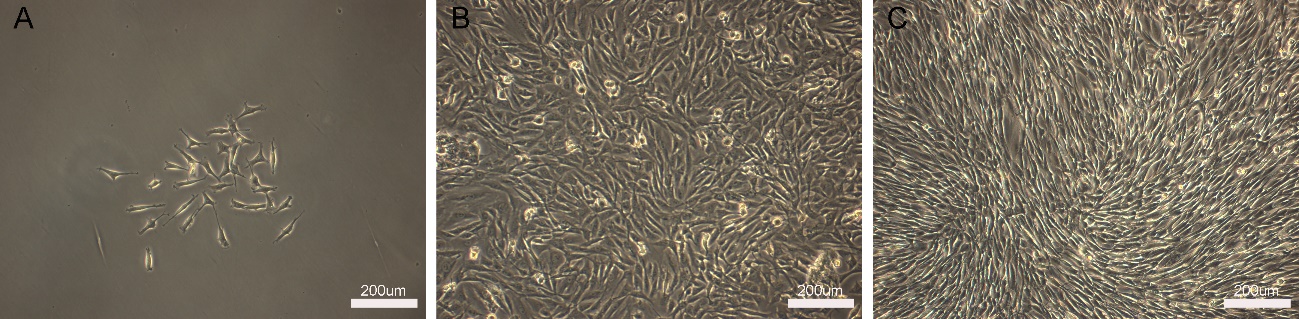
**1. Primary culture of NPMSCs**

NPMSCs isolated from the nucleus pulposus tissue of the rat tail intervertebral disc were found in the culture bottle after 24 h of fluid exchange, and the primary NPMSCs were adherted to the wall. The visual field cells were long spindle shape or polygon, and the cell refraction was good (Figure S1 A). When NPMSCs were transmitted to the second generation, the morphology of visual field cells was uniform and regular under the microscope, the proliferation rate increased significantly, and they began to gather and grow in a colony-like fashion (Figure S1 B). When cultured to the third generation of NPMSCs, it could be seen that the visual field cells as a whole grew in a vortex colony, the proliferation rate further increased, and the overall state of the cells was good (Figure S1 C).



**Fig. S1.** A shows the primary NPMSCs. The visual field cells are long spindle or polygon, and the cells have good refraction. B shows the second generation of NPMSCs, with uniform and regular morphology of visual field cells and increased proliferation rate. C shows that the visual field cells of the third generation of NPMSCs grow in a vortex colony and are in a good state. (scale bar: 200μm) (This image was produced using Adobe Illustrator software)

**2. Flow cytometry identification of NPMSCs**

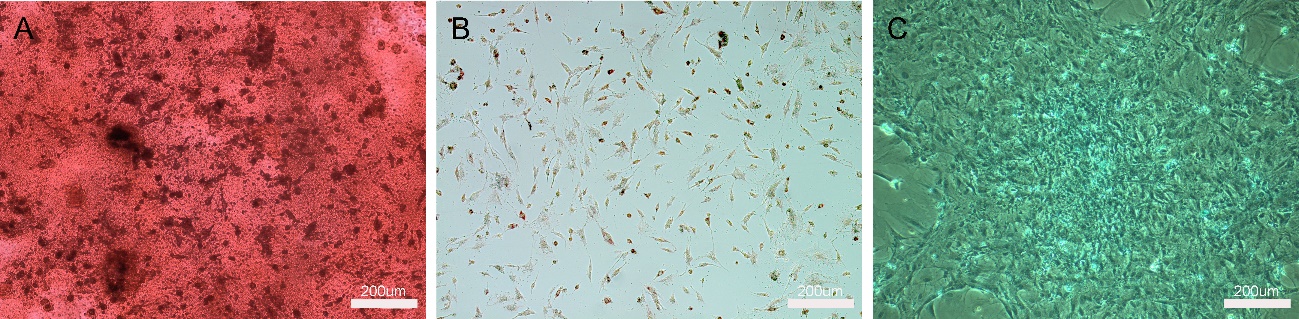
As shown in Figure S2, flow cytometry identified cells with high expression of CD90 (96.2%) and CD73 (95.9%), which are usually positive in mesenchymal stem cells, and low expression of CD34 (1.03%) and CD45 (5.33%) in mesenchymal stem cells. All the results showed that the cells met the evaluation criteria of mesenchymal stem cells.



**Fig. S2.** Flow detection showed high expression of CD73 and CD90 and low expression of CD34 and CD45. (This image was produced using Adobe Illustrator software)

1. **Three-line differentiation of NPMSCs**

The induced differentiation of bone, fat and cartilage was successfully performed in vitro. The formation of orange-red calcium nodules was observed in bone differentiation. The red stain of punctured fat droplets in the cell contour was observed by oil red O staining after lipid induction.



**Fig. S3.** (A) Alizarin red staining after osteogenic induction showed a large number of dark red calcium nodules. (B) Oil red O staining after induction of lipid formation showed the appearance of oil red fat droplets. (C) Staining of Alysin blue after induction of chondroblast. (scale bar: 200μm) (This image was produced using Adobe Illustrator software)

Special Note: The identification experiments related to NPMSCs in this study have been fully identified in our team's previous studies[28]. The above supplementary explanations for NPMSCs are provided in this paper in accordance with the requirements of the journal editorial department. The copyright of all images belongs to our team.