

Drilling Energy Correlates with Bone Density

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Purpose/Hypothesis: Determining intra-operative bone density has many potential benefits in orthopedic surgery. Bone density correlates with pullout strength and fixation strength of both screws and screw-plate constructs. No simple intra-operative bone density determination exists today. Our knowledge of material science led us to hypothesize that the Drilling Energy (DE) necessary to drill a hole and remove a volume of bone will correlate with the density of that bone.

Methods: Uniform solid foam blocks of 10, 20, 30 and 40 PCF (*Sawbones part numbers 1522-01, 03, 04, 05 respectively, Pacific Research Laboratories, Vashon, WA*) were used as surrogate bone models. A handheld surgical drill was outfitted with a method to measure drill bit torque and total drill bit energy. The holes were drilled with new 3.2 mm drill bits to a depth of 7, 12, 17 or 22 mm. An algorithm based upon DE, drill bit (type and size) and hole depth was applied to the data to produce the "Calculated PCF".

Results: Calculated PCF as a function of actual PCF is plotted below (see Figure 1). Linear regression yields a significant R-value of 0.983. Studies with various drill bit types and sizes gave similar results with significant $R > 0.95$. As expected, the correlation between calculated PCF and actual PCF when using an algorithm based upon maximum insertion torque (MIT) was not significant. The data were analyzed using StatPlus:mac software.

Conclusions: Less than 10% of patients treated for fractures have preoperative DEXA scans and DEXA scans only test regional bone densities. This leaves surgeons with little objective information concerning the density of the bone where they actually have to work. In this study, we demonstrate that DE combined with hole-depth and drill bit information can accurately predict surrogate bone block densities. Intra-operative knowledge of the actual bone density at the site being operated on will assist surgeons in the difficult decisions they make concerning bone quality and construct type. Lower bone densities indicated by lower DE's may allow surgeons to have objective intra-operative data on when to place expensive locking screw-plate constructs. Future studies with cadaveric bone and human clinical studies will have important implications for treating patients, especially those with osteoporosis or other bone affecting diseases. Real-time intra-operative bone densities could be collected to generate a global bone density database.

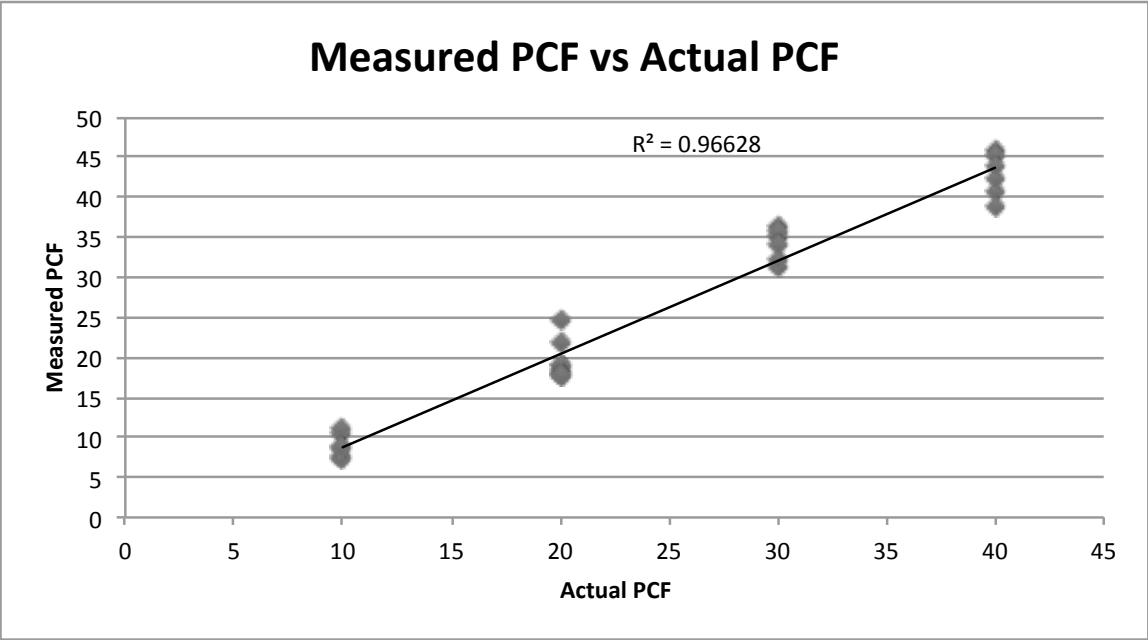


Figure 1.