



Occult Intertrochanteric Fracture Mimicking the Fracture of Greater Trochanter

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Purpose: Occult intertrochanteric fractures are misdiagnosed as isolated greater trochanteric fractures in some cases. We investigated the utility of three-dimensional computed tomography (3D-CT) and magnetic resonance imaging (MRI) in the diagnosis and outcome management of occult intertrochanteric fractures.

Materials and Methods: This study involved 23 cases of greater trochanteric fractures as diagnosed using plain radiographs from January 2004 to July 2013. Until January 2008, 9 cases were examined with 3D-CT only, while 14 cases were screened with both 3D-CT and MRI scans. We analyzed diagnostic accuracy and treatment results following 3D-CT and MRI scanning.

Results: Nine cases that underwent 3D-CT only were diagnosed with isolated greater trochanteric fractures without occult intertrochanteric fractures. Of these, a patient with displacement received surgical treatment. Of the 14 patients screened using both CT and MRI, 13 were diagnosed with occult intertrochanteric fractures. Of these, 11 were treated with surgical intervention and 2 with conservative management.

Conclusion: Three-dimensional CT has very low diagnostic accuracy in diagnosing occult intertrochanteric fractures. For this reason, MRI is recommended to confirm a suspected occult intertrochanteric fracture and to determine the most appropriate mode of treatment.

Key Words: Femur, Occult fracture, Intertrochanteric fracture, Magnetic resonance imaging, Computed tomography

INTRODUCTION

Isolated fractures of the greater trochanter are relatively

uncommon and are typically managed with conservative treatment or surgical intervention (in cases with severe displacement or in young patients). Recent studies have reported that occult intertrochanteric fractures are often misdiagnosed as isolated greater trochanteric fractures¹⁻⁴. In particular, displaced intertrochanteric fractures have been detected during follow-up in elderly patients diagnosed with greater trochanteric fractures⁵. Isolated fractures of the greater trochanter are commonly treated with conservative measures^{6,7}. When isolated fractures are associated with occult intertrochanteric fractures, a confirmed diagnosis is essential to detect the possible displacement of an intertrochanteric fracture. In diagnosing fractures, three-dimensional computed tomography (3D-CT) has a higher sensitivity than plain radiography, and this imaging modality is used in identifying fractures

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undetected on radiographs and determining fracture pattern. However, several recent studies have recommended the use of magnetic resonance imaging (MRI), which has a higher sensitivity than CT, in patients with greater trochanteric fractures for the diagnosis of occult intertrochanteric fractures^{1-4,6,8-10}. The current study aimed to investigate the diagnostic usefulness and treatment results of 3D-CT and MRI scans performed to diagnose associated occult fractures in patients with greater trochanteric fractures.

MATERIALS AND METHODS

This study involved 23 cases diagnosed with greater trochanteric fractures using plain radiographs from January 2004 to July 2013 (Table 1). The mean age of subjects was 76.2 years (range, 52-91 years), and the proportion of males to females was 6:18. Bone mineral density was measured using dual energy X-ray absorptiometry in the lumbar region and proximal femur. The average T-score was -2.61 points (range, -0.2-3.8 points). The mechanism of injury was a fall (18 cases), and traffic accidents including motor vehicle accident (2 cases), bicycle accident (2 cases) and pedestrian accident (1 case). Before January 2008, patients with greater trochanteric fractures underwent 3D-CT only to identify the presence of occult intertrochanteric fractures. After January 2008, patients underwent both 3D-CT and MRI. We detected fractures on 3mm-thick coronal and axial scans using a 128 channel 3D-CT scanner (SOMATOM[®] Definition AS plus; Siemens, Berlin, Germany). We used a 1.5 Tesla MRI scanner (1.5T System, Siemens), and obtained 3 mm-thick coronal T1- and T2-weighted images and STIR-weighted images. On average, 3D-CT scans were done 1.8 days post-injury, while MRI scans were performed 2.7 days post-injury. Occult intertrochanteric fractures were defined when 3D-CT scan revealed a fracture line undetected on plain radiographs, and when MRI T1-weighted imaging showed a low-signal-intensity line undetected on 3D-CT scan. MRI findings were categorized according to the classification system of Feldman and Staron[®]. Clinical instability was defined when a fracture line extends through more than 50% of the longitudinal axis on coronal images, and surgical treatment was conducted. Fixation was done using compression hip screws or interlocking intramedullary nails. Greater trochanteric fractures displaced greater

than 1 cm were managed with tension-band wiring or trochanteric-stabilizing plates. In cases of isolated greater trochanteric fractures, patients were placed on bed rest until pain relief, and commenced gradual weight-bearing while ambulating with crutches or a walker.

