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SPECT/CT Imaging

Knee & Hip Prosthesis

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„We greatly thank the following grant authorities for their financial support of our research.“

Deutsche Arthrose-Hilfe e.V.
Eingetragener gemeinnütziger Verein
Hilfe für gelenkkranke Menschen

UNIVERSITÄT BASEL

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Stiftung für Medizinische Forschung

Flavio Forrer, Rolf Hügli, Niklaus F. Friederich, Faik K. Afifi, Enrique Testa, Milos Dordevic, Dominic Mathis, Stephan Schoen, Silvia Reichl, Anita Matt, Markus P. Arnold, Christopher Wagner

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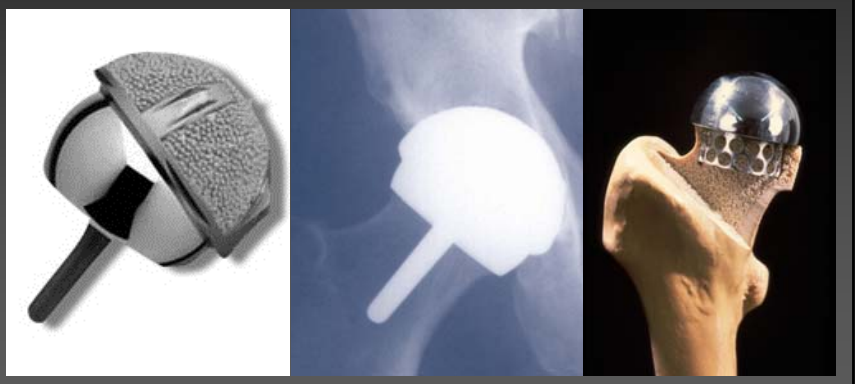
Schedule

- Basics on Arthroplasty
- What is our SPECT/CT protocol?
- Why CT including extended Houndsfield scale?
- Cases
- Biomechanics – Why do we need it?
- Our experience- more to come….
- Conclusions

Basics hip arthroplasty

Hip resurfacing not „en vogue“ anymore!
Metal- on-metal bearing problem



Basics hip arthroplasty

Short stem versus long stem

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Basics hip arthroplasty

Straight stem versus curved stem

Different fixation concept

proximal, distal, combined

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Basics hip arthroplasty

Cemented versus uncemented stem

- cemented: no ingrowth of bone, smooth surface

- cemented: ingrowth of bone; rotation stability due to rectangular shape; roughened surface

Basics hip arthroplasty

uncemented

screw cup versus press-fit

outer cup metal, inlay made of polyethylen, ceramic or metal

cemented

often polyethylen

Basics knee arthroplasty

Unicondylar versus bicondylar knee arthroplasty

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Basics knee arthroplasty

„Unconstrained“ versus „constrained“

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Basics knee arthroplasty

„Unconstrained“ – „fixed versus mobile bearing“

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Basics knee arthroplasty

Von jedem Endoprothesentyp gibt es verschiedene Modelle und Größen, die auf drei Arten eingesetzt werden:

cemented **uncemented** **hybrid**

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Examination protocoll – Scintigraphy & SPECT/CT

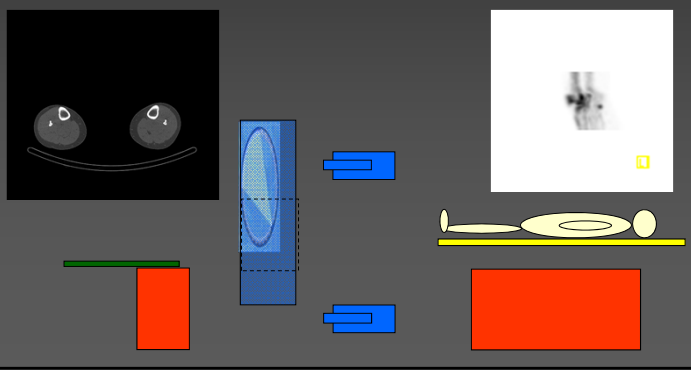
0 // 2-3 *h*

early 15min

- „perfusion phase“
- „Bloodpool –phase“2 planes

late ~40min

- Whole body ap / pa
- SPECT
- and low dose CT



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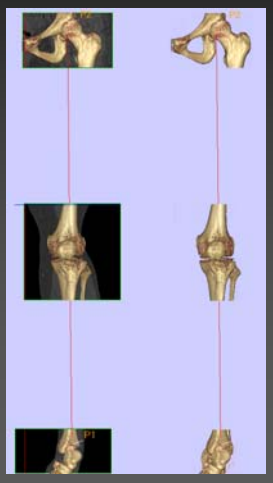
4D-SPECT/CT Protocol

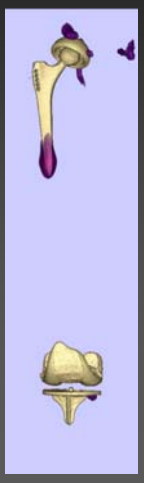


3mm slices femoral head

0.7mm slices knee

3mm slices ankle joint

Modified Imperial CT protocol (Henckel et al. JBJS Br 2006 & Hirschmann et al. 2011 BMC Medical Imaging)



