INTRODUCTION: Tissue engineered osteochondral (OC) grafts consisting of a chondrocyte-seeded hydrogel region and an underlying porous, bone-like base provide potential substitutes for allografts and autografts [1]. Previous in vitro studies in our laboratory have shown that osteochondral constructs grow better on clinically-relevant metal substrates (e.g., tantalum) rather than devitalized bone [2]. Dynamic loading (DL) has been shown to yield engineered cartilage with better functional properties, allowing for greater transport of larger molecules, such as 70 kDa dextran which is in a size similar to that of the growth factor TGF-β3, into constructs [3-5]. Modeling has suggested that DL will also benefit the engineering of OC constructs [6]. This study investigates the influence of DL on transport properties in OC constructs with highly porous titanium bases and evaluates cartilage tissue development on such bases.

METHODS: Study 1: Cylindrical titanium disks (ø10 x 4 mm, 900 or 1200 μm pores) which were 3D printed followed by sintering followed by cleaning and passivation (Stryker Orthopaedics, Mahwah, NJ) were lyophilized then weighed. Acellular OC constructs were cast using 2% w/v agarose and 30 million cells/mL in the ~2.3 mm thick chondral-only constructs with increasing pore size. These observations begin to validate it experimentally. Study 1 shows that FS constructs in part to enhanced solute transport with loading-induced convection [7]. While this effect has been predicted for OC constructs [6], this study begins to validate it experimentally. Study 1 shows that FS constructs with porous bases result in a trend of increased solute transport. Additionally, DL yields significantly more transport into OC than into chondral-only constructs with increasing pore size. These observations are expected as there is more unrestricted chondral region surface area through which molecules can transport (Fig. 1). Study 2 confirms the ability of chondrocytes to grow on the porous titanium bases used for the cell cultures. This study promotes the use of DL as a method for increasing transport in engineered cartilage OC constructs, which may facilitate fabrication of large anatomically-shaped constructs suitable for replacing entire articular surfaces [8]. Future studies will assess the growth of cell-seeded osteochondral constructs under DL cultivation conditions.

SIGNIFICANCE: Dynamic loading has been predicted to benefit the tissue engineering of osteochondral grafts. This abstract explores its effect on transport in constructs with highly porous titanium bases, while confirming the base’s biocompatibility.

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