Our study compared the diagnostic accuracy between MRI and 3D-CT, and examined: i) time of starting weight-bearing, ii) length of hospital days, and iii) complications in the group with 3D-CT only and the group with both CT and MRI. We also evaluated the postoperative capability of function and mobility using modified Koval index^{11,12}. Medical records and clinical databases used for this research were reviewed and approved by the institutional review board of Dongguk University Gyeongju Hospital (110757-201502-HR-06-01).

RESULTS

Occult intertrochanteric fractures were not detected in 9 cases with 3D-CT only. These cases were diagnosed with isolated greater trochanteric fractures and treated conservatively. Of these 9 cases, 8 showed satisfactory results by achieving bone union without any complication on follow-up plain radiographs. On the contrary, 1 case underwent plain radiography on the 9th day after injury due to persisting hip pain, and a displaced fracture was observed in the intertrochanteric region. Subsequently, internal fixation was done using a compression hip screw, and the fracture healed without any complication (Fig. 1). Excluding this case with displacement, the remaining 8 patients commenced partial weight-bearing at an average of 19.7 days (range, 14-28 days), and began ambulation with full weight-bearing at an average of 37.1 days (range, 16-58 days). On average, the modified Koval index score indicating gait ability improved from 4.75 at pre-injury to 4.00.

In 13 (92.9%) out of 14 cases screened with both imaging tests, fractures of the intertrochanteric region were undetected using 3D-CT, but MRI revealed occult fractures. A single case (7.1%) had an isolated greater trochanteric fracture. Feldman and Staron[®] classified intertrochanteric fractures on MRI scan, and there were 9 cases of pattern 1 with the fracture line from the outer to the inner cortical surfaces on coronal MRI T1 weighted image, 4 of pattern 2 with the fracture line extending to the femoral shaft, and no cases of pattern 3 and 4. Surgical management was conducted in 11 out of 13

Table 1. Demographic Data

	No	Sex	Age (yr)	CT finding	MRI finding	Complication	Treatment	BMD (T-score)	Weight bearing (day)	In hospital day	Modified Koval index	
											Pre	Post
3D-CT only	1	F	64	Isolated GT Fx.	None	None	Conservative Tx.	-2.4	21	16	5	5
	2	M	83	Isolated GT Fx.	None	None	Conservative Tx.	-1.9	16	14	4	4
	3	M	76	Isolated GT Fx.	None	None	Conservative Tx.	-0.2	24	51	5	5
	4	F	78	Isolated GT Fx.	None	None	Conservative Tx.	-2.5	14	58	3	3
	5	F	75	Isolated GT Fx.	None	None	Conservative Tx.	-2.8	21	54	5	5
	6	M	52	Isolated GT Fx.	None	None	Conservative Tx.	-3.8	18	48	5	5
	7	F	82	Isolated GT Fx.	None	None	Conservative Tx.	-2.4	19	26	4	4
	8	F	85	Isolated GT Fx.	None	None	Conservative Tx.	-3.1	10	47	3	3
	9	F	91	Isolated GT Fx.	None	Displaced	CRIF with CHS	-2.8	24	20	4	4
3D-CT & MRI	10	F	81	Isolated GT Fx.	GT Fx.	None	Conservative Tx.	-3.4	22	31	5	5
	11	F	83	Isolated GT Fx.	ITC + Fx.	None	CRIF with Gamma nail	-3.0	2	8	5	5
	12	F	76	Isolated GT Fx.	ITC Fx.	None	CRIF with ITSI nail	-2.5	4	24	5	5
	13	F	79	Isolated GT Fx.	ITC Fx.	None	CRIF with CHS	-3.8	3	15	5	4
	14	F	83	Isolated GT Fx.	ITC Fx.	None	CRIF with CHS	-3.1	3	24	4	4
	15	F	68	Isolated GT Fx.	ITC Fx.	None	CRIF with CHS	-3.3	2	13	5	5
	16	F	61	Isolated GT Fx.	ITC Fx.	None	CRIF with CHS	-2.4	4	9	4	4
	17	F	75	Isolated GT Fx.	ITC Fx.	None	CRIF with CHS	-0.6	3	28	3	2
	18	M	79	Isolated GT Fx.	ITC Fx.	None	CRIF with CHS	-2.9	3	14	4	4
	19	M	53	Isolated GT Fx.	ITC Fx.	None	CRIF with CHS	-2.5	2	9	5	5
	20	F	81	Isolated GT Fx.	ITC Fx.	None	CRIF with CHS	-3.4	4	12	3	3
	21	F	80	Isolated GT Fx.	ITC Fx.	None	CRIF with CHS	-2.6	3	9	5	5
	22	F	89	Isolated GT Fx.	ITC Fx.	None	Conservative Tx.	-2.8	24	34	3	3
	23	M	54	Isolated GT Fx.	ITC Fx.	Displaced	Bipolar hemiarthroplasty		21	92	5	5

CT: computed tomography, MRI: magnetic resonance imaging, BMD: bone mineral density, 3D: three dimensional, GT: greater trochanter, ITC: intertrochanteric, CRIF: closed reduction internal fixation, CHS: compression hip screw, ITST: intertrochanteric/subtrochanteric, Tx.: treatment.

cases with occult intertrochanteric fractures (Fig. 2), while conservative care was used in the remaining 2 cases. Partial weight-bearing was allowed in 11 cases after an average of 2.2 postoperative days (range, 1-3 days), and full weight-bearing was permitted after an average of 17.7 postoperative days (range, 11-23 days). The mean length of hospital stay was 15.7 days (range, 12-28 days). The modified Koval index indicated outstanding results in all cases, as the Koval score was from 4.27 at pre-injury to 4.18 at final follow-up on average and there were no surgical complications. Conservative treatment was carried out in 2 cases, 1 due to the patient's refusal of surgery and the other because the patient was at greater risk for surgical and

anesthesia-related complications due to diabetes, liver cirrhosis and other underlying diseases. In the first patient, long-term bed rest was maintained, and bone union of the intertrochanteric fracture was attained without displacement on follow-up radiographs. For the second patient, however, hip displacement appeared on radiographs taken on the 10th postoperative week. The displacement was managed with hip hemiarthroplasty after complete healing of deep infection caused by hematoma by undergoing multiple operations (Fig. 3).

DISCUSSION

For the diagnosis of occult intertrochanteric fractures,

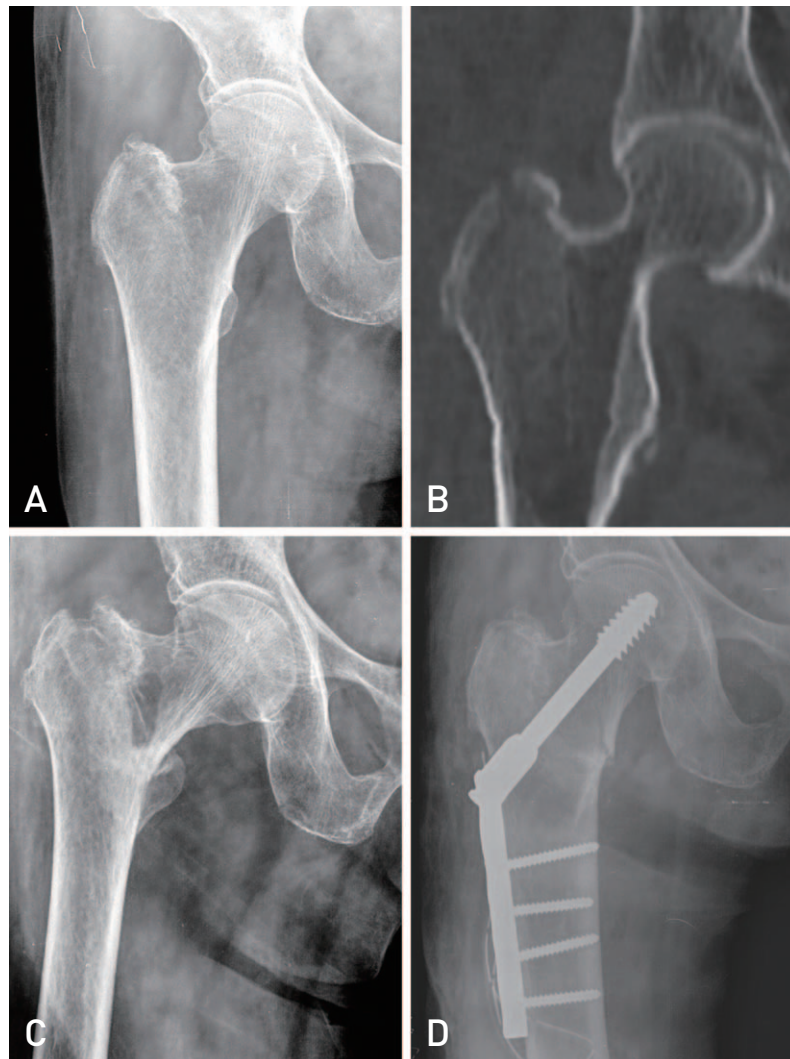


Fig. 1. A 91-year-old woman who presented with right hip pain after fall down. (A) Initial radiograph shows isolated greater trochanteric fracture. (B) Three-dimensional computed tomography shows no occult intertrochanteric fracture. (C) At 9 days after trauma, the radiography shows a displaced intertrochanteric fracture. (D) The postoperative radiograph shows fixation with compressive hip screw.

3D-CT, bone scanning and other imaging tests have been used, and have lower sensitivity and accuracy compared with MRI¹⁾. In this study, we observed that occult intertrochanteric fractures were not detected in 9 cases undergoing 3D-CT only. Of these cases, a patient was found to have an occult fracture as displacement of an intertrochanteric fracture was detected on follow-up plain radiographs. Despite bone union of the greater trochanter without displacement in the intertrochanteric region, the authors did not exclude the risk of occult fractures in the other 8 cases. Occult intertrochanteric fractures not detected with 3D-CT were identified in 13 out of 14 cases screened with MRI.

The intertrochanteric fracture is one of the most common

hip fractures in the elderly, and its incidence is gradually rising with the increase of the elderly population in recent years^{13,14)}. The prevalence of occult fractures is anticipated to be high. Even though fractures are not seen on plain radiographs in elderly patients after falls, occult fractures of the hip are typically suspected and managed when clinical symptoms appear such as hip pain and limitation of movement. Since the intertrochanteric region is more prone to displacement caused by weight-bearing during ambulation, the diagnosis of occult fractures that could be devastating to patients, when accompanied by displacement, is essential. Several previous studies have recommended MRI when an occult intertrochanteric fracture is suspected

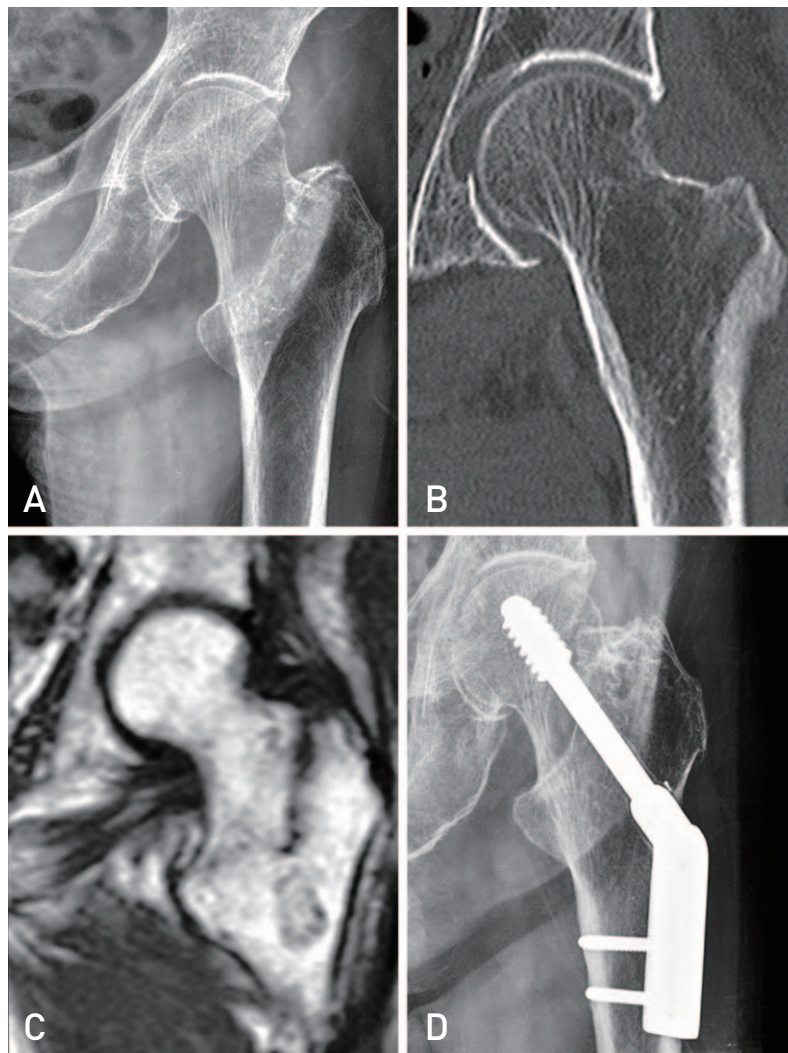


Fig. 2. A 68-years-old woman who presented with left hip pain after fall down. **(A)** Initial radiograph shows isolated greater trochanteric fracture. **(B)** Three-dimensional computed tomography shows no occult intertrochanteric fracture. **(C)** Coronal T1-weighted MRI revealed a fracture from the greater trochanter leading toward the lesser trochanter. **(D)** The postoperative radiograph shows fixation with compressive hip screw.

in patients with greater trochanteric fractures^{1-4,6,8,11,12,15,16}. Cabarrus et al.¹⁷ conducted a comparative study on sensitivity between 3D-CT and MRI in diagnosing occult fractures of the pelvis and proximal femur. Occult fractures were diagnosed in 63 (98%) out of 64 hips that underwent both MRI and CT scanning. On the contrary, occult fractures were detected by 3D-CT in only 34 (53%) out of 64 hips. These findings indicate that MRI has a considerably higher sensitivity than CT in the diagnosis of occult fractures. As the present study was able to find occult fractures with T1-weighted imaging, a number of previous studies have reported that T1-weighted imaging is more superior to T2-weighted imaging for identifying these fractures. Iwata et al.² diagnosed occult fractures in 74.2% of all subjects using MRI, although the fractures were undetected on plain radiographs. In addition, they carried out a study on diagnostic sensitivity of T1- and T2-weighted imaging, and suggested that T1-weighted imaging had excellent sensitivity in identifying occult fractures (84% vs. 100%). Frihagen et al.⁹ demonstrated that T1-weighted imaging had a lower signal to noise ratio and higher anatomical resolution compared with T2-weighted imaging. Bone scanning can be considered a diagnostic tool for detecting occult intertrochanteric fractures. This benefits of this imaging test are its relatively high sensitivity (93%)⁵ and accuracy (95%)¹⁸ of detection and low cost compared with MRI. However, bone

scanning can misdiagnose contusion, synovitis or degenerative arthritis in elderly patients as occult intertrochanteric fractures¹⁵. While MRI can be performed immediately after injury, bone screening requires at least 3 days to be done¹⁸. However, bone scan has a disadvantage of significantly increasing negative predictive rate when performed early^{12,19}. Ingari et al.¹⁹ conducted a study on pathologic correlation whether a line of low signal intensity visualized on MRI performed immediately after injury represents the actual fracture site. After creating a low-signal-intensity line on coronal MRI T1 weighted image by shocking the cadaver, biopsy was done and interposition of cancellous bone was confirmed. However, bleeding or edema were not observed. Consequently, Ingari et al.¹⁹ suggested that the line of low signal intensity on MRI image was the result of the interposition of cancellous bone, instead of a secondary change to the bone following injury. Quinn and McCarthy²⁰ interpreted a fracture line shown on MRI scan as a fracture of cancellous bone. Therefore, MRI is suitable for diagnosing occult intertrochanteric fractures immediately after injury, and bone scan has considerably limited diagnostic accuracy for occult intertrochanteric fractures compared with MRI, despite its relatively high sensitivity and accuracy. In this study, intertrochanteric fractures undetected by 3D-CT in 13 out of 14 cases screened with both imaging scans were confirmed with MRI T1-weighted imaging.

