

:
 : 1996 2000 5 1112
 가 23 MR
 : 가 20 47 31 ,
 가 17
 17
 6
 가 45
 가 28 가 , I
 15 , III 2 IV 1 . 11 (ilium)
 10 (core
 decompression), 5 (vascularized fibular graft), 6
 :
 MR 가 .

1980 가 1987 Atkinson (9)
 , , , , 가 가
 , (bone marrow 가 가
 transplantation, BMT) (1 - 3). (4, 8, 11,
 가 5 60% 가 13 - 15).
 (4, 5).
 가 MR
 (graft versus host disease)
 10% 가
 (5 - 7). 60 - 70%
 가
 (4, 5, 8). 1996 2000 5
 1112 MR 가
 23 MR
 가 13 , 10
 31 (20 - 47) 23 (1) 17
 5 , 15 , 2 , 4
 (allogeneic transplantation)
 (unrelated transplantation), 2 가
 2002 12 9 2003 6 11 .

¹가
²가
³가

(autologous peripheral blood stem cell transplantation)

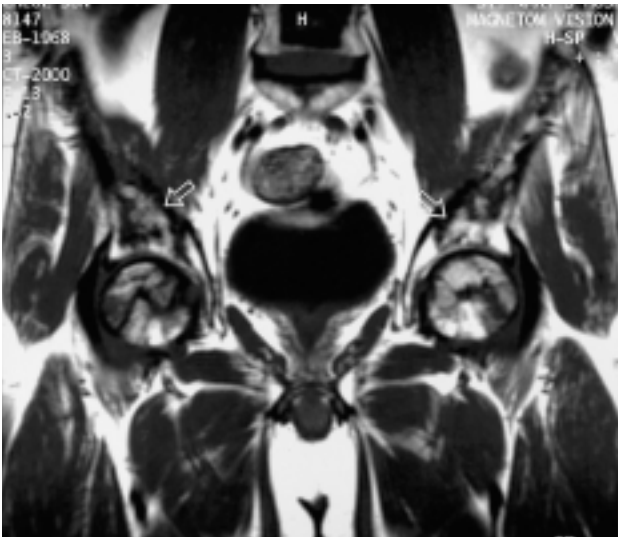
가 , 가 20 47
31 2 31
가 17 가
1.5T (Magnetom Vision Plus, Siemens, Erlangen, Germany)
T1 (TR/TE=750/12 msec), T2 (TR/TE=3000 - 4000/100 - 120 msec) gadopentetate dimeglumine 0.2 ml/kg
T1 (TR/TE=900/12 msec) , busulfan, melphalan 4
Matrix number 228 × 256 256 × 512, FOV 330 mm, 4.0 mm 5.0 mm procarbazine, antithymocyte globulin, cyclophosphamide BCNU, VP - 16 Ara - C
0.4 mm 0.5 mm
MR ARCO (Association (16) cyclosporin FK506 methotrexate
Research Circulation Osseous) 17
가
15% A, 15 - 30% 250 - 500 mg/day prednisolone 5 - 7
B, 30% C
6 cyclosporin

Table 1. Characteristics of 23 Patients Developing Osteonecrosis of the Femoral Head after Marrow Transplantation

