

:

:

126 188

376

:

11.4% (43/376)

T1 T2

52.1%, 38.8%,

11.2%, 24.2%

100%, 95.3%, 39.5%, 86.5%,
21.9%, 28.1%, 40.5%, 40.7%,
71.5%, 86.4%, 84.0%

54.1%, 68.5%, 92.5%, 83.9%,
100%, 99.1%, 92.2%, 97.9%, 59.3%,

가 ($p < 0.001$).

:

가

가 (1, 2).

가

(7 - 9),

가

가

(3).

polymethylmethacrylate (PMMA)

(4 - 2003 1 2005 5

6).

138

126

71.7 (42 - 92)

가 98 , 가 28

126

188

376

2006 1 2

2006 11 30

4 5
(T4: 1 , T5: 3 , T6: 6 , T7: 7 , T8: 8 , T9: 6 ,
T10: 10 , T11: 22 , T12: 31 , L1: 46 , L2: 21 , L3:
16 , L4: 7 , L5: 4)

DSA (digital subtraction angiography)가
(Integris V - 3000, Koninklijke Philips
Electronics, N.V.)

11 13 (J type bone
marrow needle, Manan Medical Products, Gainesville, 30
U.S.A.) 1/3

0.9% 1:1
Polymethylmethacrylate (PMMA, CMW3 bone cement,
DePuy international Ltd, Blackpool, England) 15 cc
(barium sulfate) 가
(PMMA monomer) 5 - 8 cc 30cc 1
, 1 cc
가
가