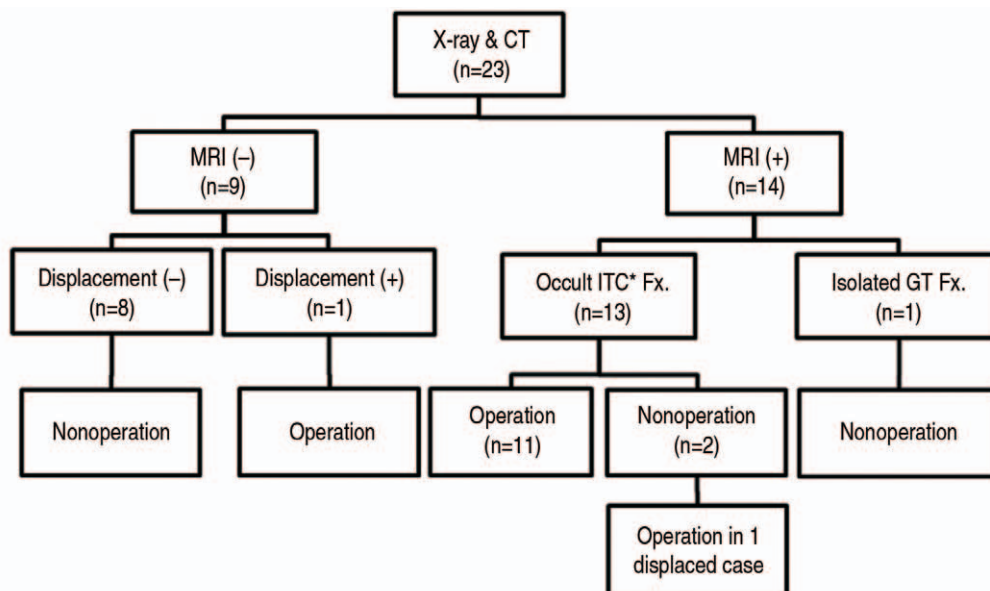


Fig. 3. Summary of diagnosis and treatment. CT: computed tomography, MRI: magnetic resonance imaging, ITC: intertrochanter, Fx.: fracture, GT: greater trochanter.

We were able to diagnose occult intertrochanteric fractures relatively early by performing 3D-CT an average of 1.8 days after injury and MRI an average of 2.7 days after injury.

There are currently no clinical practice guidelines for occult intertrochanteric fractures. Alam et al.²¹⁾ proposed that nonoperative management is sufficient for obtaining bone union. Rubin et al.²²⁾ recommended conservative treatment for patients with occult intertrochanteric fractures and gait ability because the purpose of surgical management of occult intertrochanteric fractures was early ambulation. On the other hand, Schultz et al.²³⁾ and Craig et al.⁷⁾ suggested that surgical management is required when a fracture line crosses the midline on coronal MRI T1-weighted image when a line is drawn between the greater and lesser trochanters. Frihagen et al.⁹⁾ proposed that surgical intervention is necessary in patients at greater risk of displacement due to a load increase in the inner layers of the cortical bone if a fracture line extends through more than half of the longitudinal axis; otherwise, conservative care is used. Feldman et al.¹⁶⁾ underscored the importance of early surgical treatment and ambulation because of the risk of displacement in occult intertrochanteric fractures. Holder et al.⁵⁾ reported a case that underwent surgical intervention by detecting displaced intertrochanteric fracture, in which MRI examination could not be done because of a pacemaker. In the current study, surgical management was instituted as a conservative approach in 1 case diagnosed with an isolated greater trochanteric fracture with CT and 1 case diagnosed with an occult intertrochanteric fracture with MRI. Bone union was achieved without any complication in the first case (diagnosed with CT only), while hip hemiarthroplasty was conducted in the second case after undergoing multiple operations due to deep infection caused by hematoma. In the 11 hips that received surgical treatment after being diagnosed as occult intertrochanteric fractures, postoperative complications were not observed and earlier ambulation with partial and full weight-bearing was achieved compared to hips with isolated greater trochanteric fractures. We anticipate that surgical management and early ambulation following early detection of occult intertrochanteric fractures using MRI will help prevent possible complications accompanied by conservative treatment. Additional studies are warranted to further investigate the effectiveness of surgery for occult fractures compared with conservative

treatment.

This retrospective study was limited in certain aspects. First, our study involved a relatively small sample size. Second, since occult intertrochanteric fractures were confirmed by performing MRI in 14 out of 23 cases with greater trochanteric fractures, we cannot exclude the possibility of occult intertrochanteric fractures in the remaining 9 cases screened with 3D-CT only.

CONCLUSION

Three-dimensional CT has very low diagnostic accuracy in diagnosing occult intertrochanteric fractures. Therefore, MRI is recommended to confirm a suspected occult intertrochanteric fracture and to determine the mode of treatment early.

CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest relevant to this article.