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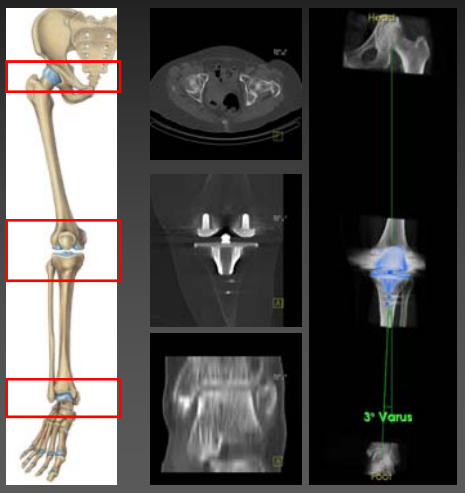
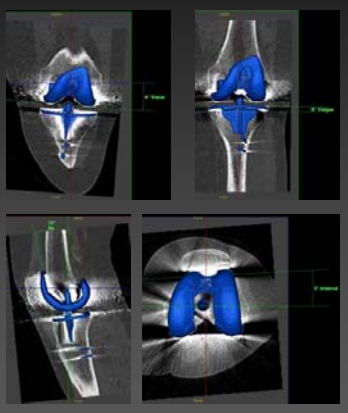
SPECT/CT protocol – „biomechanical aquisition“





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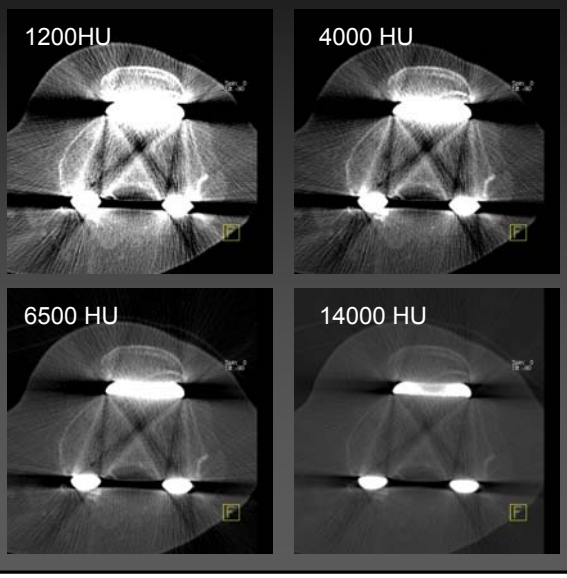
CT image quality – importance of extended scale



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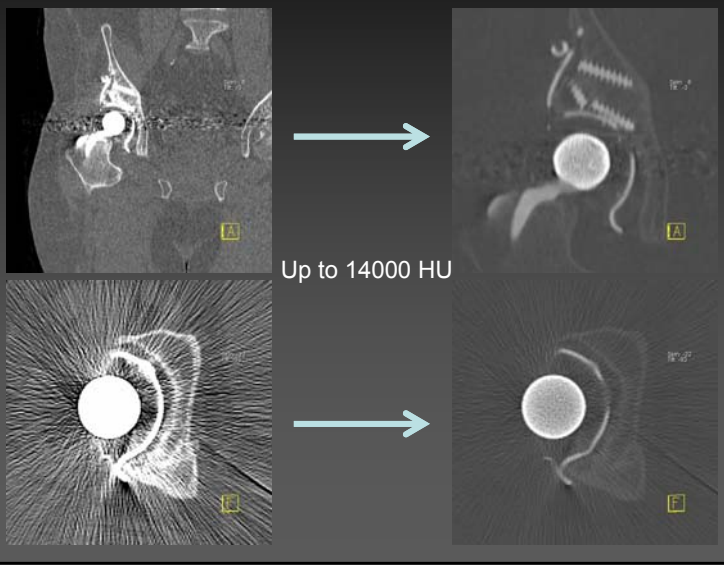
Extended scale necessary? - YES



Case examples

- The “typical“ case
- Uptake – always pathological?
- No Uptake – everything OK?
- Hypersensitivity reaction
- Infection
- Biomechanical knowledge – why we need it

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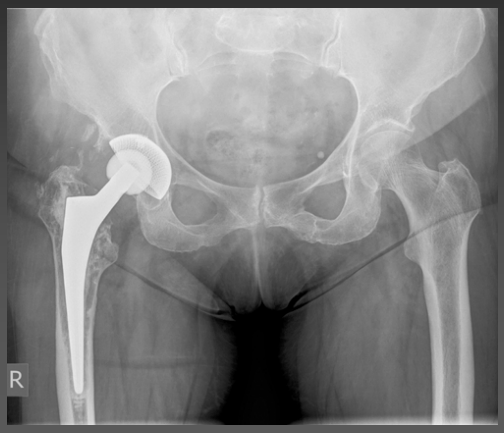
The “typical“ case

recurrent weight bearing, activity related pain 10 yrs after THA



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The “typical“ case

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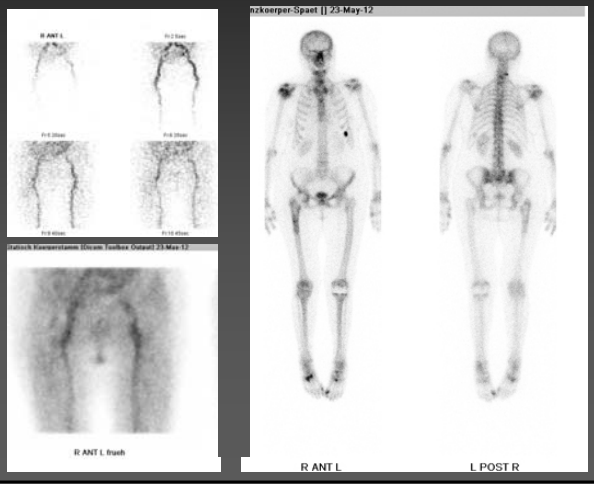

