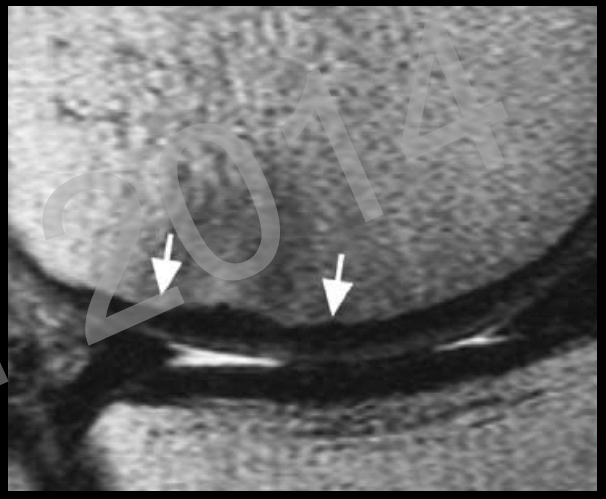
6. Subchondral bone

Subchondral lamina

- Intact
- Not intact



broken subchondral lamina



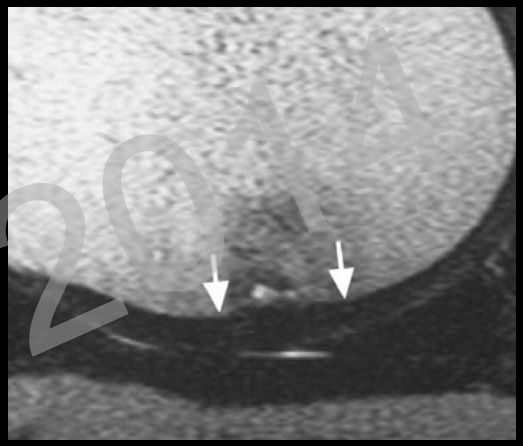
S. Marlovits et al. / European Journal of Radiology 52 (2004) 310–319
S.Trattnig et al. / European Journal of Radiology (2007)17:103-118

Cartilage Assessment

6. Subchondral bone

- Normal bone marrow signal
- Edema, granulation tissue, cysts, sclerosis

subchondral alterations

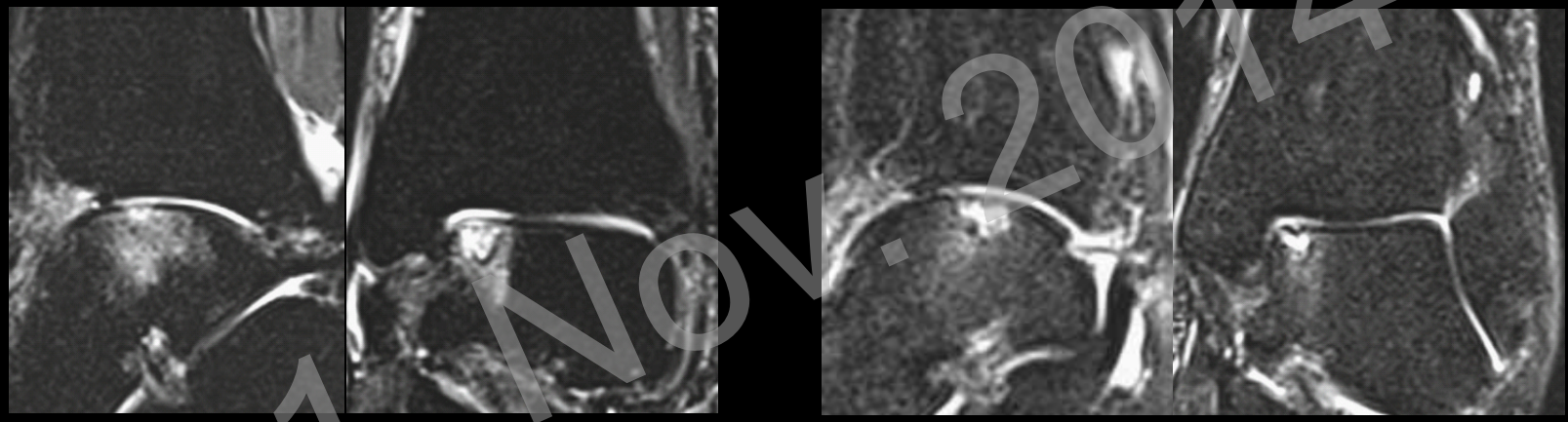


S. Marlovits et al. / European Journal of Radiology 52 (2004) 310–319
S.Trattnig et al. / European Journal of Radiology (2007)17:103-118

