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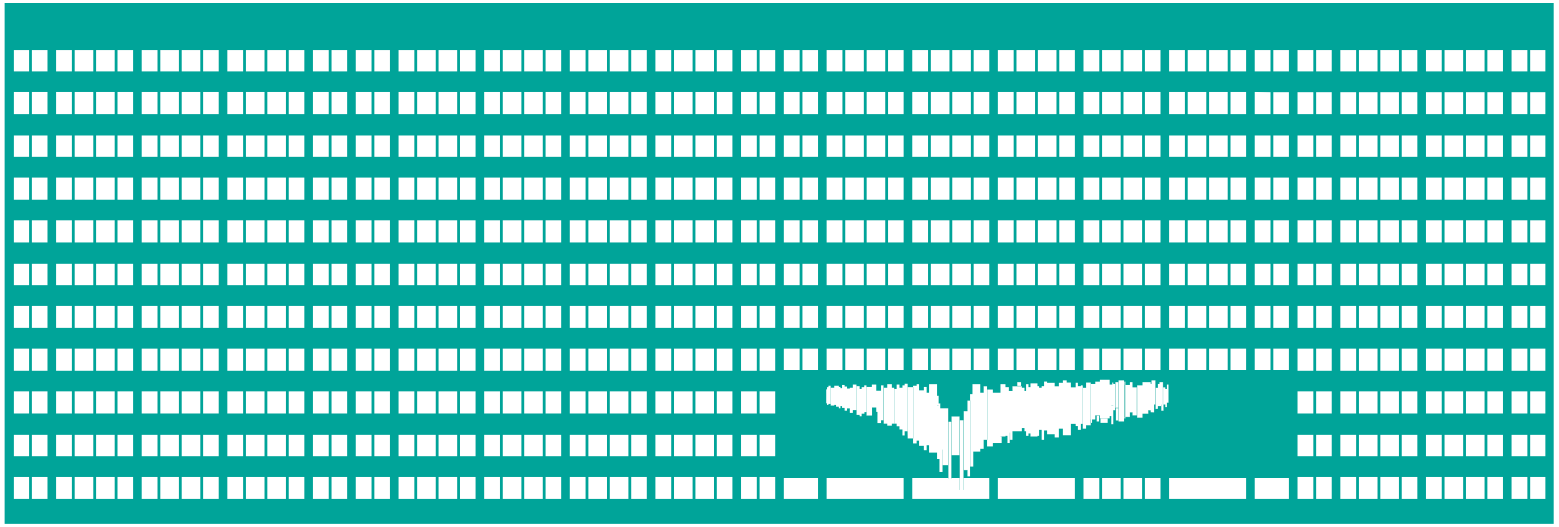

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VSB TECHNICAL UNIVERSITY OF OSTRAVA | FACULTY OF MECHANICAL ENGINEERING | DEPARTMENT OF APPLIED MECHANICS

FEM SIMULATION OF HEADLESS SCREW

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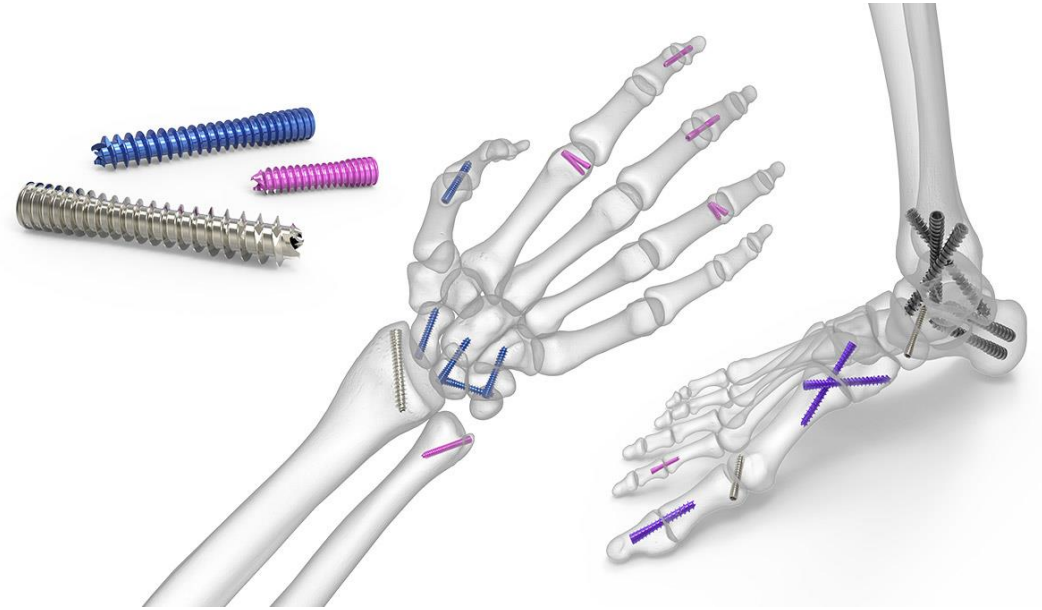
Introduction 1