16

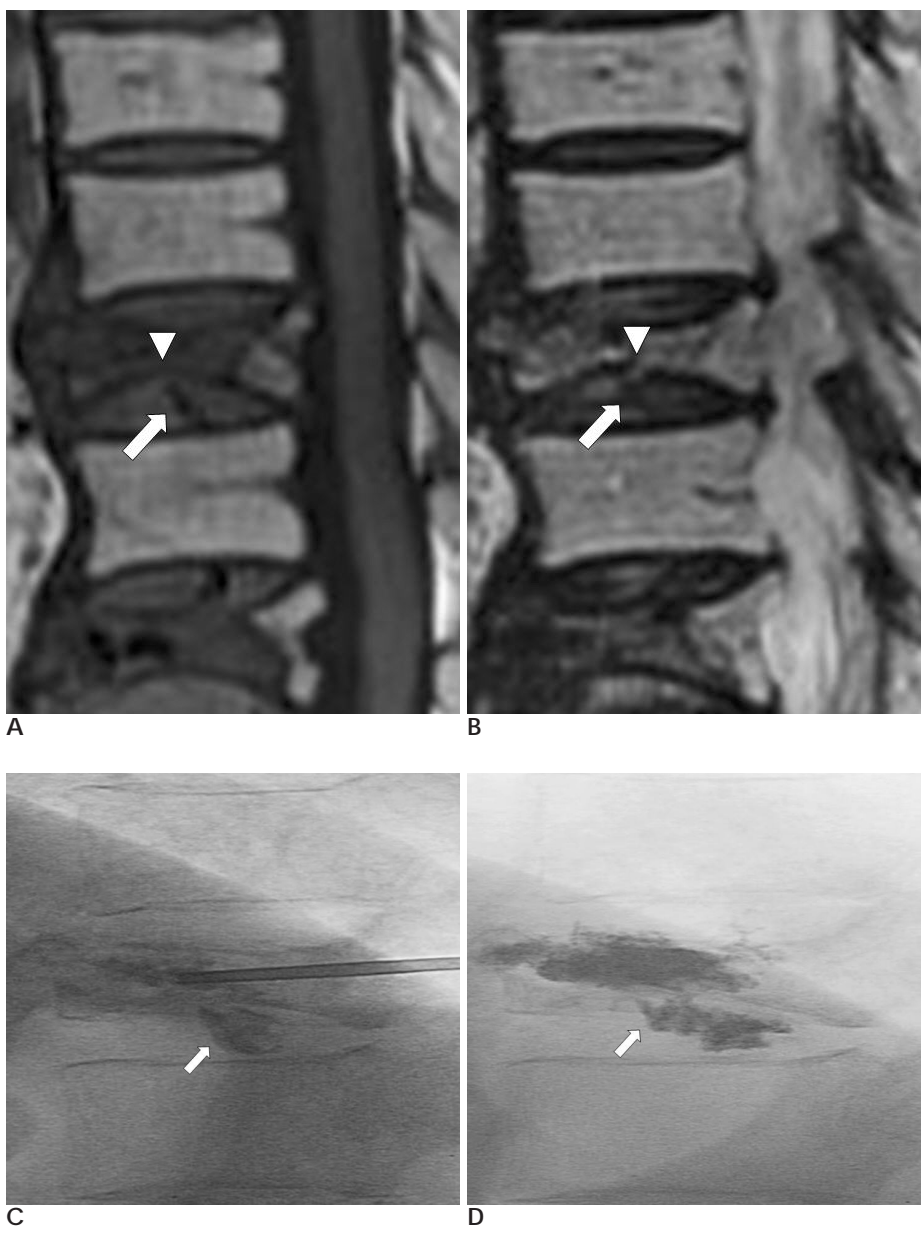


Fig. 1. A 64-year-old female had undergone vertebroplasty of T11 and L1 body due to acute compression fractures. T1 weighted (A) and T2 weighted (B) sagittal images show cortical defect at vertebral lower endplate (arrowheads) of T11 body and low signal intensity linear lesions in the disc (arrows). After contrast (C) and bone cement (D) injection, fluoroscopic images show leakage of bone cement at intervertebral space at the same site of disc lesion (arrows).

2

SPSS version 10
(Chi-square test)

188

376

(vertical), (oblique)

T1

T2

(Fig. 1A, B).

126

188

376

41

(T5: 1, T7: 1, T9:

(Fig. 1C, D).

2, T10: 1, T11: 2, T12: 9, L1: 16, L2: 5, L3:

1 L3: 3)

43

가

T1

T2

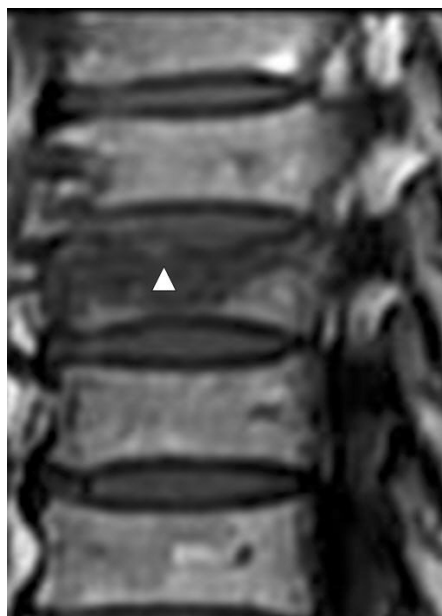
1.5 - 14 cc

(6.79 cc) ,

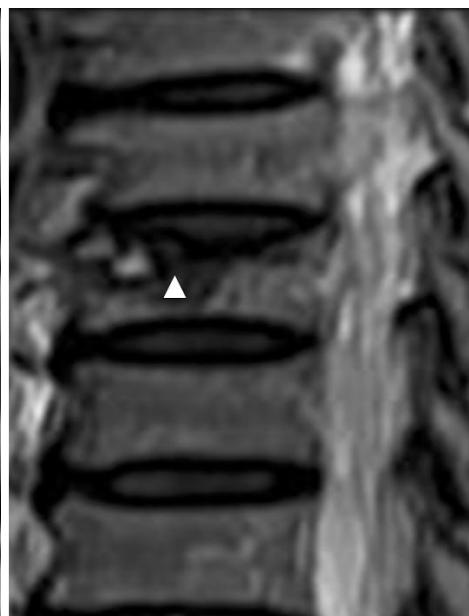
2.5 - 14 cc (

7.81 cc) .

T1 T2

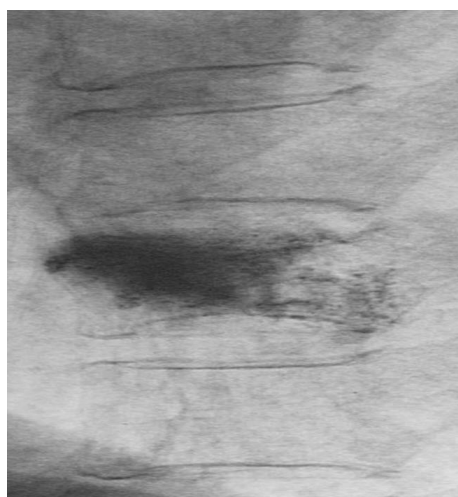


A

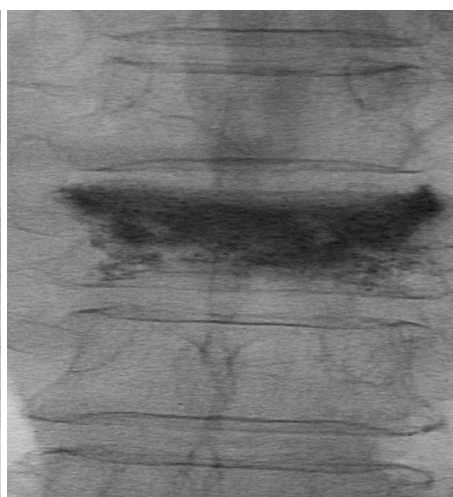


B

Fig. 2. A 78-year-old female who had undergone vertebroplasty of T9 body due to acute compression fracture. T1 weighted (A) and T2 weighted (B) sagittal images show cortical defect at vertebral upper endplate (arrowheads) of T9 body, but there is no low signal intensity linear lesion in the disc. After bone cement injection (C & D), fluoroscopic images show no leakage of bone cement.



C



D

196 (52.1%), 146 (38.8%) , (86.4%, 84.0%)
42 (11.2%), 91 (24.2%) . (59.3%, 71.5%) (Table 2).

T1
21.9% (43/196) ,
(0/180).
40.5% (17/42)
(Fig. 1),
1984 Deramond Galibert (10)
7.8% (26/334) , 92.2% (308/334)
(Fig. 2). T2 가 가 .
28.1% (41/146), 24
0.9% (2/230) .
40.7% (37/91)
(Fig. 1), 2.1% (6/285) (11 - 16).
, 97.9% (279/285) 가
(Fig. 2). T1 T2 .
($p < 0.001$) (Table 1).
T1 가
(100%) T2 가 (17).
(95.3%) (86.5%)
T1 가 가 .
(39.5%) T1 T2 ,
(92.5%), T2
(83.9%), T2
(68.5%), T1
(54.1%) .
T1 T2 (PMMA monomer)
(40.5%, 40.7%) (21.9%, 28.1%) 가 (7 - 9).
T1
(100%), T2
(99.1%), T2
(97.9%), T1 Lin (18)
(92.2%) . T1 T2 가
가

Table 1. Numbers of Intradiscal Leakage in Association with End Plate Cortical Injury and Intradiscal Low Signal Intensity Lesions in 376 Upper and Lower End Plates

MRI Findings	Leakage into the Disc	No Leakage into the Disc	Total
EP (+) in T1WI	43	153	196
EP (-) in T1WI	0	180	180
EP (+) in T2WI	41	105	146
EP (-) in T2WI	2	228	230
LSI (+) in T1WI	17	25	42
LSI (-) in T1WI	26	308	334
LSI (+) in T2WI	37	54	91
LSI (-) in T2WI	6	279	285

EP: end plate cortical injury
LSI: intradiscal low signal intensity lesion associated with end plate cortical injury

Table 2. Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value and Accuracy of Endplate Cortical Bone Defect and Low Signal Intensity Lesion of Disc on MRI

