Articular cartilage repair using intra-articular magnet and synovium derived cells: using magnetic targeting system.

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INTRODUCTION:
We previously reported that magnetically labeled synovium derived cells could be collected in the osteochondral defect using intra-articular magnet. We investigated the availability of this magnetic targeting system for repairing articular cartilage using rat models.

METHODS:
Synovium derived cells were harvested from knee joints of SD rat (aged 11 weeks), and cultivated in DMEM medium. We used passage 3 cells, and synovium derived cells were magnetic labeled with ferumoxides and poly-L-lysine. Osteochondral defect (2 mm in diameter and 1 mm in depth) was made in the center of the patellar groove of SD rat (aged 11 weeks) (Fig.1). Pt-Fe magnet (1 mm in diameter and 3 mm in length, 1.0 Tesla) was set at the bottom of osteochondral defect. Then we injected synovium derived cells into the knee joint. We made four groups: in Groups A and B, magnetically labeled synovium derived cells were injected after setting permanent magnet (Group A) or nonmagnetic alloy (Group B). In Groups C and D, magnetically labeled synovium derived cells were injected after setting permanent magnet (Group C) or nonmagnetic alloy (Group D). The rats were sacrificed 4 weeks, 8 weeks, and 12 weeks after treatment, and osteochondral defects were evaluated histologically. The morphological findings of each time point were quantitated using the scoring system described by Wakitani et al. in which a full score was 14 and a lower score indicated improvement.

RESULTS:
At 4 weeks after treatment, the repairs of osteochondral defects in Groups B-D were poor, but those in Group A appeared to be covered with the tissue containing cartilage-like cells (Fig.2). The cells were stained with toluidine blue and type-II collagen. At 8 weeks after treatment, the repairs of osteochondral defects were improved compared to those at 4 weeks. In particular, the cartilage-like cells were abundant in the osteochondral defects of Group A (figure not shown). At 12 weeks after treatment, the osteochondral defects were covered with the tissue containing cartilage-like cells in all groups, but the thickness and staining of the cartilage-like layers were increased in Group A compared to those in Groups B-D (Fig.3).

Histological grading scores were significantly better in Group A than in Groups B-D at all time points after treatment, especially at 12 weeks (Fig. 4). These findings suggested that our method using magnetically labeled synovium derived cells and intra-articular magnet was effective for repairing osteochondral defect.

DISCUSSION:
Our cell delivery system is useful for efficient and minimally invasive repair of osteochondral defect. We believe that this novel cell delivery system is applicable to human osteochondral defect caused by osteoarthritis or trauma.