11th. World Congress on Computational Mechanics (WCCM XI)
5th. European Conference on Computational Mechanics (ECCM V)
6th. European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

# P-FEA OF PATHOLOGICAL HUMAN FEMURS

**Zohar Yosibash**[1]

[1] Dept. of Mechanical Engineering, Ben-Gurion University, Beer-Sheva, Israel, zohary@bgu.ac.il

**Key words:** *p-FEA, femur, metastatic tumors, fracture.*

Recent patient-specific QCT-based high-order finite element (p-FE) models have been shown to predict well the mechanical response of fresh frozen healthy femurs in-vitro, including the risk of fracture [4, 1, 3]. These p-FE models account for the exact geometry as well as the inhomogeneous material properties of femurs, are created in a semi-automated manner from QCT scans and validated on a large cohort of fresh frozen healthy femurs.

Since in clinical practice pathological femurs are of interest, we herein extend the use of QCT-based p-FEMs to femurs with metastatic tumors, femurs with a prosthesis following a total-hip-replacement procedure and femurs containing benign and giant-cell-tumors that underwent curettage and cement filling.

p-FE analyses on femurs affected by metastatic or benign tumors (based on QCT scans) will be presented and their results compared to a experiments performed on fourteen femurs containing metastases. We also address the generation of p-FE models of femurs with metallic implants from QCT images that are corrupted due to X-ray scatter from the metallic implants [2]. The FE predictions of strains, displacements and fracture loads are compared to experimental observations following a verification and validation procedure.

**Acknowledgements:** The author acknowledges the help of prof. C. Milgrom, Hadassah University Hospital, Jerusalem, Dr. N. Trabelsi, Mr. Ilan Gilad, A. Katz and Mrs. R. Mayo from BGU. The author gratefully acknowledges the generous support of the Technical University of Munich - Institute for Advanced Study, funded by the German Excellence Initiative. Part of the study was supported by grant no. 3-00000-7375 from the Chief Scientist Office of the Ministry of Health, Israel.

## REFERENCES

[1] N. Trabelsi, Z. Yosibash, C. Wutte, R. Augat, and S. Eberle. Patient-specific finite element analysis of the human femur - a double-blinded biomechanical validation.

*Jour. Biomech.*, 44:1666 – 1672, 2011.

[2] Z. Yosibash, A Katz, and C. Milgrom. Toward verified and validated FE simulations of a femur with a cemented hip prosthesis. *Med. Eng. Phys.*, 2013. In Press.

[3] Z. Yosibash, D. Tal, and N. Trabelsi. Predicting the yield of the proximal femur using high order finite element analysis with inhomogeneous orthotropic material properties. *Philosophycal Transaction of the Royal Society: A*, 368:2707–2723, 2010.

[4] Z. Yosibash, N. Trabelsi, and C. Milgrom. Reliable simulations of the human proximal femur by high-order finite element analysis validated by experimental observations. *Jour. Biomech.*, 40:3688–3699, 2007.