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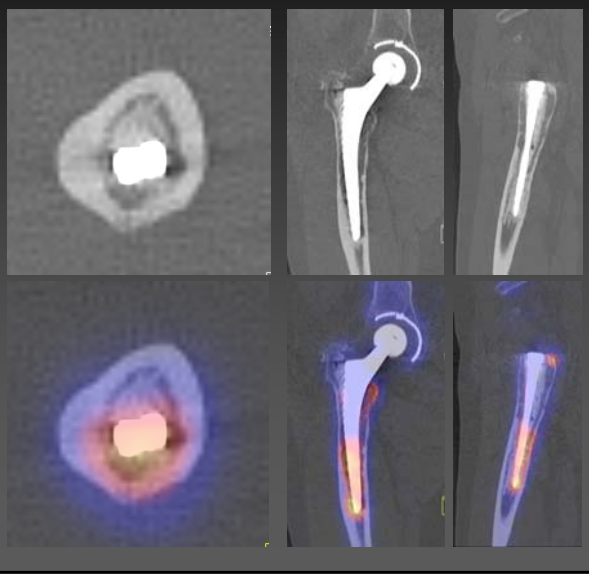
The “typical“ case



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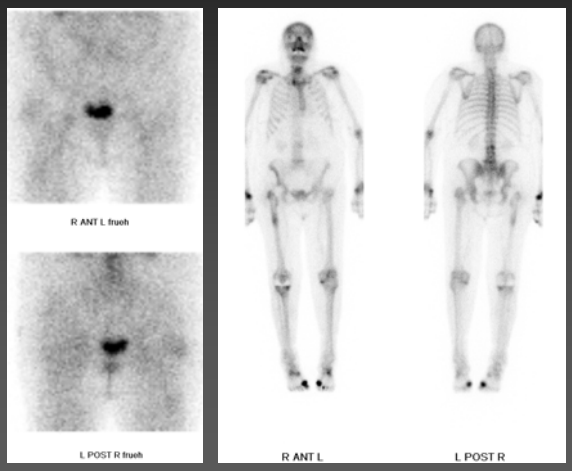
Does increased uptake always indicate a pathology?

Referred from GP for knee pain



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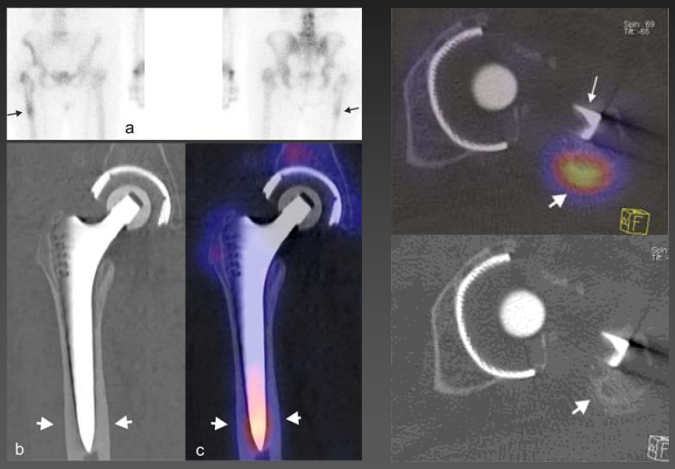
Does increased uptake always indicate a pathology?



Cortical hypertrophy at distal fixation zone; ectopic ossification

Rasch H, Hirschmann M, Huegli R. SPECT-CT - **Prospects in Joint Imaging and Diagnostic Follow up after Arthroplasty**
Der Nuklearmediziner. 2012; 35 (03) :154-60. **DOI** http://dx.doi.org/ 10.1055/s-0032-1321822; Georg Thieme Verlag KG

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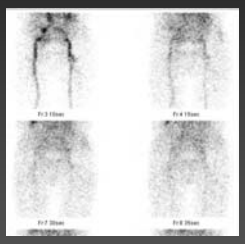
No periprosthetic Uptake – everything OK?

Past right sided THA 1999; activity related pain in right hip



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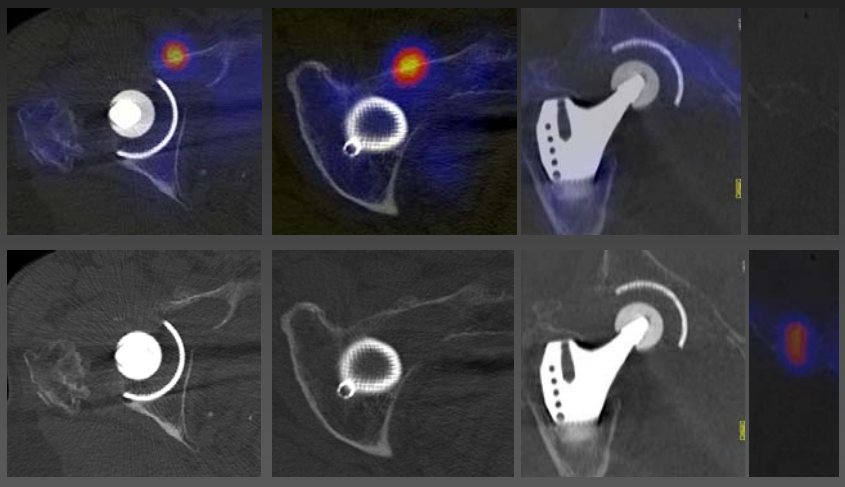
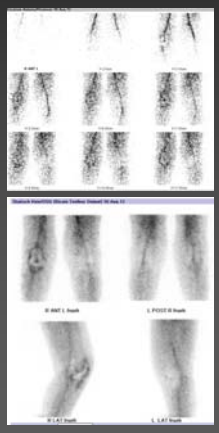
No Uptake – everything OK?