Source internet

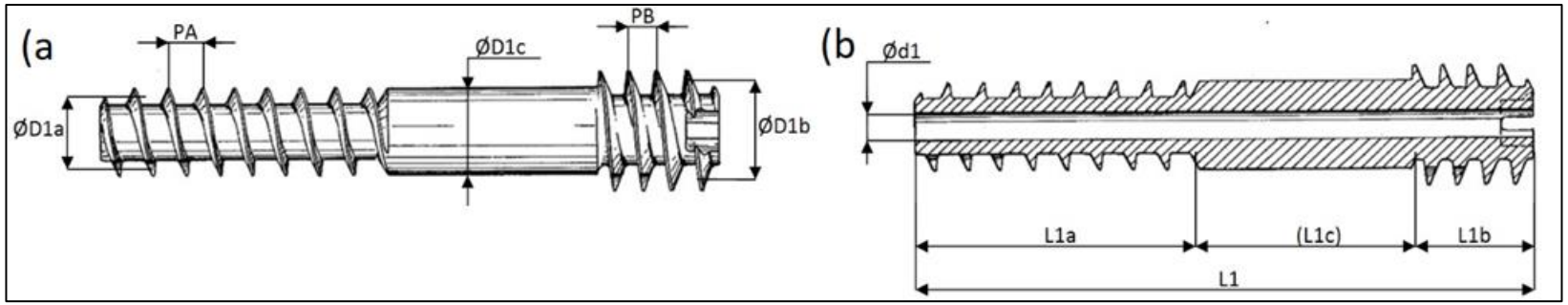
Introduction 2

There are many ways of osteosynthetical treatment of broken bones via internal fixation.

One of them is internal fixation by headless screw, which causes desired compression of bone fragments, especially treatment for 5th metatarsal fractures. FEA (i.e. stress, deformation) was done for prototype of headless screw Ti4.0/1.4x30/75 for 5th metatarsus.

Simulations were also based on experiment and are followed by other simulation methods too.

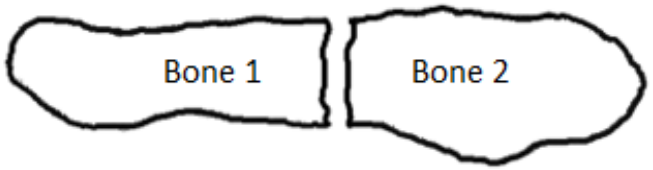
According to results of modelling, the headless screws can be applied in orthopaedics for treatment of fractures.

