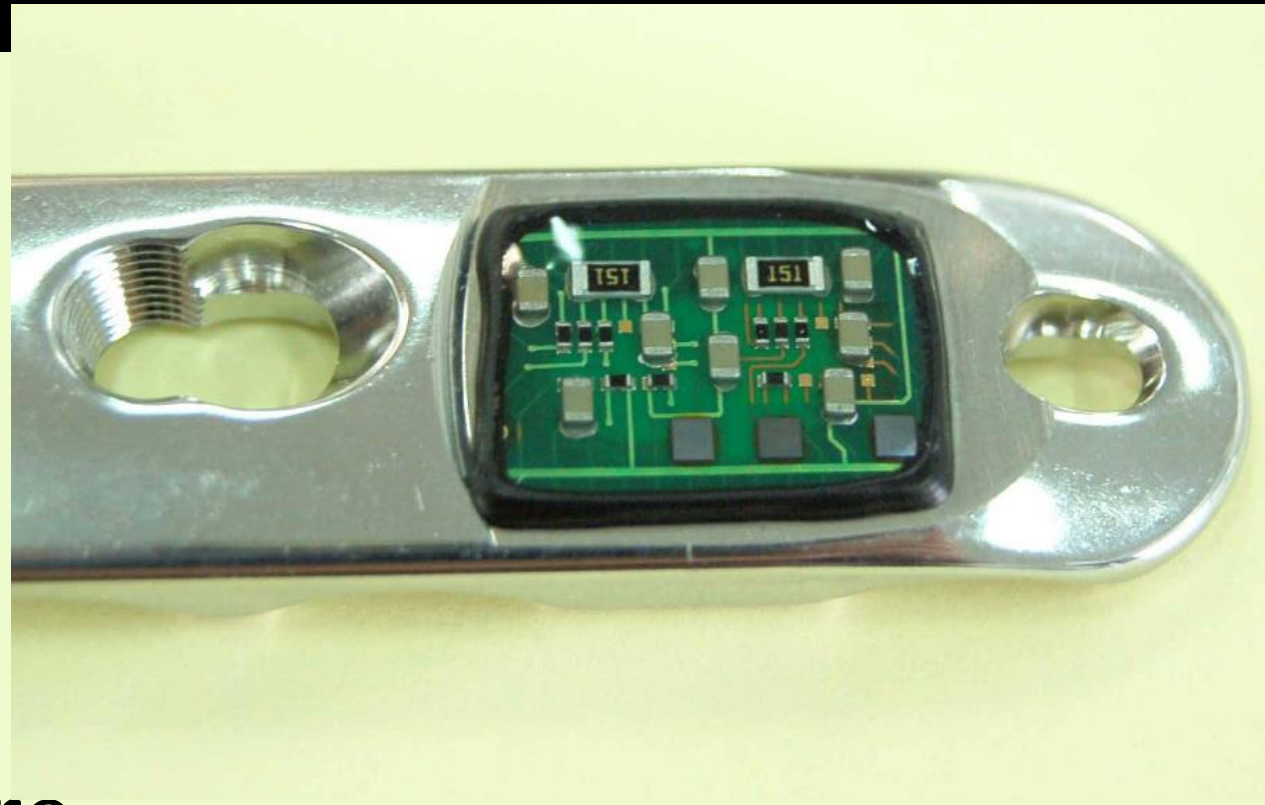
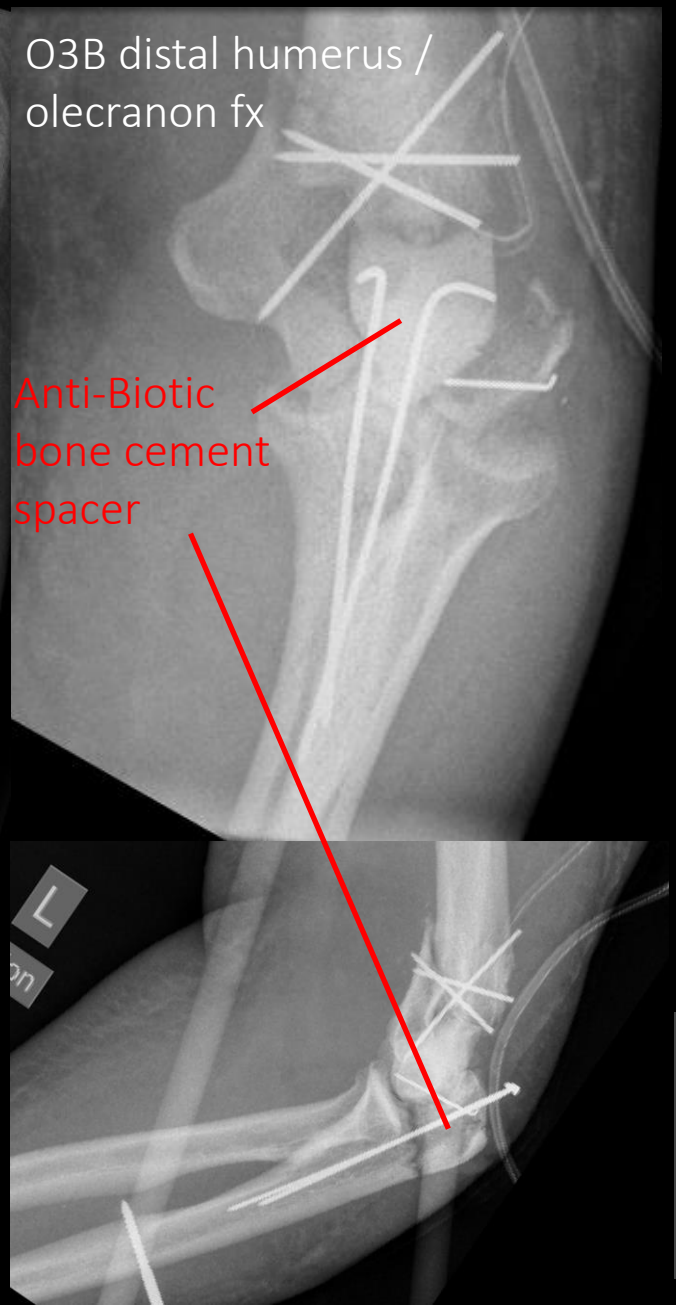
Implants - Are There Any Advancements Left to Make?

focus only a few aspects…

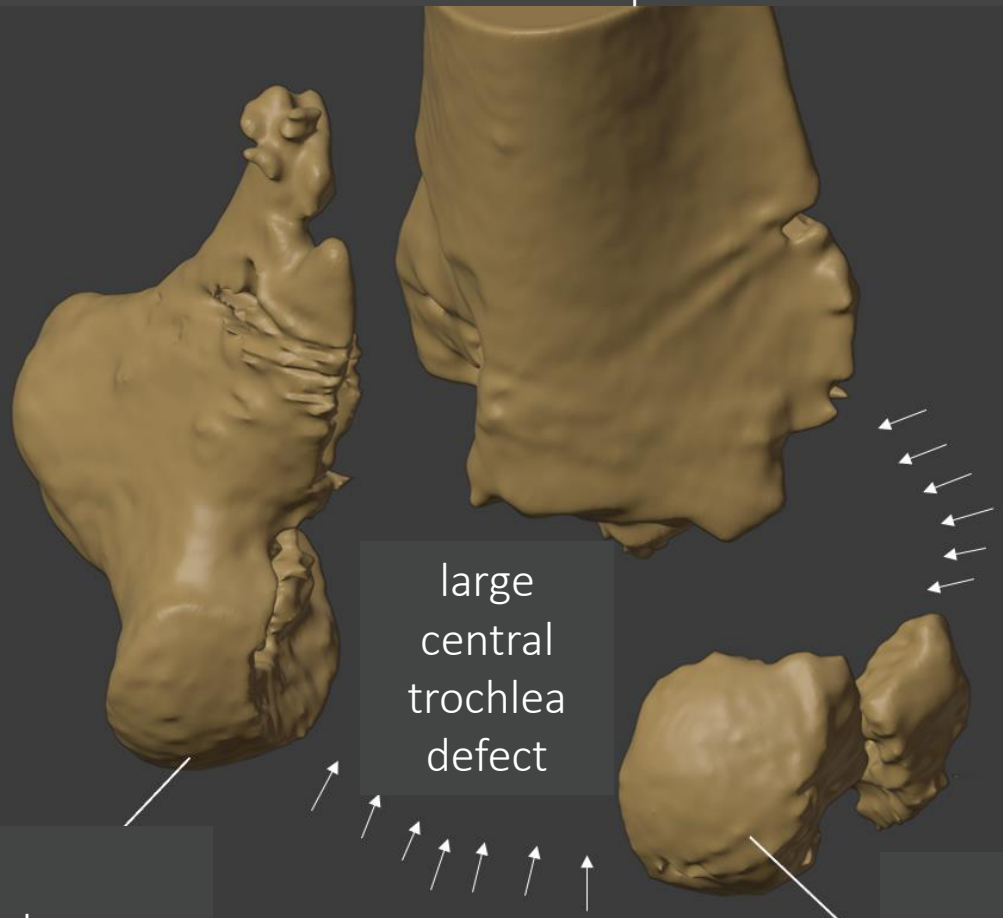
- individualized implants
- Hybrid implants
- Smart active implants
- Reduction support
- Periprosthetic trauma care



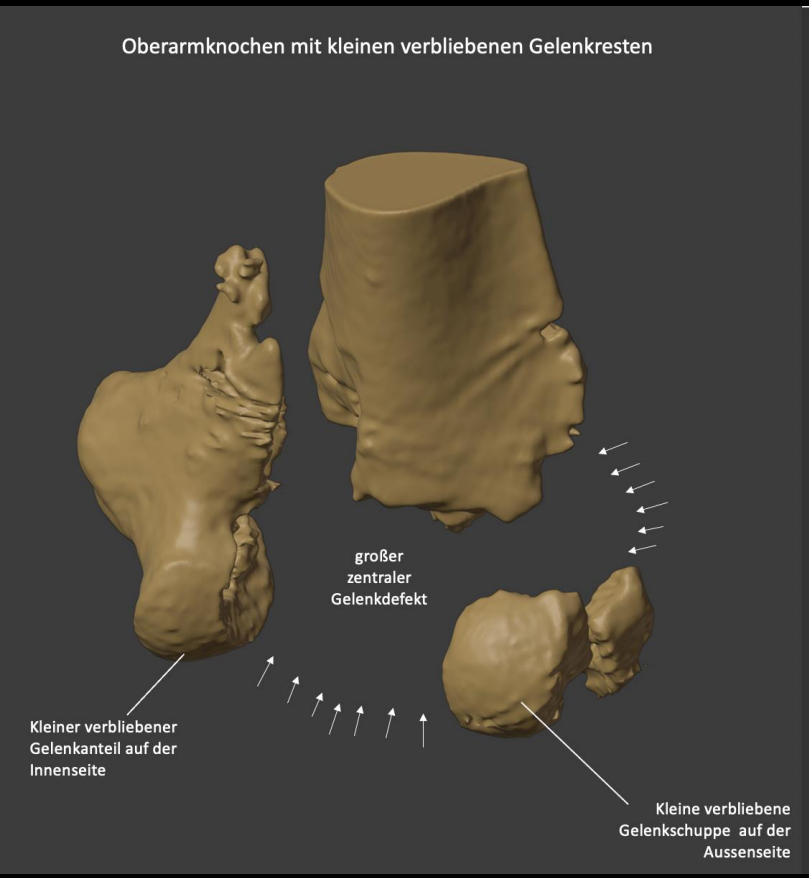
Individualized Implants - Hybrid Implants