Rasch H, Hirschmann M, Huegli R. SPECT-CT - **Prospects in Joint Imaging and Diagnostic Follow up after Arthroplasty** Der Nuklearmediziner. 2012; 35 (03) :154-60. **DOI** http://dx.doi.org/ 10.1055/s-0032-1321822; Georg Thieme Verlag KG

Hypersensitivity reaction?

Past UKA 06/2011, past TKA 01/2012, burning sensation and pain, extension deficit



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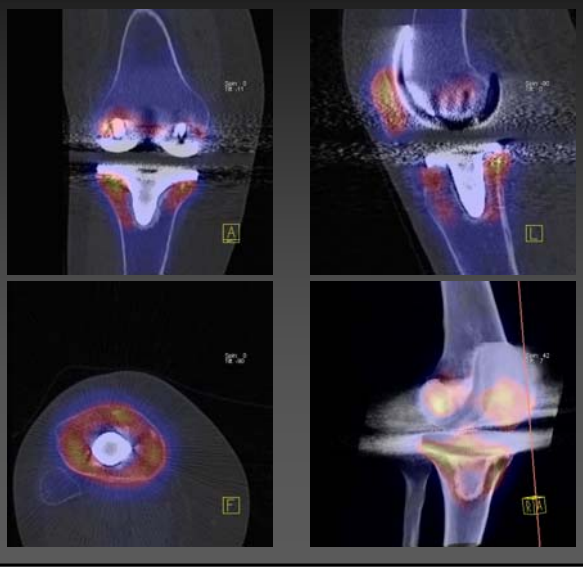
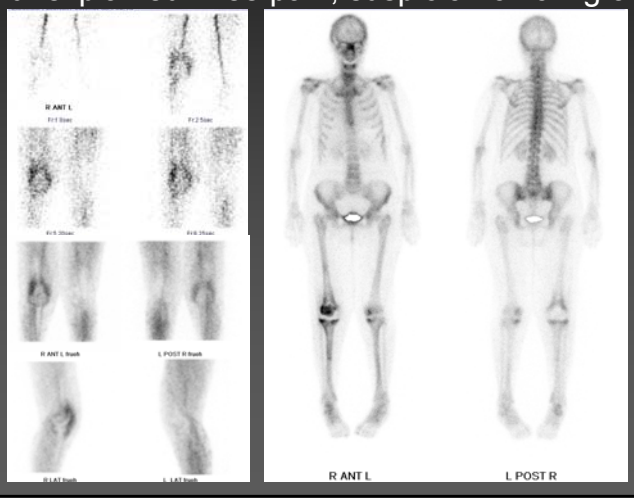
Hypersensitivity reaction?

Hypersensitivity reaction?



Infection – 3 Phase scintigraphy

TKR 06/2005; Arthroscopy with biopsy 12/2011+ 10/2012; unexplained knee pain; suspicion of low grade infection



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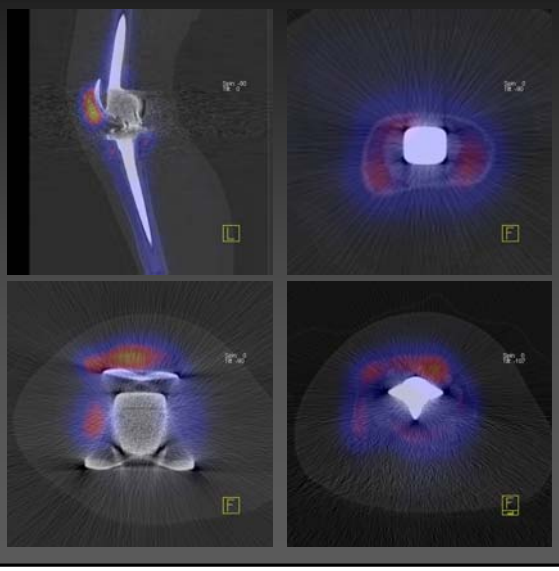
Infection – SPECT/CT



