Simulation of Fracture Healing due to Intramedulary Nailing

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Introduction

unreamed Intramedullary Nailing

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high interfragmentary movements (IFM)

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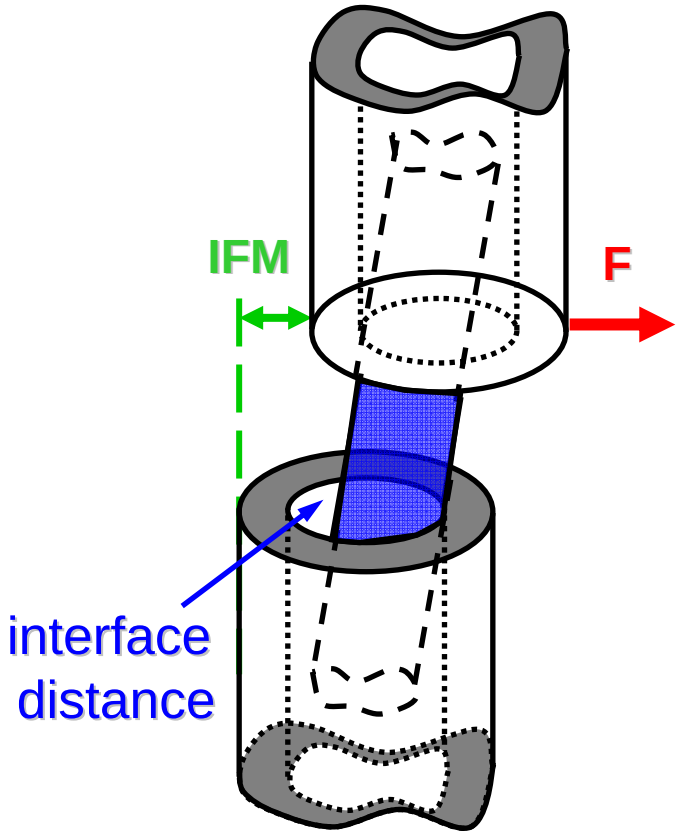
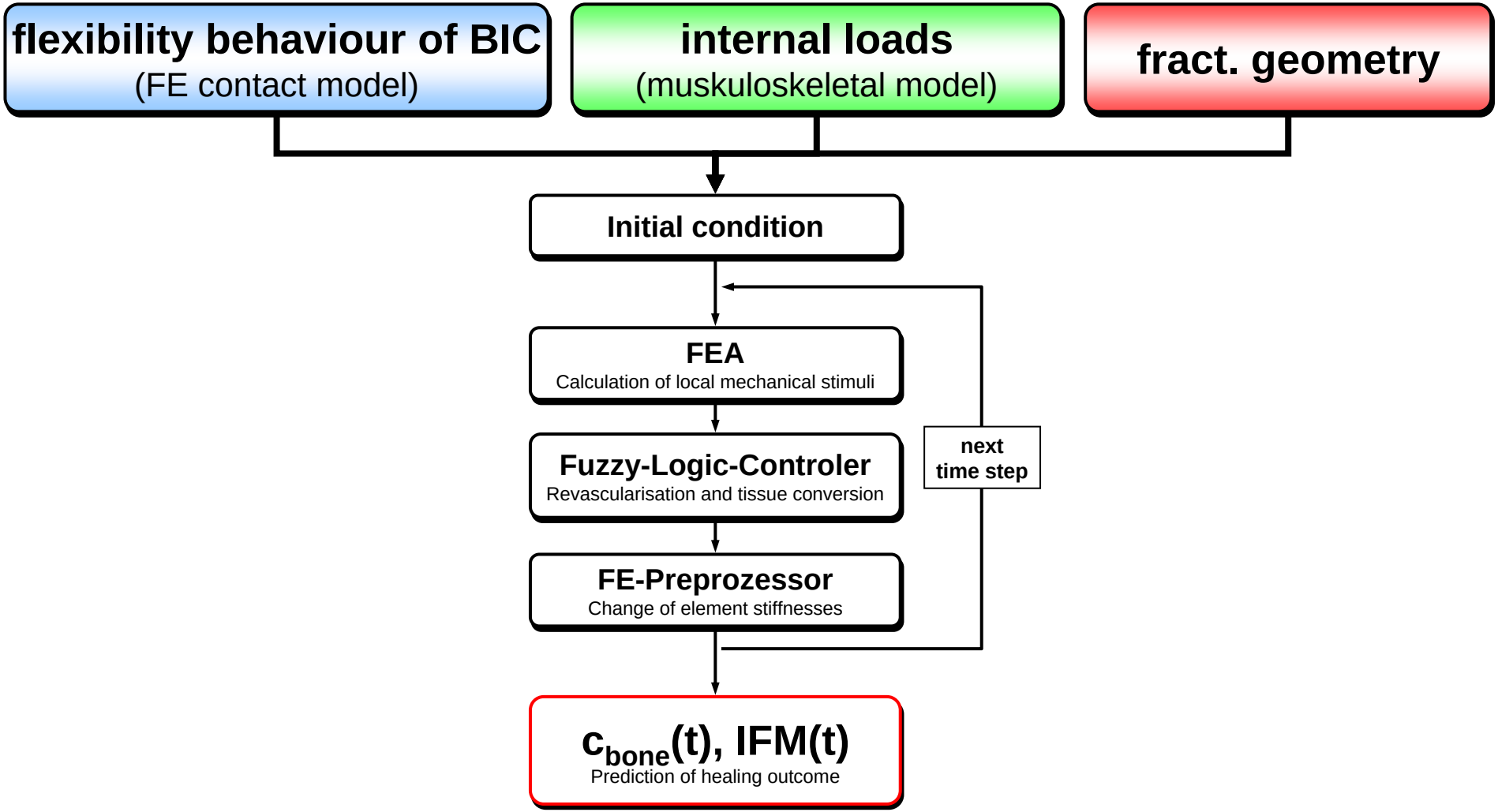
critical for healing outcome*

*Claes et al., J Orth Res 1997
*Augat et al., J Orth Res 2003
*Larsen et al., J Orth Res 2004