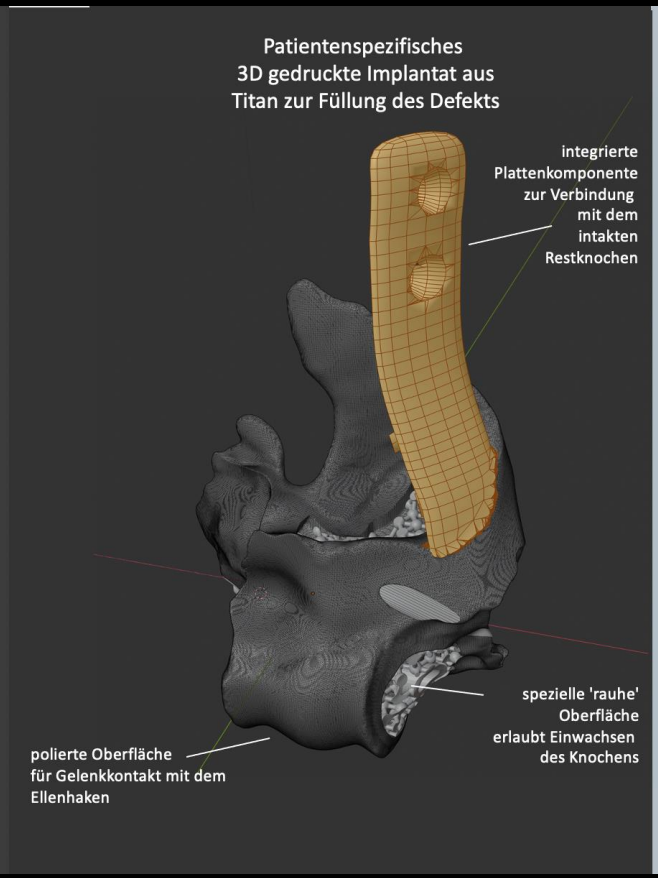


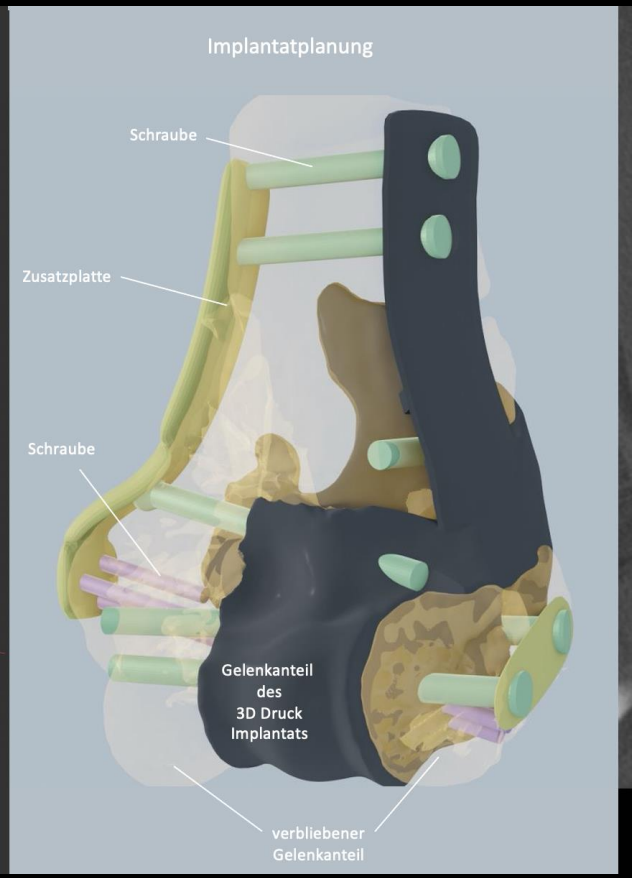
Problem: Large articular defect
too big and too complex for a auto-graft
What are the options?