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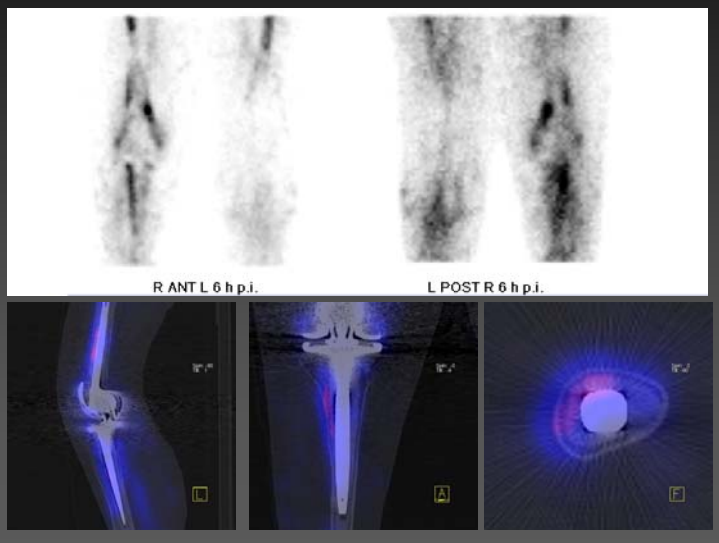
Infection – anti-granulocyte scintigraphy



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„A special case at the end“

TKA right 17.02.2011; past arthroscopic arthrolysis 3/2012
persistent pain, indication for secondary patellar resurfacing

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„A special case at the end“

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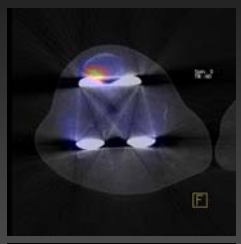
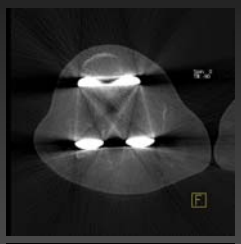
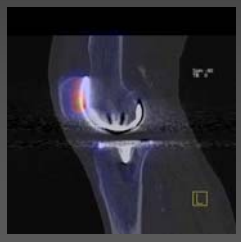
„A special case at the end“

Look more closely!







Only patellar hyperpression?

Did you know
what was wrong?

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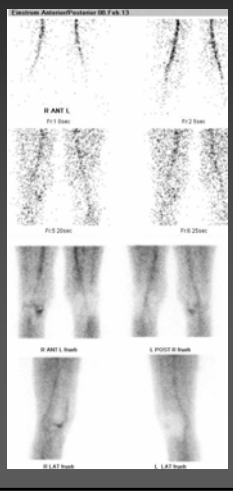
Biomechanics – Do we need it?

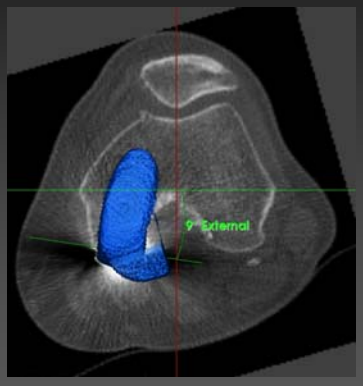
UKA 3 years ago, unexplained anterior knee pain



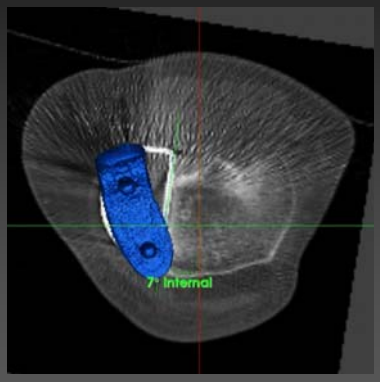
Biomechanics – Do we need?

No patella problem - BUT.....

UKA rotation alignment (internal-external)

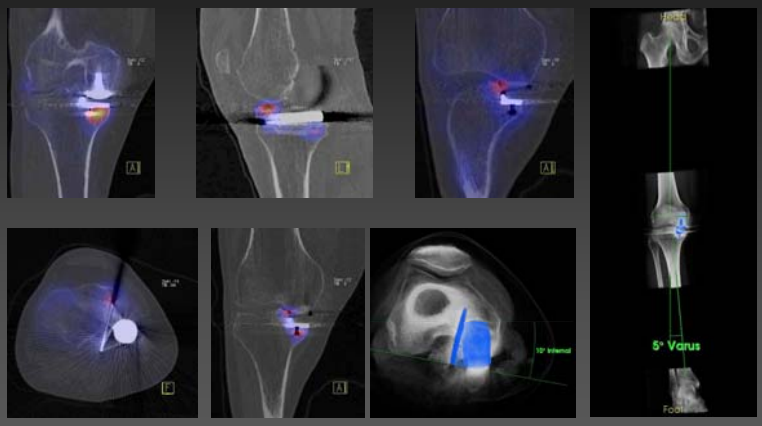


Femoral alignment



Combined alignment

Biomechanics – Do we need it?



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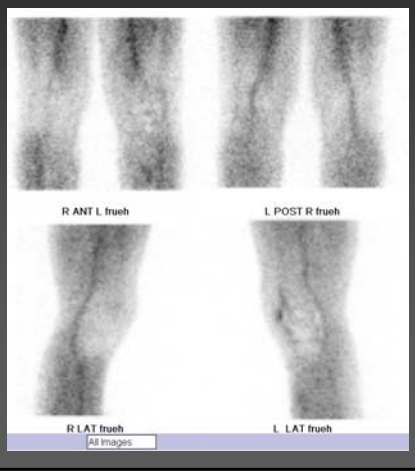
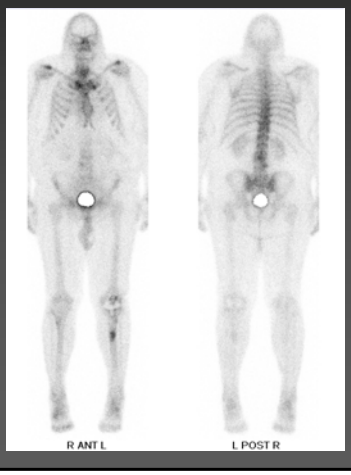
Biomechanics – Do we need it?

