Comments on Innovative design of minimal invasive biodegradable poly(glycerol-dodecanoate) nucleus pulposus scaffold with function regeneration

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This study sought to be inspired by the spreading shape of cucumber vines to design and prepare a disc nucleus pulposus scaffold with regenerative capabilities to address the serious problems associated with disc degeneration.[1] Intervertebral disc degeneration is a common health problem that usually leads to back pain and nerve compression, significantly affecting patients' quality of life.[2] For the treatment of disc degeneration, traditional methods include surgical interventions and medications, but there are limitations and risks. As a result, researchers have begun to explore more innovative treatment modalities for more effective intervertebral disc repair and regeneration.[3]

In this study, the researchers used poly(glycerol-dodecanoate) (PGD) to prepare an implantable disc nucleus pulposus scaffold that can be implanted *in vivo*, and the regenerative function of the scaffold was achieved by specifically linking the chemokine stromal cell-derived factor-1α (SDF-1α) to PGD. These scaffolds possessed key properties such as shape memory, mechanical support and degradation rate, which could be optimised by adjusting the synthesis parameters of PGD to ensure compatibility with the native disc nucleus pulposus (**Figure 1**).

The first concerns the use of the chemokine SDF-1α. The researchers chose SDF-1α as an induction factor for the disc nucleus pulposus scaffold because SDF-1α has strong biological activity in inducing cell migration and chemoattraction. By linking SDF-1α to PGD, the researchers realised that the scaffold releases SDF-1α *in vivo*, which attracts autologous stem cells to migrate to the region of the disc nucleus pulposus and promotes the regeneration of the degenerated nucleus pulposus. This approach can be used as an innovative biological therapy that provides new ideas for treating disc degeneration.[4] The second is about the shape memory property of the scaffold. This property refers to the ability of a scaffold to remember its original shape and to regain that shape under some stimulus conditions. In this study, the PGD scaffold was able to spontaneously undergo shape changes to adapt to the cavity of the nucleus pulposus of the intervertebral disc, which means that the scaffold is better able to adapt to different disc morphologies, improving the success rate of the surgery and patient outcomes. In addition, the scaffold degraded at a moderate rate compared to conventional implants, without being too fast or too slow, which allowed for the slow release of SDF-1α and the provision of needed regulatory factors for stem cells, which could reduce the deleterious effects on patients.[5, 6]

In the experiment, the researchers first delivered PGD rods with smaller diameters into the disc nucleus pulposus cavity of New Zealand white rabbits through hollow needles and observed that stimulated by body temperature, the PGD scaffolds would spontaneously undergo shape changes to fit into the disc nucleus pulposus cavity and to avoid extruding out of the puncture holes in the annulus fibrosus when compressed.

Encouragingly, the experimental results showed that the PGD intervertebral disc nucleus pulposus scaffold not only maintains the height of the intervertebral disc, but also has the ability to stimulate autologous stem cells to migrate and regenerate the degenerated nucleus pulposus in a relatively short period of time through the released SDF-1α. This novel minimally invasive nucleus pulposus regeneration treatment has great potential for clinical application.

Overall, this study designed and prepared for the first time a regenerative disc nucleus pulposus scaffold with regenerative function inspired by the morphology of a plant vine, which successfully realised the properties of form the memory, physiological assistance, and the rate of degradation, and was able to suit with autologous nucleus pulposus, and achieved satisfactory results in the experiments. This innovative treatment provides new ideas for the treatment of intervertebral disc degeneration and brings new hope to patients.

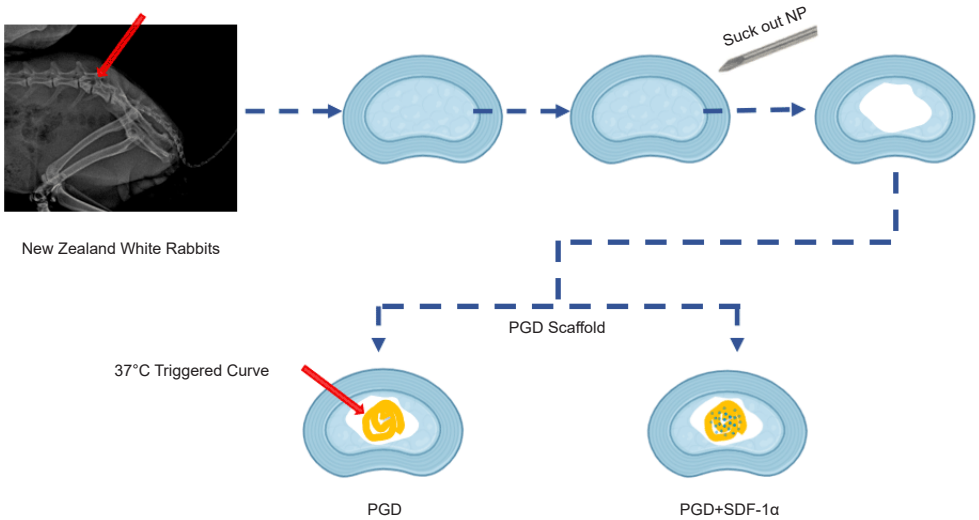

Figure 1. The surgical procedure for nucleus pulposus scaffold implantation in the L5–L6 intervertebral disc of rabbits involves the use of a C-arm machine. A hollow needle with a diameter of 1.2 mm is inserted into the nucleus pulposus of the L5–L6 intervertebral disc. During the operation, a platinum ring is fixed onto the nucleus pulposus scaffold, and the position of the scaffold is observed using X-ray imaging. The nucleus pulposus scaffold group is divided into the implant PGD group and the PGD + SDF-1α scaffold group. Created with BioRender.com. PGD: poly(glycerol-dodecanoate); SDF-1α: stromal cell-derived factor-1α.

However, I still have some concerns. Firstly, this research is still in the laboratory stage and has not been widely validated in clinical practice. Although the experimental results have shown promising effectiveness, further clinical trials are necessary to assess the efficacy, safety, and long-term tolerance of the scaffold. Only after sufficient validation can its feasibility and effectiveness in clinical applications be determined. Additionally, the study needs to further consider the long-term effects and stability of the scaffold. Intervertebral disc degeneration is a chronic process, and the treatment approach requires long-lasting effects. Issues such as the degradation rate of the scaffold, the persistence of cell migration, and the long-term stability of regenerating nucleus pulposus need to be further researched and evaluated. Finally, treating intervertebral disc degeneration is just one application direction in the field of medicine. The potential application of the scaffold in other diseases still needs further research and exploration. Different diseases may have different treatment needs and mechanisms, hence further research is needed to determine the feasibility and effectiveness of the scaffold in other diseases.

Author contributions

HZ: Data curation, investigation, methodology, software, writing – original draft; AW: conceptualization, project administration, resources, supervision, writing – review & editing. Both authors approved the final version of the manuscript.

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Conflicts of interest statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

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