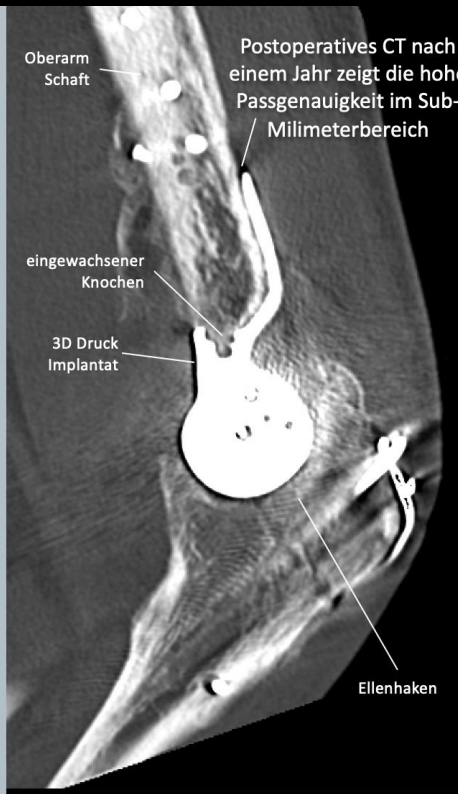


Individualized Implants - Hybrid Implants

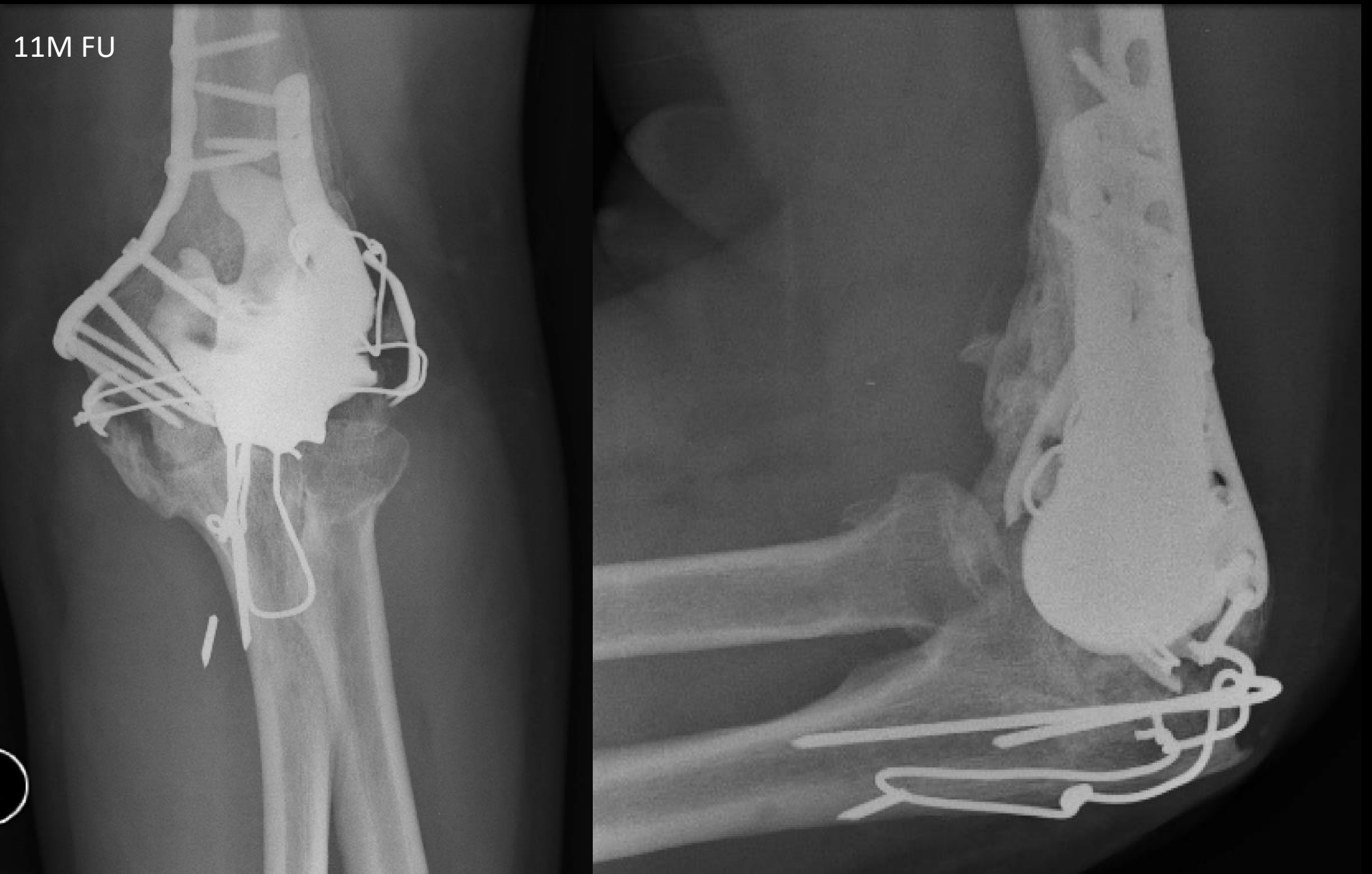




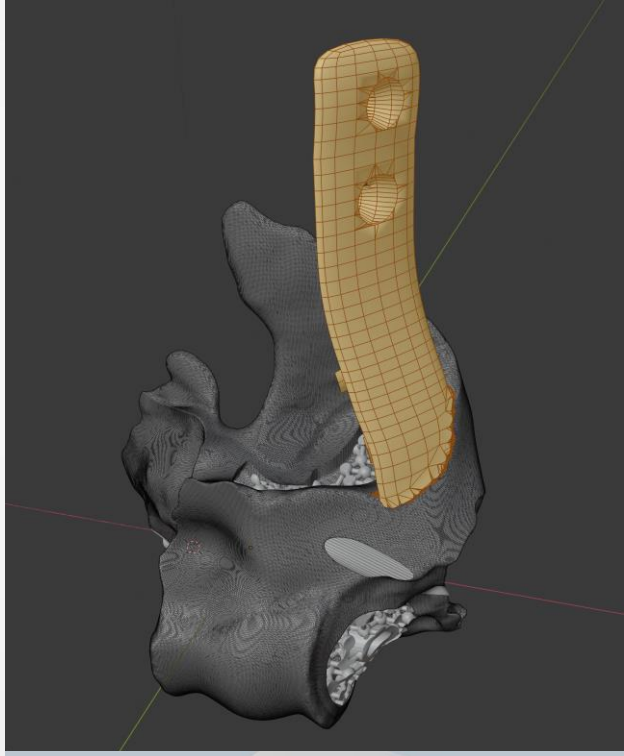


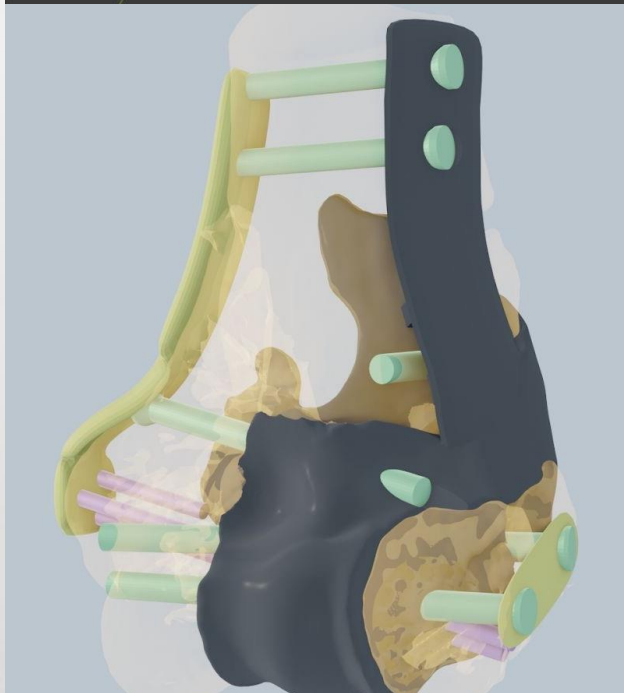


Individualized Implants - Hybrid Implants



11M FU





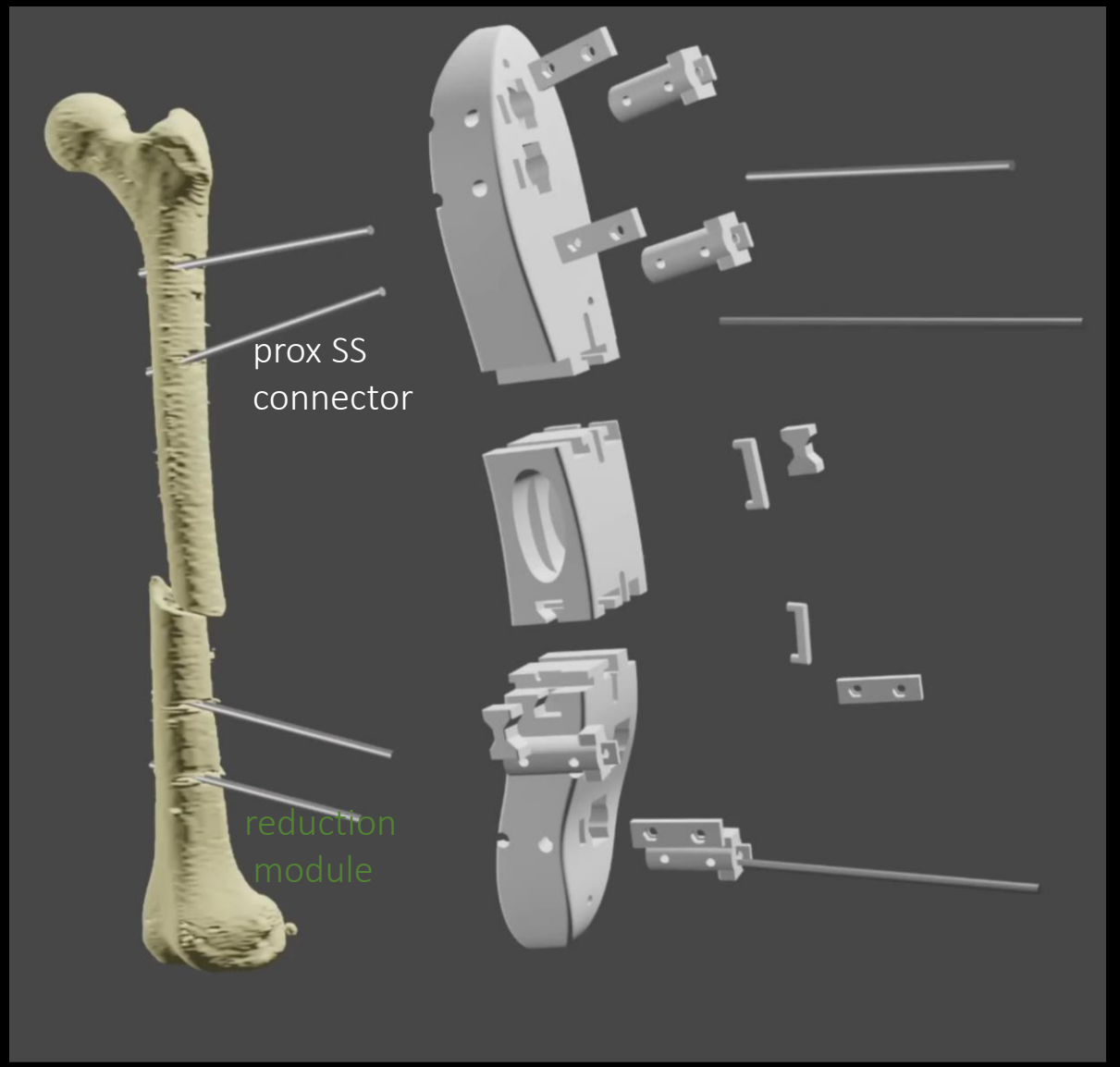
Individualized Implants - Hybrid Implants

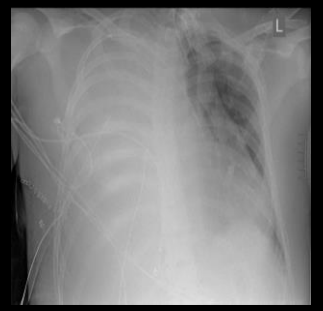
Example: polytrauma, massive liver trauma and chest injury, packing, lung resection, DCO … ECMO … ICU for 6 weeks … How can 3D print help?

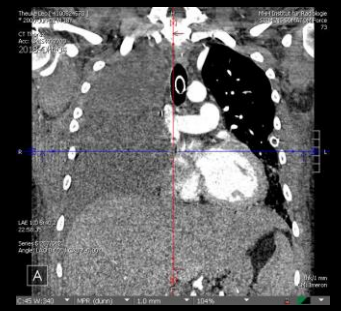
1. 3D copy of the contralateral femur
2. Comparison with the fractured exfixed femur
3. 3D print of a proximal and distal Schanz screw connector and a reduction module
4. Removal of classic exfix and application of the SS connectors.
5. Automatic reduction by the application of the snap-in reduction module

Advantages

- +++ precise
- even outside the OR (ICU)



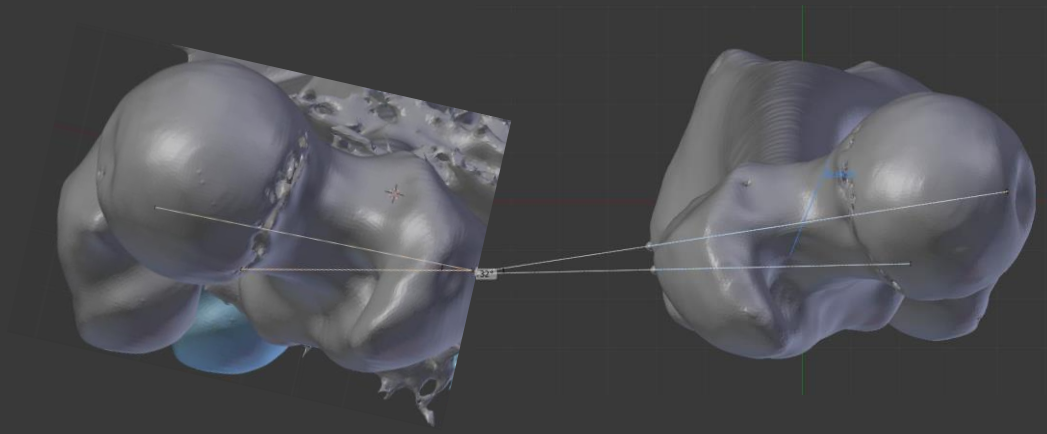




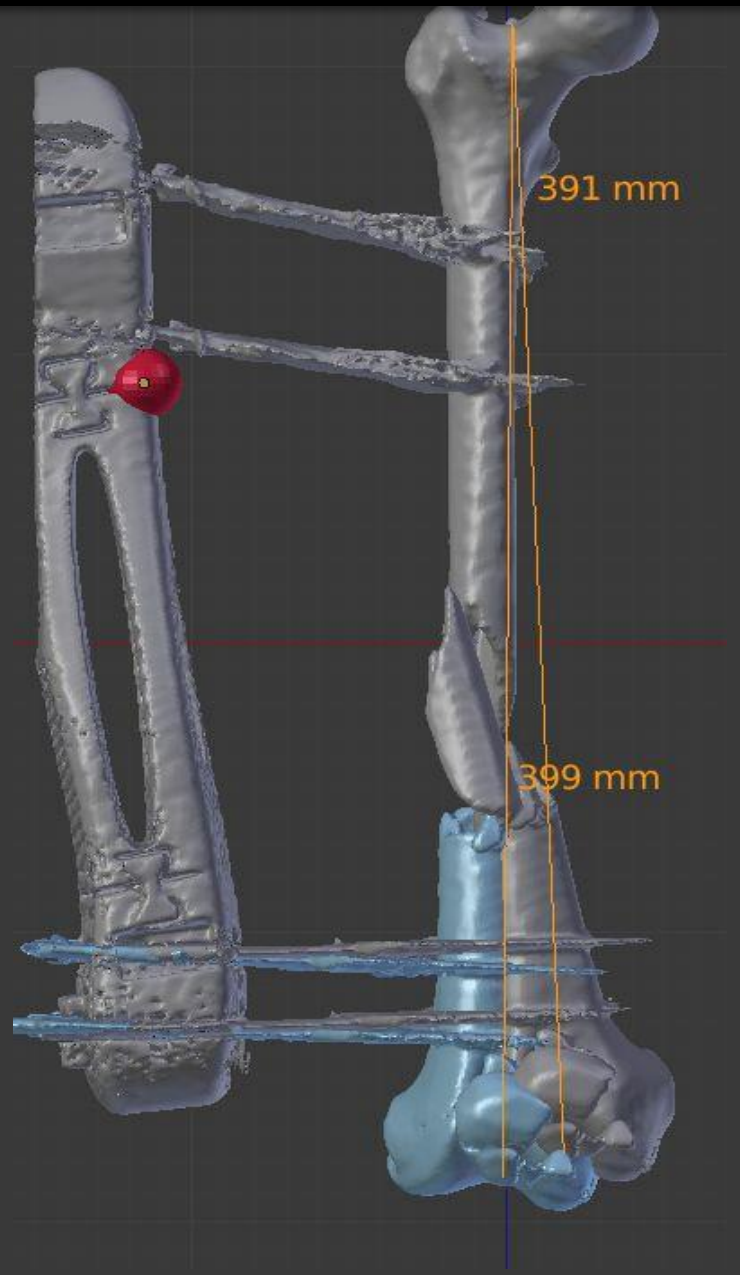
Individualized Implants - Hybrid Implants

