degeneration under excessive mechanical loads and potential AF repair or regen-
eration using adequate mechanical stimulation.
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308 MATRIX ELASTICITY-DEPENDENT DIFFERENTIATION OF ANNULUS FIBROUS-DERIVED STEM CELLS
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Background: Annulus fibrosus (AF) injuries commonly lead to substantial interver-
tebral disc (IVD) degeneration, the major cause of lower back pain which affects
about 80% of the population. Recently, tissue engineering has evolved into a prom-
sising approach for AF regeneration. While a lot of attempts have been made during
the last decade, constructing engineered AFs remains challenging due to the
tremendous complexity of AF tissue at cellular, biochemical, microstructural,
and biomechanical levels. It is known that the elasticity of matrix effectively di-
 rects the lineage specification of stem cells.

Methods: We synthesized a series of biodegradable polyether carbonate ure-
thaneurea (PECU) materials whose elasticity approximated that of native AF tis-
 sue. Fibrous PECUU scaffolds were fabricated by electrospinning technique and used
for culturing AF-derived stem cells (AFSCs). The growth, gene expression, biochemical,
biochemical and biomechanical characteristics of AFSCs were studied. In partic-
ular, we explored the potential of AFSCs to achieve diversified differentiation of
cells by varying the elasticity of substrate.

Results: By adjusting the molecular weight of polycarbonates, ratios of hard segment
to soft segment, a series of polyurethanes were obtained with different elastic modulus (PECU1, 13.4MPa; PECU2, 6.4MPa; PECU3, 5.1MPa; PECU4, 2.5MPa), which is close to the elastic modulus of AF tissue. When AFSCs were cultured on elec-
trospun fibrous PECUU scaffolds, the gene expression of collagen-I in them increased
with the elasticity of scaffold material, whereas the expression of collagen-II and aggrecan genes showed an opposite trend. At protein level, the content of collagen-I gradually increased with substrate elasticity, while collagen-II and GAG
contents decreased. In addition, the cell traction forces (CTFs) of AFSCs gradually
decreased with scaffold elasticity. Such substrate elasticity-dependent changes of
AFSCs were similar to the gradual transition in the gene, biochemical, and biome-
chanical characteristics of cells from inner to outer regions of native AF tissue.

Discussion and Conclusion: Together, findings from this study have, for the first
time, implied that depending on the substrate elasticity, AFSCs may differentiate
into various types of AF-like cells. Therefore, this study provides solid basis for the
use of AFSCs in the treatment of IVD degeneration.
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336 HOW PATIENT-OPTIMISED DEVICE CONFIGURATION CAN PROVIDE FRACTURE SITE STIMULATION AND REDUCE AGE-RELATED SCREW LOOSENING RISK IN LOCKED PLATING
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Objective: When using locked plating for bone fracture fixation, screw loosening
is reported as one of the most frequent complications and is commonly attributed to
an incorrect choice of screw configuration. Choosing a patient-optimised screw
configuration is not straightforward as there are many interdependent variables
that affect device performance. The aim of the study was to develop a framework
for device selection and configuration based on three key variables of interest: (1)
interfragmentary motion (IFM); (2) strain concentrations around screws; and (3)
stress levels within the plate.

Methods: Finite element models of a tibia with a comminuted diaphyseal fracture
were developed incorporating cortical bone heterogeneity, orthotropy and geomet-
rical nonlinearity. Strain concentrations around screws (SCS) were used as indicators
of regions that may undergo loosening. Plate stress, SCS and IFM were measured
for a total of 10 different screw configurations and two different bone qualities (20
unique models). Axial and torsional load cases were considered.