Cartilage Assessment

6. Subchondral bone: marrow edema

- Frequent finding after surgery
- Typically decreases with time



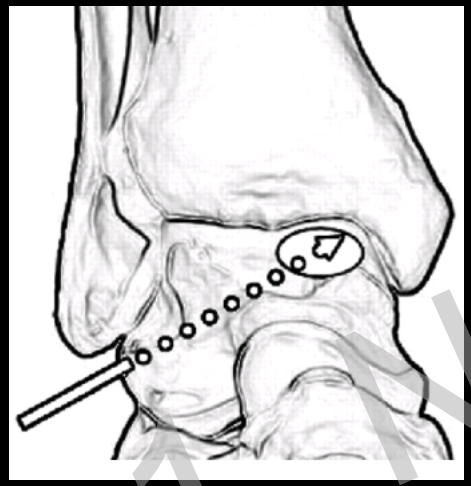
3 month

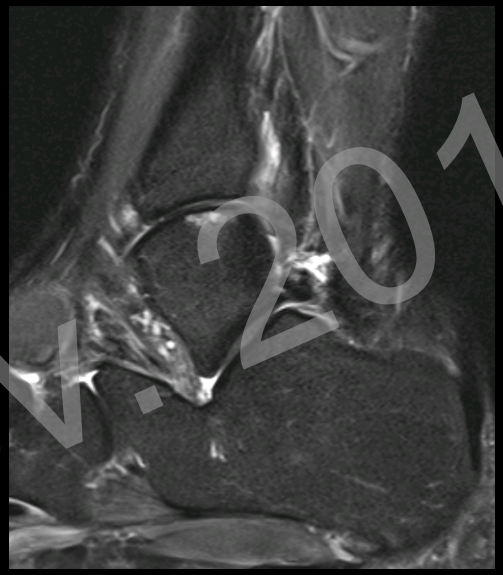
12 month

Cartilage Assessment

6. Subchondral bone: marrow edema

- Insufficient as independant factor for evaluation of repair quality





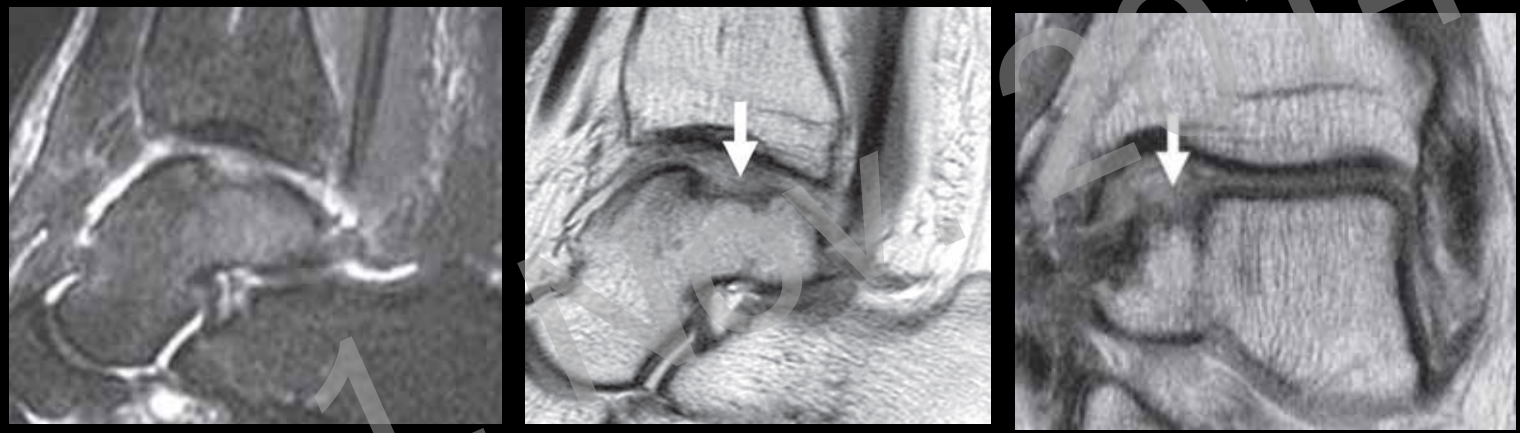
Tao et al. / European Radiology 2014; 24:1758-1767

Cartilage Assessment

6. Subchondral bone: marrow edema

- Persistent bone marrow edema + incomplete filling of the defect + thin and irregular repair surface

  = indicative of treatment failure



MOCART-SCORE

Variable	Classes	Points
Degree of defect repair and defect filling	Complete	20
	Hypertrophy	15
	Incomplete >50%	10
	<50%	5
	Subchondral bone exposed	0
Integration to border zone	Complete	15
	Incomplete	10
	Demarcating border seen	5
	Defect visible	0
	<50% length of repair tissue	
	>50% length of repair tissue	
Surface of the repair tissue	Intact	10
	Damaged	5
	<50% length of repair tissue	0
	>50% length of repair tissue	
Structure of the repair tissue	Homogenous	5
	Inhomgenous	0
Signal intensity of the repair tissue	DualFSE	
	Isointense	15
	Moderately hyperintense	5
	Markedly hyperintense	0
	3D gradient	15
	Isointense	5
	Moderately hypointense	0
	Markedly hypointense	
Subchondral lamina	Intact	5
	Not Intact	0
Subchondral bone	Intact	5
	Not intact	0
Adhesions	No	5
	Yes	0
Effusion	No	5
	Yes	0

Sanghvi D. et al. / Indian J Radiol Imaging. 2014 Jul-Sep; 24(3): 249–253.