TKA 2008; patellar resurfacing 2010; anterior knee pain





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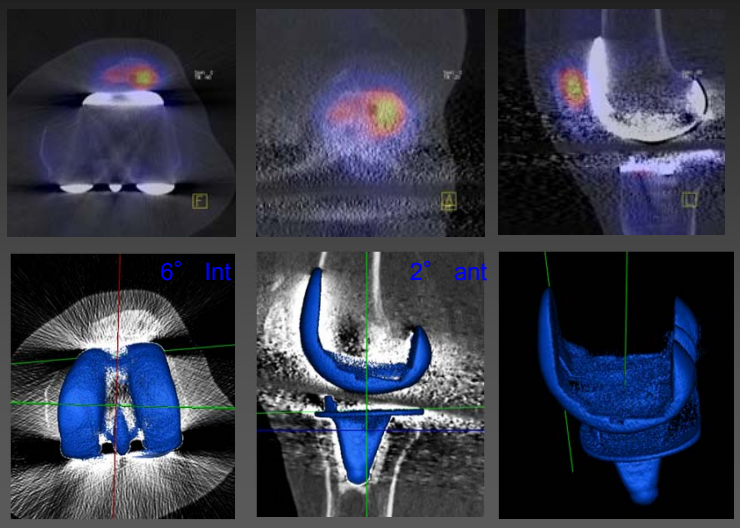
Biomechanics – Do we need it?



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Biomechanics – own results!

RESEARCH ARTICLE Open Access

Clinical value of SPECT/CT for evaluation of patients with painful knees after total knee arthroplasty-a new dimension of diagnostics?

Michael T Hirschmann[1*], Praveen Konala[2], Farhad Iranpour[2], Anna Kerner[3], Helmut Rasch[3], Niklaus F Friederich[1]

Results: SPECT/CT imaging changed the suspected diagnosis and the proposed treatment in 19/23 (83%) knees. Progression of patellofemoral OA (n = 11), loosening of the tibial (n = 3) and loosening of the femoral component (n = 2) were identified as the leading causes of pain after TKA.
Patients with externally rotated tibial trays showed higher tracer uptake in the medial patellar facet (p = 0.049) and in the femur (p = 0.051). Patients with knee pain due to patellofemoral OA showed significantly higher tracer uptake in the patella than others (p < 0.001).

Conclusions: SPECT/CT was very helpful in establishing the diagnosis and guiding subsequent management in patients with painful knees after TKA, particularly in patients with patellofemoral problems and malpositioned or loose TKA.

- **SPECT/CT tracer uptake related to TKA component position!**
- **Unpublished data 200 painful TKA!**

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SPECT-CT – Chancen in der Gelenkdiagnostik und Beurteilung von Patienten nach Endoprothetik

SPECT-CT – Prospects in Joint Imaging and Diagnostic Follow up after Arthroplasty

Rasch H et al. SPECT-CT – Chancen ... Der Nuklearmediziner 2012; 35: 154–160

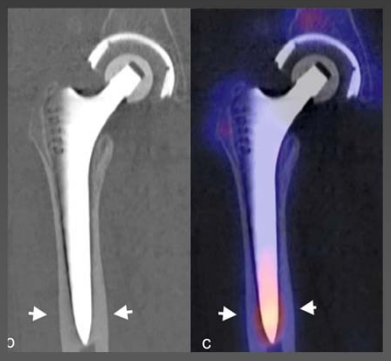

Abb. 3 Distal verblockende nicht zementierte Hüftprothese. Planar **a** umschriebener Uptake am distalen Prothesenschaft. In der SPECT CT **b** u. **c** eindeutige Zuordnung zum distalen Prothesenschaftdrittel ohne radiologische Lockerungszeichen, jedoch deutlicher enostaler Kortikalisverdickung als Stressreaktion bei distal fixierter Prothese.

- Distal versus proximal or combined stem fixation
- Orientation and position of THR
- varus-valgus stem leads to increased SPECT/CT distally

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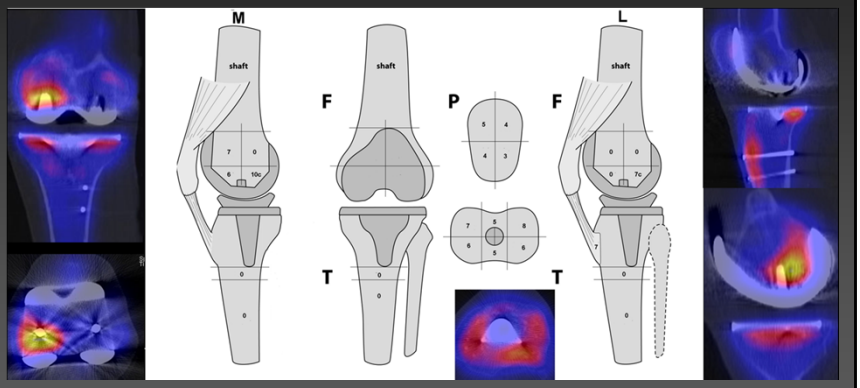
Combination of SPECT/CT tracer uptake and TKR component position: new era of imaging!



