Introduction:
Bone quality, apart from bone mineral density, is increasingly being recognized for its importance in the assessment of fracture risk. Collagen cross-linking is a relevant factor for determining the tensile strength of bone. Non-enzymatic collagen cross-linking with the accumulation of advanced glycation end products (AGEs) stiffens and embrittles collagen fibers thus increasing bone fragility and fracture risk. Echogenicity is an ultrasound (US) parameter providing information regarding the skin collagen structure and can be determined by assigning amplitudes of echoes for each pixel on a scale and segmenting the image by pixel range. Enhancement of lower dermis echogenicity is observed with increasing age. We hypothesized that both skin and bone collagen are aging in the same fashion and that skin ultrasound measurements would therefore be associated with in-vivo bone quality.
Methods:
Prospectively collected data of 110 patients undergoing open posterior lumbar fusion at a single academic institution was analyzed. Preoperative standardized skin ultrasound measurements were performed in the lumbar region for the assessment of dermal thickness and echogenicity. Intraoperative bone biopsies from the posterior superior iliac spine were obtained and analyzed with confocal fluorescence microscopy for fluorescent advanced glycation end products (fAGEs, trabecular and cortical), representing non-enzymatic collagen cross-linking. Pearson's correlation coefficients were calculated to examine relationships between 1) US measurements and fAGEs, and 2) age and fAGEs stratified by sex. Multivariable linear regression analysis with adjustments for age, sex, BMI, diabetes and HbA1c was used to investigate associations between US measurements and fAGEs.
Results:
110 patients (51.9% female; mean age 61.6years; BMI 29.8kg/m2)were included in the final analysis, excluding patients with anti-osteoporotic drug therapy and non-caucasian ethnicity In the univariate analysis, trabecular fAGEs increased with subcutaneous echogenicity ($r = 0.31$; $p = 0.039$); cortical and trabecular AGEs decreased with age, but only in women (cortical: $r = -0.32$, $p = 0.031$; trabecular: $r = -0.32$; $p = 0.031$). After adjusting for age, sex, BMI, diabetes and HbA1c, significant associations were found between cortical fAGEs and lower dermal echogenicity ($\beta = 1.01$; $p = 0.012$), cortical fAGEs and subcutaneous echogenicity ($\beta = 1.01$; $p = 0.021$), and trabecular fAGEs and lower dermal echogenicity ($\beta = 1.01$; $p = 0.021$).
Conclusion:
This is the first study to assess in-vivo bone quality and skin US measurements regarding non-enzymatic collagen cross-linking in lumbar spine fusion patients. Dermal US measurements were found to be significantly associated with collagen properties in bone such as fAGEs. As a non-invasive assessment tool, skin US measurements might be incorporated into future practice to investigate connective tissue ageing and bone quality in spine surgery patients.