Imaging of Cartilage Repair

Table 7

Statistical Analysis Results

Category	ICC	95% CI	*P* Value	ICC Interpretation
Degree of defect repair and filling	0.7222	0.4761-0.8632	<.0001	Good reliability
Integration into border zone	0.4800	0.1448-0.7205	.0034	Poor to moderate reliability
Surface of repair tissue	0.8523	0.7029-0.9298	<.0001	Good reliability
Adhesion	0.0000	−0.3544 to 0.3648	.5000	Poor to moderate reliability
Synovitis	0.7797	0.5732-0.8931	<.0001	Good reliability

Abbreviations: CI, confidence interval; ICC, intraclass correlation coefficient.

Imaging of Cartilage Repair

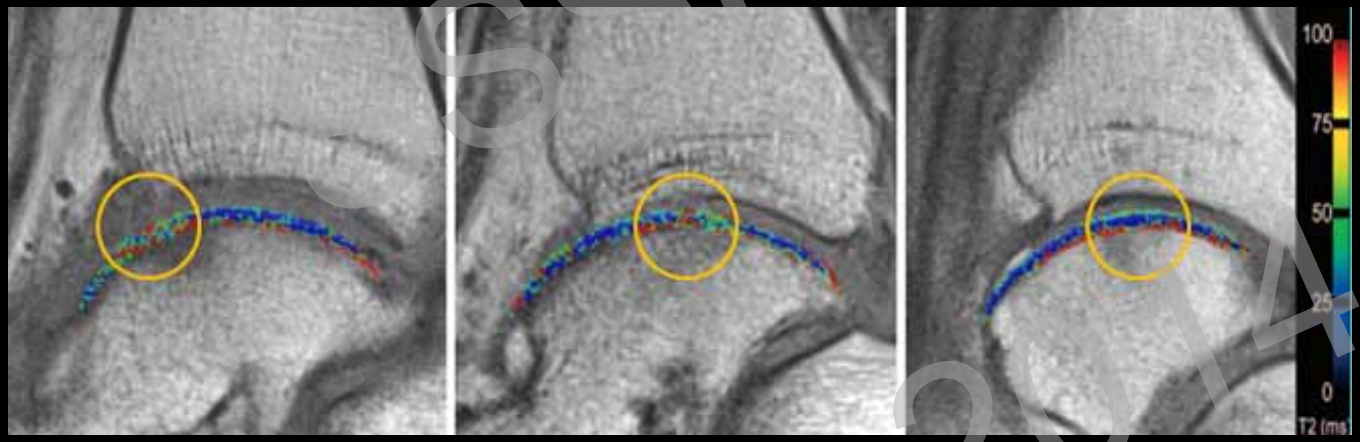
Follow-up MR imaging:

- At 3–6 postoperative months: assessment of the volume and the integration of repair tissue
- And at 1 year: allows an evaluation of the maturation and identification of any complications

