Pain Physician. 2006;9:253-256, ISSN 1533-3159

A Case Report

Partial Regeneration of the Human Hip Via Autologous Bone Marrow Nucleated Cell transfer: A Case Study

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History: This is a case report of a 64-year-old white male with a 20 year history of unilateral hip pain that had become debilitating over the last several years. On intake, Harris hip score was rated as: Pain subscale=10, Function subscale=32, Deformity subscale=4, Motions subscale=4.775 with a total score of 50.8 out of 100. MRI of the affected hip showed severe degeneration with spurring, decrease in joint space, and several large subchondral cysts. The patient had been evaluated by an orthopedic surgeon and told he was a candidate for bipolar hip replacement.

Method: Two autologous nucleated cell collections were performed from bone marrow with subsequent isolation and transfers into the intra-articular hip using a hyaluronic acid and thrombin activated platelet rich plasma scaffold. Marrow samples were processed by centrifugation and lysis techniques to isolate nucleated cells.

Conclusion: This report describes partial by articular surface regeneration 8 weeks after intraarticular bone marrow transfer.

Post-op 3.0T FGRE MRI showed neocortex formation when compared to immediate pre-op MRI and objective improvements were noted that coincided with subjective reports of improvement.

Key words: osteoarthritis hip, intra-articular autologous bone marrow transfer.

The use of progenitor cells in regenerative medicine holds great promise for degenerative joint disease (1). Specifically, the mesenchymal stem cell (MSC) lineage has been used in animal models to regenerate articular cartilage and bone (2-15). Gangji has recently reported on a large case series where autologous mononuclear bone marrow cells were implanted into the femoral head (16). This demonstrated a significant reduction in the advancement of osteonecrosis (in the sub-articular region) on subsequent imaging in their case series. We are not aware of any attempts to use a similar technique for regeneration of articular structures in a patient population. The purpose of the current investigation was to determine if transfer of autologous nucleated cell bone marrow (including mesenchymal stem cells and heme progenitors) could stimulate partial regeneration of a severely degenerated human hip.

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Disclaimer: There was no external funding in the preparation of this manuscript.
Conflict of Interest: None.
Manuscript received on: 05/19/2006
Revision submitted on: 06/12/2006
Accepted for publication on: 06/15/2006

Case Report

RM was a 64-year-old white male with a 20-year history of unilateral hip pain that had advanced to become debilitating over the last several years. On intake, Harris hip score was rated as: pain, subscale=10; function, subscale=32; deformity, subscale=4; motions, subscale=4.775; with a total score of 50.8 out of 100. MRI of the affected hip showed severe degeneration with spurring, decrease in joint space, and several large subchondral cysts. The patient had been evaluated by an orthopedic surgeon and told he was a candidate for bipolar hip replacement.

Methods

The research protocol was approved through a non-profit Institutional Review Board (The Spinal Injury Foundation). The inclusion criteria were as follows:

1. MRI evidence of unilateral hip degenerative osteoarthritis
2. Orthopedic evaluation determining positive candidacy for a unipolar or bipolar hip prothesis
3. Males or females
4. Age under 60 years
5. Intra-articular hip injection with 0.75% bupivacaine without sedation or intravenous anesthesia reduces hip pain by >75%
6. Unwillingness to proceed with surgical management
7. Failure of conservative management
8. Ongoing disabling pain

Exclusion Criteria

1. Active inflammatory or connective tissue disease thought to impact pain condition (i.e. lupus, fibromyalgia, RA)
2. Active endocrine disorder that might impact pain condition (i.e. hypothyroidism, diabetes)
3. Active neurologic disorder that might impact pain condition (i.e. peripheral neuropathy, multiple sclerosis)
4. Active cardiac disease
5. Active pulmonary disease requiring medication usage
6. A history of dyspnea or other reactions to transfusion of homologous blood products

Pre-Procedure Data Collection

1. CBC and SMAC to rule out un-

known medical condition (within 3 months of procedure)
2. Pre-procedure MRI within 3 months of planned procedure

Post-Procedure Data Collection (at 4 weeks):

1. Post-procedure MRI using the same scanner and technique as pre-procedure scan

Outcome Endpoints (obtained at 4, 8, 12 weeks):

1. Pre and post modified VAS
2. Pre and post Functional Rating Index
3. Pre and post lumbar range of motion using double inclinometry

Medication Restrictions

For one week prior to the procedure and three months after the procedure the patient was restricted from taking steroids or NSAID's.

Blood Draws

1. Pre-surgical labs including a CBC and SMAC
2. Post-surgical labs drawn at 2 weeks and include a CBC and SMAC.

Two nucleated cell transfer procedures were performed in this patient one month apart. Both of these procedures followed the same cell isolation technique. In the first procedure 50 mL of marrow draw was taken from the posterior superior iliac spine (PSIS) and in the second procedure, a total of 200 mL of marrow was taken from the bilateral PSIS areas.

Marrow samples were processed by centrifugation and lysis techniques in a sterile laminar flow hood using sterile cell culture techniques. An initial 1000g spin was performed for 15 minutes to separate plasma from RBC's/nucleated cells. The plasma supernatant was then aspirated from the RBC/nucleated cell layer and the resulting cells were suspended in normal saline. RBC lysis was then undertaken by exposing cells to distilled water for 10 second intervals, followed by the addition of concentrated saline to result in a final saline concentration of 0.9%. Nucleated and unlysed RBS were separated from the RBC lysis products by spinning at 300 g for 5 minutes to form a cell pellet followed by resuspension of the pellet in normal saline. This step was repeated until the cell pellet became white in color and the cell suspension lost its red color, indicating that the number of RBC's left in solution was minimal. The resultant nucleated cell pellet was then added to 2 mL Hyaluronic acid in the first procedure (Hyalgan, Sanofi-Adventist) and a thrombin activated platelet rich plasma gel in the second procedure.

The platelet rich plasma for procedure #2 was created by drawing 20 mL of whole venous blood from a peripheral vein. This sample was then centrifuged at 200g for 5 minutes, and the platelet rich supernatant removed. The supernatant was then spun at 1000g for 15 minutes to form a platelet cell pellet. Five mL of supernatant was then removed from this solution and the pellet suspended in the remaining 5 mL. This platelet rich plasma sample was then activated with 1000 IU of thrombin (Crossseal-Johnson & Johnson Wound Management) and 0.2 mL of ascorbic acid (500 mg/mL American Reagent NDC 0517-5050-01). This formed a loosely adherent gel.

The above cell and scaffold preparations were injected with a 25 gauge 4-inch quinkie needle under sterile technique with the patient in the prone position. The lateral inferior portion of the femoral head was used as the target and Isovue contrast was injected first to demonstrate an arthrogram with the majority of the spread being intra-articular at the femoral head. The patient was kept in the prone or supine position for a minimum of 60 minutes to allow for cell attachment. Post procedure therapy included normal activities and the patient was told to walk to tolerance a minimum of 30 minutes 3-5 times a week.

Results

It was estimated, based on volume of marrow drawn (50 cc) that less than 100,000 mesenchymal stem cells were transferred in procedure #1. Four weeks after procedure #1, immediate pre-op and post-op MRI changes on the same 1.5 MRI magnet using the same imaging protocols revealed no changes. However, the patient did report some clinical improvements. The second procedure resulted in an estimated 300,000-400,000 mesenchymal stem cells transferred (based on 200 cc of total marrow drawn). This procedure included immediate pre-op and post-op scanning using a General Electric Signa HD3.0TGE MRI scanner.

Figure 1 shows the patient's weight bearing surface of the hip in a Coronal Fast Gradient Recall Echo (FGRE) sequence using identical 2nd pre-procedure and post-procedure protocols. The pre-procedure image shows a discontinuous joint surface with no clearly identifiable joint space at the superior lateral weight bearing surface. The 4 week post-procedure image below demonstrates a clearly identifiable joint space in this same region with the area above the dominant subchrondral cyst now demonstrating apparent neocortex.