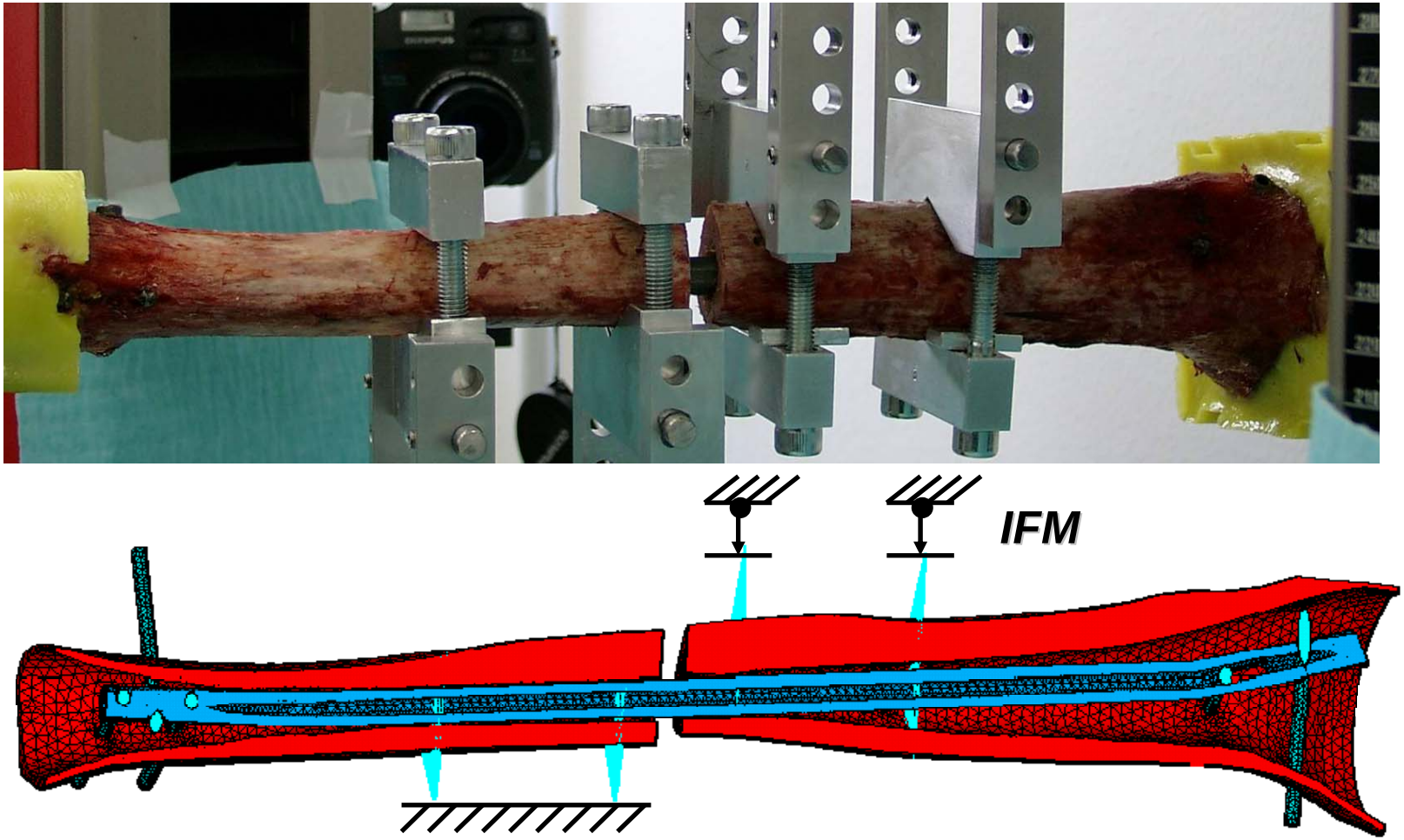
Aim: **Simulation of fracture healing process to analyze the influence of <u>fracture type</u> and <u>interface distance</u> on the healing outcome**

simulation of fracture healing process



flexibility behaviour of BIC
(FE contact model)

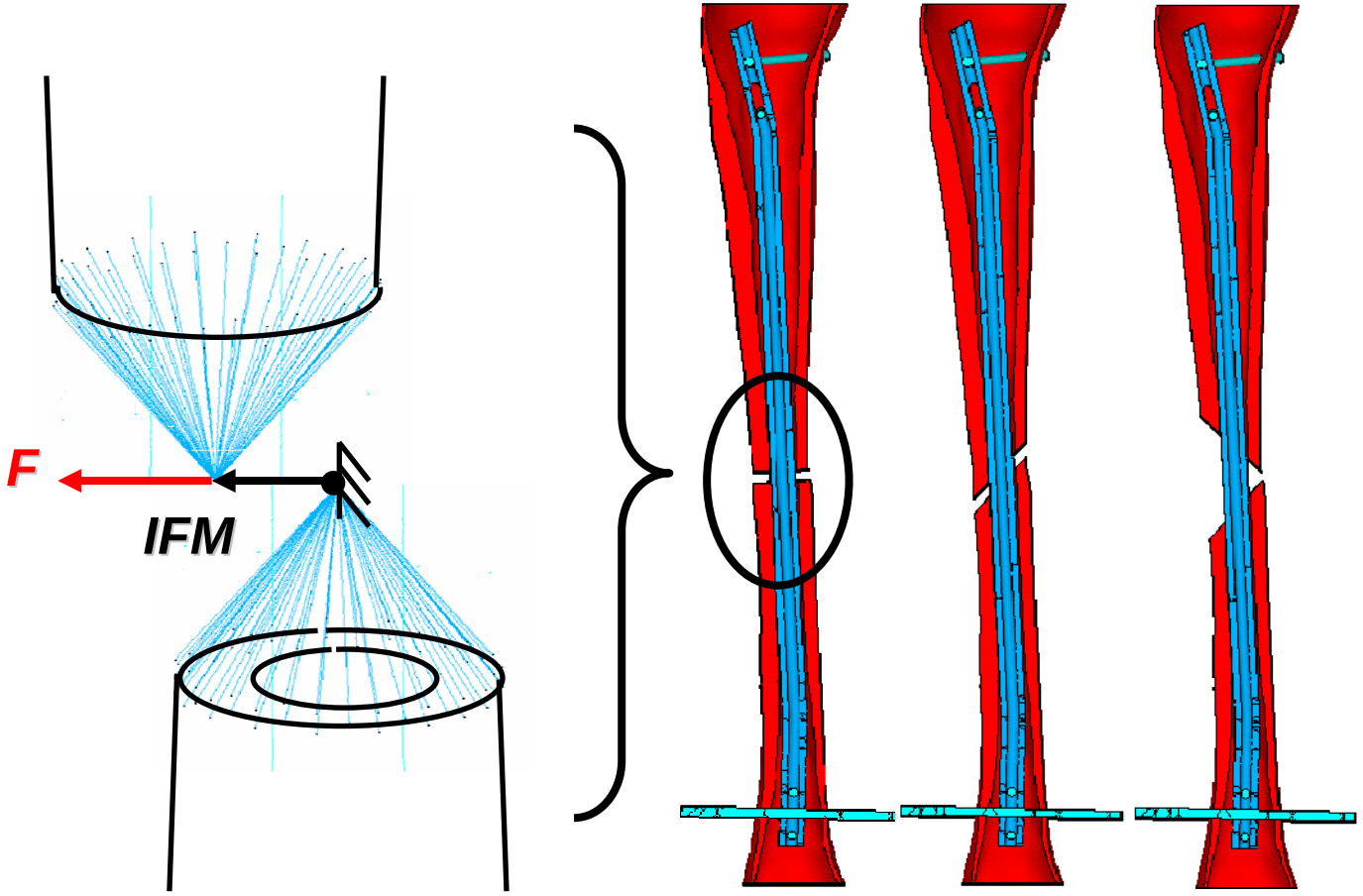
reconstruction of an in vitro tested bone implant complex (BIC)



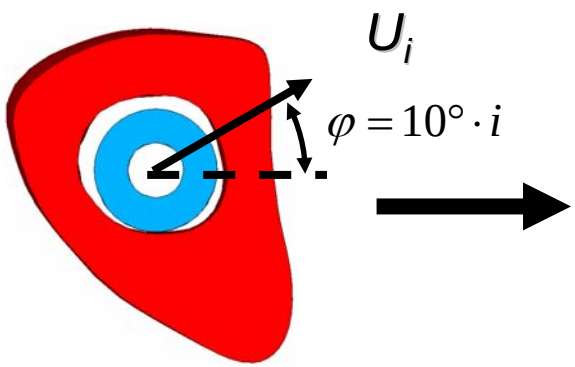
determination of flexibility behaviour

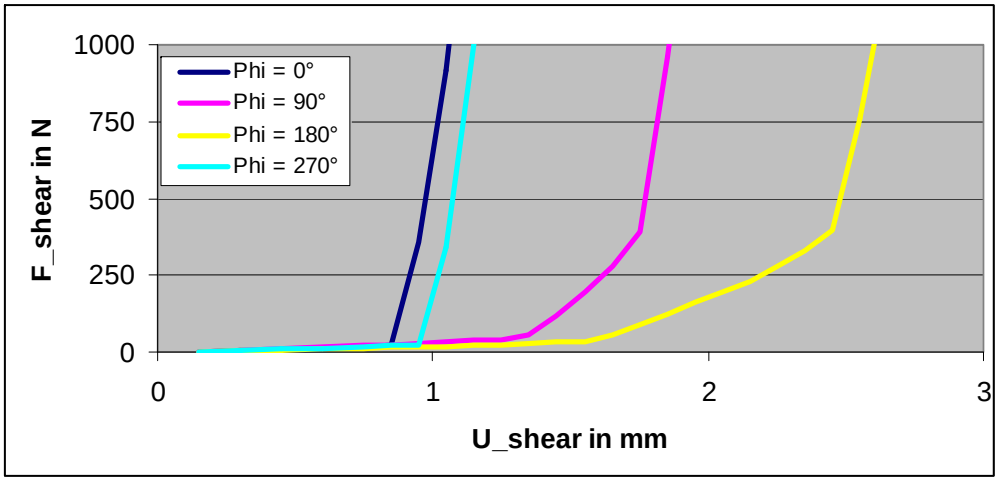
due to idealized fractures

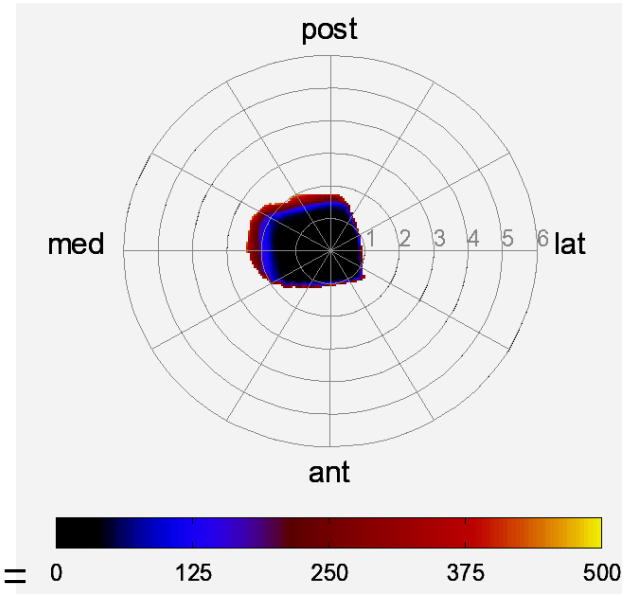
boundary conditions applied on rigid beam elements



direction dependent contact





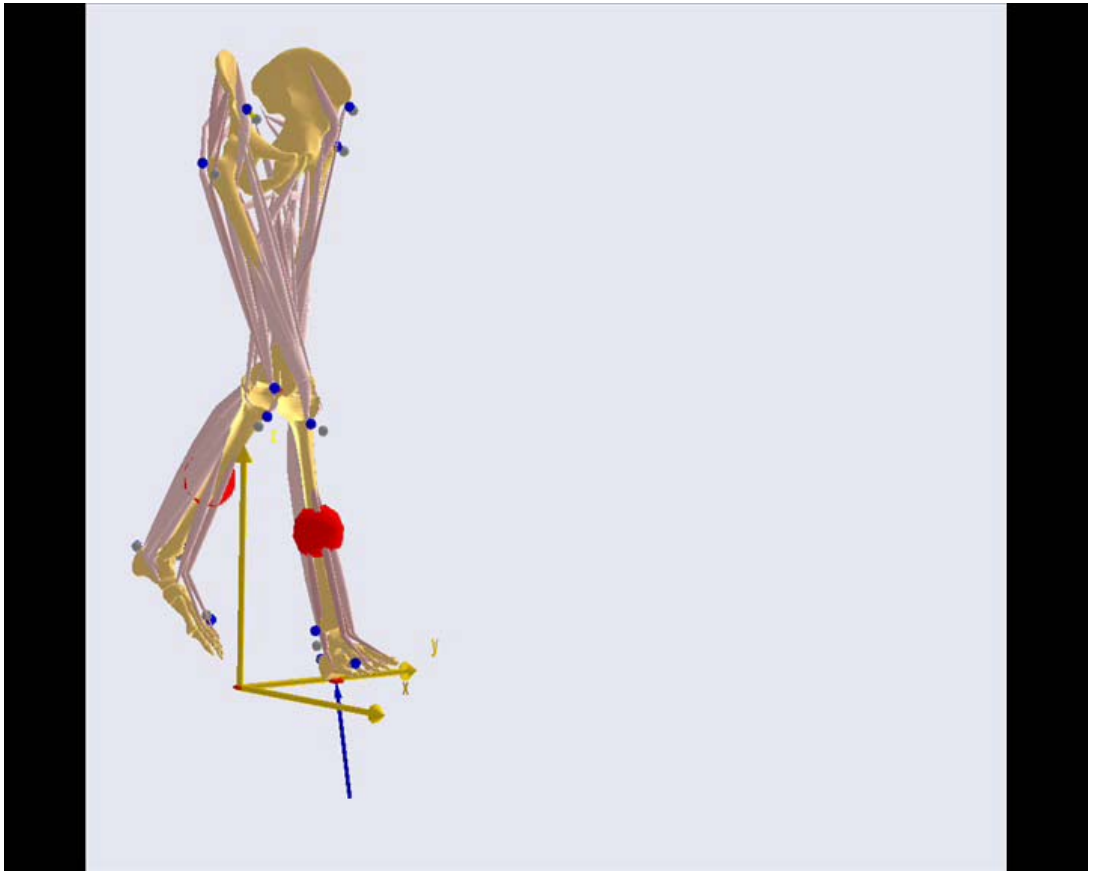


F_{shear} =

specific map of shear flexibility behaviour

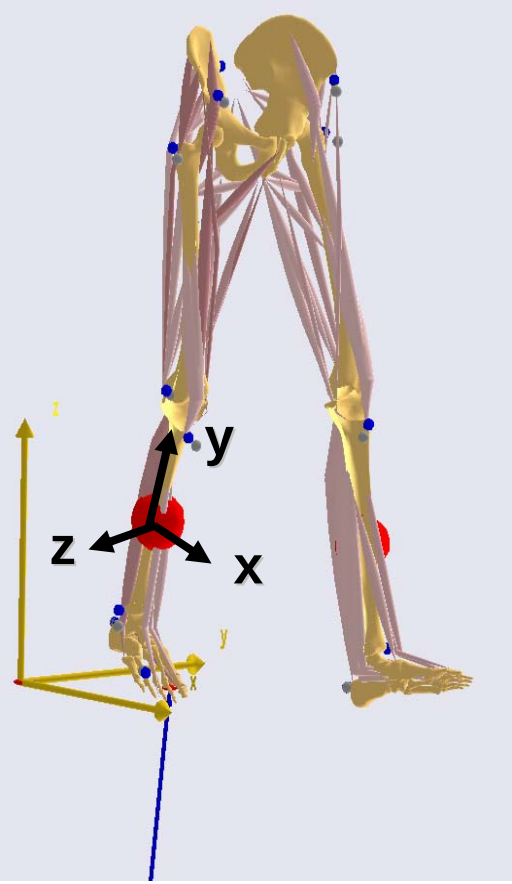
internal loads
(muskuloskeletal model)

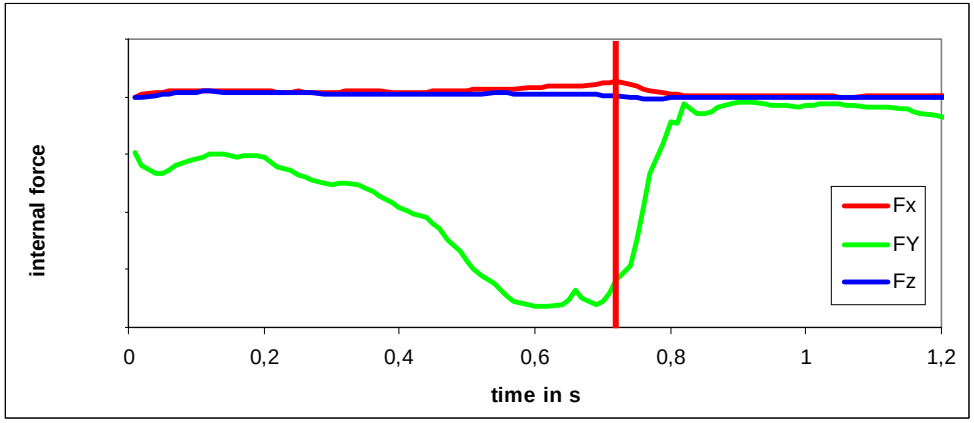
modification of musculoskeletal model „gait 3D“ from AnyBody repository 6

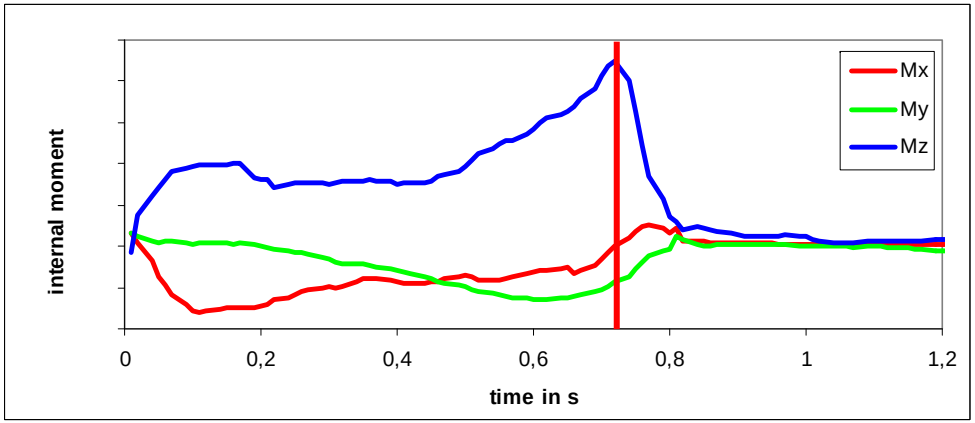


Internal load case with AnyBody

modification of musculoskeletal model „gait 3D“ from AnyBody repository 6

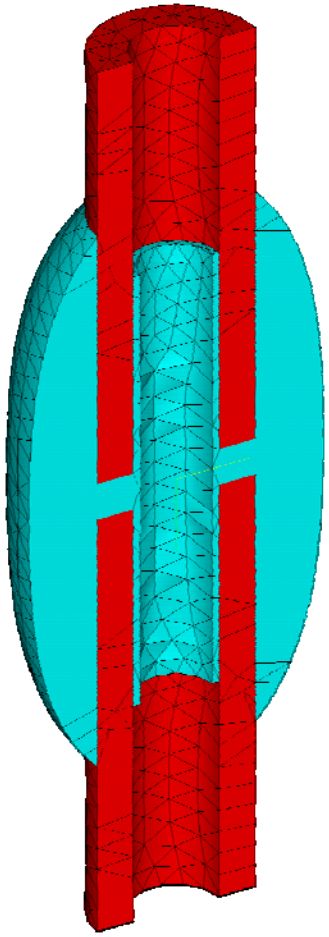




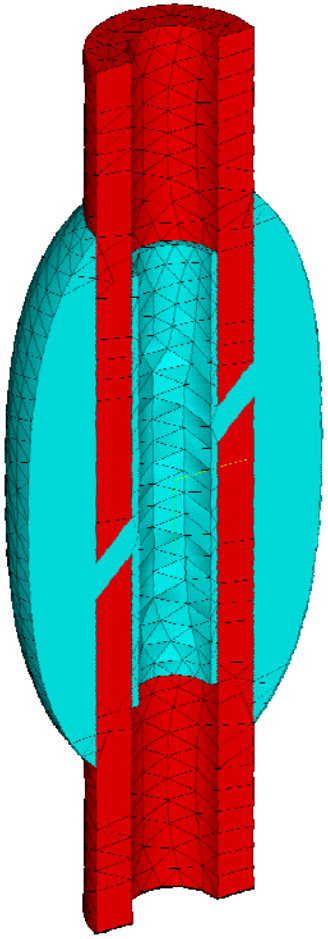


fract. geometry

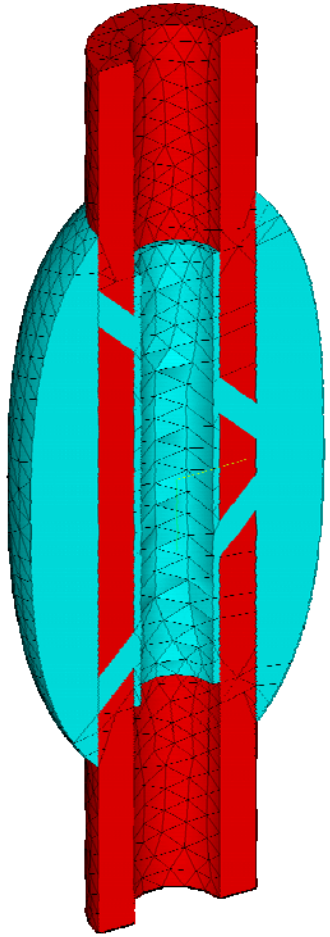
transverse fract.