Y. Choi et al./ RadioGraphics 2008; 28:1043–1059

Imaging of Cartilage Repair

T2-Mapping after Microfracturing



8 month 18 month 23 month

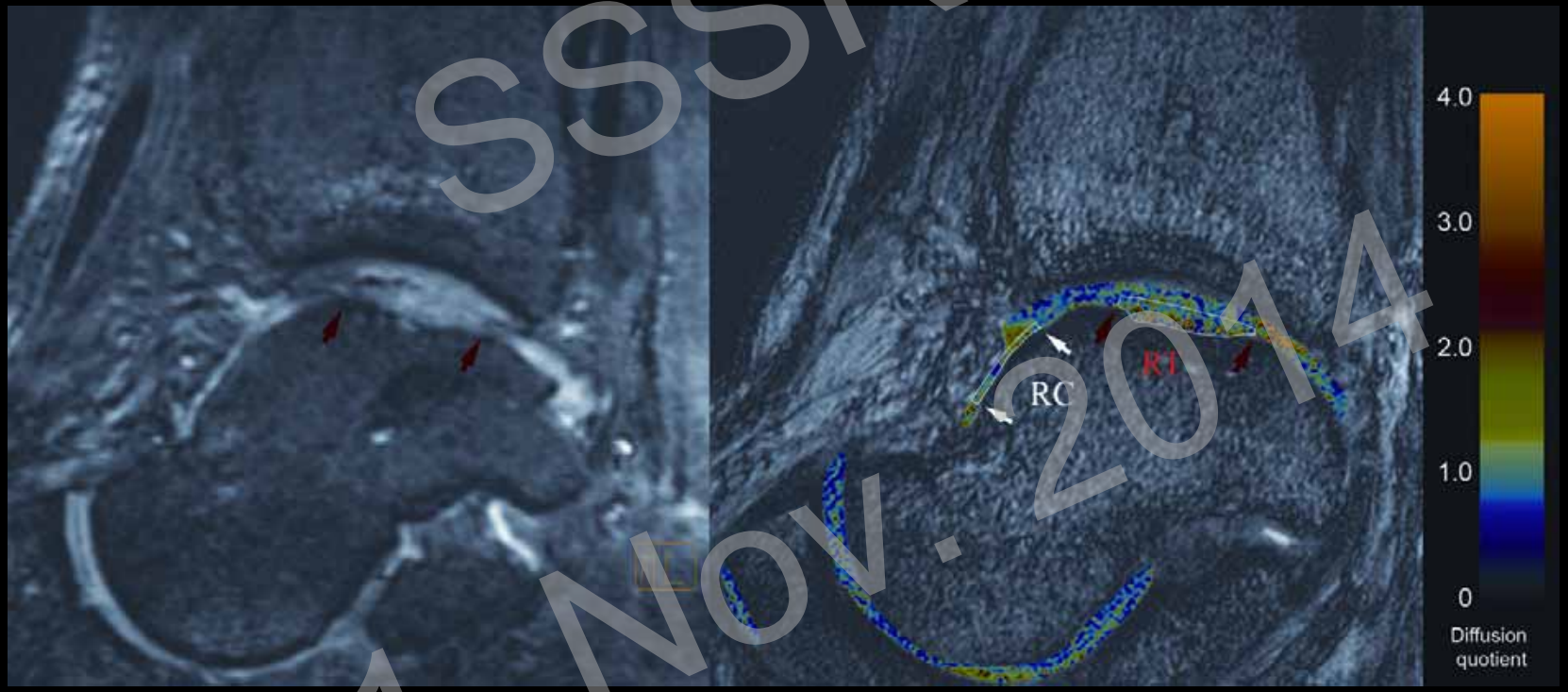
T2-index (repair/native cartilage)

decreases with increasing time after surgery

Imaging of Cartilage Repair

Diffusion-weighted-Imaging (DWI)

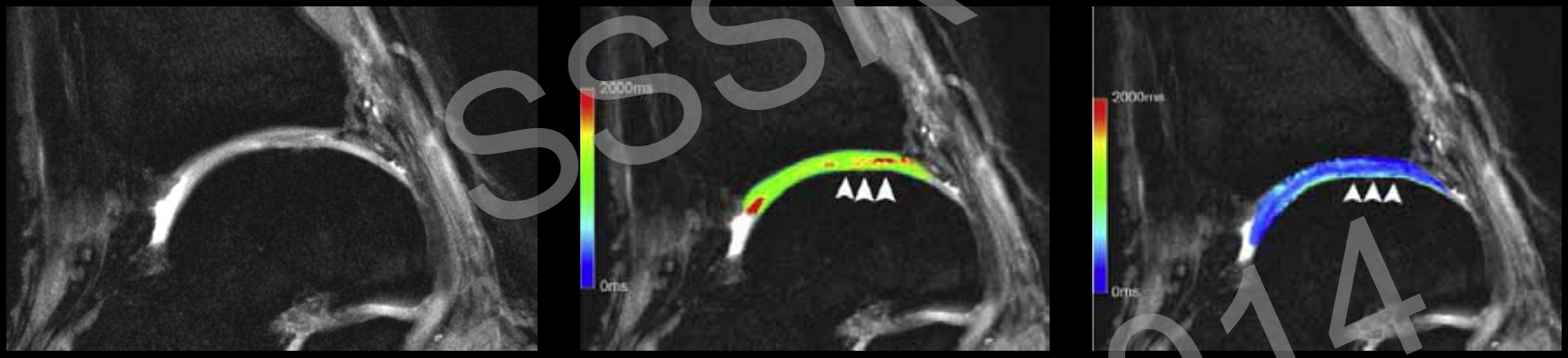
after Chondrocyte Transplantation and Microfracturing



To distinguish between different repair tissue qualities

Imaging of Cartilage Repair

dGEMRIC post AMIC



Pre contrast T1 Post contrast T1

Glycosaminoglycan content in repair tissue is lower than in normal hyaline cartilage

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Lateral Ankle Ligament Reconstruction

Why postoperative MR imaging ?

1. Assessment of ligament or reconstruction integrity:
   hypointense on T2-weighted MR images, in continuity
2. Assessment of related abnormalities:
   e.g. osteochondral defects and mechanical stress reactions
3. Assessment of complications: e.g. infection, impingement

Y. Choi et al. / RadioGraphics 2008; 28:1043–1059
Zanetti et al. / SeminMusculoskelet Radiol 2010;14:357–364

Preoperative

Anterior talofibular ligament (ATFL):

‘normal’, diameter = 1.0 to 3.2 mm

‘thickened’, diameter > 3.2 mm

‘thin or absent’ diameter < 1.0 mm → ~~direct ligament repair (Broström)~~

Lateral Ankle Ligament Reconstruction

<u>After Broström (=direct ligament repair):</u>

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Y. Choi et al./ RadioGraphics 2008; 28:1043–1059