Hirschmann MT et al.: A novel standardized algorithm for evaluating patients with painful TKA using combined single photon emission tomography and conventional computerized tomography;
Knee Surg Sports Traumatol Arthrosc. 2010 Jul;18(7):939-44.

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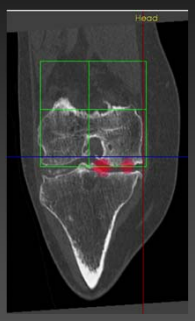
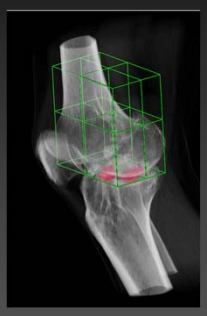
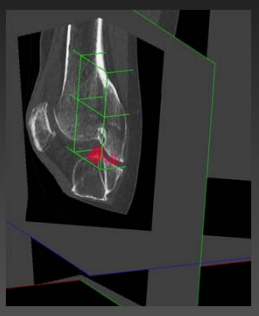
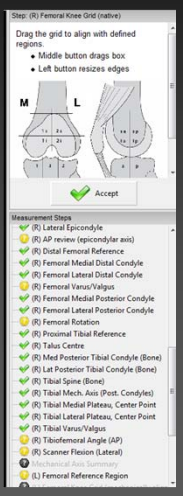
Biomechanics – software tool









Histogram Summary

Region	min	max	mean	stdev	n	nrmmin	nrmmax	nrmmean	nrmstdev
1ia	9	559	190.20	133.68	567	0.11	7.06	2.40	1.69
1ip	24	509	243.28	103.16	381	0.30	6.43	3.07	1.30
1sa	2	126	48.12	37.49	478	0.03	1.59	0.61	0.47
1sp	4	249	55.37	62.79	324	0.05	3.15	0.70	0.79
2ia	16	423	107.35	63.68	485	0.20	5.34	1.36	0.80
2ip	50	376	130.07	54.81	321	0.63	4.75	1.64	0.69
2sa	6	131	61.89	26.43	407	0.08	1.66	0.78	0.33
2sp	3	186	37.27	41.79	274	0.04	2.35	0.47	0.53

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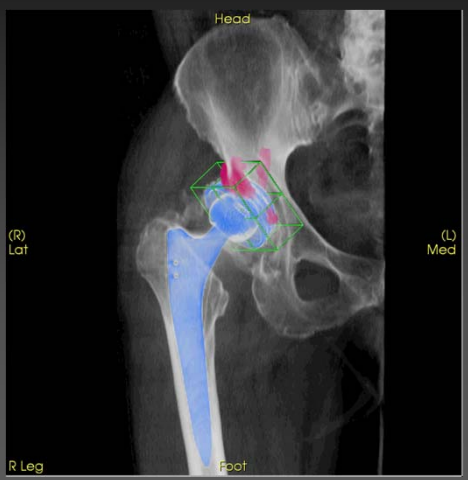
Assessment of tracer uptake distribution and intentity



3D volumetric quantification and localization using customised software

OrthoImagingSolutions

Hirschmann MT et al., BMC Medical Imaging 2012

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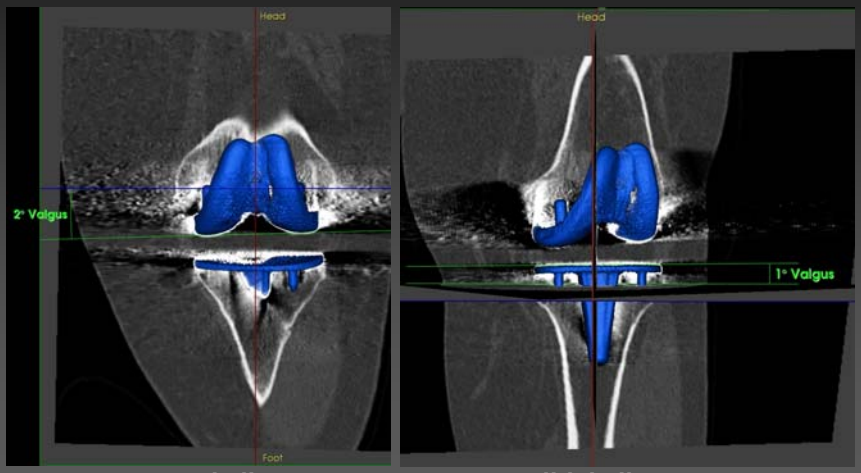
Varus-Valgus alignment (coronal)



Femoral alignment **Tibial alignment**

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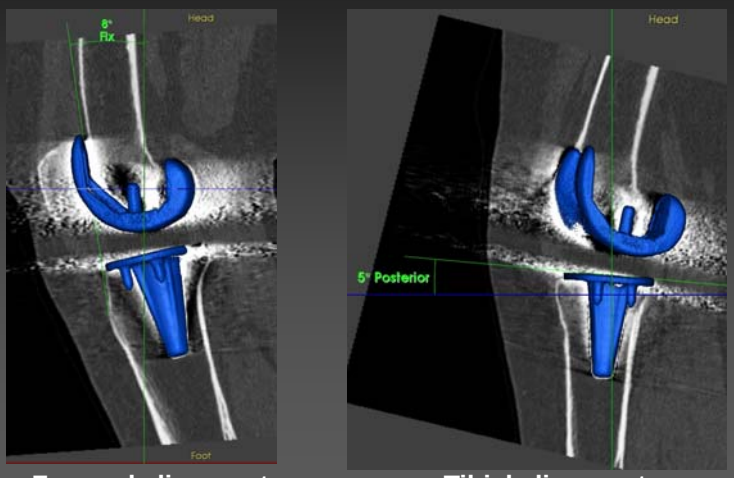
Sagittal alignment (flexion-extension)