3D alignment analysis postop

3D printed
reduction
ExFix
for 3D print
template assisted
navigation

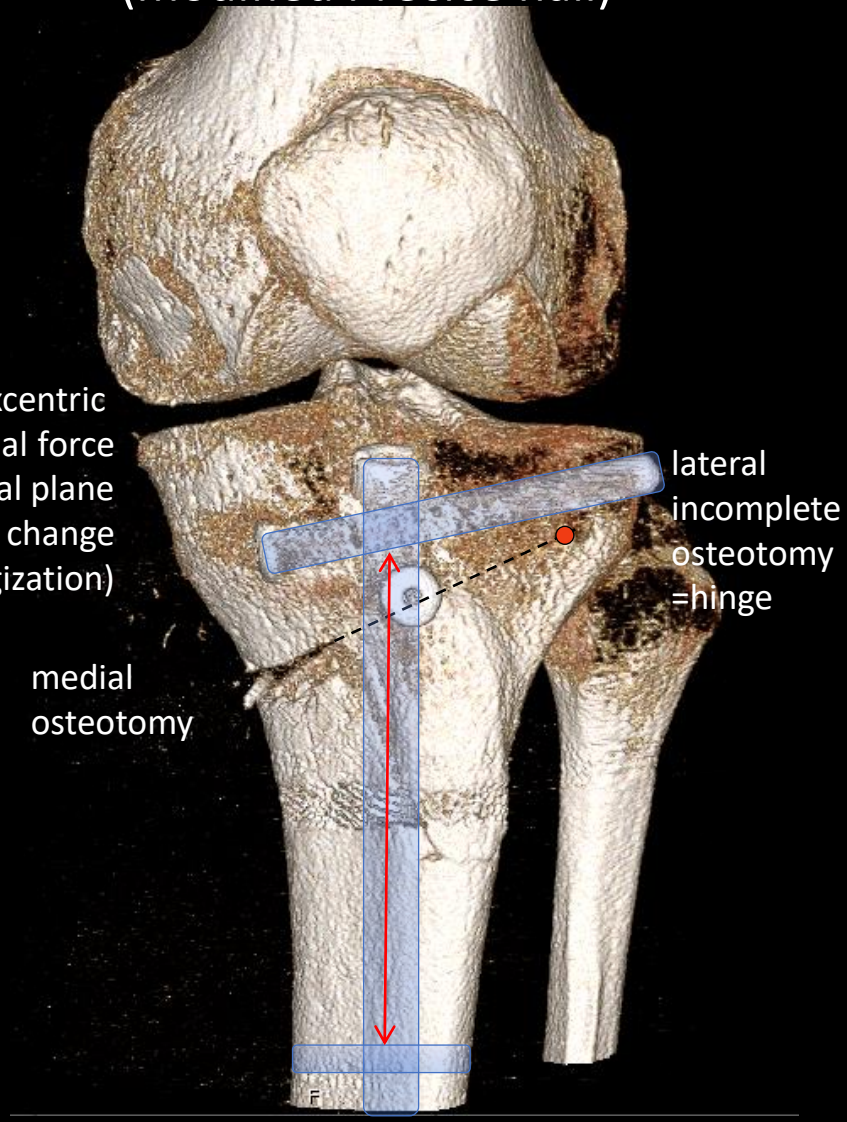


Difference: 4.1°



Reduction Support by the implant

alignment modification
during osteotomy healing
(modified Precice nail)



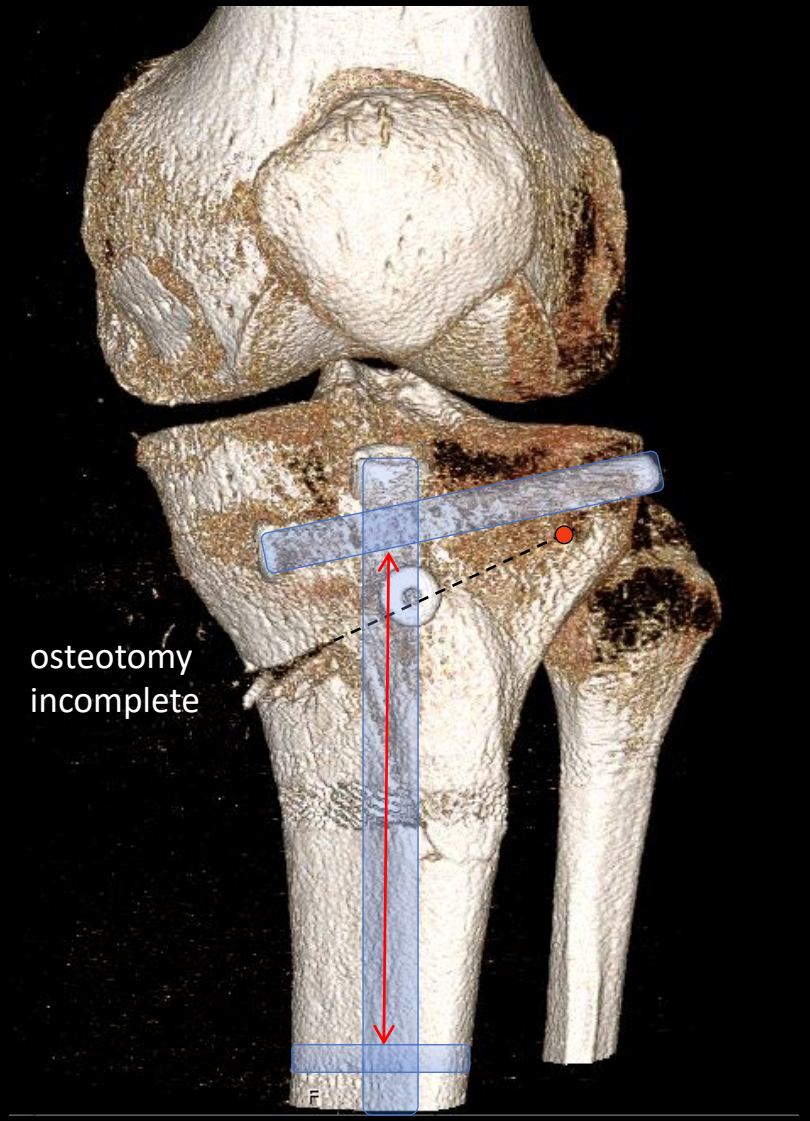
preop

d5 postop

d13 postop

d18 postop

alignment changing nail
(modified Precice nail)



not only …

- forward/backward
- distraction/compression

…

Advancements

- Torsion?
- feed back information from bone-implant complex to outside
  (stiffness, degree of healing, loading capacity)
- aktive bone healing stimulating patterns

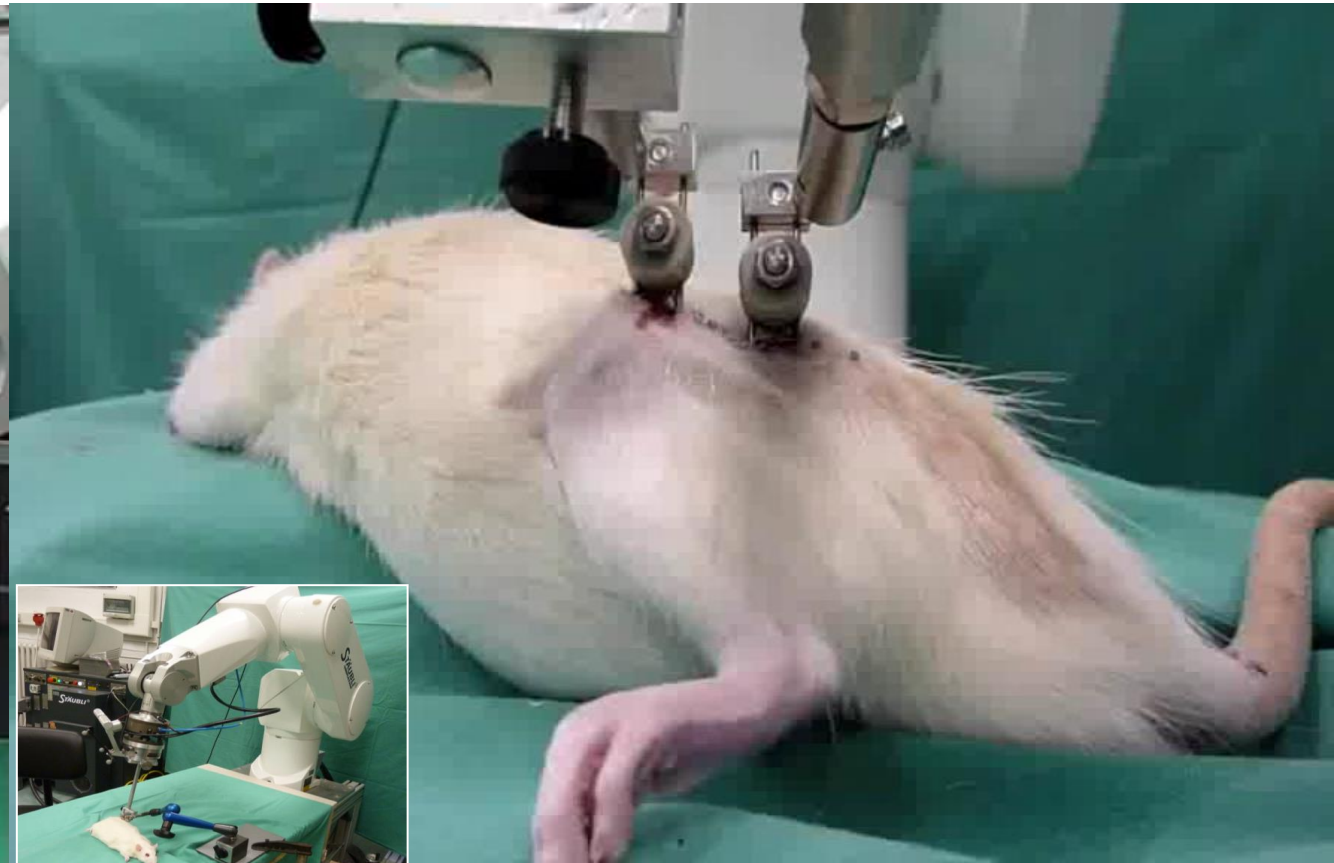
Reduction Support by the specific devices

THE INTERNATIONAL JOURNAL OF MEDICAL ROBOTICS AND COMPUTER ASSISTED SURGERY
Int J Med Robotics Comput Assist Surg 2006; **2**: 238–250.
Published online 3 April 2006 in Wiley InterScience (www.interscience.wiley.com). **DOI:** 10.1002/rcs.81

ORIGINAL ARTICLE

A surgical telemanipulator for femur shaft fracture reduction†

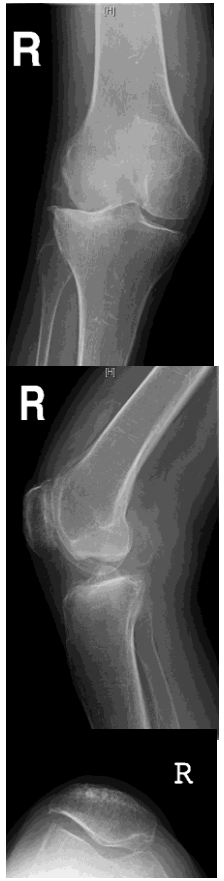
R Westphal, S Winkelbach, T Gosling, T Hufner, J Faulstich, P Martin, C Krettek, F Wahl