MRI Findings	Sensitivity	Specificity	PPV	NPV	Accuracy
EP (+) in T1WI	100%	54.1%	21.9%	100%	59.3%
EP (+) in T2WI	95.3%	68.5%	28.1%	99.1%	71.5%
LSI (+) in T1WI	39.5%	92.5%	40.5%	92.2%	86.4%
LSI (+) in T2WI	86.5%	83.9%	40.7%	97.9%	84.0%

EP: end plate cortical injury
LSI: intradiscal low signal intensity lesion associated with end plate cortical injury
PPV : positive predictive value
NPV : negative predictive value

가
(19) T1 100%
가
가 T1
(45) (7) 가 ,
T1 T2
,
188 T1 T2
가
가
가
Oner (20) 가
가
가
가
7.81 cc
가 6.36 cc
가 53% 39%
가 T11 38%,
17% 가
가
가 28.1 - 40.7%
(19) (38.8%)
가
가
가
가
가
(10),
가
Peh
가
(21, 22),
가
가
(23). 2 cc

(23).

가

1. Melton LJ 3rd, Kan SH, Frye MA, Wahner HW, O Fallon WM, Riggs BL. Epidemiology of vertebral fractures in women. *Am J Epidemiol* 1989;129:1000-1011
2. Kanis JA, McCloskey EV. Epidemiology of vertebral osteoporosis. *Bone* 1992;13 Suppl 2:S1-10
3. Rapado A. General management of vertebral fracture. *Bone* 1996;18(3suppl):191S-196S

4. Murphy KJ, Deramond H. Percutaneous vertebroplasty in benign and malignant disease. *Neuroimaging Clin N Am* 2000;10:535-545
5. Park JY, Kim SC, Lee JY, Cha SH. Percutaneous vertebroplasty for the treatment of osteoporotic vertebral compression fractures. *J Korean Radiol Soc* 2003;48:433-439
6. Jensen ME, Evans AJ, Mathis JM, Kallmes DF, Cloft HJ, Dion JE. Percutaneous polymethylmethacrylate vertebroplasty in the treatment of osteoporotic vertebral body compression fractures: technical aspects. *AJNR Am J Neuroradiol* 1997;18:1897-1904
7. Appel NB, Gilula LA. Percutaneous vertebroplasty in patients with spinal canal compromise. *AJR Am J Roentgenol* 2004;182:947-951
8. Ratliff J, Nguyen T, Heiss J. Root and spinal cord compression from methylmethacrylate vertebroplasty. *Spine* 2001;26:E300-E302
9. Yoo KY, Jeong SW, Yoon W, Lee J. Acute respiratory distress syndrome associated with pulmonary cement embolism following percutaneous vertebroplasty with polymethylmethacrylate. *Spine* 2004;29:E294-E297
10. Galibert P, Deramond H, Rosat P, Le Gars D. Preliminary note on the treatment of vertebral angioma by percutaneous acrylic vertebroplasty. *Neurochirurgie* 1987;33:166-168
11. Cortet B, Cotten A, Boutry N, Flipo RM, Duquesnoy B, Chastanet P, et al. Percutaneous vertebroplasty in the treatment of osteoporotic vertebral compression fractures: an open prospective study. *J Rheumatol* 1999;26:2222-2228
12. Cotten A, Boutry N, Cortet B, Assaker R, Demondion X, Leblond D, et al. Percutaneous vertebroplasty : state of the art. *Radiographics* 1998;18:311-320
13. Deramond H, Derrasson R, Galibert R. Percutaneous vertebroplasty with acrylic cement in the treatment of aggressive spinal angiomias. *Rachis* 1989;1:143-153
14. Grados F, Depriester C, Cayrolle G, Hardy N, Deramond H, Fardellone P. Long-term observations of vertebral osteoporotic fractures treated by percutaneous vertebroplasty. *Rheumatology* 2000;39:1410-1414
15. Deramond H, Depriester C, Galibert P, Le Gars D. Percutaneous vertebroplasty with polymethylmethacrylate: technique, indications and results. *Radiol Clin North Am* 1998;36:533-546
16. Zoarski GH, Snow P, Olan WJ, Stallmeyer MJ, Dick BW, Hebel JR, et al. Percutaneous vertebroplasty for osteoporotic compression fractures: quantitative prospective evaluation of long-term outcomes. *J Vasc Interv Radiol* 2002;13:139-148
17. Do HM. Intraosseous venography during percutaneous vertebroplasty; is it needed. *AJNR Am J Neuroradiol* 2002;23:508-509
18. Lin EP, Ekholm S, Hiwatashi A, Westesson PL. Vertebroplasty; cement leakage into the disc increases the risk of new fracture of adjacent vertebral body. *AJNR Am J Neuroradiol* 2004;25:175-180
19. Koh YH, Han DH, Choi YH, Cha JH, Jun DS, Jin W, et al. MR predictors of bone cement leakage in patients receiving percutaneous vertebroplasty. *J Korean Radiol Soc* 2005;53:41-47
20. Oner FC, vd Rijt RH, Ramos LM, Groen GJ, Dhert WJ, Verbout AJ. Correlation of MR images of disc injuries with anatomic sections in experimental thoracolumbar spine fractures. *Eur Spine J* 1999;8:194-198
21. Gilula L. Is insufficient use of polymethylmethacrylate a cause for vertebroplasty failure necessitating repeat vertebroplasty? *AJNR Am J Neuroradiol* 2003;24:2120-2122
22. Peh WC, Gilula LA, Peck DD. Percutaneous vertebroplasty for severe osteoporotic vertebral body compression fractures. *Radiology* 2002;223:121-126
23. Ryu KS, Park CK, Kim MC, Kang JK. Dose-dependent epidural leakage of polymethylmethacrylate after percutaneous vertebroplasty in patient with osteoporotic vertebral compression fractures. *J Neurosurg* 2002;96 Suppl:56-61

MR Findings Predictive of Intradiscal Leakage of Bone Cement in Vertebroplasty¹

Kye Ho Lee, M.D., Dong Soo Yoo, M.D., You Me Kim, M.D., Young Seok Lee, M.D.

¹Department of Radiology, Dankook University College of Medicine

Purpose: To evaluate the relation between pre-operative MR findings and intradiscal bone cement leakage.

Materials and Methods: Pre-operative MR and vertebroplasty were performed in 188 vertebral bodies, 376 superior and inferior cortical endplates and intervertebral discs of 126 patients. We analyzed the relation between endplate cortical injury and intradiscal linear low signal intensity lesions in the pre-operative MR images and measured intradiscal bone cement leakage on post-operative CT and fluoroscopy.

Results: Intradiscal bone cement leakage was found in 11.4% (43/376) of the cases. The incidence of endplate cortical injury in T1, T2 weighted MR images were 52.1% and 38.8%, respectively; the incidence of intradiscal linear low signal intensity lesions in T1, T2 weighted images were 11.2% and 24.2%, respectively. In relation with pre-operative MR findings and intradiscal bone cement leakage, the sensitivities of end plate cortical injury in T1 and T2 weighted images and intradiscal low signal intensity lesions in T1 and T2 weighted images were 100%, 95.3%, 39.5%, 86.5%, the specificities were 54.1%, 68.5%, 92.5%, 83.9%, the positive predictive values were 21.9%, 28.1%, 40.5%, 40.7%, the negative predictive values were 100%, 99.1%, 92.2%, 97.9%, and the accuracy were 59.3%, 71.5%, 86.4%, 84.0%. The incidence of intradiscal bone cement leakage was significantly increased when endplate cortical injury and intradiscal linear low signal intensity lesions were observed ($p < 0.001$).

Conclusion: Endplate cortical injury and intradiscal linear low signal intensity observed in pre-operative MR are useful findings in predicting intradiscal bone cement leakage.

Index words : Vertebroplasty
Intervertebral disc
Spine
Osteoporosis
Magnetic resonance (MR)

Address reprint requests to : Dong Soo Yoo, M.D., Department of Radiology, Dankook University College of Medicine
16-5 Anseo-Dong, Cheonan, Chungcheong Nam Do Republic of Korea
Tel. 82-41-550-6907 Fax. 82-41-552-9674 E-mail: radyds@dankook.ac.kr