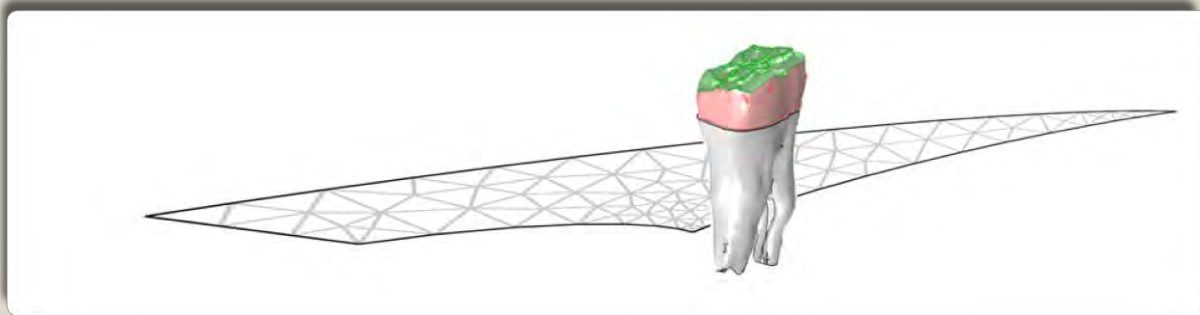


Finite Element Analysis of Equine Tooth Movement Under Masticatory Loading



M. Gardemin,¹ V. Cordes², M. Lüpke,¹ C. Staszuk²

¹ Institute for General Radiology and Medical Physics,

² Institute of Anatomy

Introduction

Connection Between Mechanical Load in the Equine Tooth and Common Appearance of Equine Tooth Diseases



Chewing forces cause mechanical load in the equine tooth and its surrounding tissues , the periodontal ligament (PDL)

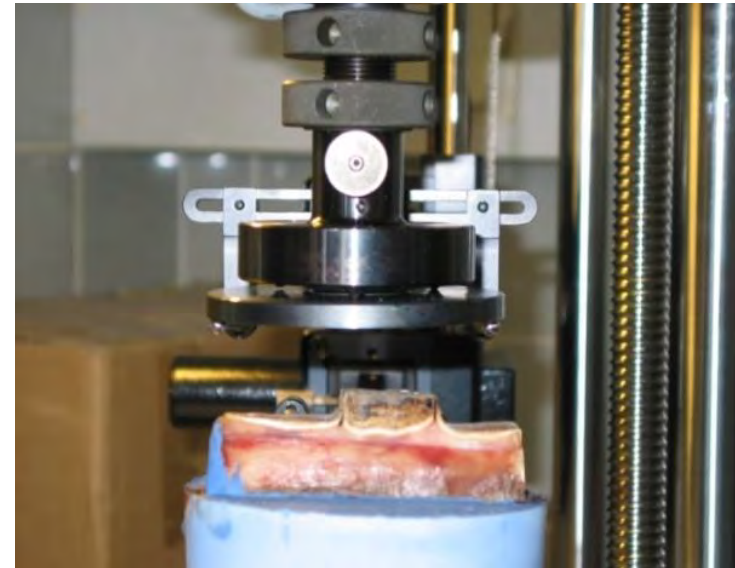
In a simulation it is possible to locate distinct areas of high stress and strain.

Interrelate these areas with those where distinct diseases often occur

Further investigations.
Development of restorative therapies

Simulations in Human Dentistry and Research in Equine Dentistry

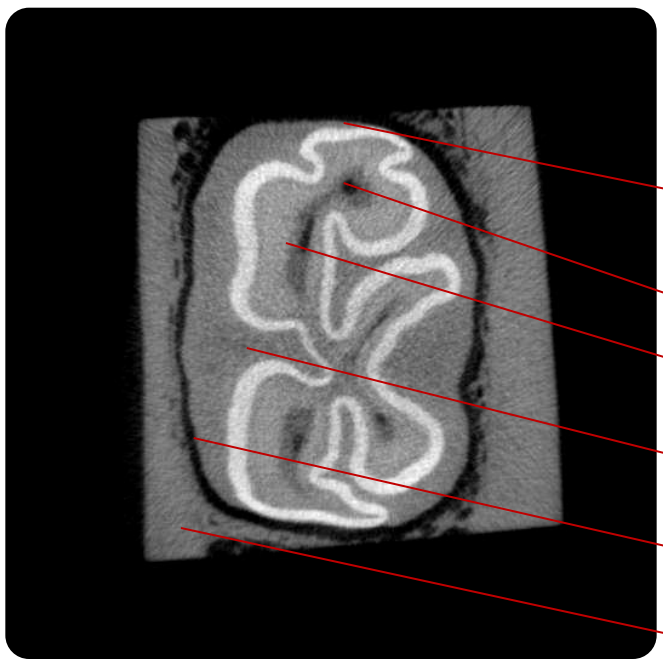
- FEM-Simulations are held mainly regarding the application of mechanical compatibility of implants. Biomechanical Data are cited in a wide range .
- In equine dentistry, some data regarding chewing forces and tooth movement are available (Staszyk et al. 2006, Cordes et al. 2011)



Cordes et al. 2011,
Experiment at Hannover
Medical School

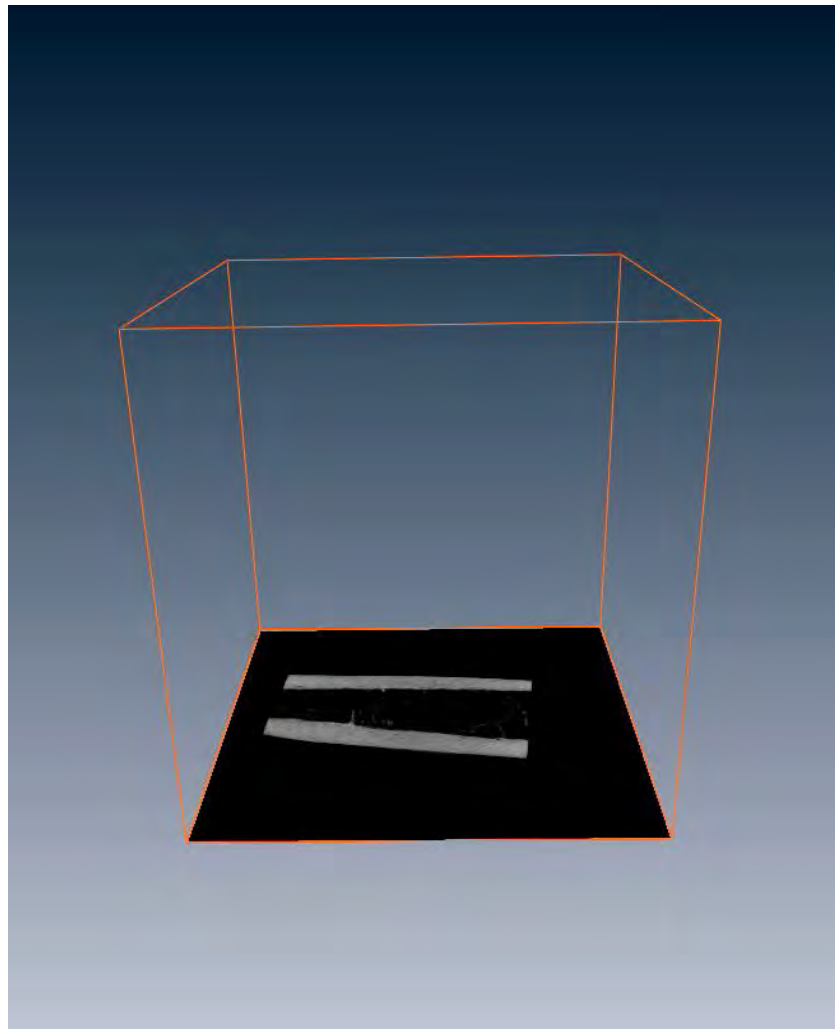
Methods

Micro-CT Data and Elasticity



Material	Youngs Modulus [MPa]	Poisson Ratio
Enamel	84,100	0.30
Pulp	2	0.45
Dentin	18,600	0.31
Cement	15,000	0.30
PDL	2.9	0.45
Compact B.	20,000	0.30