Reduction Support by the implant

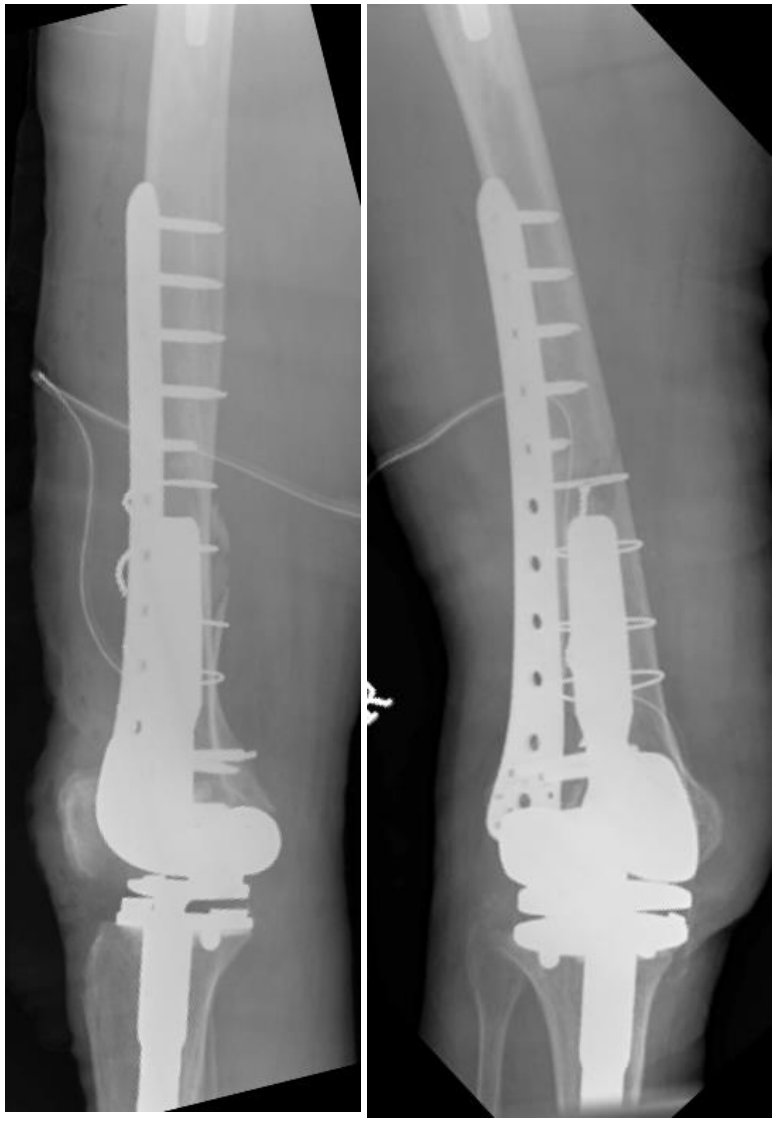
Problems in periprosthetic fractures

TKA 2007

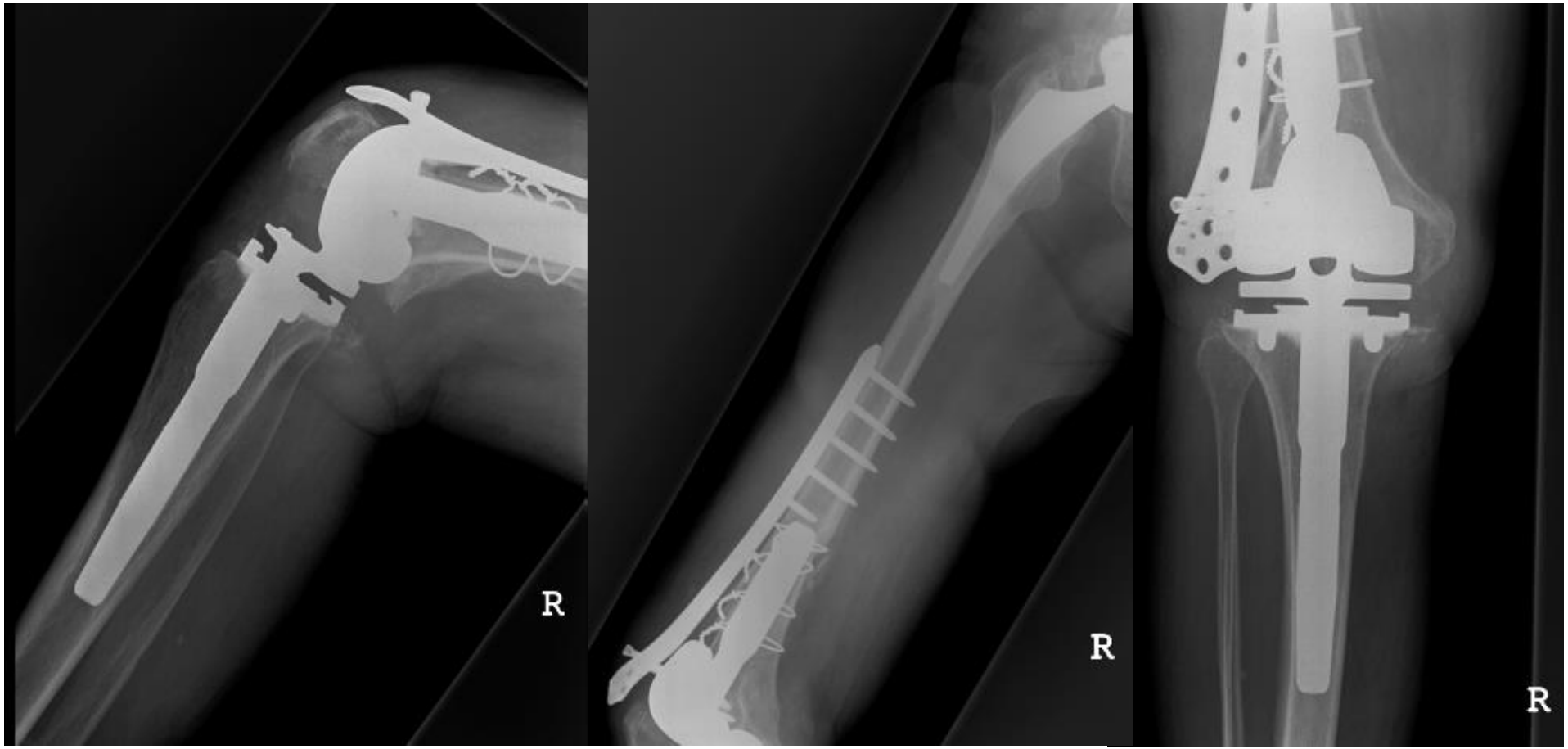


10d after implantation hinged TKA the patient feels a crack in her knee

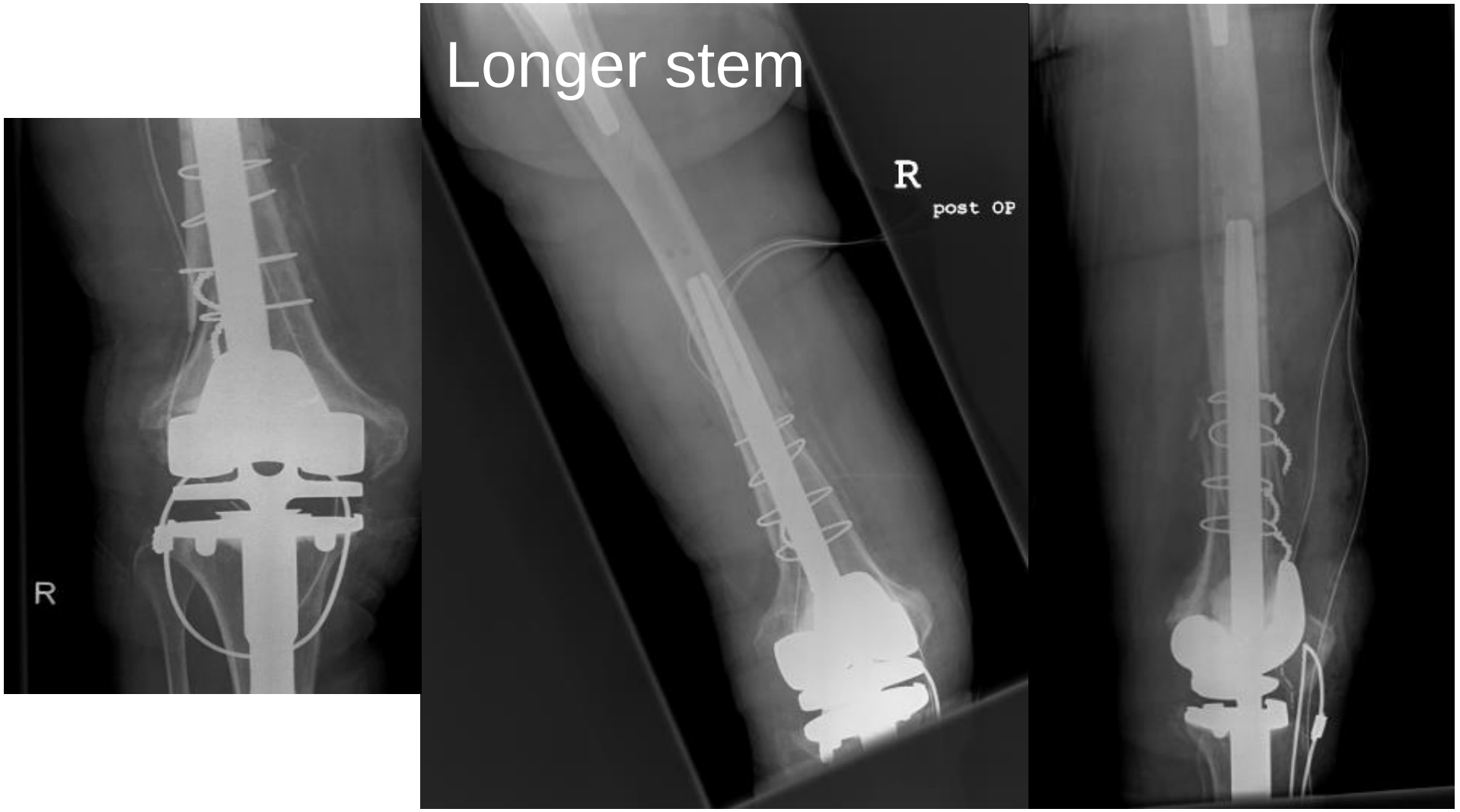
Problems in periprosthetic fractures



Problems in periprosthetic fractures



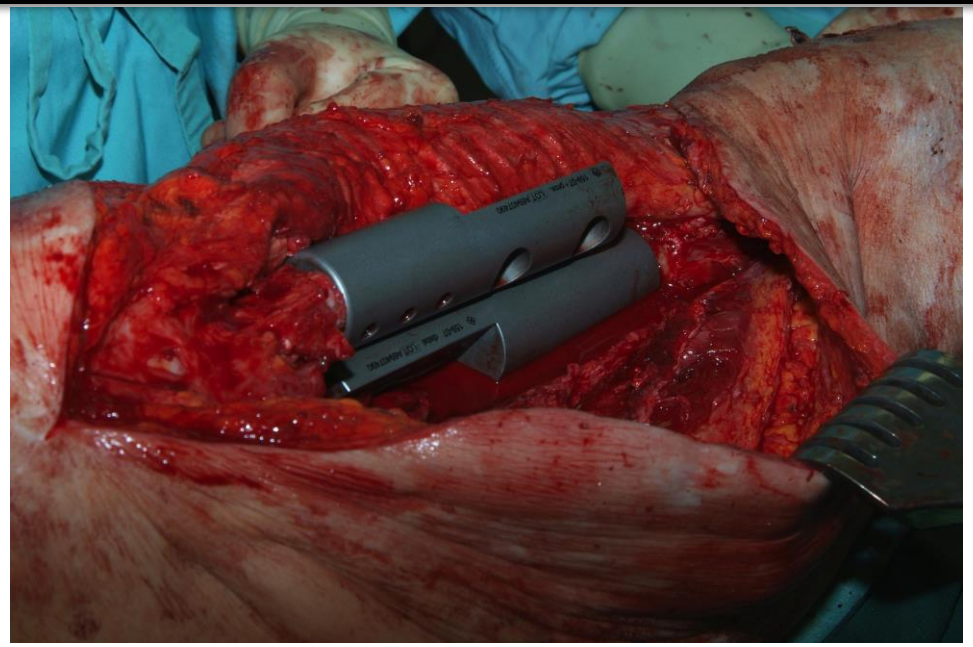
1 month later Low energy fall, pain right knee

