Hyaluronan-coated Aligned Collagen Hydrogel Stabilizes Intervertebral Discs via Fibrotic Remodeling of the Annulus Fibrosus

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PROBLEM STATEMENT : CHRONIC LOW BACK PAIN (CLBP)

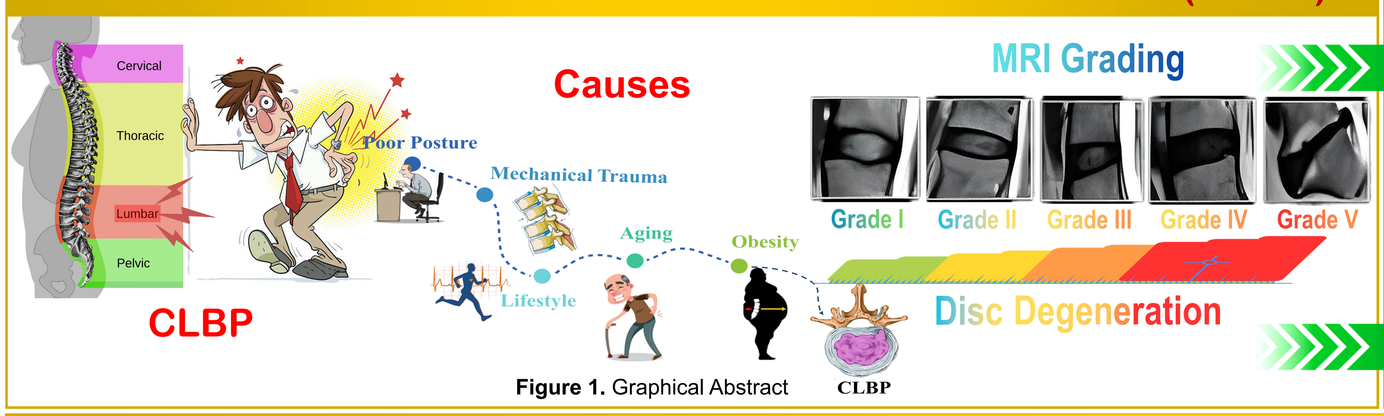


Figure 1. Graphical Abstract

SOLUTION OFFERED

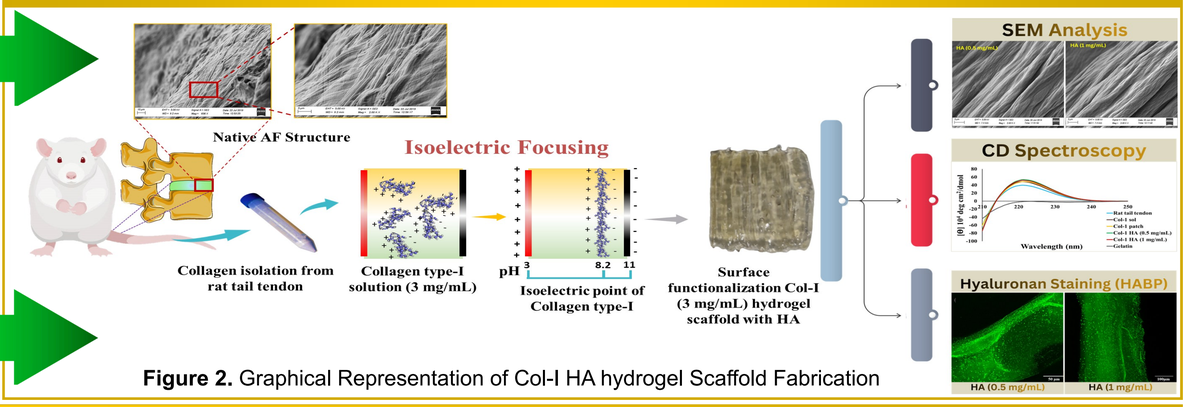


Figure 2. Graphical Representation of Col-I HA hydrogel Scaffold Fabrication

IN VITRO & EX VIVO ASSESSMENT

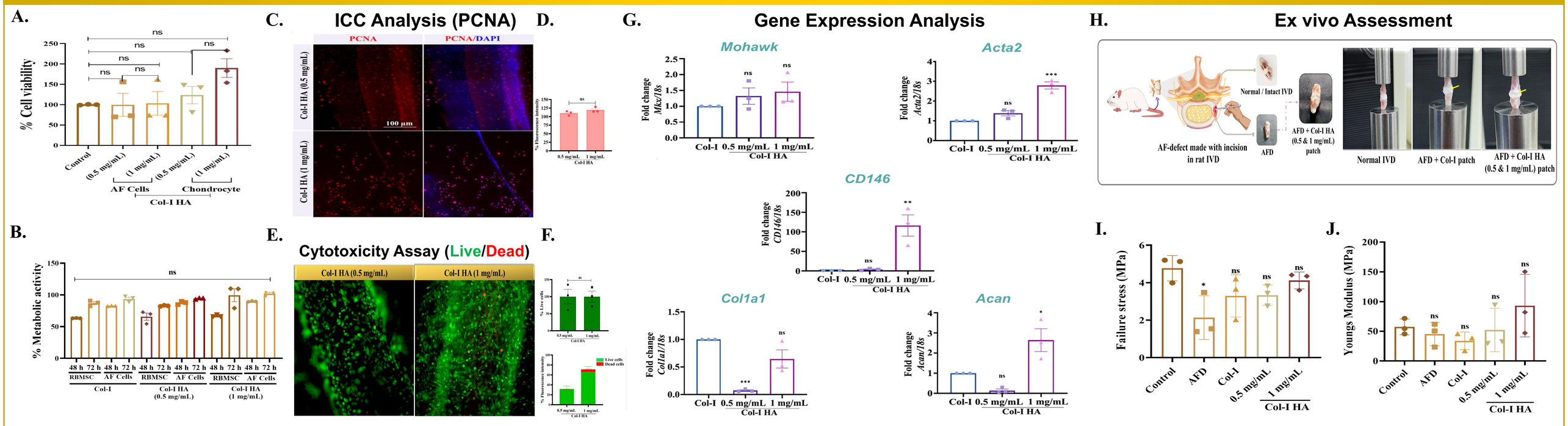


Figure 3. Graphical plots for *in vitro* cell viability and metabolic activity compared to the control (A,B). ICC analysis, Cytotoxicity assay, qPCR gene