The only significant change in range of motion noted was a 15 degree increase in hip extension. A self-reported functional rating index was used to measure changes in function (17). At 12-week follow-up, this questionnaire demonstrated one level improvement in travel, recreation, and standing tolerance. The patient's walking distance and sitting tolerance had improved by two levels.

Discussion

It appears in this case study that the patient had undergone partial regeneration of the weight bearing surface of his hip joint. The coronal FGRE sequence was used for its ability to show bony and microtrabecular anatomy, however, the results seen in the MRI could be caused by artifact. One type of artifact potentially resulting in a dark joint line is "chemical shift," but the fact that both pre and post imaging studies were performed with identical protocols would tend to rule this out. In addition, phase differences were not present between the pre-op and 4-week post-op films (18, 19). Another possible source of artifact is the "magic angle effect" seen in ligament imaging (20-23). This phenomenon typically only occurs with organized linear structures such as ligaments and tendons, however, making it an unlikely explanation for the MRI findings. The change in signal intensity could also be due to movement ar-

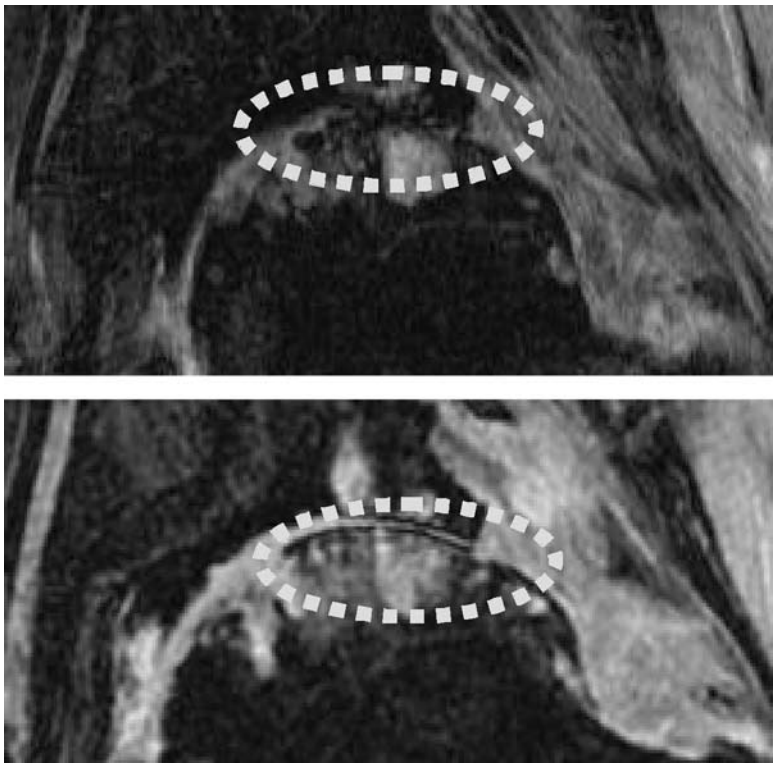

Fig. 1. *Patient's weight-bearing surface of the hip in a Coronal Fast Gradient Recall Echo (FGRE) sequence using identical 2nd pre-procedure and post-procedure protocols.*

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tifact, but other image sequences were not similarly degraded, so this appears unlikely. In addition, the fact that this signal intensity change and apparent reorganization of the relationship between the acetabulum and femoral head occurred in the context of measurable clinical change indicates that the imaging is demonstrated actual changes in joint morphology.

Conclusion

This case report describes apparent partial articular surface neocortex regeneration in a severely degenerated hip 8 weeks after autologous intraarticular bone marrow transfer. To date, we are unaware of any published report of regeneration of any portion of a human hip through adult autologous stem cell therapy. More research with more subjects is needed to determine if this technique has clinical merit, including case series and randomized controlled trials as well as, improved imaging protocols (including micro-CT). In addition, isolation of mesenchymal stem cells with expansion would increase the "dose" of what is likely the active population of cells capable of both cartilage and bone differentiation. However, for the interventional pain community, this "needle out/needle in" procedure used to possibly repair degenerated joints may hold great promise.

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