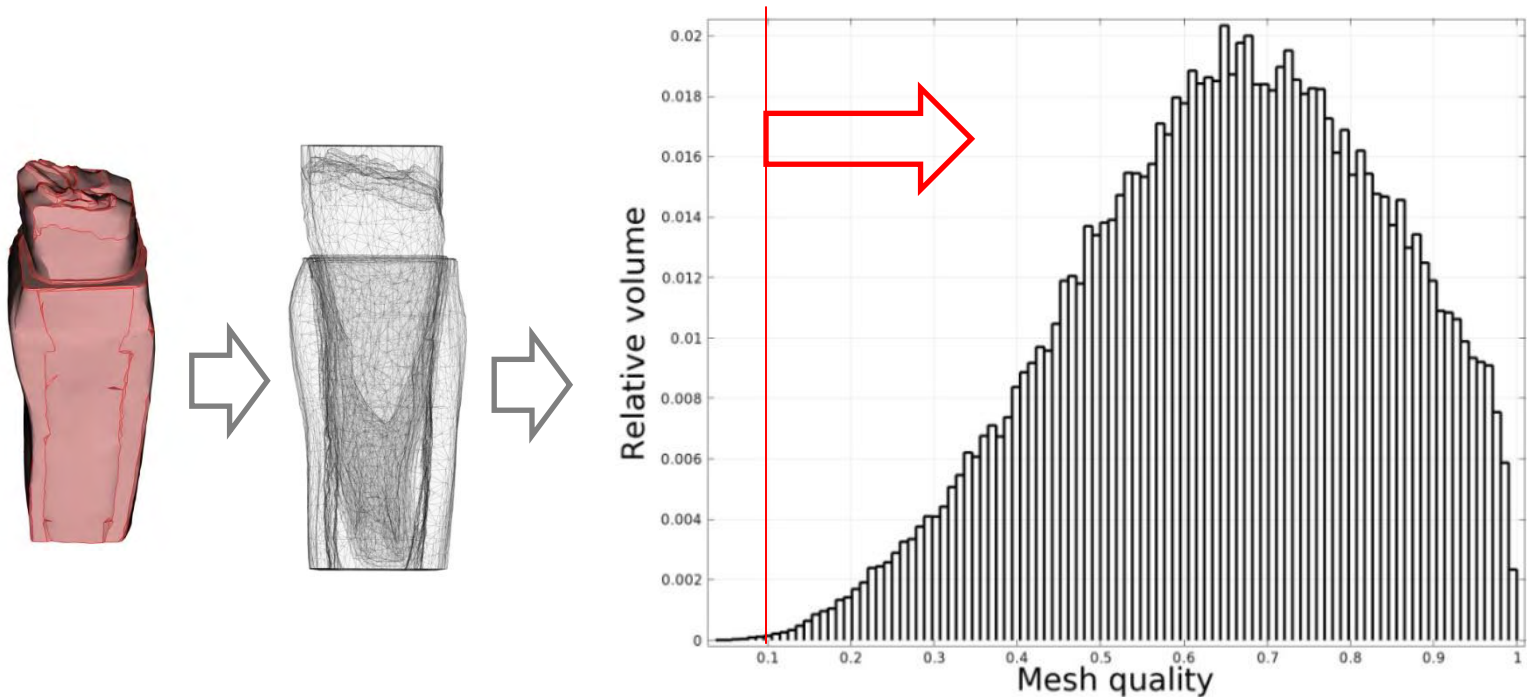
Methods



Simplification and a 3-D Surface Model

Material	Youngs Modulus [MPa]	Poisson Ratio
Tooth	20,000	0.30
PDL	2.9	0.45
Bone	20,000	0.30
Block	20,000	0.30

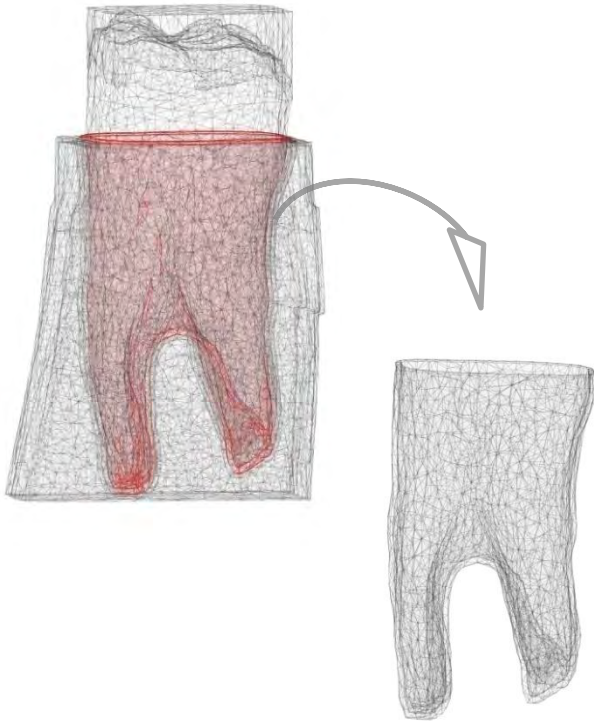
Meshing (Tetrahedral)



3-D Tetrahedral Mesh from the Tooth-System (102,000 Tetrahedra) and Histogram of Tetra-Quality

Methods

Number of Elements per Subdomain

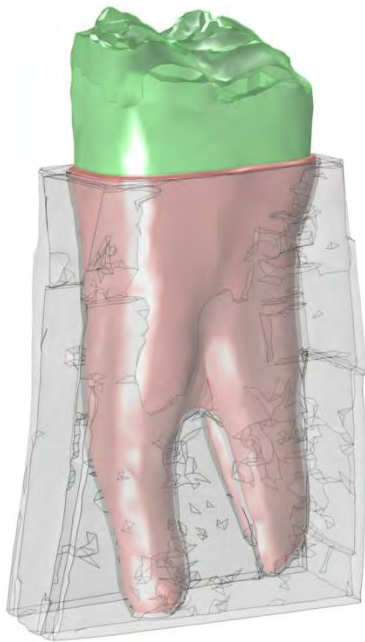


Subdomain	Number of Tetrahedra	Percent of All
Tooth	29,953	29.4 %
PDL	9,118	8.9 %
Jawbone	58,214	57.1 %
Block	4,616	4.7 %