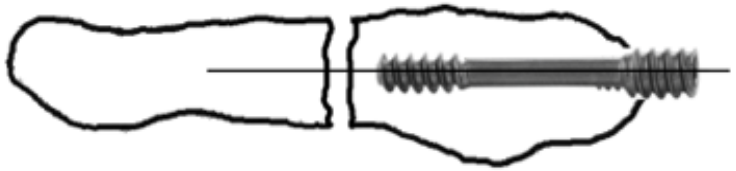


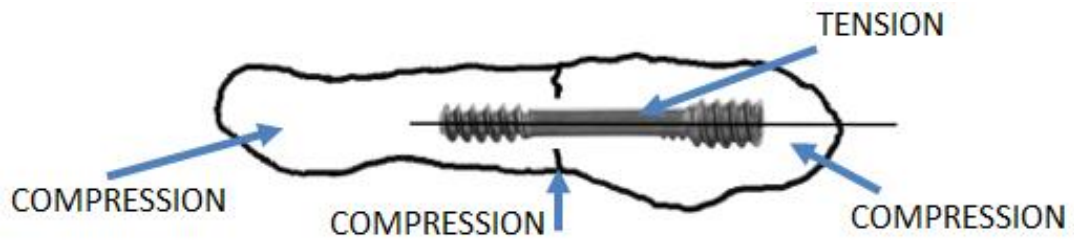
Method

Application (implantation) of headless screw

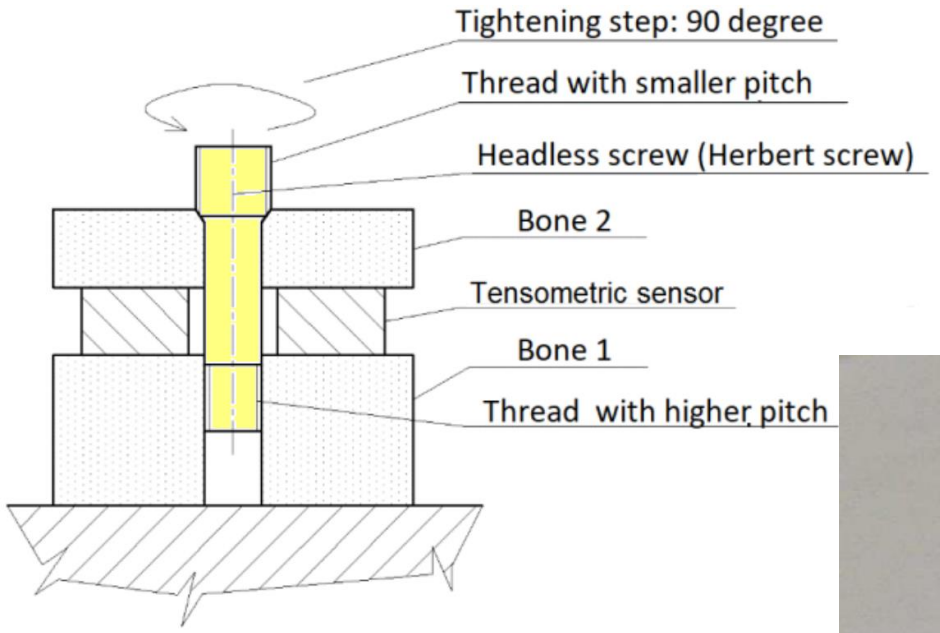
Firstly, Kirschner wire is drilled into bone. This wire helps to implement cannulated headless screw, which will cause the compression of both bone fragments.