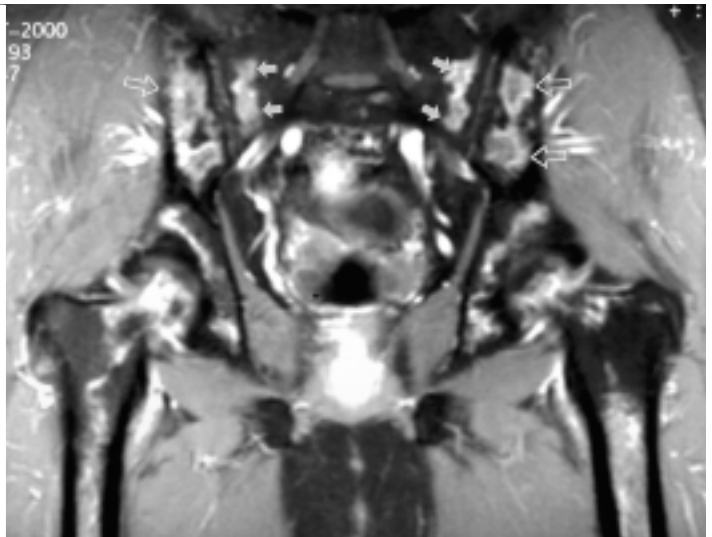
Patient No	Initial disease*	Age at osteonecrosis diagnosis (yr)	Sex	BMT type [†]	Interval	Hip pain	Stage [‡] , RT	Stage [‡] , Lt	Steroid pulse	Surgery [§]
1	AA	19	F	unrelated	23	+	II-C	II-C	+	THR, Lt
2	AA	20	F	Allo	23	+	II-C	II-C	+	Core, both
3	AA	24	F	Allo	18	+	II-B	II-C	+	none
4	AA	27	F	unrelated	2	-	II-C	II-C	-	none
5	AA	47	M	Allo	10	+	II-B	II-B	-	THR, both
6	ALL	20	M	Allo	17	+	II-C	II-B	+	THR, Rt
7	ALL	31	F	Allo	24	+	II-B	II-B	-	none
8	ALL	33	M	unrelated	3	-	II-C	I-B	-	none
9	AML	26	F	Auto	31	+	II-C	II-C	+	Core, Rt
10	AML	28	F	Allo	13	+	I-A	I-B	+	VFG, both
11	AML	31	M	Allo	23	+	II-C	II-C	-	VFG, Rt
12	AML	32	M	Allo	16	+	II-C	II-C	+	THR, both
13	AML	33	M	Allo	15	+	I-B	I-B	+	Core, Lt
14	AML	35	M	Allo	19	+	I-B	I-B	+	Core, Lt
15	AML	45	M	Allo	24	+	I-B	II-C	+	Core, Lt
16	CLL	35	M	Allo	15	+	II-B	II-B	+	Core, both
17	CML	23	M	unrelated	18	+	II-C	II-C	+	VFG, both
18	CML	30	M	Allo	21	-	III-B	II-C	+	Core, Rt
19	CML	42	M	Allo	14	+	I-B	I-B	+	none
20	CML	43	F	Allo	16	+	II-C	III-C	+	none
21	MDS	27	F	Allo	18	+	none	II-B	+	Core, Lt
22	MDS	33	F	Allo	3	-	I-B	I-B	-	none
23	NHL	33	M	Auto	15	+	I-B	I-B	+	none

*CML: chronic myelogenous leukemia, ALL: acute lymphocytic leukemia, AA: aplastic anemia, AML: acute myelogenous leukemia
NHL: non-Hodgkin's lymphor, MDS: myelodysplastic syndrome, CLL: chronic lymphocytic leukemia, Interval: Interval (months) from MBT to development of osteonecrosis, [†]BMT: bone marrow transplantation, Allo: allogeneic, Auto: autologous peripheral stem cell transplantation, + : presence, - : absence, [‡]ARCO: classification, A: < 15% involvement of the femoral head, B: 15 - 30% involvement of the femoral head, C: > 30% involvement of the femoral head, [§]Core: core decompression, VFG:vascularized fibular graft, THR: total hip replacement

23 MR Table 3 2 7
 1 1 가 45 25
 가 ARCO II 15 , III 2
 가 28 가 , I 가
 IV 1 가 24 , 30% 21
 30% 가 11 (ilium) (hemoglobinopathy),
 . 11 (Fig. , , , , 가
 1). (16 - 19). 1987 Atkinson (9)
 21 (core decom- 가 가 (4, 8, 9, 11, 13 - 15)
 10 (vascularized fibular 가
 pression), 5 가
 graft), 6



A



B



C

Fig.1. A thirty-two-year old male with acute myelocytic leukemia received allogeneic marrow transplant 16months ago and steroid pulse therapy was done immediately after the trasnplantation because of acute graft versus host disease. Coronal T1-weighted pre-contrast (A), post-contrast (B) and T2-weighted images (C) of the hip show large irregular defects in both femoral heads anterosuperiorly. In addition to osteonecrosis in both femoral heads, there are multiple medullary infarcts in both iliums (hollow arrows), sacrum (white arrows), and femoral diaphyses (black arrows).