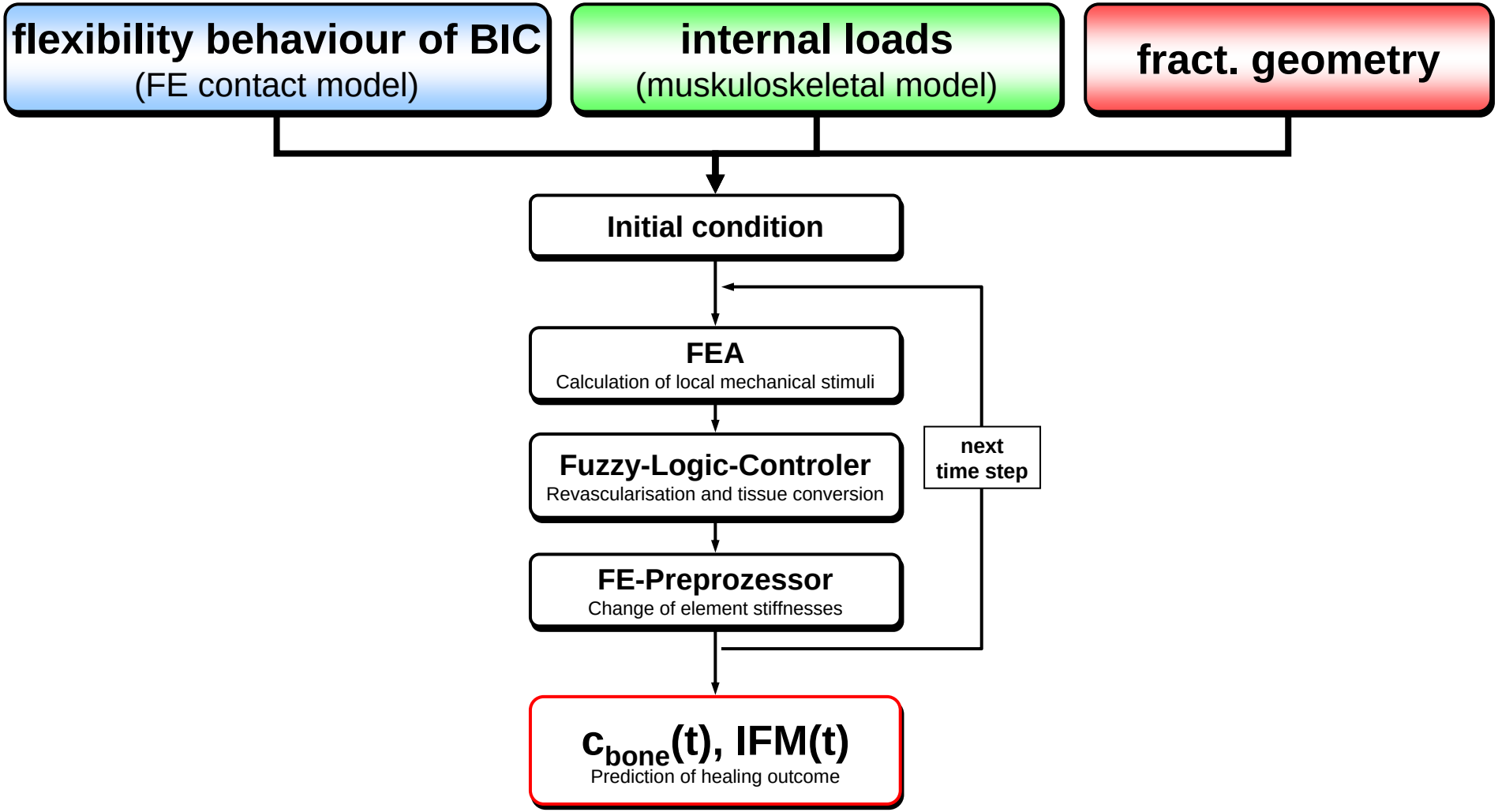
oblique fract.



bending wedge fract.

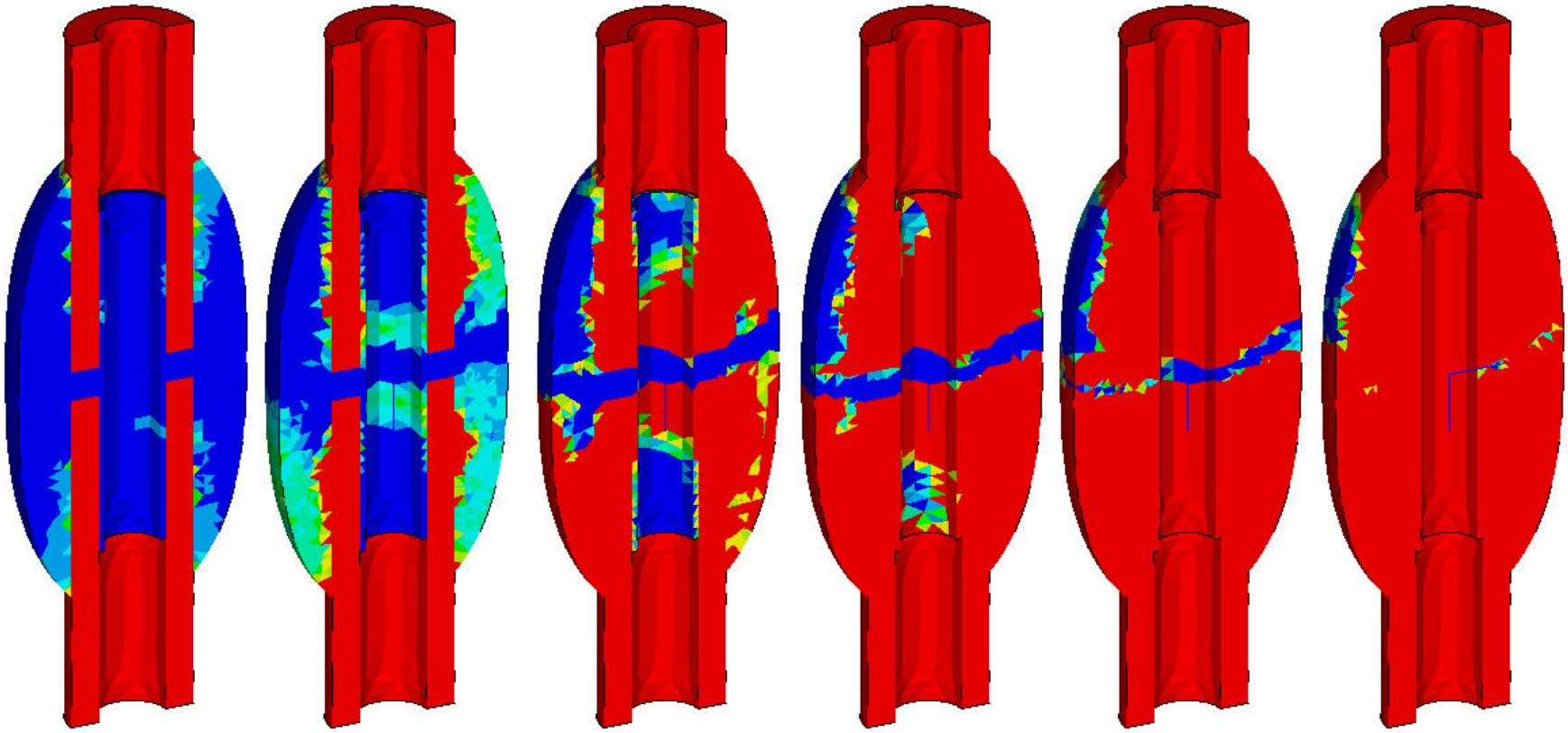


simulation of fracture healing process



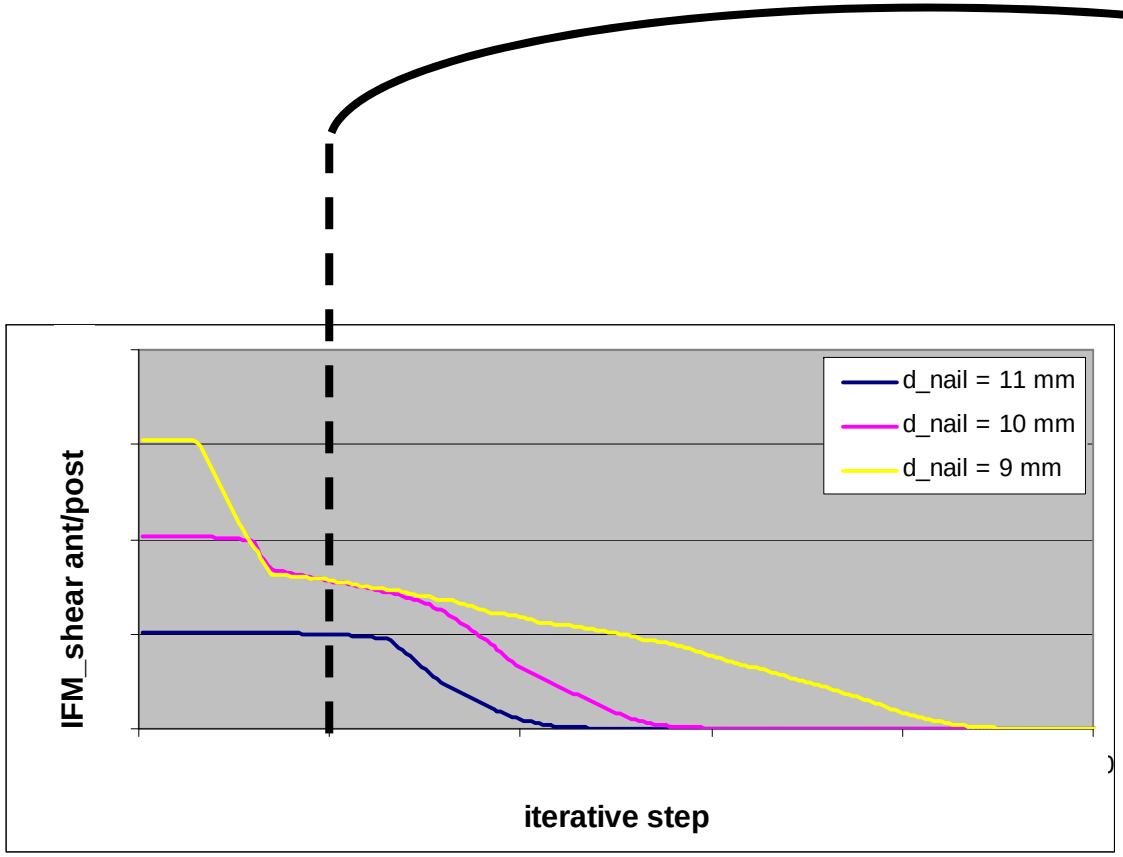
results of healing simulation

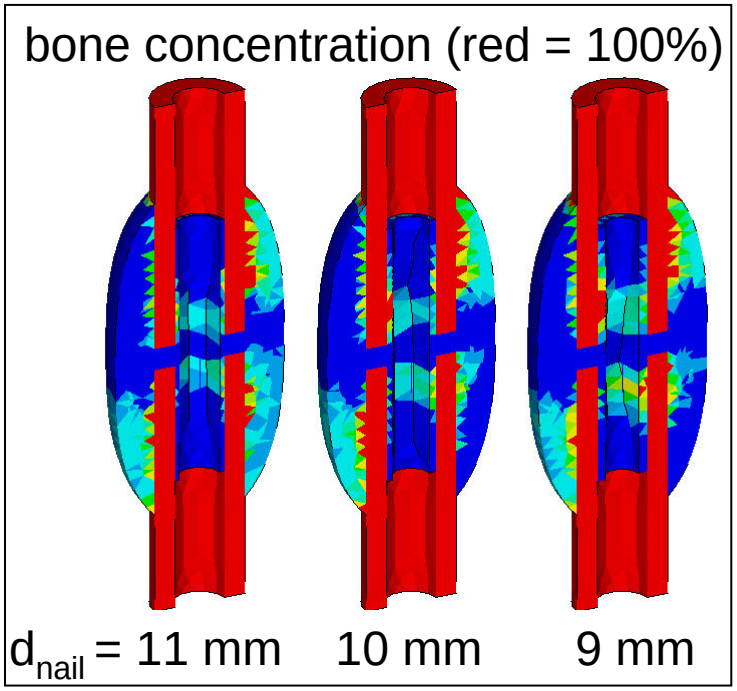
time course of bone concentration in the callus region



Influence of nail diameter (interface distance)

time course of IFM, transverse fracture





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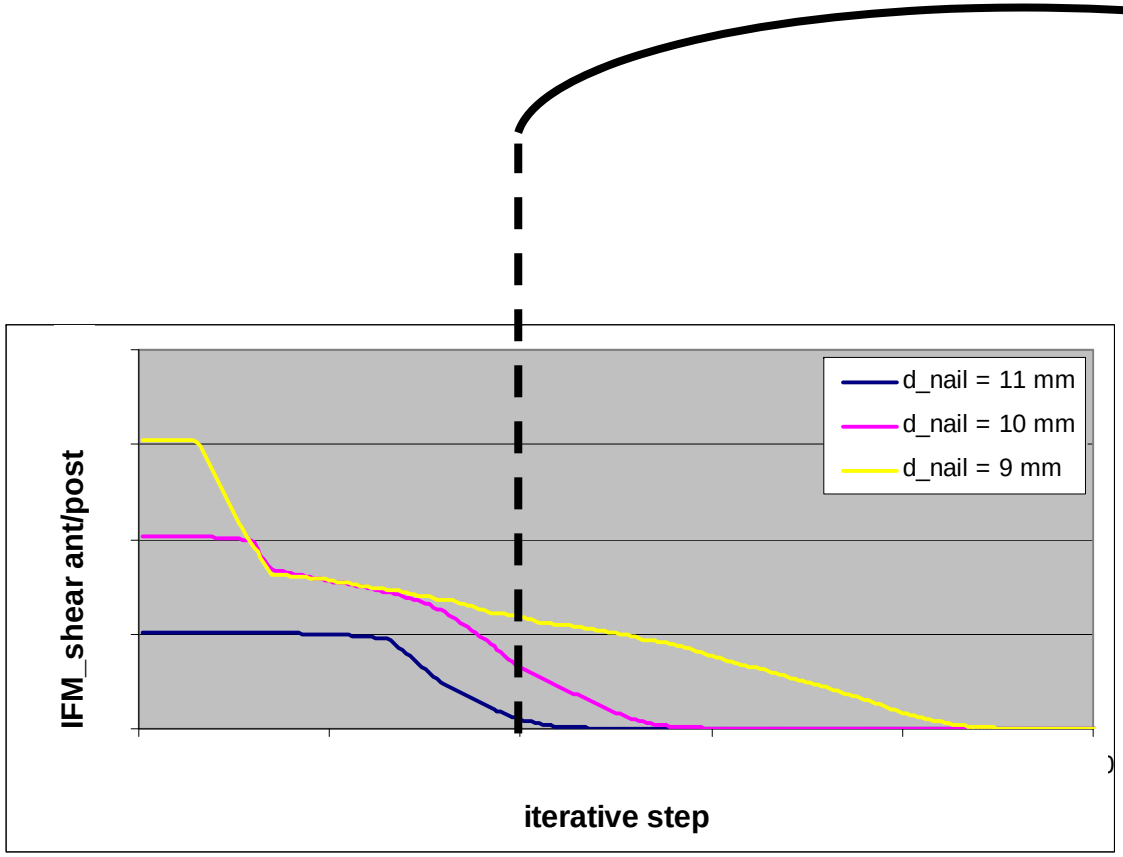

