6th CT-User Meeting

Joint venture:

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037 P13 Correlation of subchondral bone density and mechanical strength in the canine talus

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Introduction and objectives: The main function of loadbearing bones is the transduction of compressive forces during locomotion. These forces give rise to local strains and stresses at the level of the subchondral bone plate and induce bone modelling and remodelling. Based on Wolf's law, changes in density lead to an optimal bone structure for the task at hand, i.e. the higher the forces, the stronger the bone needs to be and the higher the density will become. This study was conducted to investigate the relation between subchondral bone density and subchondral bone strength, determined by indentation testing.

Materials and methods: Twenty pairs of canine tali were tested using a custom designed indentor. Test points were located on the medial and lateral trochlear ridge and the trochlea tali and were positioned using a predefined grid. The device measured the resistant force of the indentation needle at a constant speed of 1 mm/s. Using a ball joint and custom made frame, all test points were positioned perpendicular to the indentation needle. After testing, CT scans were made to provide the exact location of the test point and to ensure full penetration of the subchondral bone plate. Using a previously described technique to map the subchondral bone densities (computer tomographic osteoabsorptiometry, CTOAM), the density at each test point was measured. With a calibrated density phantom, these density measurements were expressed in mg hydroxyapatite / cm3. For each test point (on average 16 test points for each talus), the density was measured and the force necessary to penetrate the subchondral bone plate was registered and correlation coefficients were calculated.

Results and conclusion: In all cases a high correlation was found between subchondral bone density and mechanical strength. Average r2 was 0,91, with a range of 0,83 – 0,98. Visual representation of both density and strength testing results show very similar and repeatable patterns. This study shows that the use of non invasive techniques like CT, combined with CTOAM can not only be used to evaluate subchondral bone density, but that it can also be related to actual subchondral bone strength.