Femoral alignment **Tibial alignment**

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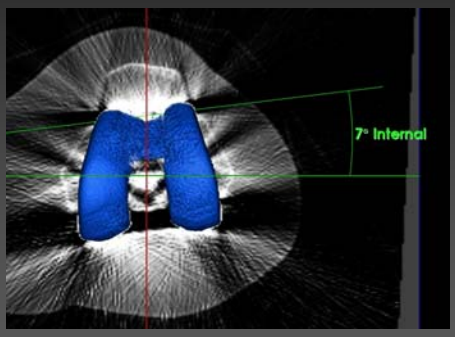
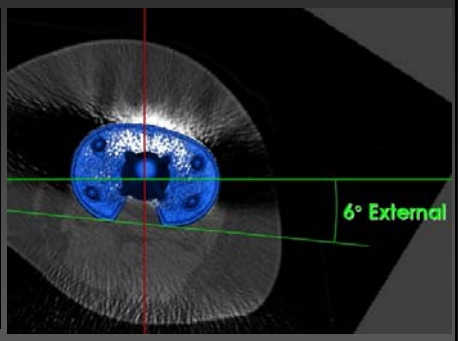
Rotational alignment (internal-external)





Femoral alignment

Tibial alignment

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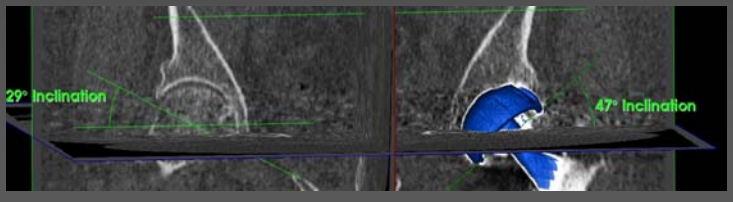
Biomechanical measurement of THA

NEW: biomechanical analysis in true 3-D



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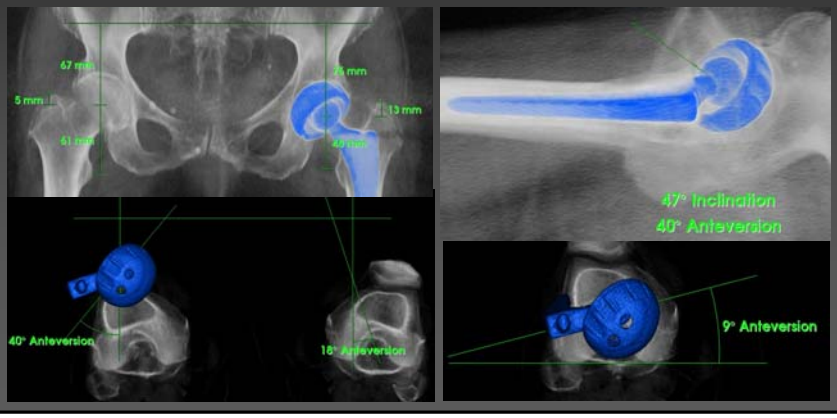
Biomechanical measurement of THA

- Usage of true 3 D Landmarks
- Reproducible measurements
- Possibility to differentiate and correlate uptake patterns with biomechar



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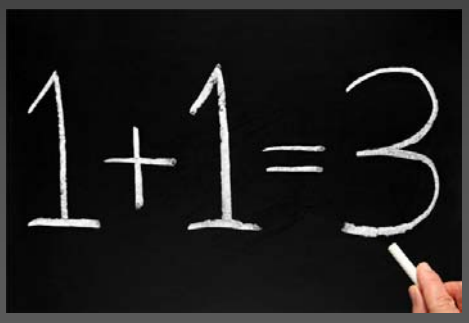
Conclusion

Mechanics and structure and biology

- **Mechanics**
  - mechanical alignment
  - anatomical alignment
- **Structure**
  - bone
  - Muscles
  - Tendons
  - Ligaments
- Biology/Metabolism

SPECT + CT = SPECT/CT



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Questions you should ask to your surgeon

- Age of implant
- Type, design of prosthesis
- Mode of fixation
- Site of pain
- Mechanical alignment
- Loading pattern

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Tips from our experience

- Reducing scanning time
- Radiation dose reduction
- Improving image quality
  - Extended CT scale
  - Cut-out bladder uptake

- Relative component position (e.g. bearing partners)
- SPECT/CT can be helpful as early as 6mths after surgery

Take home messages

- Use all information – metabolic, biomechnical and morphological information to obtain a correct diagnosis
- Prosthesis loosening does not always show an uptake
- Not every periprosthetic uptake is loosening or infection – look for biomechanics
- For correct intepretation you have to know the biomechanics of the implanted type of prosthesis (e.g. fixation of THA proximal or distal)

Talk to your surgeon – interdisciplinary approach