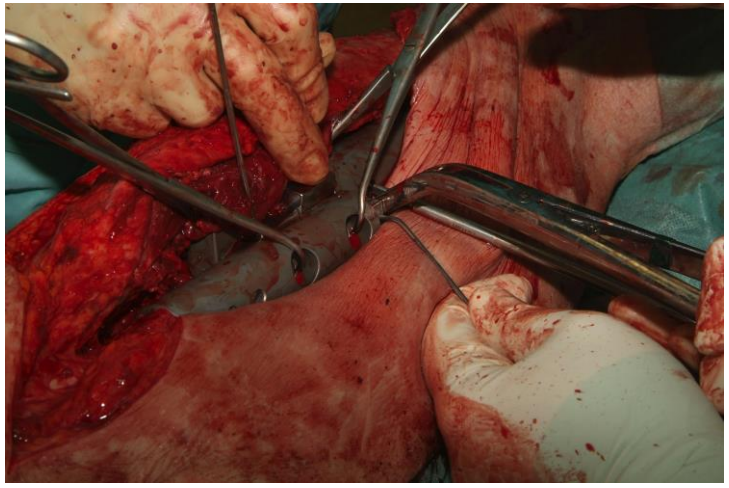

Longer stem
R
post OP
R

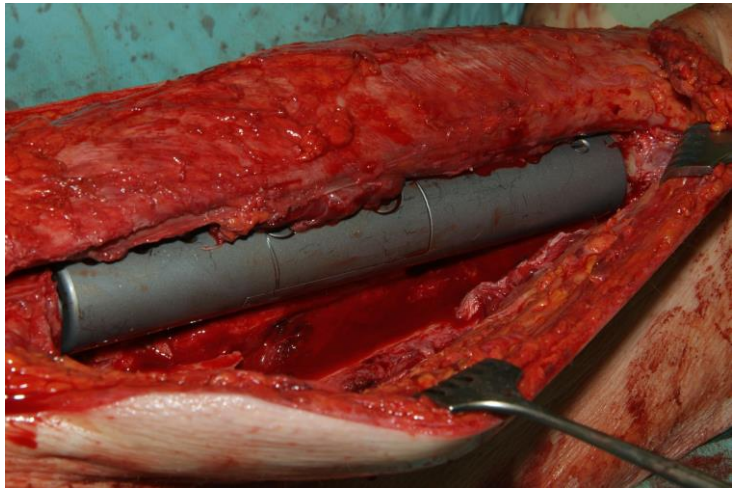
Problems in periprosthetic fractures

Additional trauma (fall from chair) 1 month after longer stem implantation

Problems in periprosthetic fractures







Custom made diaphyseal spacer

Problems in periprosthetic fractures

The only mechanically sound structure is the implant …

Medical Engineering & Physics 36 (2014) 239–243

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journal homepage: www.elsevier.com/locate/medengphy

Technical note

Intraprosthetic screw fixation increases primary fixation stability in periprosthetic fractures of the femur—A biomechanical study

Stephan Brand [a,*], Johannes Klotz [b], Thomas Hassel [b], Maximilian Petri [a], Max Ettinger [c], Friedrich-Wilhelm Bach [b], Christian Krettek [a], Thomas Gösling [a]

[a] Trauma Department Hannover Medical School, MHH, Germany
[b] Leibniz University Hannover, Institute of Materials Science, Germany
[c] Department of Orthopaedic Surgery, Hannover Medical School, Germany

ARTICLE INFO

Article history:
Received 2 January 2013
Received in revised form 17 July 2013
Accepted 19 July 2013

Keywords:
Periprosthetic fracture
LISS-plate
Locking-screw plating
Intraprosthetic screw fixation

ABSTRACT

Background: The purpose of this study was to develop a new fixation technique for the treatment of periprosthetic fractures using intraprosthetic screw fixation. The goal was to biomechanically evaluate the increase in primary fixation stability compared to unicortical locked-screw plating.
Methods: A Vancouver C periprosthetic fracture was simulated in femur prosthesis constructs. Fixation was then performed with either unicortical locked-screw plating using the LISS-plate or with intraprosthetic screw fixation. Fixation stability was compared in an axial load-to-failure model.
Results: The intraprosthetic fixation model was superior to the unicortical locked-screw fixation in all tested devices. The intraprosthetic fixation model required 11,807 N ± 1596 N for failure and the unicortical locked-screw plating required 7649 N ± 653 N ($p = 0.002$).
Conclusion: Intraprosthetic screw anchorage with a special prosthesis drill enhances the primary stability in treating periprosthetic fractures by internal fixation.

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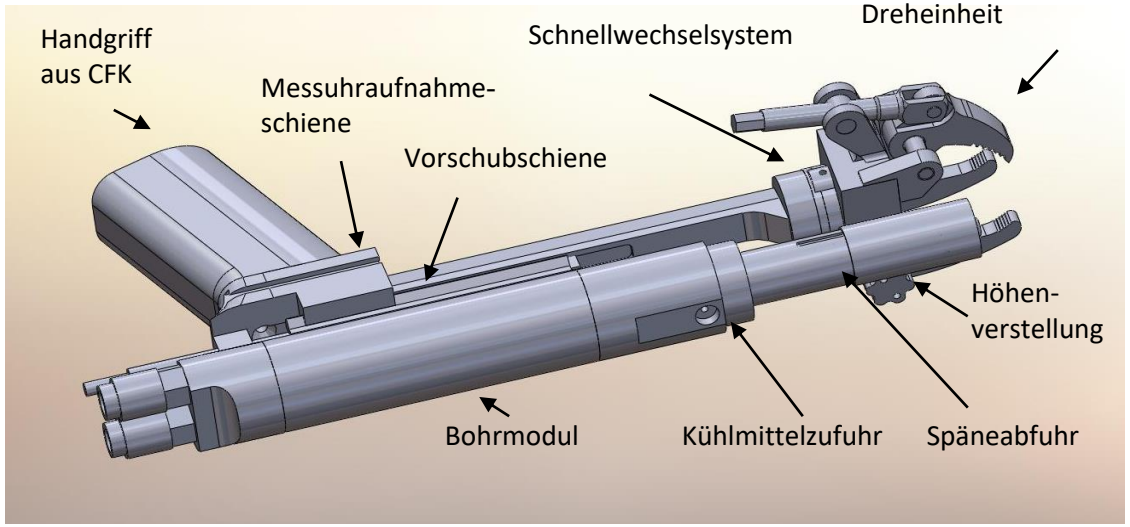
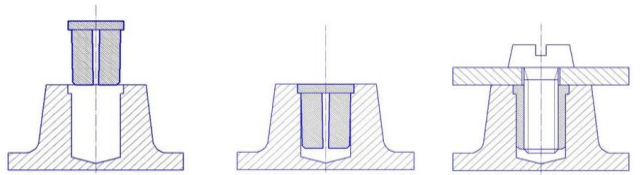
The only mechanically sound structure is the implant …

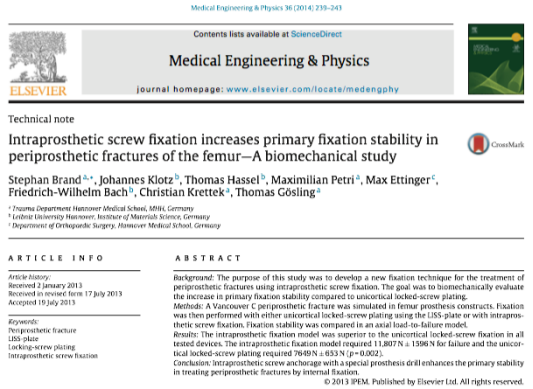
Prosthetic Bridging

direct drilling in prosthesis



Brand S et al Intraprosthetic screw fixation increases primary fixation stability in periprosthetic fractures of the femur - a biomechanical study. Medical engineering & physics. 2014;36(2):239-43.





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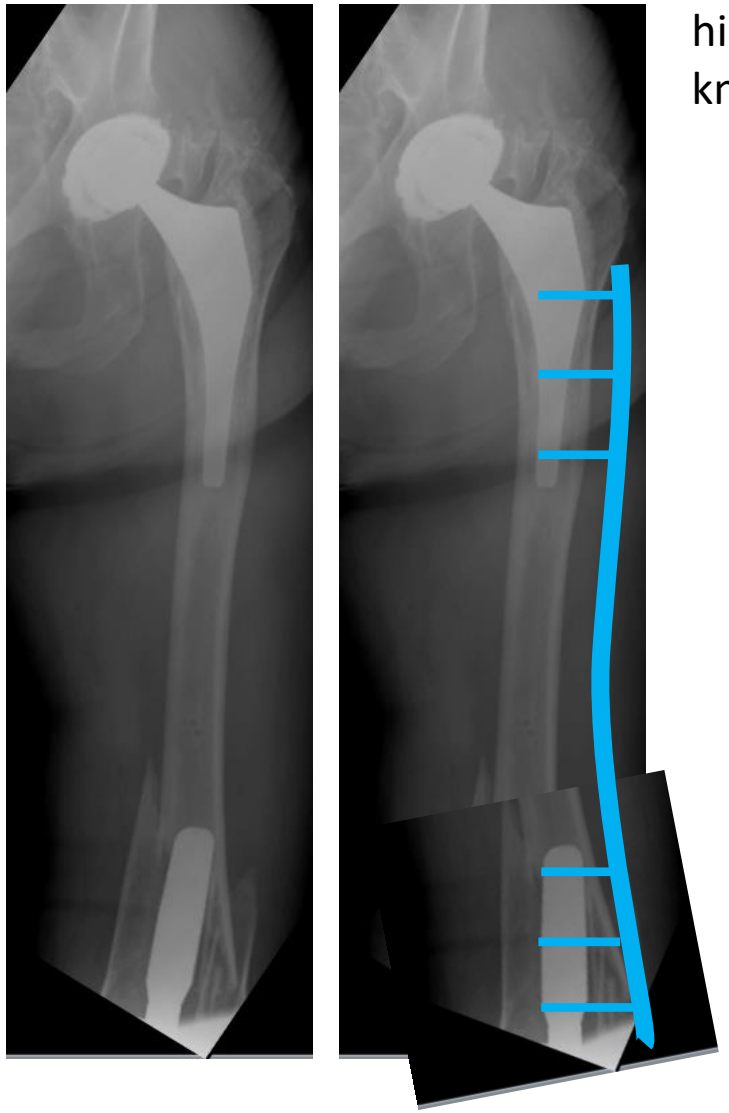
The only mechanically sound structure is the implant …