Former Experimental, Analytical and Stochastic Approaches



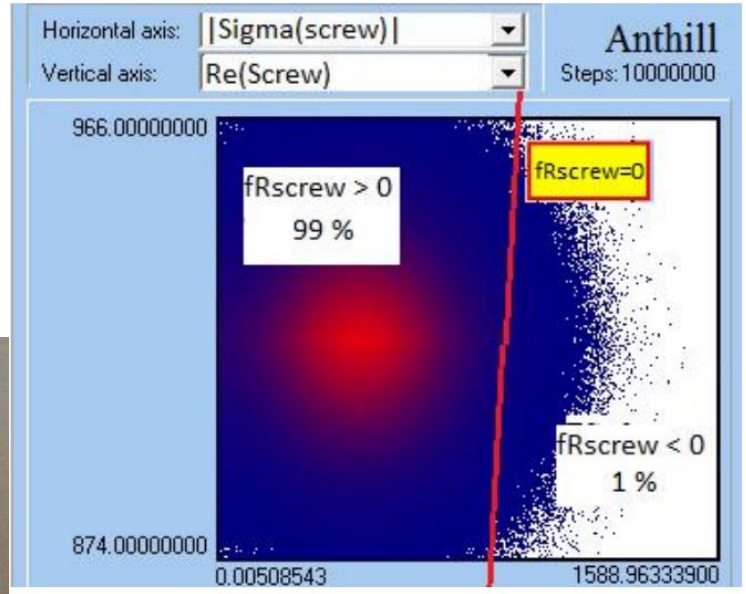
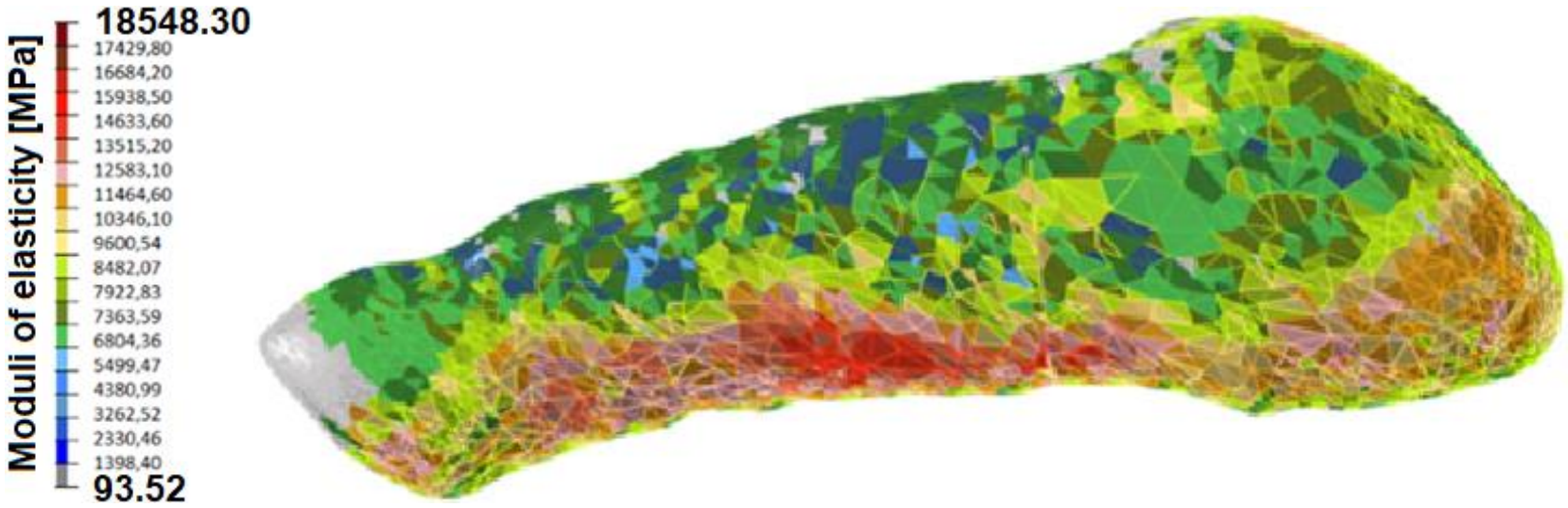


Figure 13. Function of screw reliability, Sigma(screw)max vs. Re(Screw), (2D graph of stochastic distribution) - Anthill software

FEA

Real material properties (100 different elastic material properties in volume of 5th metatarsus) were obtained from CT scans and used as input parametres for FE analysis. Mimics software was used for processing of CT scans.



FEA

Prototype of headless screw Ti 4.0/1.4x30/7 was used for this specific case of fracture of 5th metatarsus.

Isotropic and homogeneous material is considered for headless screw, which is made of Ti6Al4V.

