**Supplementary Data**

The modulus of elasticity (E-modulus) was calculated as follows:

(1)

*L* (the fulcrum span) = 18 mm, *F* was a deflection, and *I* was a moment of inertia of fracture surface caused by the three-point bending mechanical test.

The energy to failure was calculated as follows:

(2)

Work-of-fracture for the three-point bending test was calculated as the area under the load-displacement curve divided by the specimen's cross-sectional area, and reported in units of J/m2. *F* was a deflection.

(3)

*aout* (long half axes of the outer ring of collected femur) = 2.25 mm, *bout*(short half axes of the outer ring of collected femur) = 1.75 mm, the long and short half axes of the inner ring were *ain* (long half axes of the inner ring of the collected femur) = 1.5 mm, *bin* (short half axes of the inner ring of collected femur) = 1 mm, *A* was the cross-sectional area of the fracture, and *F* was a deflection.

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**Fig. S1 Surgical procedures of right femoral DO in the rat.**