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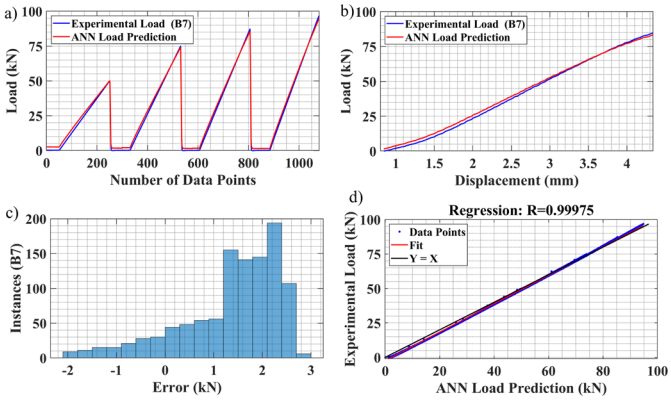
gold standard to be employed for prediction of load [1] in preference to relatively inaccurate, expensive and time-consuming tools such as FEA. In addition, examples of areas where such predictive capability is of great value are the design and post-operative analysis of orthopaedic implants [2].Nine hydrated third metacarpal bones (B1-B9) from thoroughbred horses were tested in ex vivo experiments. A set of strain gauges was attached to the lateral, dorsal, and palmar cortices of the bones. Compressive cyclic loads were applied to the bones using an MTS machine. Displacement of the machine ends, the values of six kinds strains, the applied load, and the rate of loading were recorded. The input sector had 10 variables, including time (t), side (left or right limb), age (y), and strains (ε). The output of the simulation was the cyclic load being applied to the bone samples.The ANN model was successfully trained using ex-vivo measurements from B1, B3, B4, and B5. Afterwards, the ANN model was employed to predict the responses of B7. Figure 1a presents the comparison of the ex-vivo experiments and the load prediction of the ANN. The trend of experimental results was consistent with the prediction of the ANN. A force-displacement curve recorded experimentally and that obtained via the ANN model are demonstrated in Figure 1b. A histogram of errors between the ex-vivo load and the prediction of the ANN is presented in Figure 1c. The outcome of regression analysis between experimental results and the prediction of the ANN model is illustrated in Figure 1d.Artificial neural networks (nonlinear mapping approach) were used to solve the forward problem for the estimation of applied load. The ability of ANN to predict load from measurements of displacement, rate of loading, age, side (left or right limb), and strains was discussed. ANN is an invaluable tool for quantifying responses of long bones under mechanical loading.[1] A. A. Zadpoor. (2013). J Mech Behav Biomed Mater. 27: 249-61.[2] S. Mouloodi et al. (2020). J Mech Behav Biomed Mater. 102: 103527.



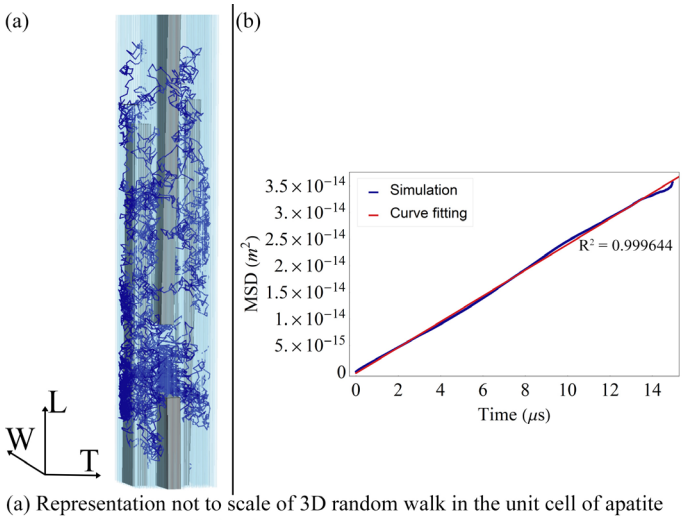
The ANN model was trained using data points from B1, B3, B4 and B5 and then employed to predict the loading of B7. a) Comparison of experimental forces with the prediction of the ANN model. b) Comparison of the second cycle of the force-displacement curve. c) Histogram of errors. d) The regression model.