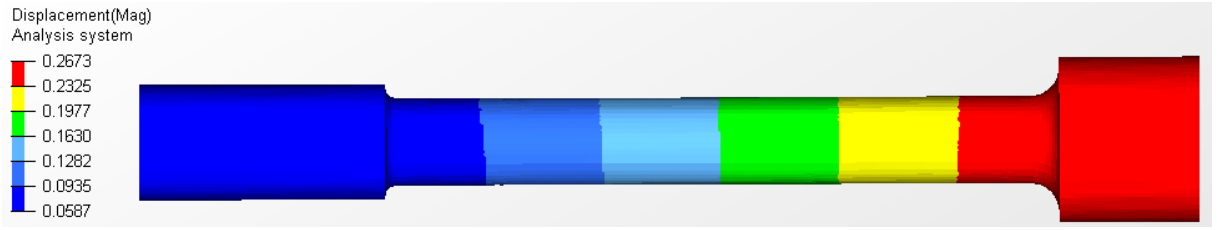
Dimensions of headless screw Ti: 4.0/1.1x30/7, producer MEDIN a.s.				
Length [mm]	L1	L1a	L1b	L1c
	30	7	4	19
Mean diameter [mm]	D1a	D1b	D1c	D1
	3.3	4.7	2.5	1.4
Thread pitch [mm]	PA		PB	
	1.1		0.9	

Modulus of Elasticity E [MPa]	Poisson's Ratio [1]	Yield Stress Re [MPa]
110000	0.31	920

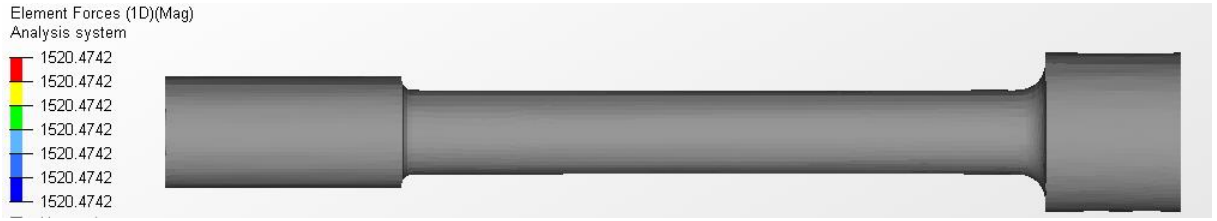
FEA - results

Optistruct solver was used for FEA.

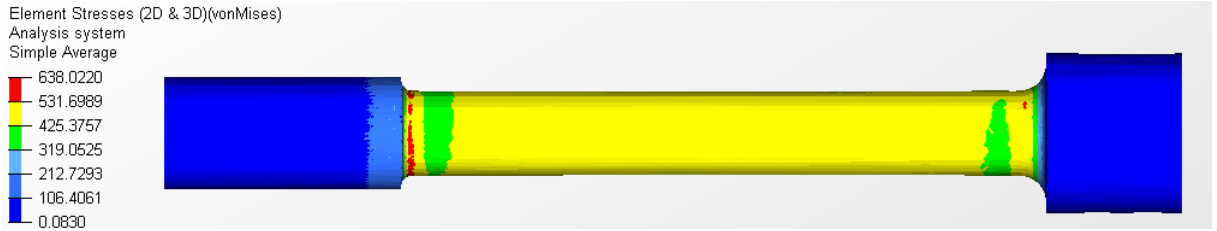
Displacement of bone fragments causes extension of headless screw 0.27 mm



Axial normal force in headless screw is caused by its extension. This normal force $NF = 1520.5$ N



The maximum values of equivalent von Mises stress in headless screw are located in screw shank



CONCLUSION

Stress-deformation states, in the prototype of headless (Herbert) screw implanted in a human broken 5th metatarsus, were made using FE analysis.

FE analyses were performed in cooperation of VSB - TU Ostrava, University of Ostrava, Medin, a.s. and University Hospital of Ostrava.

All simulations were done as a part of the Ph.D. study at the Department of Applied Mechanics at the VSB – Technical University of Ostrava.

The results of the simulations will be published in the doctoral thesis of the main author.

Acknowledgement

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