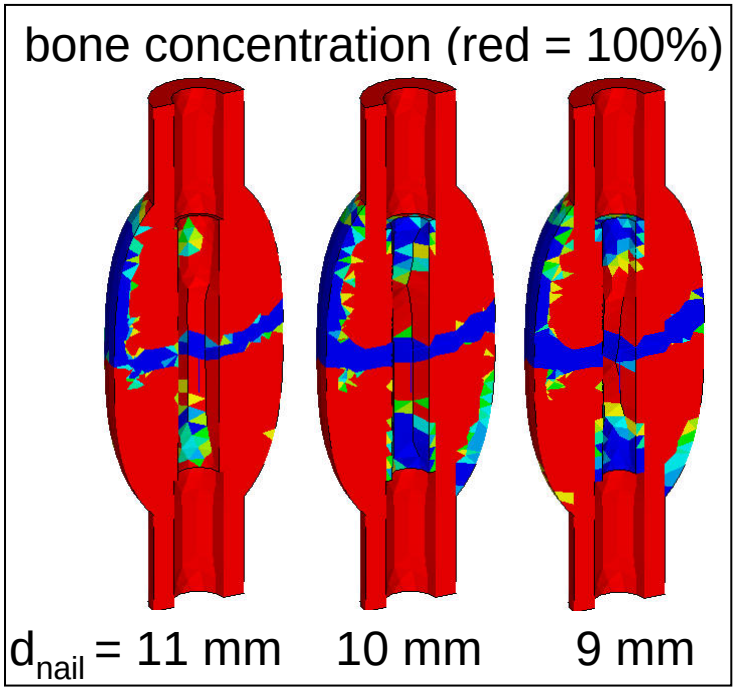

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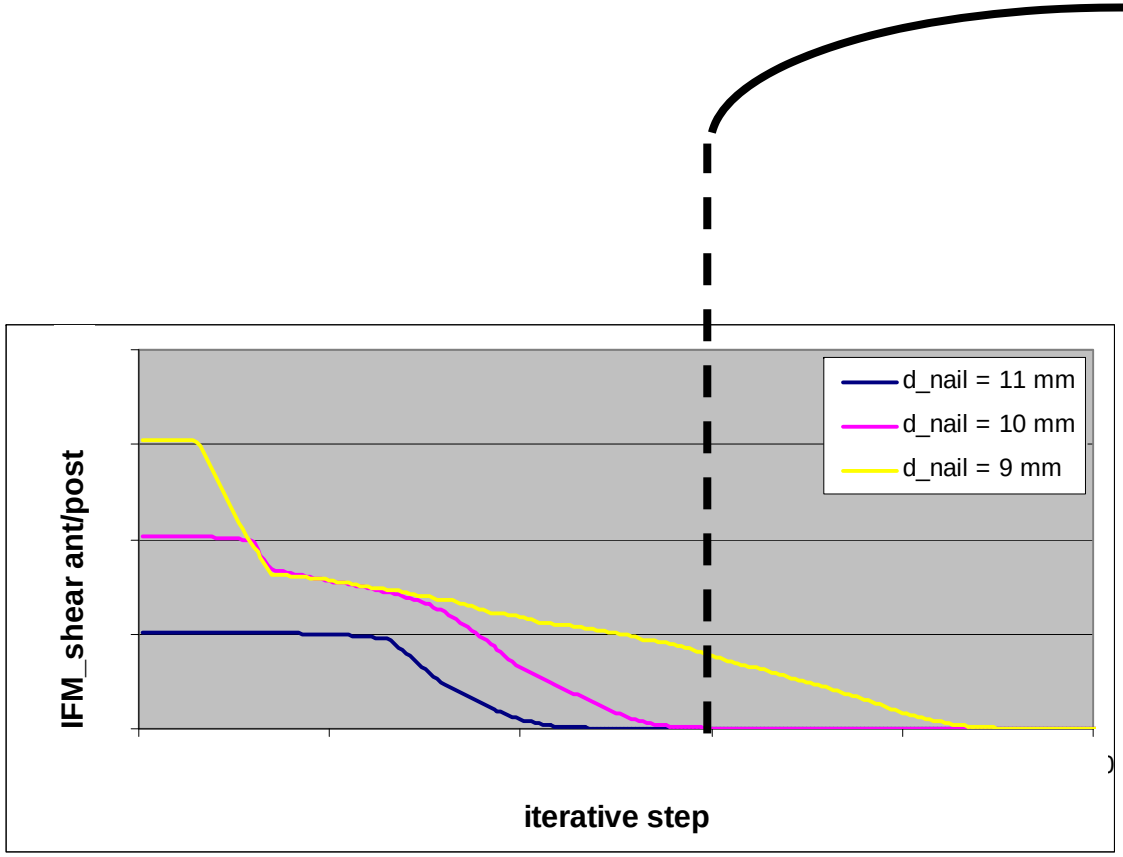
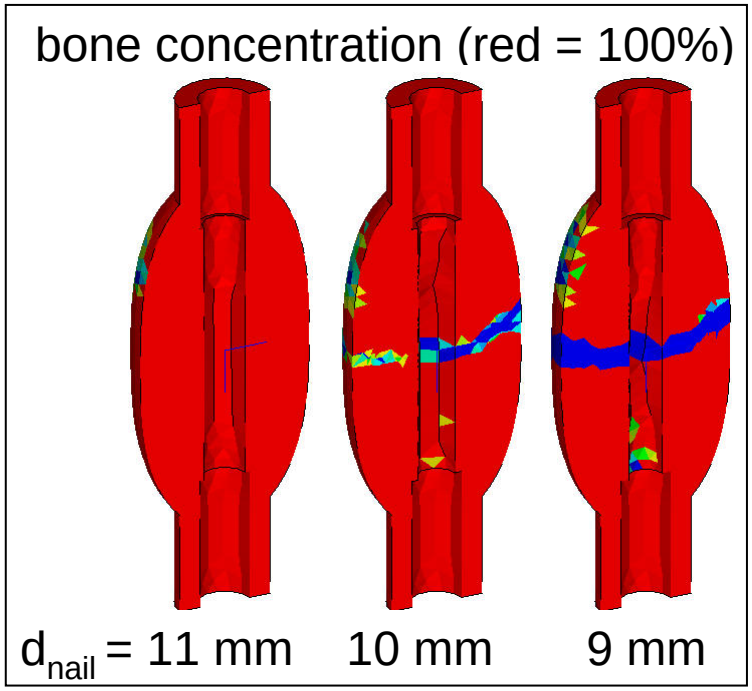
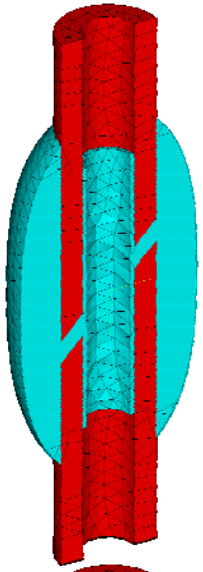
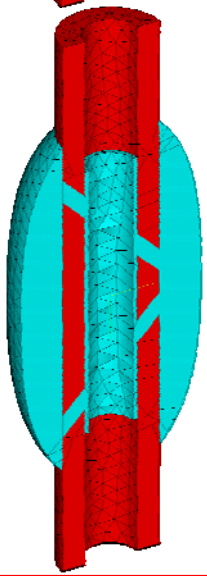
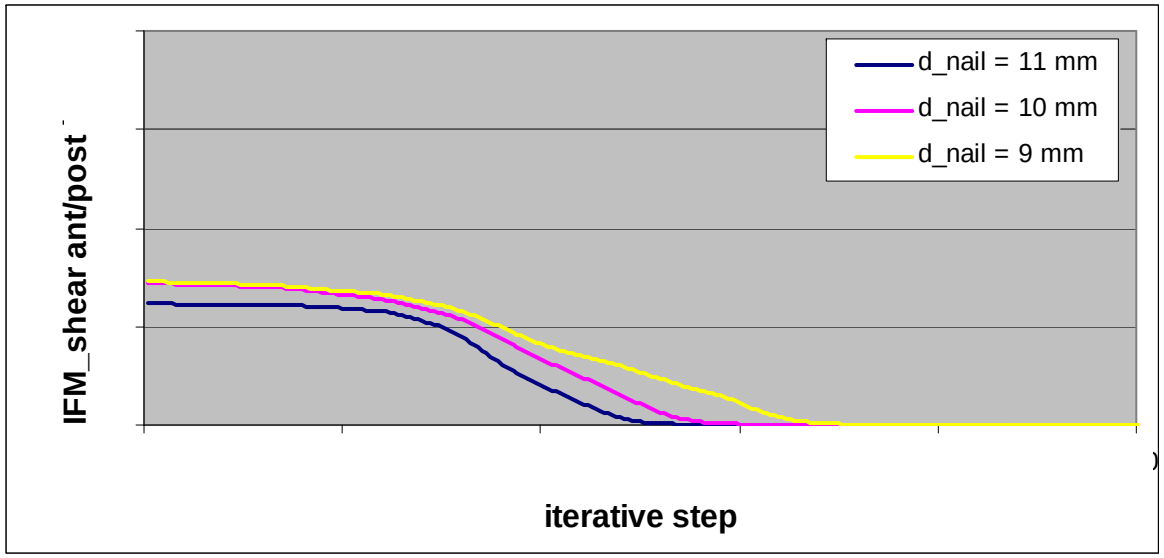


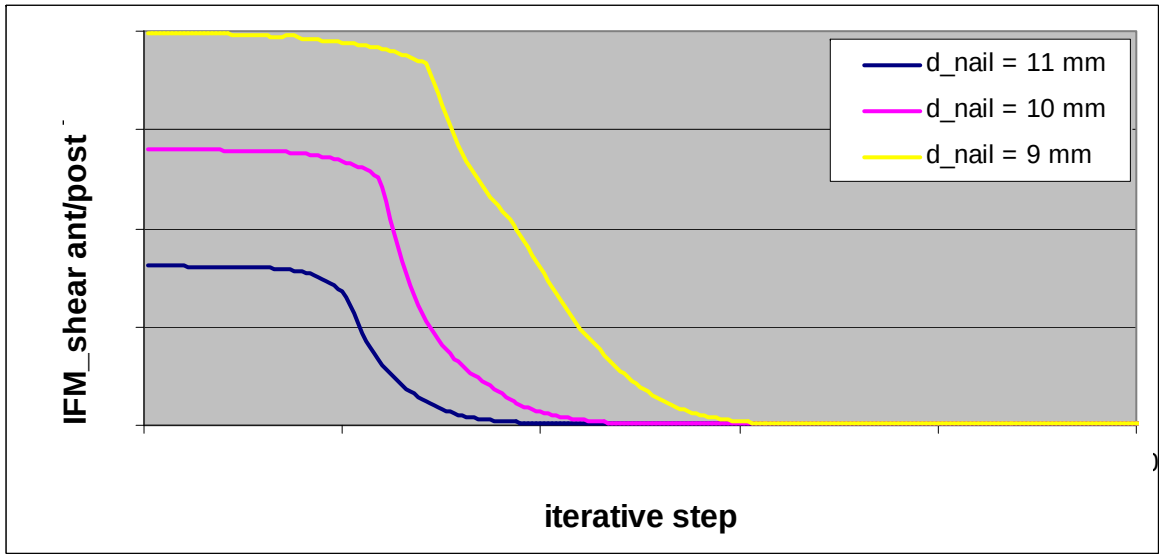


Influence of fracture type









limitations

- **Influence of cancellous bone and soft tissue on the BIC flexibility behaviour was neglected**
- **Internal loads for stimulus were taken out of normal gait of a healthy human**
- **Only idealized fracture geometries were investigated**
- **Beside valcularity, no biological factors were simulated**

discussion

- **Influence of the mechanical behaviour of the BIC with regard to healing time can be analyzed**

- **Thin intramedullary unreamed nails (large interface distance)**

  and

- **transverse osteotomies are critical for fracture healing process any might prolong the healing time**

- **method will be used for optimizing current osteosynthesis implants in terms of minimizing the healing time**

Acknowledgements:

- biomechanical research lab, BGU Murnau

- G. v. Oldenburg, Stryker Osteosynthesis