Results: The study found that the material of the plate and the size of the bridging
spans influenced all three variables of interest. Screw spacing was found to be
particularly influential in poorer bone quality. Leaving two empty holes between
screws near the fracture reduced SCS by 49% in osteoporotic bone compared to
particularly influential in poorer bone quality. Leaving two empty holes between
screws near the fracture reduced SCS by 49% in osteoporotic bone compared to

Conclusion: Due to the large number of device variables and patient factors, the
current guidelines regarding locking screw placement are somewhat unclear. This
study provides valuable information regarding the configuration of locked plate
devices for specific individuals. The results are presented in a decision making
tree representing the first step towards comprehensive guidelines.
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348 STIFFNESS IN LIVING CARTILAGE INCREASES AFTER SELF-MATING ARTICULATION — A NONINVASIVE STUDY
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Introduction: While studies have demonstrated that osteoarthritis is linked to the
softening of articular cartilage, the effect of tribological stress on cartilage me-
chanical properties is not well-understood. Noninvasive indentation has made mechanical
characterizations of biological tissues at micro- and nano-scales possible. Howev-
er, using noninvasive indentation on cartilage is challenging due to its heterogeneous,
biphasic, and soft material properties. In this study, we developed a method to char-
acterize articular cartilage explants using the Ti-950 Tribodinder by Hys-
itosyn. Once we established a repeatable noninvasive method, we compared
mechanical properties of live cartilage explants before and after undergoing self-
maturing articulation in a joint motion simulator.

Methods: Cartilage explants were obtained from the patella-femoral groove of 24-
week-old bovine and placed in DMEM/F12 media at 37 °C. For method develop-
ment, phosphate buffered saline was added to keep freeze-thawed explants hy-
drated during indentation with a 20μm indenter in order to optimize parameters
including fluid levels and software settings. To test for reproducibility, we per-
formed duplicates of five indents in five regions on the explant. A joint simulator
that applies complex motion patterns on explants was utilized. Load (40N) and
shear were applied to live explants for 3 hours (540 cycles) using a modified hip-ball onto which a live cartilage strip is sutured, creating a cartilage-on-carti-
lage (CoC) interface with the explant. We performed a 3X3 array of 84 mm deep
indents in the articulated and non-articulated regions of the explant before and after
articulation (n = 18 indents). In one explant, noninvasive indentation was performed
one hour and three hours post-articulation to observe potential changes in me-
chanical properties over time.

Results: In method development, we found that factors including fluid level and
indent setpoint influence the Young’s Modulus (E). For reproducibility, we used a
paired t-test analysis and found no significant differences between duplicates
(E = 367±72Pa, p = 0.809). For our pre- and post-CoC articulation stiffness compari-
sions, a one-way ANOVA analysis blocked by animal demonstrated that following artic-
ulation, E significantly increases in the articulated region (p < 0.001) but not in the
surrounding unworn region (p = 0.26). In the non-articulated region, Epre-test =
124±86Pa and Epost-test = 137±86Pa, whereas in the articulated region, Epre-test =
105±36Pa and Epost-test = 461±30Pa. Additionally, 3hr-post-articulation indentation
results indicated that in the articulated region, E = 127±5Pa, demonstrating that with
time, articular cartilage stiffness may return to its pre-articulation conditions.

Discussion and Conclusion: We found that the stiffness of live cartilage increases
significantly following simulated articulation and that the variability increases in post-
test measurements. This stiffness increase may be attributed to fluid flow
out of the explant during articulation and a compaction of the cartilage tissue,
leading to a higher modulus. Over time, the explant stiffness decreases to pre-
test modulus levels, indicating that stiffness increase is a transient response to
articulation. Limitations include: (1) post-test indent time after articulation and its
influence on mechanical properties; and (2) animal properties; and (2) animal properties.

Introduction: Current methods of diagnosing bone diseases like avascular necrosis
(AVN) are subjective and no reliable assessment of the fracture risk is available.
AVN leads to an interruption of the blood supply, which results in the death of
bone tissue and its collapse if left untreated. A fracture prediction tool is needed
to help clinicians find the most suitable treatment. One route to finding the
strength of bones, including the femur, can be the utilisation of biomech-
anical mechanics, where bone is a structural member subjected to load. Ozono et al.
(1991) reported that collapse of the femoral head most often occurs when the
lesion location is in the weight bearing area. Therefore lesions lateral to the femur

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356 ASSESSMENT OF THE FRACTURE RISK OF PROXIMAL PORCINE FEARUS WITH SIMULATED LESIONS USING A FRACTURE PREDICTION METHOD BASED ON BEAM THEORY
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