Prosthesis to prosthesis



hip to
knee replacement

Prosthesis to Bone

Prosthesis: Advancements left to make …

prostheses shoud have standardized connector options

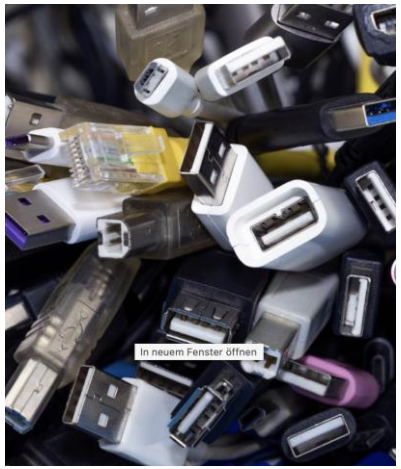
- extramedullary fixation
- intramedullary fixation

would require legislation to implement …

Prosthesis: Advancements left to make …

… like EU did with mandatory USB-C connector by 2024

end of 2024



Summary Advancements Left to Make …

- individualized implants / Hybrid implants
- Smart active implants
- Reduction support
- Periprosthetic trauma care

Case 3, Hildegard F, *

- 87 year old female
- TKA 2001 right side
- THA 2003 after femoral neck fracture right side

- Low energy fall
- Pain right leg

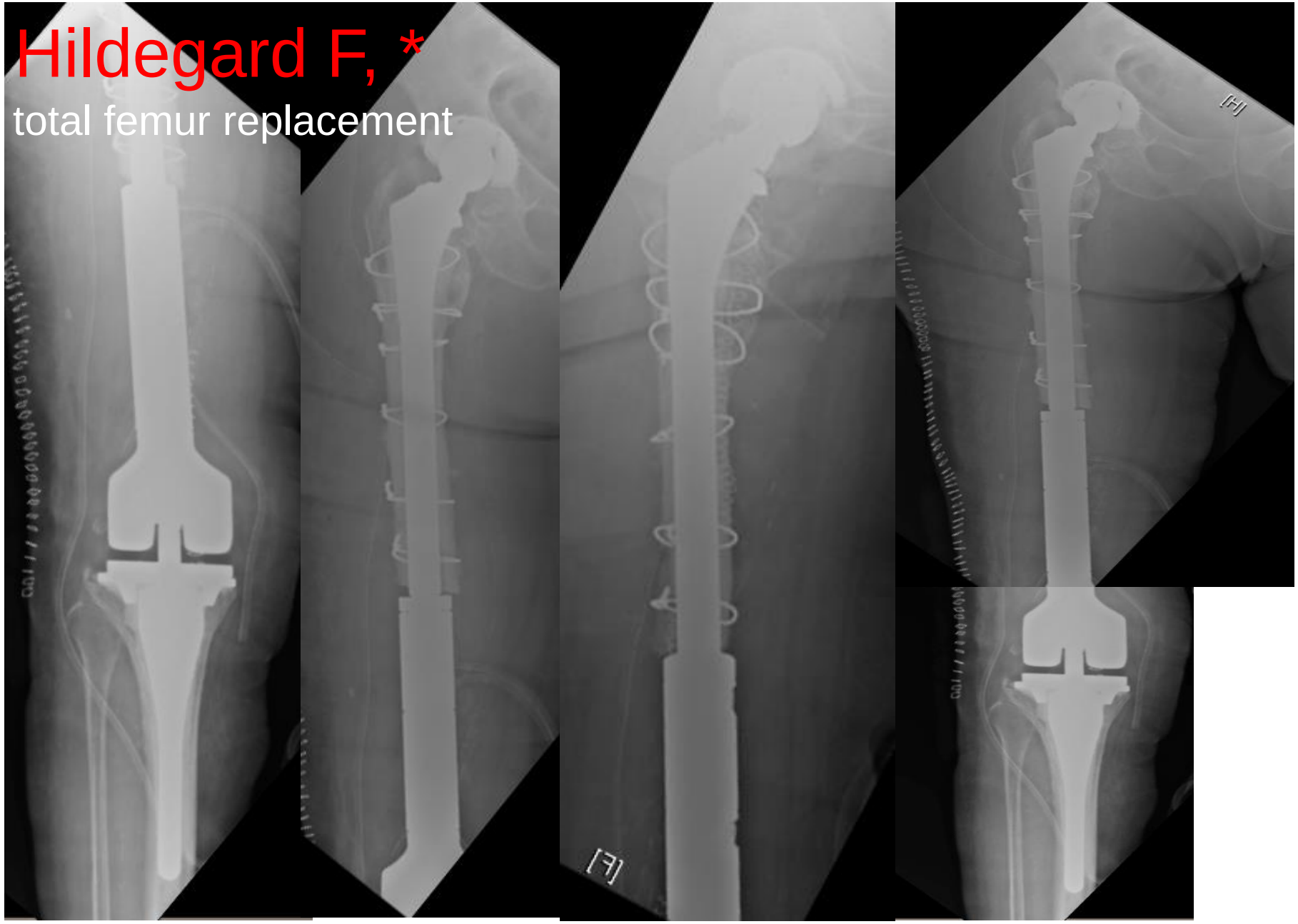
Hildegard F, *

after minor fall 2 month later

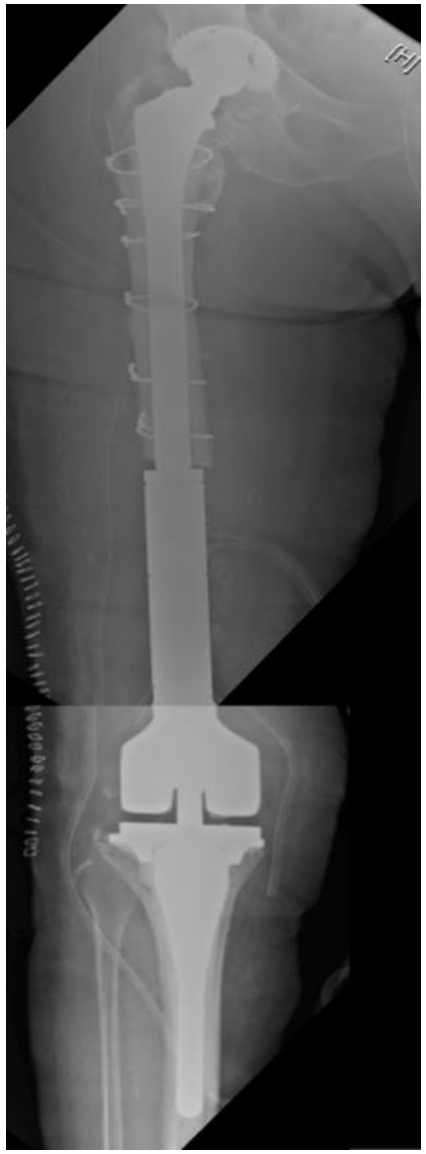
Intraop dead avital bone ... 12 cm resection and spacer implantation ...