expression analysis, and ex vivo mechanical characterization (C-J). Data represent the mean ± SD (ANOVA followed by Dunnett's post-hoc test: *p ≤ 0.05, **p < 0.01, ***p < 0.001).

IN VIVO MODEL DEVELOPMENT AND VALIDATION

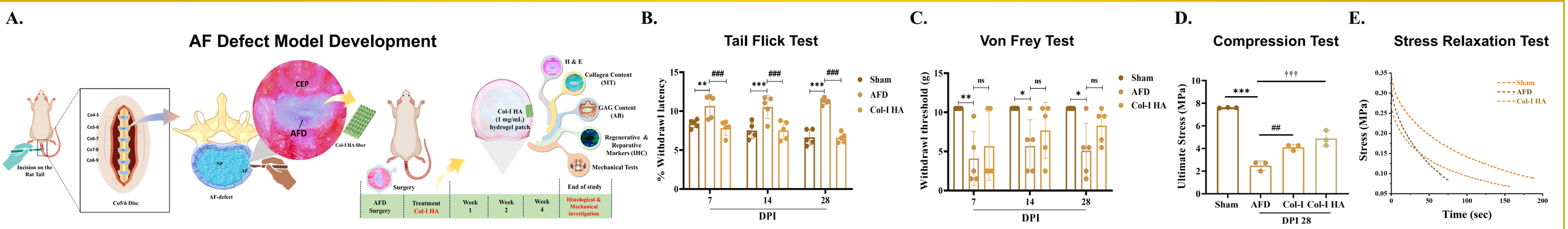


Figure 4. Schematic illustration for *in vivo* AF Defect model developemnt (A). Bar graph shows behavioral analysis (Tail flick and Von Frey test) of Col-I HA implanted animals (B,C). Biomechanical compression and stress relaxation evaluation of Col-I HA implanted rat IVDs via UTM analysis (D,E). Data represent the mean ± SD (ANOVA followed by Dunnett's post-hoc test : *p ≤ 0.05, **p < 0.01, ***p < 0.001).