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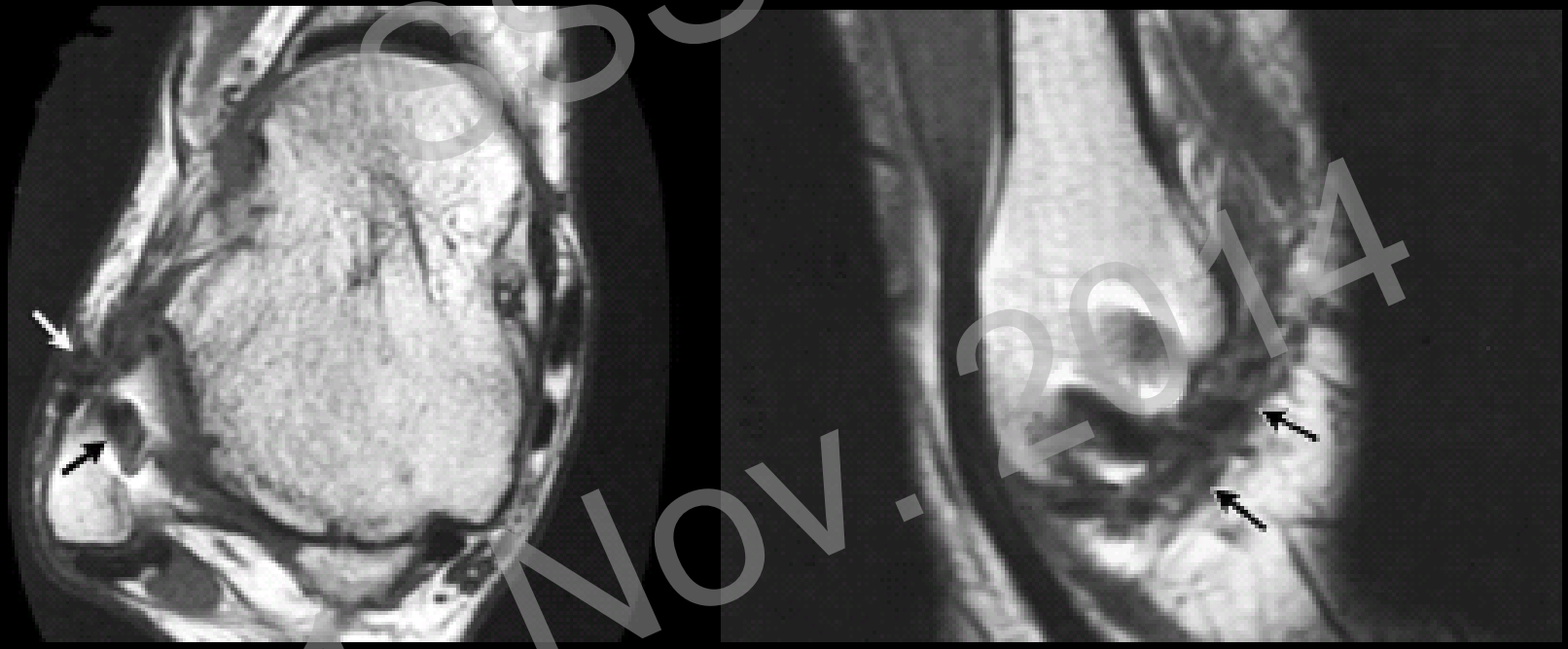
Lateral Ankle Ligament Reconstruction

After Broström:



34 years, male

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Y. Choi et al. / RadioGraphics 2008; 28:1043–1059

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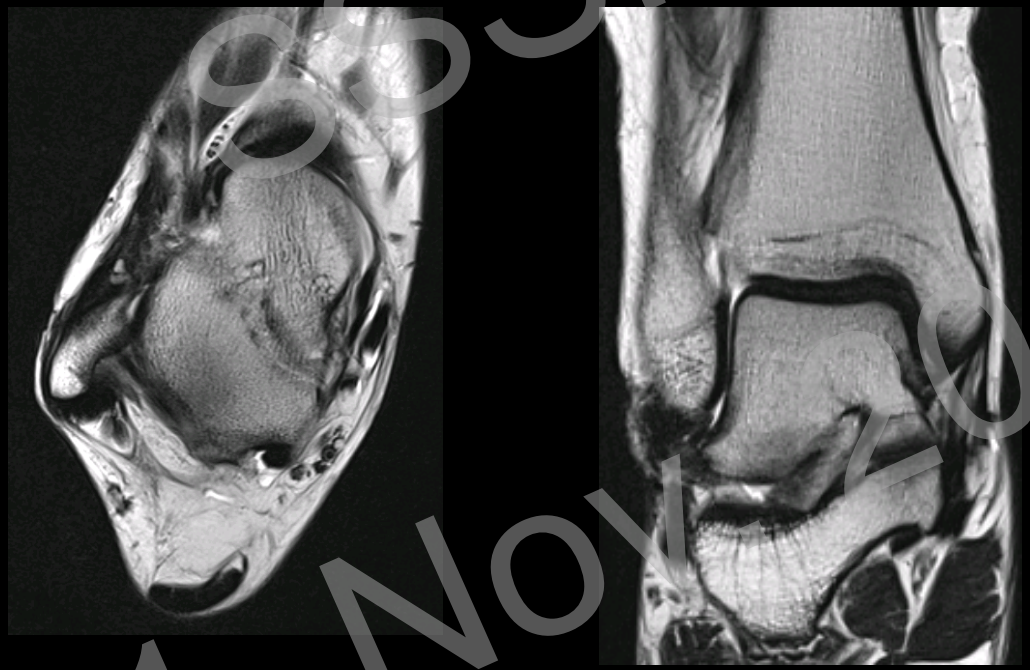
Lateral Ankle Ligament Reconstruction

After Broström:

Prominent scar tissue

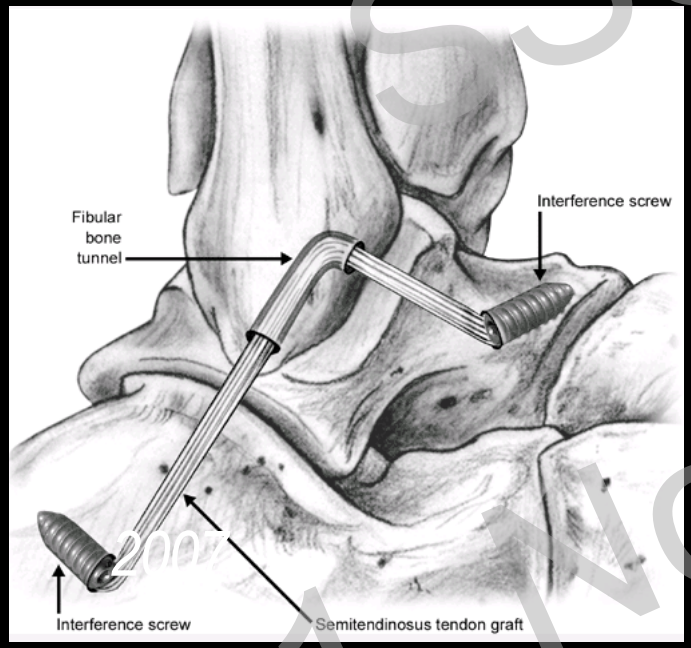


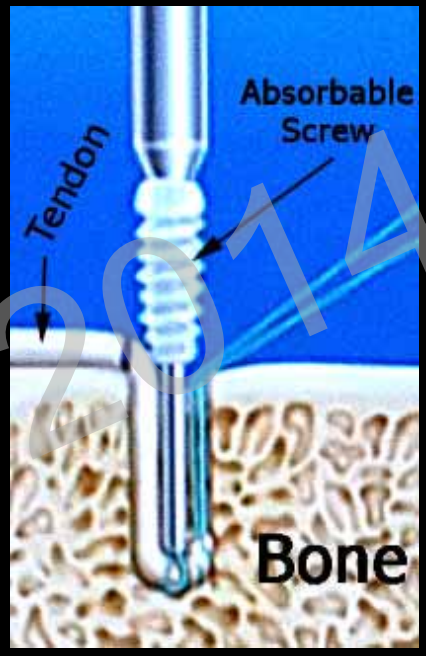
19 years, male, massive pain 1 year postop

Lateral Ankle Ligament Reconstruction

<u>After anatomical reconstruction:</u> - anterior talofibular ligament (ATFL)

- calcaneofibular ligament (CFL)





Lateral Ankle Ligament Reconstruction

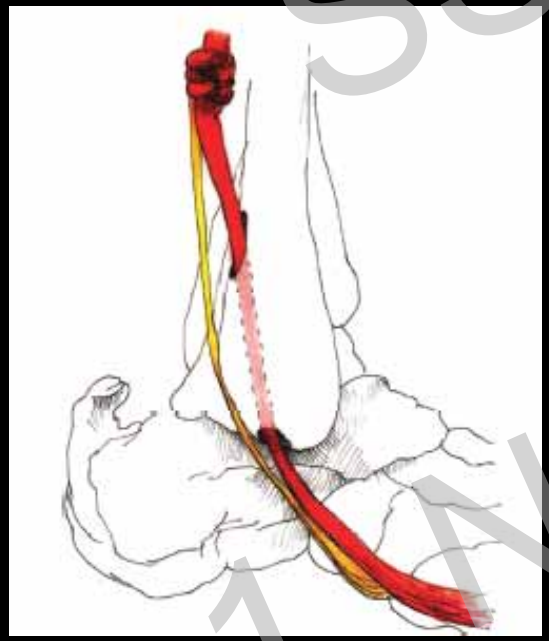
After anatomical reconstruction:

45 years, m, gracilis-Tendon, 1 year postop

Lateral Ankle Ligament Reconstruction

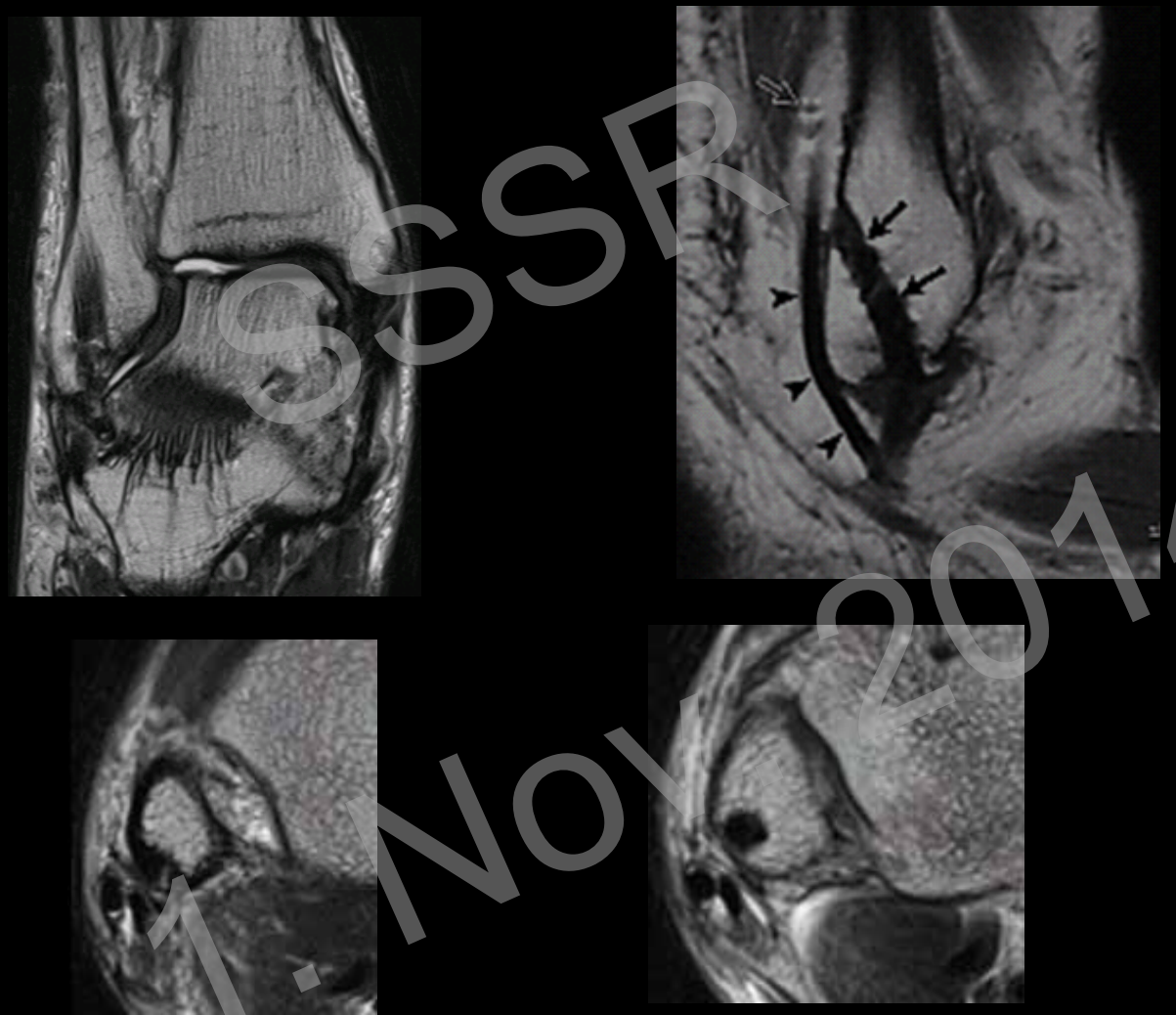
Extra-anatomical reconstructions:

- Peroneus brevis tendon Re-Routing



- ATFL reconstruction
- tendon splitting above the ankle
- oblique vertical fibular tunnel