- study of 27 consecutive THAs with a minimal two-year follow-up. *J Bone Joint Surg Br* 1996;78B:878-883
15. Wiesmann A, Pereira P, Bohm P, Faul C, Kanz L, Einsele H. Avascular necrosis of bone following allogeneic stem cell transplantation: MR screening and therapeutic options. *Bone Marrow Transplant* 1998;22:565-569
 16. Resnick D, Sweet DE, Madewell JE: Osteonecrosis: Pathogenesis, diagnostic techniques, specific situations, and complications. In: Resnick D ed. *Diagnosis of Bone and Joint Disorders*. Ed 4. Philadelphia: WB Saunders, 2002:3599-3685
 17. Ficat RP. Idiopathic bone necrosis of the femoral head. Early diagnosis and treatment. *J Bone Joint Surg* 1985;67:3-9
 18. Arlet J. Nontraumatic avascular necrosis of the femoral head. Past, present, and future. *Clin Orthop* 1992;277:12-21
 19. Mankin HJ. Nontraumatic necrosis of bone (osteonecrosis). *N Engl J Med* 1992;326:1473-1479
 20. Torii Y, Hasegawa Y, Kubo T, et al. Osteonecrosis of the femoral head after allogeneic bone marrow transplantation. *Clin Orthop* 2001;382:124-132
 21. Mitchell DG, Rao VM, Dalinka MK, et al. Femoral head avascular necrosis: correlation of MR imaging, radiographic staging, radionuclide imaging, and clinical findings. *Radiology* 1987;162:709-715
 22. Glickstein MF, Burk DL Jr, Schiebler ML, et al. Avascular necrosis versus other diseases of the hip: sensitivity of MR imaging. *Radiology* 1988;169:213-215
 23. Mori A, Hashino S, Kobayashi S, et al. Avascular necrosis in the femoral head secondary to bone marrow infarction in a patient with graft-versus-host disease after unrelated bone marrow transplantation. *Ann Hematol* 2001;80:238-242
 24. Fink JC, Leisenring WM, Sullivan KM, Sherrard DJ, Weiss NS. Avascular necrosis following bone marrow transplantation: a case-control study. *Bone* 1998;22:67-71
 25. Zizic TM, Marcoux C, Hungerford DS, Dansereau JV, Stevens MB. Corticosteroid therapy associated with ischemic necrosis of bone in systemic lupus erythematosus. *Am J Med* 1985;79:596-604
 26. Feletti C, Di Felice A, Scolari MP, Bonomini V. Glucocorticoids and avascular bone necrosis in renal transplantation. *Adv Exp Med Biol* 1984;171:361-368
 27. Isono SS, Woolson ST, Schurman DJ. Total joint arthroplasty for steroid-induced osteonecrosis in cardiac transplant patients. *Clin Orthop* 1987;217:201-208
 28. Saito S, Ohzono K, Ono K. Joint-preserving operations for idiopathic avascular necrosis of the femoral head. Results of core decompression, grafting and osteotomy. *J Bone Joint Surg Br* 1988;70:78-84
 29. Markel DC, Miskovsky C, Sculco TP, Pellicci PM, Salvati EA. Core decompression for osteonecrosis of the femoral head. *Clin Orthop* 1996;323:226-233
 30. Hopson CN, Siverhus SW. Ischemic necrosis of the femoral head. Treatment by core decompression. *J Bone Joint Surg Am* 1988;70:1048-1051
 31. Camp JF, Colwell CW Jr. Core decompression of the femoral head for osteonecrosis. *J Bone Joint Surg Am* 1986;68:1313-1319
 32. Mont MA, Carbone JJ, Fairbank AC. Core decompression versus nonoperative management for osteonecrosis of the hip. *Clin Orthop* 1996;24:169-178
 33. Inao S, Ando M, Gotoh E, Matsuno T. Minimum 10-year results of Sugioka's osteotomy for femoral head osteonecrosis. *Clin Orthop* 1999;368:141-148
 34. Hartley WT, McAuley JP, Culpepper WJ, Engh CA Jr, Engh CA Sr. Osteonecrosis of the femoral head treated with cementless total hip arthroplasty. *J Bone Joint Surg Am* 2000;82:1408-1413
 35. Callaghan JJ, Albright JC, Goetz DD, Olejniczak JP, Johnston RC. Charnley total hip arthroplasty with cement. Minimum twenty-five-year follow-up. *J Bone Joint Surg Am* 2000;82:487-497

Osteonecrosis of the Femoral Head after Bone Marrow Transplantation¹

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Purpose: To retrospectively review finding of osteonecrosis of the femoral head after bone marrow transplantation.

Materials and Methods: We reviewed the clinical and MR findings of osteonecrosis of the femoral head in 23 of 1112 patients who underwent marrow transplantation during a five-year follow-up period lasting from 1996 to 2000.

Results: Mean age at the time of diagnosis was 31 (range, 20 - 47) years, and the mean time from transplant to diagnosis was 17 months. All patients developed variable graft-versus-host disease and seventeen were treated with high-dose prednisolone and/or cyclosporin for severe acute or extensive chronic graft versus host disease. Osteonecrosis was diagnosed by magnetic resonance (MR) imaging, which allowed early detection of disease assessment of its stage. At the time of diagnosis, 15 hips were at stage I, 28 at stage II, two at stage III, and none at stage IV, according to the international ARCO classification system. Osteonecrosis of femoral diaphyses, the lower lumbar spine, or pelvic bones in the MR field was also found to have occurred in 11 patients. Initial treatment was conservative: 21 hips underwent surgery [core decompression ($n=10$), vascularized fibular bone graft ($n=5$), and joint replacement ($n=6$)].

Conclusion: In patients receiving high-dose steroids for the treatment of graft-versus-host disease, MR screening might help detect osteonecrosis at an early stage.

Index words : Bone marrow, transplantation
Bones, necrosis
Hip, MR
Steroids, complications

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