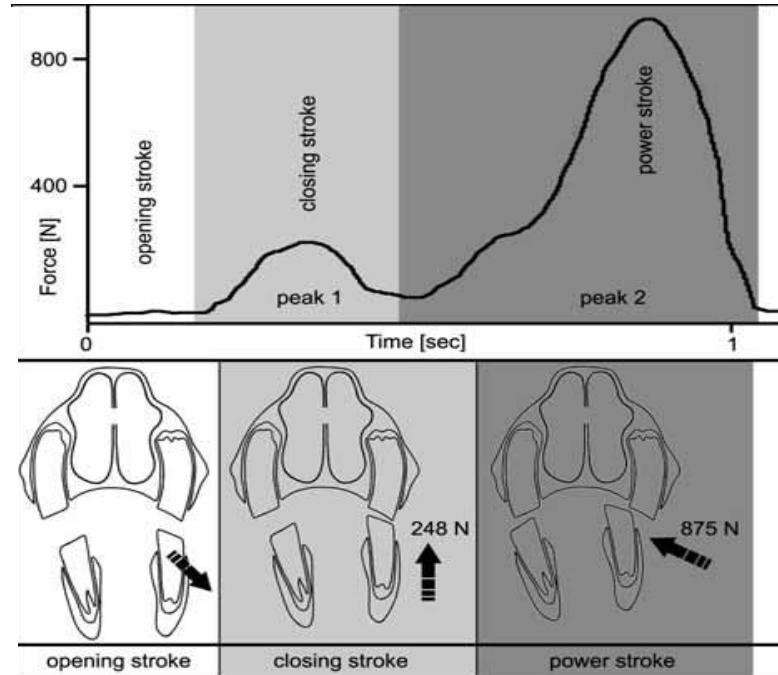
Methods

Boundary Conditions

1000 N



~1000 N

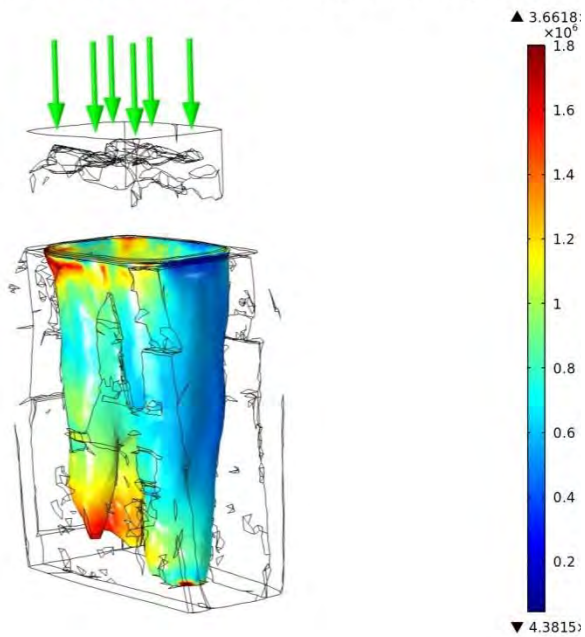


Staszuk C. et al. Measurement of masticatory force in the horses. Pferdeheilkd 2006; 22:12-16.

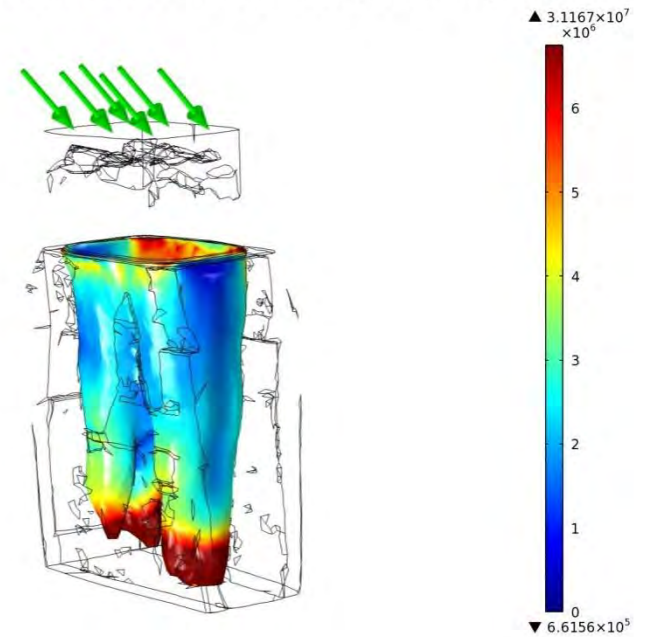
Results

Distribution of von Mises Stress

Volume: von Mises stress (Pa) Arrow: Load (Spatial)



Volume: von Mises stress (Pa) Arrow: Load (Spatial)



- Creation of new subdomains (areas of pressure)

Discussion

Reliability of the FE-Simulation

Von Mises Stress and Stress-Strain
Illustration



Comparison with results from
Literature (Cordes 2011)

Checking the Computational Results



Check mesh quality.
Proof of visible irregularities.
Change meshing methods.

Improvements



Non-linearity of the PDL.
Viscoelasticity.