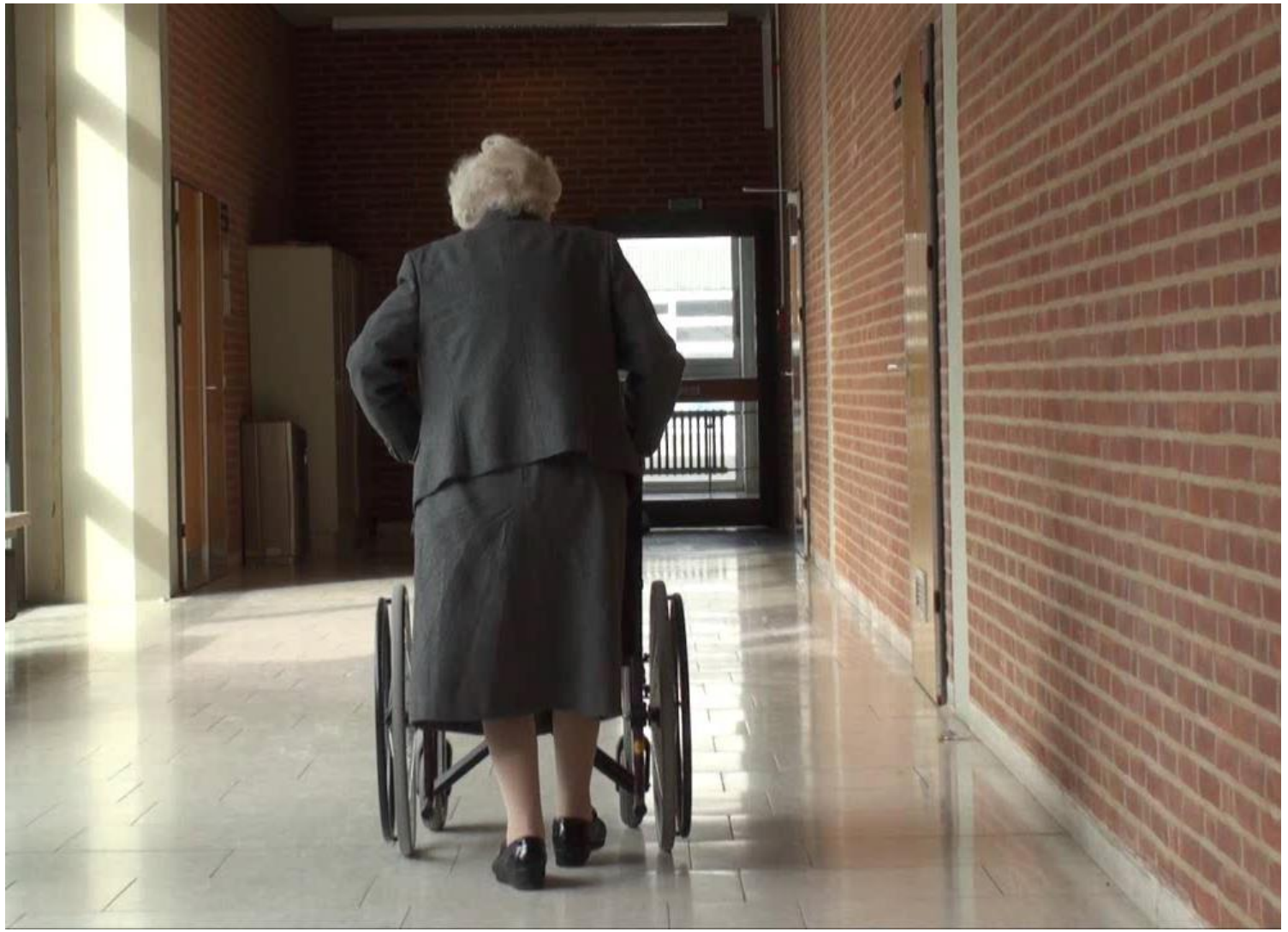
Hildegard F, *

total femur replacement



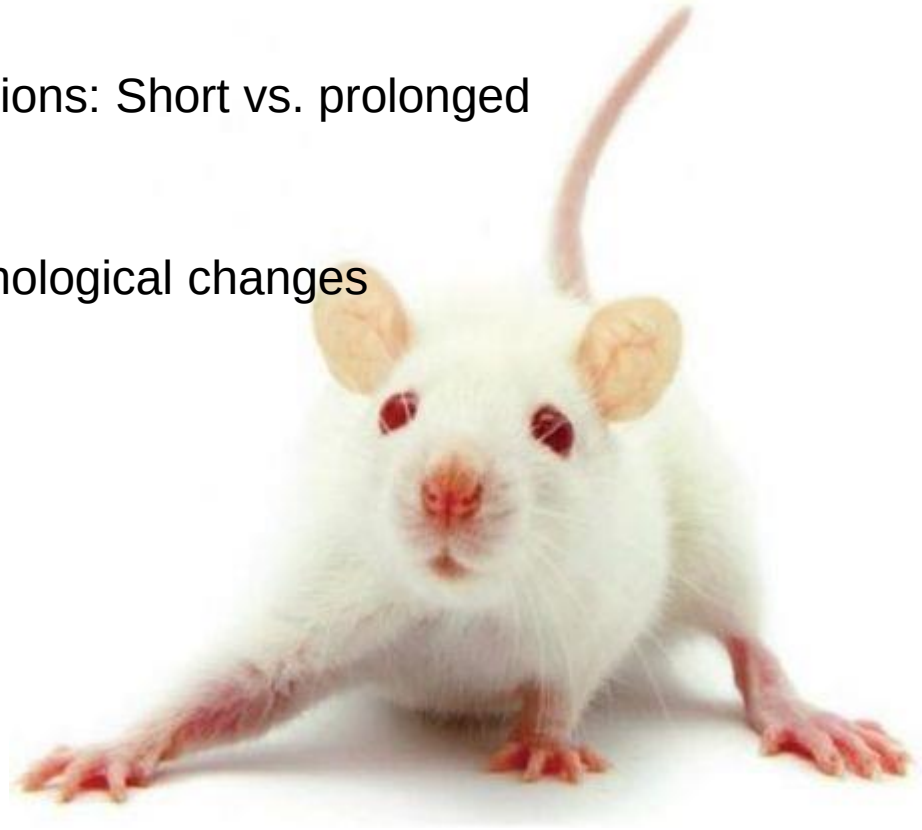
Hildegard F, *



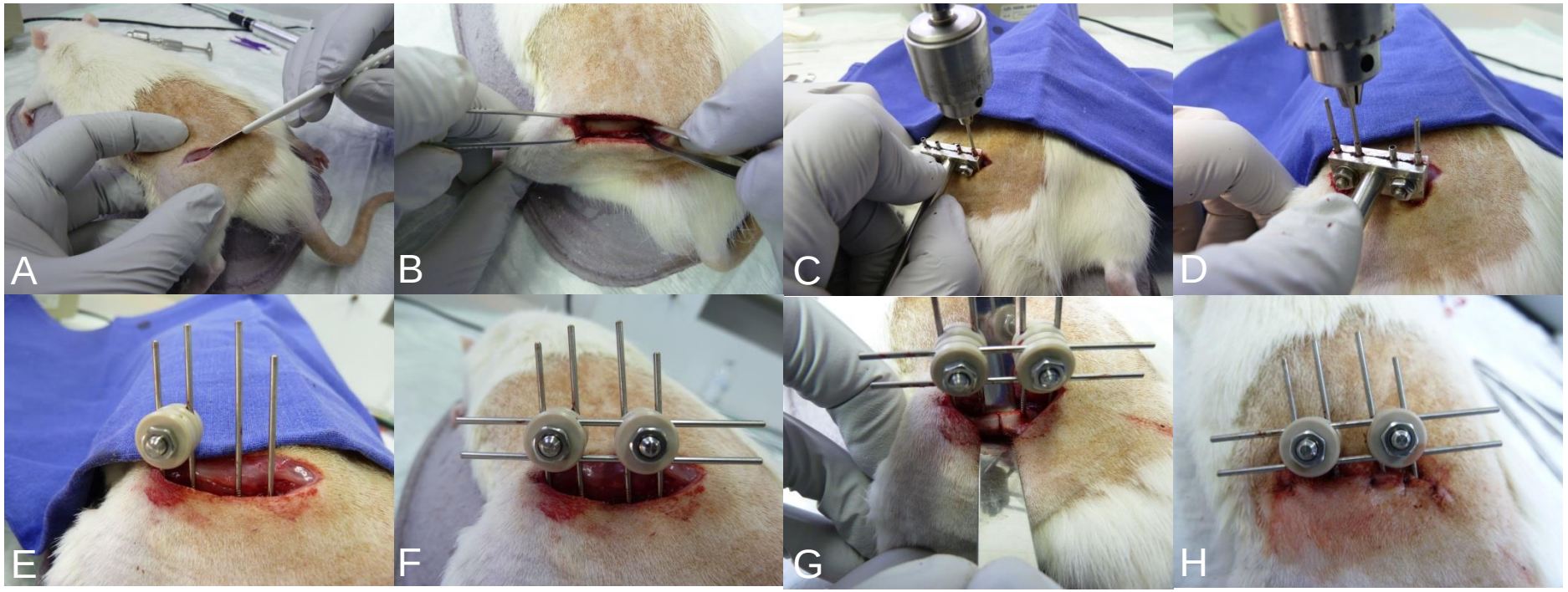


Study design:

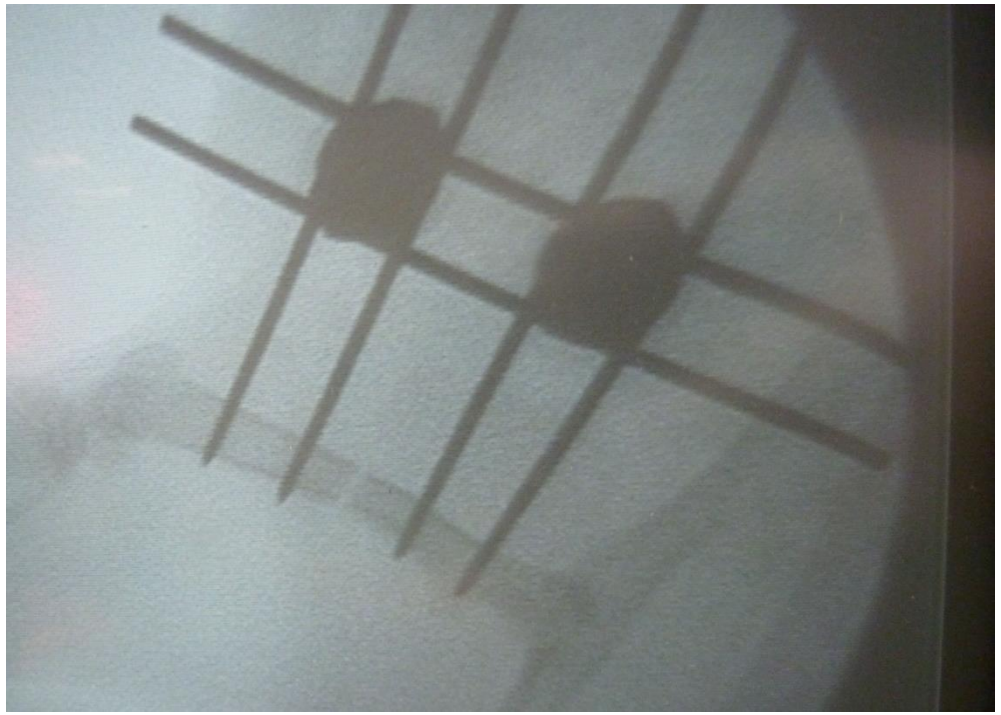
1. Establishment of a model of robot-assisted repositioning of femoral fractures in rats
    - Construction of a fixateur externe
    - Creation of a control program for the robot
2. Analysis of plasma cytokine concentrations: Short vs. prolonged repositioning maneuver
3. Analysis of muscle biopsies to find pathological changes
4. Analysis of non-decalcified bone slices
1. µCT and biomechanical analysis

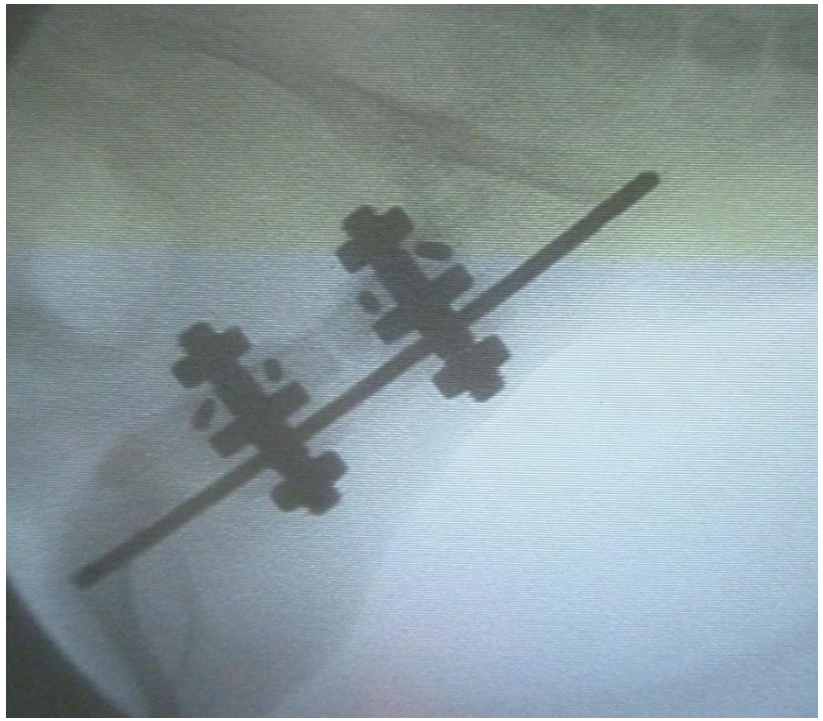


Implantation of Fixateur extern:

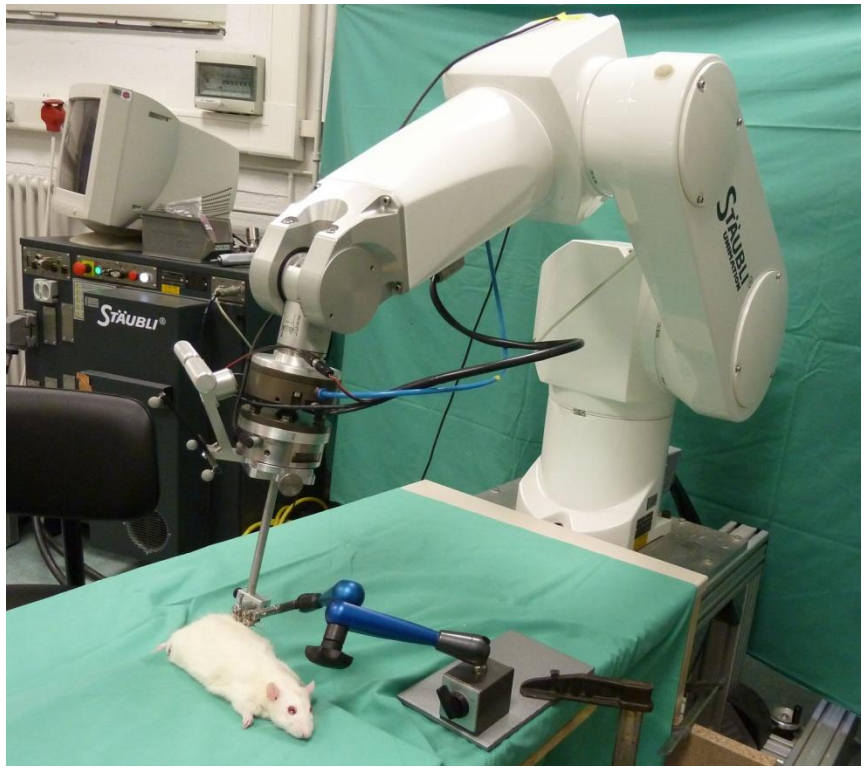


Implantation of Fixateur extern:





Repositiong maneuver:



Dislocation:

↔ 2mm

↕ 10 mm up and down

Sham: -

Short repositioning: 1x time

Prolonged repositioning: 10x times

Repositiong maneuver: