Title: **Design of a Portable and Low-Cost Device to Quantify Anterior Cruciate Ligament Rupture Force in Mice**

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Abstract (3500 characters or 500 words Limit)

Anterior cruciate ligament (ACL) injury is a common sports injury that can lead to post-traumatic osteoarthritis (PTOA) with a reported incidence rate of over 50%. Non-invasive Mouse ACL injury models provide clinically relevant ways to study the OA pathogenesis and treatment. Most non-surgical OA models induce ACL rupture with mechanical loads on the knee tibia or femoral head, and the ACL-rupture forces are recorded during the load application. While some research groups use electromagnetic materials testing machines (EMT) to induce ACL injury and measure the applied force, others developed portable devices. Inspired by the portable devices, the objective of this study is to design a low-cost portable device to non-invasively induce ACL injury in a mouse model to study PTOA. A device was designed, consisting of (a) two 3D printed parts, (b) aluminum beam with a strain gauge, and (c) circuit with a digital voltage output linearly proportional to the applied load. The strain gauge instrumented device exhibited a linear relationship for the applied forces ranging from 0 to 22 N. To induce ACL injury, anesthetized 8-9 weeks old female/male C57BL/6 mice (n=209 knee joints) were subject to an axial force which was applied along the long axis of the femur on mice with the knee joint in maximum flexion. Reaction force caused femoral compression via the knee, resulting in ACL rupture. All mice passed a positive Lachman test, and the increased joint laxity of injured mice were confirmed by the X-ray-based Drawer test. The recorded load-time graphs showed the average rate of 1 N/s and the mean peak load (ACL rupture force) of 14.3 ± 2.9 N for female mice and 15.0 ± 3.1 N for male mice. Forces required to rupture ACL in female mice were slightly lower than in male mice, but not statistically significant. Previous literatures reported the mean rupture load of 6.78 N for femoral compression [Rodeo, 2020], and 10.19 N, 11 N, and 19 N for tibial compression studies [Haudenschild, 2012, Christiansen, 2018]. These studies have demonstrated the weight-dependent and loading rate-dependent ACL-rupture force. In summary, our measurement of the mean ACL rupture force is comparable with previous studies, and we have not observed sexual differences at 8-weeks of C57BL/6 mice. Future research will investigate the loading-dependent, age-dependent and other joint disease-dependent ACL-rupture force.