

Supplementary Materials

High-density Horizontal Stacking of Chondrocytes via the Synergy of Biocompatible Magnetic Gelatin Nanocarriers and Internal Magnetic Navigation for Enhancing Cartilage Repair

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Supplementary data

Table S1. Primers used in this study.

Marker gene	Sequences (5'-3')		Accession No.
<i>Gapdh</i>	Forward	AGGTCATCCACGACCACTTC	NM_001082253
	Reverse	GTGAGTTTCCCGTTCAGCTC	
<i>Col II</i>	Forward	CAACAACCAGATCGAGAGCA	NM_001195671
	Reverse	GCTCCACCAGTTCTTCTTGG	
<i>Agg</i>	Forward	GACTCTTTCACATGCTTATGCCTTCC	XM_002723376
	Reverse	GTGACGATGCTGCTCAGGTGTG	
<i>SOX9</i>	Forward	TTCATGAAGATGACCGACGA	AY_598935
	Reverse	GTCCAGTCGTAGCCCTTGAG	
<i>TIMP3</i>	Forward	CACCGTCAAGCAGATGAAGA	NM_001195682
	Reverse	CACAGCCCCGTGTATACCTT	
<i>Col I</i>	Forward	TAAGAGCTCCAAGGCCAAGA	NM_001082253
	Reverse	TGTTCTGAGAGGCGTGATTG	
<i>MMP13</i>	Forward	TCCCTGGGTCTGTTTCACTC	NM_001082037
	Reverse	TCTCCCCTCAGAGTGCTGAT	

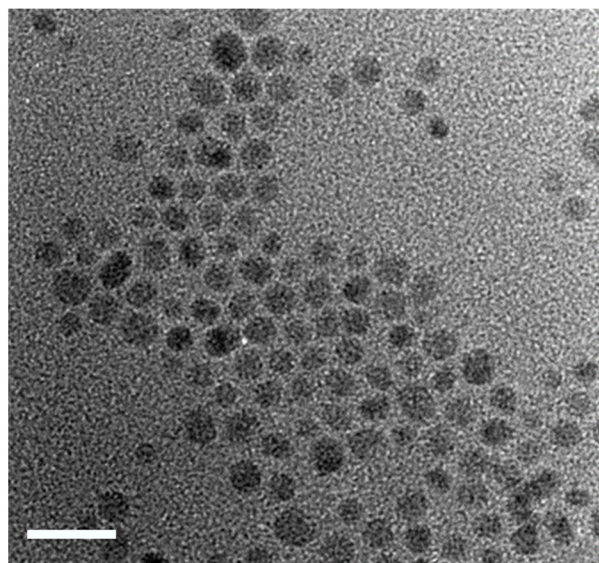


Figure S1. TEM image of SPIONs; scale bar = 20 nm.

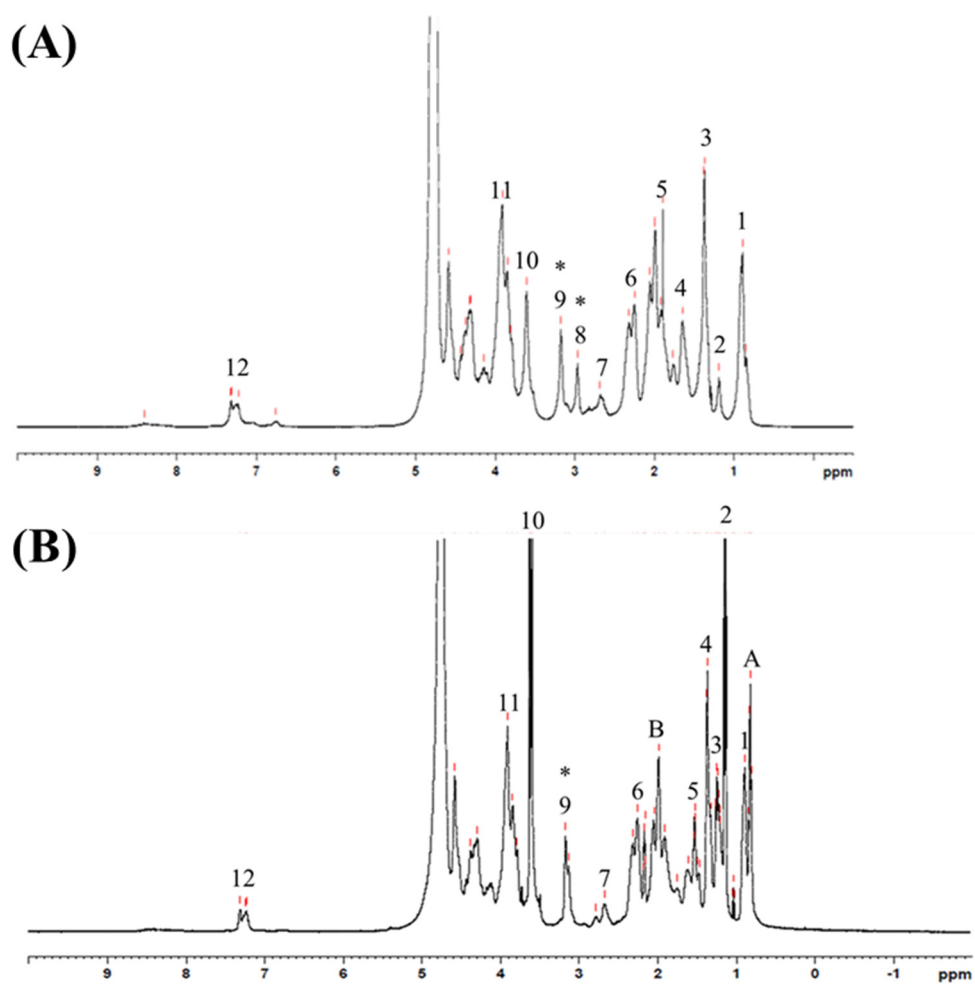


Figure S2. ^1H -NMR spectrum of gelatin molecules in D_2O : (A) primitive and (B) modified gelatin molecules.

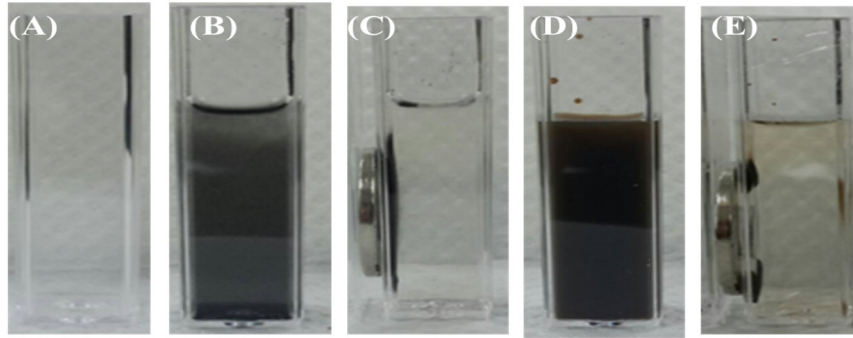


Figure S3. Evaluation of magnetic-guiding ability of the nanoparticles (A) blank, (B) SPIO, (C) MAGNC suspensions (20 µg/ml MAGNCs were homogeneously dispersed in d²H₂O), (D) photo magnetic-guiding test of SPIO nanoparticles, (E) magnetic-guiding test of MAGNCs.

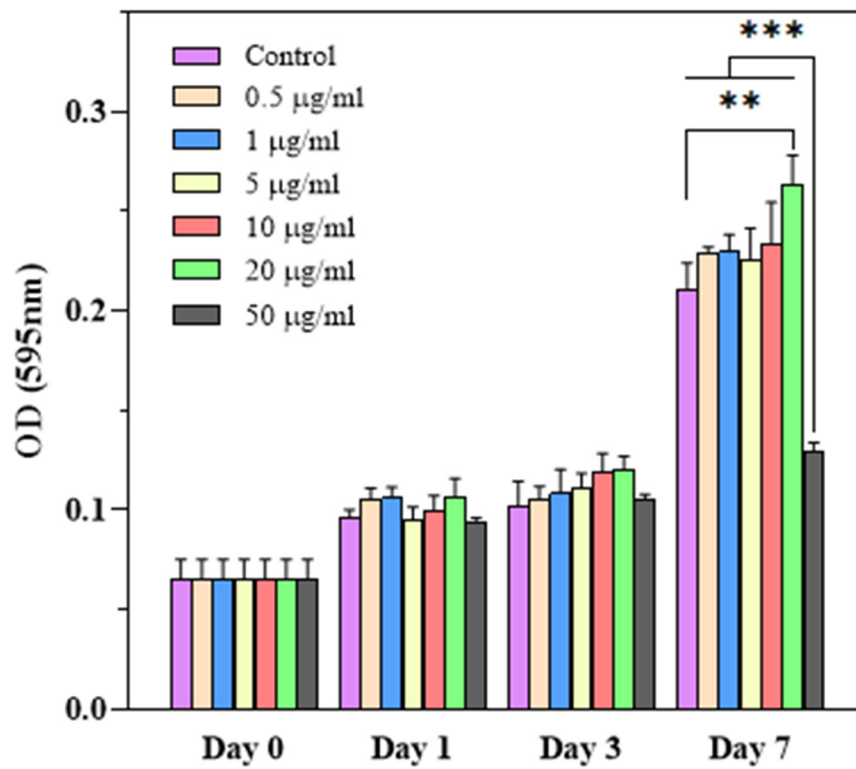


Figure S4. Cell proliferation assessment: chondrocytes were co-cultured with MAGNCs containing different concentrations of SPIONs for 1, 3, and 7 days. Data represent mean±SD, * $p < 0.05$ ** $p < 0.01$, *** $p < 0.001$.

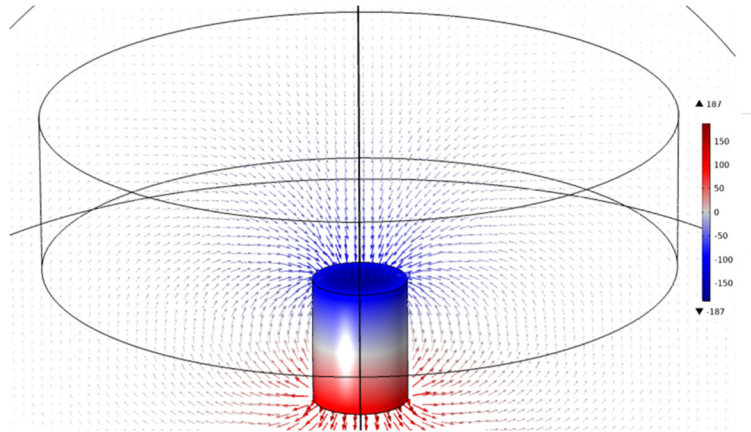


Figure S5. Simulation illustration of in vitro magnetic flux density distribution.

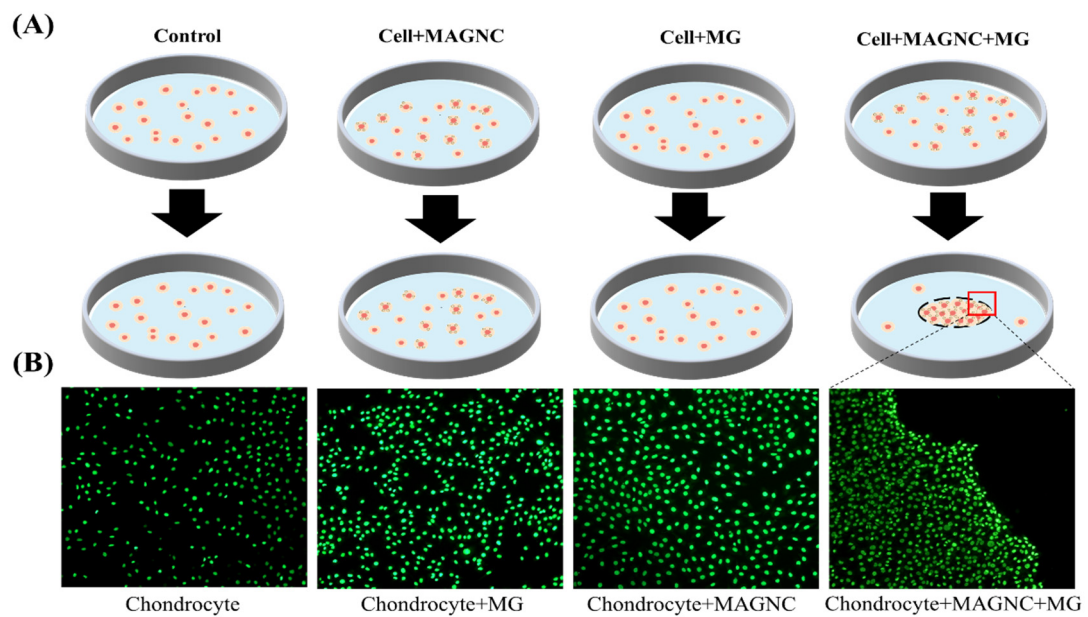


Figure S6. (A) Illustration of the in vitro magnetic guidance of MAGNC-labeled chondrocytes. (B) Florescence microscopy of the cells around magnetic enrichment with magnitudes of 10× (scale bar = 100 μm)

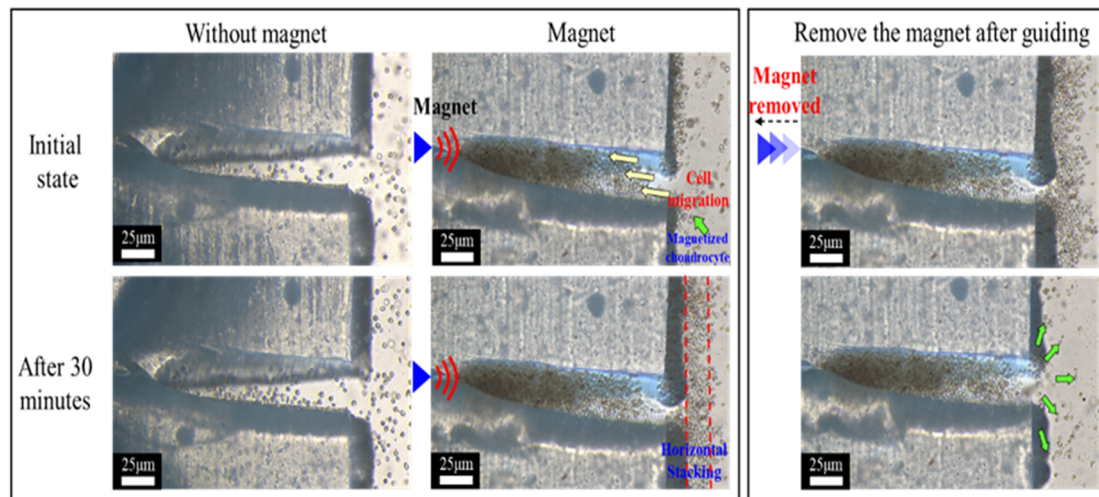


Figure S7. In vitro experiment to simulate cell migration by an external magnetic force to observe the dynamic movement of chondrocytes.

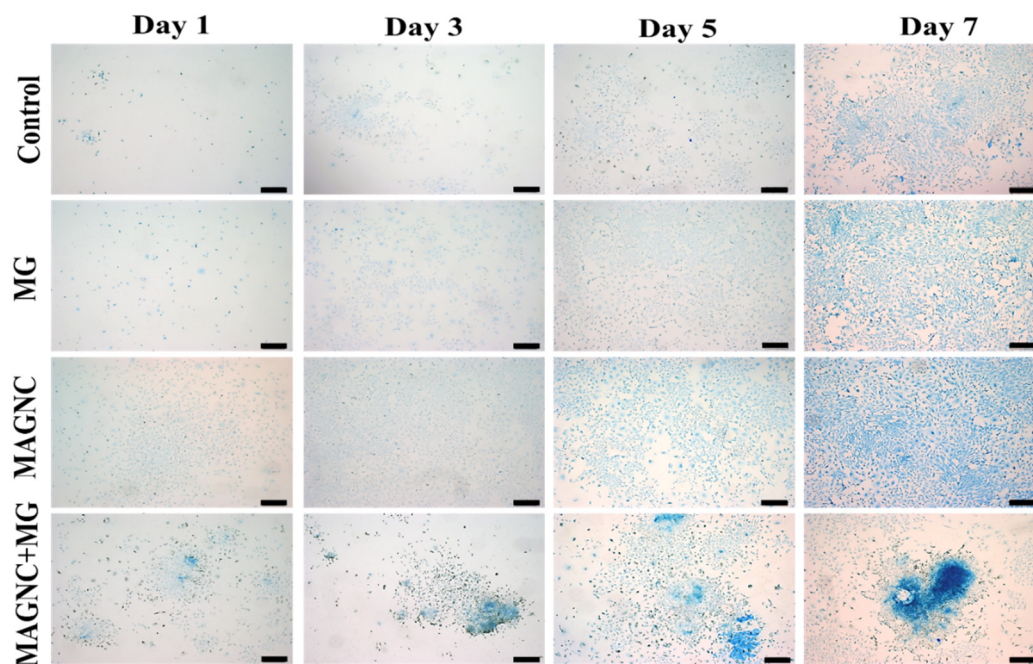


Figure S8. Alcian blue staining. GAGs secreted from chondrocytes were stained with Alcian blue to demonstrate the significant differences between GAGs and chondrocytes receiving various stimulations. (Scale bar: 200 µm)

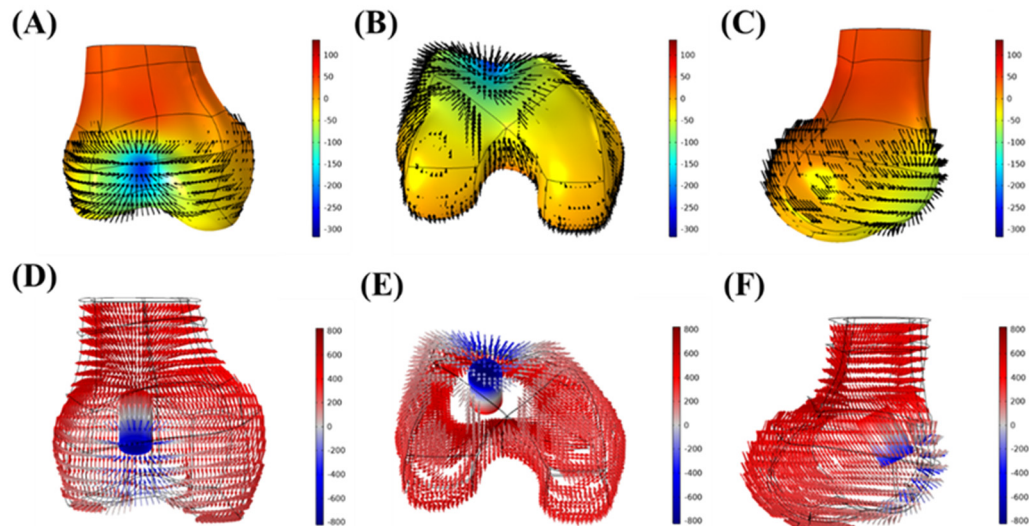


Figure S9. Simulation illustration of in vivo magnetic flux density distribution. Magnetic flux density distribution in (A) the x-y, (B) x-z, and (C) y-z planes along the cartilage surface. Magnetic flux density distribution in the (D) x-y (E) x-z and (F) y-z planes along magnet in the femur to simulate external magnetic field through cartilage surface.

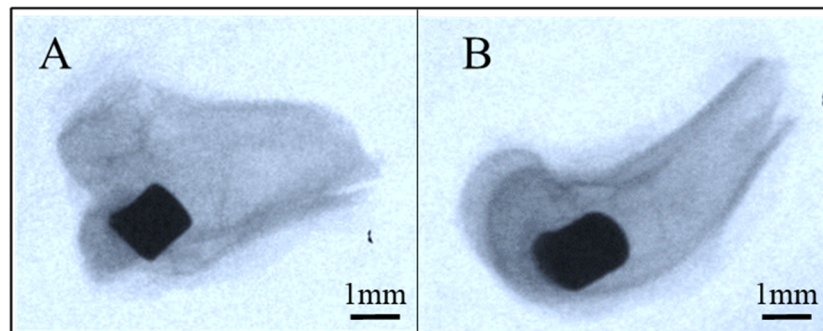


Figure S10. Location of the magnetic column. (A) X-ray images of implanted magnetic column; top view; (B) side view.

Movie S1. Observation of the guidance of SPIO magnetized chondrocytes via external magnet.

Movie S2. Observation of the guidance of MAGNC-magnetized chondrocytes via external magnet.