***Disclosures: Saeed Mouloodi**, None*

P-315

Random Walk in 3D Model of Water Diffusion in the Human Mineralized Collagen Fibril *Fabiano Bini[1], Andrada Pica[1], Andrea Marinozzi[2], Franco Marinozzi[1]. [1]Department of Mechanical and Aerospace Engineering, "Sapienza" University of Rome, Italy, [2]Orthopedy and Traumatology Area, "Campus Bio-Medico" University, Italy

At the nanoscale bone tissue is characterized by the mineralized collagen fibril (MCF), a recurring structure mainly composed of apatite mineral, tropocollagen molecules (TC) and water. The latter has a crucial role in bone biomineralization. In this study, we aim to analyse the mass transport at the collagen-apatite level of porosity by means of a 3D random walk model.We considered a representative building block of the MCF according to [1-2]. We assumed a mineral volume fraction that represents an intermediate mineralized condition (32%vol). The geometrical dimensions of the nanocrystals and TC molecules are obtained with random extractions from Gaussian probability distribution functions within the range indicated in literature. We generated a model of the building block using the Metropolis algorithm in which platelets start in a regular configuration and then are subjected to random displacements and inclinations. The analysed arrangement of the building block is obtained after roughly 6·106 moves and rotations.The water diffusion within the building block is simulated by using a 3D random walk method. We computed the trajectory of the water molecule for 30k time steps Δt = 5·10-10 s and take the average over 300 water particles. We assume that mineral platelets and TC molecules are impermeable obstacles to water diffusion. Periodic boundary conditions are used to prevent error from the finite size of the building block.The diffusion coefficient is calculated from the mean square displacement of water molecules (MSD) according to the equation D=MSD/2nt, where D is the diffusion coefficient, n is the spatial dimension, i.e. n=3, t is the time, i.e. t = nT·Δt, with nT –number of time steps [3].The model provides a good prediction of the apparent diffusion coefficient, i.e. D = 3.25·10-10 m2/s in agreement with previous results achieved from experimental [4] and computational investigations [2]. The 3D random walk model is a valuable tool for investigating the influence of the structural hindrance on the diffusivity since the structure of the building block is included in the diffusion model.Insights into MCF structure and properties enhance the understanding of bone mineralization and may improve the design of smart structural nanomaterials.References:1. Jäger et al. (2000). Biophys. J. 79: 1737-17462. Bini et al. (2019). Sci. Rep. 9:26583. Stylianopoulos et al. (2010). Biophys. J. 99:3119-31284. Marinozzi et al. (2014). Biomatter 4:1 e28237



(a) Representation not to scale of 3D random walk in the unit cell of apatite (gray) and collagen (light blue)
(b) MSD plot from simulated trajectories. Diffusion coefficient obtained from linear regression of MSD data is D = $3.25 \cdot 10^{-10}$ $m^2 s^{-1}$

***Disclosures: Fabiano Bini**, None*

P-316

The Interactive Effects of Dynamization Time and Degree on Bone Healing *Ruisen Fu[1], Bettina Willie[2], Haisheng Yang[1]. [1]Department of Biomedical Engineering, Beijing University of Technology, China, [2]McGill University, Shriners Hospitals for Children, Canada

Introduction: Dynamization, reducing the fixation stiffness from a rigid to a more flexible condition, is widely used clinically to promote fracture healing. However, the most effective time to apply dynamization on healing outcomes remains controversial. Preclinical studies have demonstrated that dynamization with a degree of ~0.1 (the ratio of the flexible to rigid stiffness) at an early stage of healing (e.g. one week post-osteotomy) in rat femurs led to delayed healing (1-2). In contrast, a clinical study observed enhanced bone healing with early dynamization (3). It should be noted that the baseline fixation stiffness as well as the dynamization degree are different between those studies. Given the critical role of the fixation stiffness in determining the interfragmentary movement and thus regulating the healing process, it is important to understand how the degree and timing of dynamization interactively affects the healing process. Thus, the aim of the current study was to use finite element modeling to quantify the combined effect of degree and timing of dynamization on healing outcomes in an ovine model.Methods: Based on an ovine tibial fracture healing model which involves a fuzzy logic-based mechano-regulated tissue differentiation algorithm (4-5), we applied varied dynamization degrees (DC=0.1 to 1; 1 represents a rigid fixation) at 1, 2, 3, and 4 weeks (R1wF, R2wF, R3wF, R4wF) and computationally evaluated bone formation and biomechanical integrity during the healing process.Results: Our results demonstrated that early dynamization (at 1 and 2 weeks) significantly affected the healing process and outcomes (Fig. 1). However, the beneficial effect of early dynamization was dependent of the dynamization degree. Specifically, a higher dynamization degree (e.g. 0.1) led to a marked delay in bone formation and unrecovered stiffness whereas moderate dynamization degrees (e.g. 0.3 or 0.5) significantly enhanced bone formation and biomechanical properties of the fractured bone (Fig. 1).Conclusions: Our results suggest that dynamization degree and timing interactively affects the healing process and therefore clinical application of dynamization should consider their interaction carefully to achieve a beneficial healing outcome.References: [1]. Claes et al, JOR, 2009. [2]. Willie et al, CORR, 2011. [3]. Huang et al, Injury, 2012. [4]. Shefelbine et al, JB, 2005. [5]. Simon et al, CMBBE, 2011. Acknowledgement: NSFC (11702008), BJNSF (7202003).