IN VIVO ASSESSMENT OF COL-I HA HYDROGEL IN IVD STABILIZATION AND REGENERATION

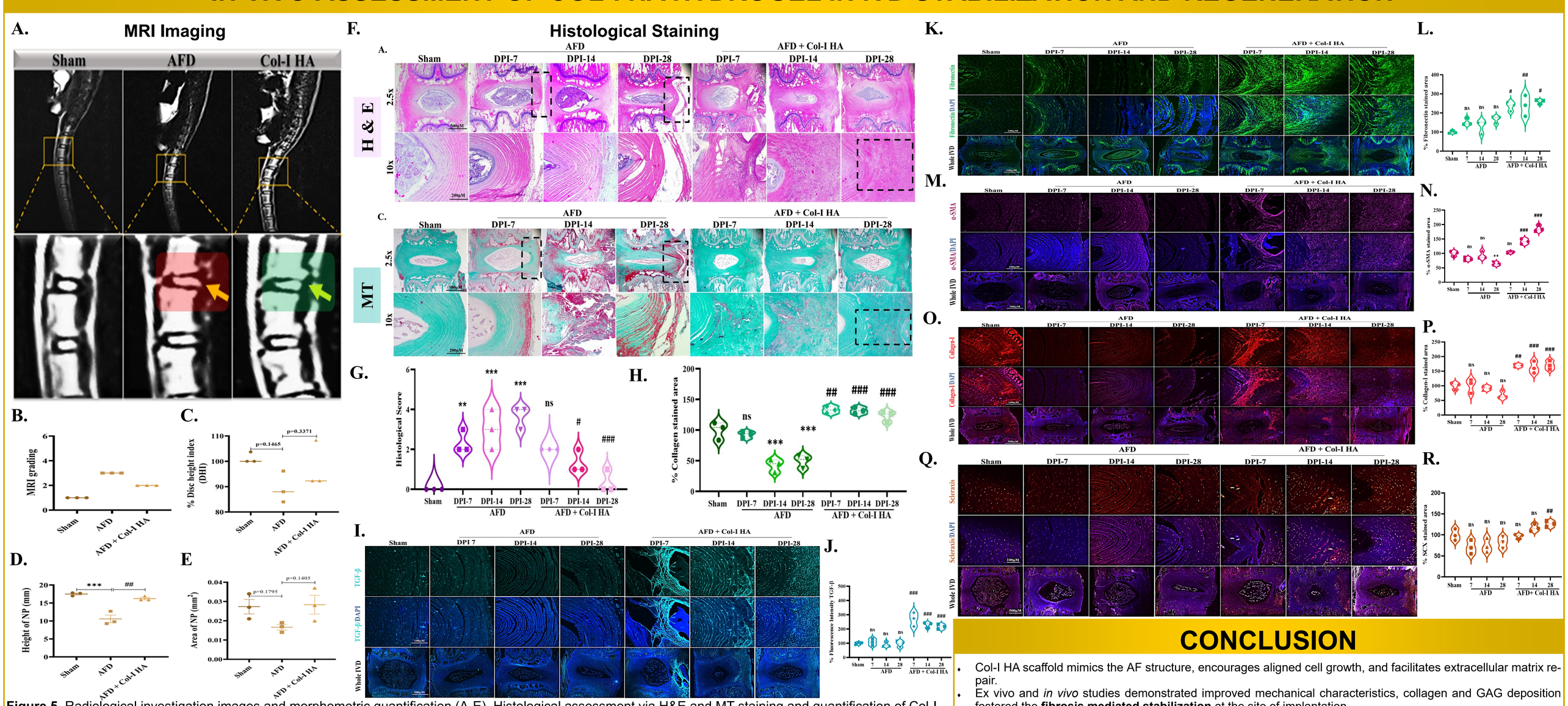


Figure 5. Radiological investigation images and morphometric quantification (A-E). Histological assessment via H&E and MT staining and quantification of Col-I HA implanted discs (F,H). Immunohistochemcial evaluation for TGF-β, Fibronectin, α-SMA, Collagen, and Scleraxis (I-Q). Data represent the mean ± SD (ANOVA followed by Dunnett's post-hoc test : *p ≤ 0.05, **p < 0.01, ***p < 0.001).

CONCLUSION

- Col-I HA scaffold mimics the AF structure, encourages aligned cell growth, and facilitates extracellular matrix repair.
- Ex vivo and *in vivo* studies demonstrated improved mechanical characteristics, collagen and GAG deposition fostered the **fibrosis mediated stabilization** at the site of implantation.
- Overall, this study shows a promising biomaterial-based technique for reinstating IVD biomechanics and structural stability, which might be useful as a potential therapeutic strategy for IVDD.

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