1. Multiplex differentiation potential test of BMSCs

For osteogenesis, BMSCs were cultured in osteogenic induction medium (Cyagen biotechnology, Suzhou, China). Then, alkaline phosphatase (ALP) staining was performed after 7 days, and Alizarin Red staining was performed after 21 days. For adipogenesis, cells were cultured in adipogenic induction medium (Cyagen biotechnology, Suzhou, China) Then, the formation of lipid vacuoles was assessed by Oil Red O staining after 21 days.

Observed by a bright-field microscopy (Nikon, Japan), P3 BMSCs exhibited a fibroblast-like and long spindle-shaped morphology (**Figure S1 a**). For multiplex differentiation potential test, ALP was widely expressed in the osteogenic induced cells after 7 days (**Figure S1 b**) and calcium deposits, which are stained orange-red by Alizarin Red, were also widely distributed in the osteogenic induced cells after 21 days (**Figure S1 c**). Meanwhile, Oil red O staining also came to a positive result for adipogenic differentiation (**Figure S1 d**).

2. Flow cytometry test of BMSCs

To identify the phenotype of BMSCs, the cells were incubated with monoclonal rabbit antibodies against CD29, CD90, CD45 and CD34 (Abcam, UK). The cells were washed three times with PBS after incubation with primary antibodies. Then, the cells were incubated with goat-anti-rabbit IgG secondary antibodies (BD, USA) labeled with fluorescent markers including FITC, phycoerythrin (PE) and BD Horizon™ V450. Last, the fluorescence of BMSCs were detected by a four-color multiparameter flow cytometer (FACSVerse, BD, USA).

For flow cytometry tests, more than 95% of the BMSCs expressed typical MSC markers CD29 and CD90; and more than 95% of them were negative

for hematopoietic CD45 and CD34 (**Figure S1 e**). In sum, the isolated cells were proved to be BMSCs in many ways.

3. GFP labeling of BMSCs by GFP-HLBV infection

BMSCs were incubated with green fluorescent protein-lentivirus (Hanbio, Beijing, China) transfection medium according to the multiplicity of infection (MOI) as 50. After 24 hours, transfection medium was changed to DMEM/F12 culture medium. Then, 72 hours after transfection, the cells were cultured with conditioned medium containing 1 μg ml^{-1} puromycin for one week. Finally, BMSCs expressing GFP were selected by inverted fluorescence microscope (Leica, Germany) and were used in part of subsequent studies.

All the BMSCs used in cell adhesion tests and animal models were transfected with GFP lentiviral vectors. Obviously, more than 80% cells were positive for GFP after transfection (**Figure S1 f**).

4. Strength test after degradation

The test of strength behavior of the scaffolds was carried out during the revision and the results were shown in **Figure S2 a**. Take PTMO-III scaffold as an example, the average compressive strength of the scaffold at 10% weight loss is 16.06 MPa, and the young's modulus is 87.12 MPa. The average compressive strength of the scaffold at 20% weight loss is 10.86 MPa, and the young's modulus is 57.28 MPa. Which means that, comparing to the 0% weight loss, 10% weight loss leads to about 15% strength loss, and 20% weight loss leads to about 40% strength loss. Since there are a lot of new bone formation around the scaffold during the scaffold degradation (as shown in Figure 8 & 9), which can effectively compensate the mechanical strength loss caused

by the stent degradation, therefore, we believe the weight loss of scaffold might not result in the insufficient mechanical strength support for the defect area.

5. Oxygen release test of H_2O_2, CaO_2 and MgO_2

In order to prove the difference of oxygen release rate among H_2O_2, CaO_2 and MgO_2, we used hydrogen peroxide solution, calcium peroxide powder and magnesium peroxide powder to test their oxygen release rate. We should make sure that the three peroxides have the same amount of substance before test. The test was carried out at 37°C, and the results are shown in **Figure S3 a**. It can be seen that hydrogen peroxide shows the fastest oxygen release rate as described in previous study. The concentration of dissolved oxygen reaches the peak at day 1, then decreases rapidly, and then drops to the level of water at day 2. The oxygen release rate of CaO_2 was much slower than that of H_2O_2. It reached the peak at day 2, then decreased slowly, and dropped to the level of water at day 5. The oxygen release curve of MgO_2 reached the peak at day 3 and dropped to the level of water at day 7. Therefore, we confirmed that MgO_2 has slower oxygen release rate than H_2O_2 and CaO_2.

6. Oxygen release test and cytotoxicity test of PTMO-IV scaffold

Considering the flexibility in the design of shape and structure of scaffold, PCL needs to account for more than 80% of the mixture. In pre-experiment, we tried to construct a PTMO-IV scaffold (PCL / β-TCP / MgO_2 = 80:5:15) , and related oxygen release test and cytotoxicity test were carried out. The results are shown in **Figure S3 b-d**. It can be seen from **Figure S3 b** that the oxygen release rate of PTMO-IV scaffold is faster than that of PTMO-III scaffold, which is in line with the trend that the higher the proportion of MgO_2, the faster the oxygen release. Then, we co-cultured the scaffold with

BMSCs under normoxia and hypoxia. The results of live/dead cell staining are shown in **Figure S3 c-d**. It can be seen that the proportion of dead cells in PTMO-IV group is much higher than that in PTMO-III group and control group under both normoxia and hypoxia, which means PTMO-IV scaffold may has higher cytotoxicity. We think that this is because the high content of MgO_2 leads to rapid and massive O_2 release in early stage, which created a high oxygen microenvironment with cytotoxicity. Considering the results of this pre-experiment, we decided to exclude PTMO-IV scaffold from the formal experiment because further experiments are meaningless if scaffold is cytotoxic. Therefore, we finally chose the three kinds of scaffolds mentioned in article for further experiments in vivo and in vitro.

7. Actual parameters test of scaffold

In order to determine the actual parameters of scaffolds, we measured the pore size and wire diameter of scaffold under scanning electron microscope. 25 positions of scaffold were selected randomly, and the data were made into a histogram, as shown in **Figure S3 e**. It can be seen that the pore size and wire diameter of scaffolds are normal distribution, the average value of pore size is 408.58μm, and the average value of wire diameter is 303.57μm, both of which are very close to design value.