REFERENCES

1. Chatha H, Ullah S, Cheema Z. Review article: Magnetic resonance imaging and computed tomography in the diagnosis of occult proximal femur fractures. *J Orthop Surg (Hong Kong)*. 2011;19:99-103.
2. Iwata T, Nozawa S, Dohjima T, et al. The value of T1-weighted coronal MRI scans in diagnosing occult fracture of the hip. *J Bone Joint Surg Br*. 2012;94:969-73.
3. Reiter M, O'Brien SD, Bui-Mansfield LT, Alderete J. Greater trochanteric fracture with occult intertrochanteric extension. *Emerg Radiol*. 2013;20:469-72.
4. Lee KH, Kim HM, Kim YS, et al. Isolated fractures of the greater trochanter with occult intertrochanteric extension. *Arch Orthop Trauma Surg*. 2010;130:1275-80.
5. Holder LE, Schwarz C, Wernicke PG, Michael RH. Radionuclide bone imaging in the early detection of fractures of the proximal femur (hip): multifactorial analysis. *Radiology*. 1990;174:509-15.
6. Omura T, Takahashi M, Koide Y, et al. Evaluation of isolated fractures of the greater trochanter with magnetic resonance imaging. *Arch Orthop Trauma Surg*. 2000;120:195-7.
7. Craig JG, Moed BR, Eyler WR, van Holsbeeck M. Fractures of the greater trochanter: intertrochanteric extension shown by MR imaging. *Skeletal Radiol*. 2000;29:572-6.
8. Feldman F, Staron RB. MRI of seemingly isolated greater trochanteric fractures. *AJR Am J Roentgenol*. 2004;183:323-9.
9. Frihagen F, Nordsletten L, Tariq R, Madsen JE. MRI diagnosis of occult hip fractures. *Acta Orthop*. 2005;76:

- 524-30.
10. Beloosesky Y, HersHKovitz A, Guz A, Golan H, Salai M, Weiss A. *Clinical characteristics and long-term mortality of occult hip fracture elderly patients. Injury.* 2010;41:343-7.
11. Koval KJ, Skovron ML, Aharonoff GB, Meadows SE, Zuckerman JD. *Ambulatory ability after hip fracture. A prospective study in geriatric patients. Clin Orthop Relat Res.* 1995;(310):150-9.
12. Koval KJ, Zuckerman JD. *Functional recovery after fracture of the hip. J Bone Joint Surg Am.* 1994;76:751-8.
13. Kanis JA, Johnell O, De Laet C, Jonsson B, Oden A, Ogelsby AK. *International variations in hip fracture probabilities: implications for risk assessment. J Bone Miner Res.* 2002;17:1237-44.
14. Gullberg B, Johnell O, Kanis JA. *World-wide projections for hip fracture. Osteoporos Int.* 1997;7:407-13.
15. Rizzo PF, Gould ES, Lyden JP, Asnis SE. *Diagnosis of occult fractures about the hip. Magnetic resonance imaging compared with bone-scanning. J Bone Joint Surg Am.* 1993;75:395-401.
16. Feldman F, Staron R, Zwass A, Rubin S, Haramati N. *MR imaging: its role in detecting occult fractures. Skeletal Radiol.* 1994;23:439-44.
17. Cabarrus MC, Ambekar A, Lu Y, Link TM. *MRI and CT of insufficiency fractures of the pelvis and the proximal femur. AJR Am J Roentgenol.* 2008;191:995-1001.
18. Matin P. *The appearance of bone scans following fractures, including immediate and long-term studies. J Nucl Med.* 1979;20:1227-31.
19. Ingari JV, Smith DK, Aufdemorte TB, Yaszemski MJ. *Anatomic significance of magnetic resonance imaging findings in hip fracture. Clin Orthop Relat Res.* 1996;(332):209-14.
20. Quinn SF, McCarthy JL. *Prospective evaluation of patients with suspected hip fracture and indeterminate radiographs: use of T1-weighted MR images. Radiology.* 1993;187:469-71.
21. Alam A, Willett K, Ostlere S. *The MRI diagnosis and management of incomplete intertrochanteric fractures of the femur. J Bone Joint Surg Br.* 2005;87:1253-5.
22. Rubin G, Malka I, Rozen N. *Should we operate on occult hip fractures? Isr Med Assoc J.* 2010;12:316-7.
23. Schultz E, Miller TT, Boruchov SD, Schmell EB, Toledano B. *Incomplete intertrochanteric fractures: imaging features and clinical management. Radiology.* 1999;211:237-40.