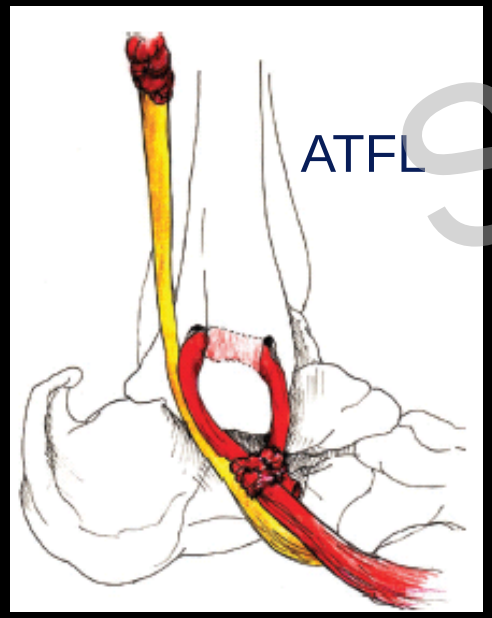
Peroneus brevis Tendon Rerouting



57 years, m, 20 years after operation

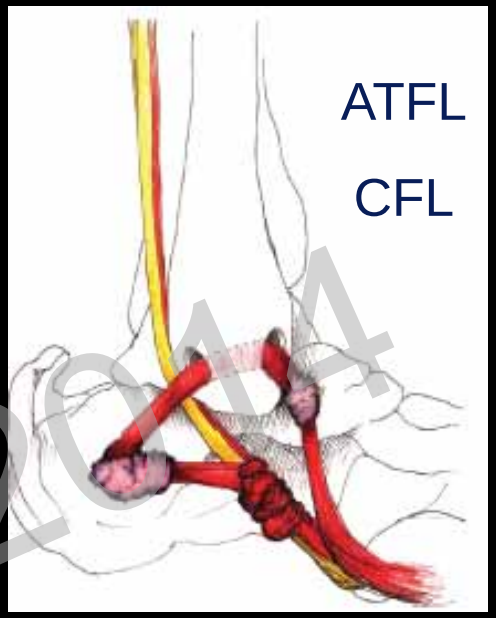
Peroneus brevis Tendon

Extraanatomical reconstructions



Loop

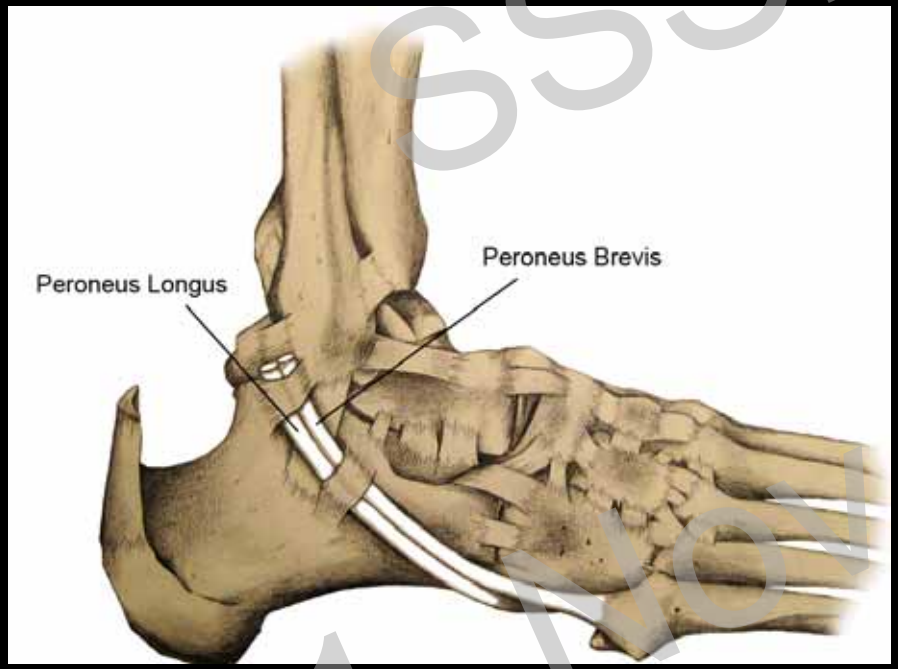
Watson-Jones

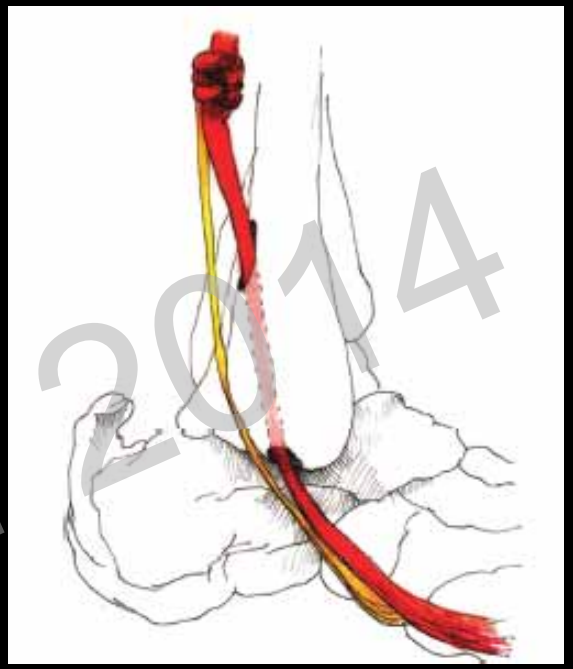


Chrisman-Snooke

Peroneus brevis Tendon

- follow the tendon from its insertion at the 5th metatarsal bone





Summary

Cartilage Repair:

- Best correlation with clinical outcome: Defect filling, surface of repair tissue
- Bone marrow edeme is frequent and should not be interpreted as independent factor

Lateral Ligament Reconstruction:

- Knowledge about surgical technique is important
- MRI : most important for assessment of complications
- MRI can not assess instability

Thank you