

Herniation Pits of the Femur Neck : Incidence and Radiologic Findings¹

Jae Hyun Cho, M.D., Jin Suk Suh, M.D., Hye Yeon Lee M.D.²

Purpose : In order to assess the incidence and radiologic findings of herniation pit of the femur neck in Korean.

Materials and Methods : In 152 macerated femurs of 88 cadavers, and randomly selected 115 hips of 70 patients, the presence of herniation pit was determined by using fluoroscopy and radiography. It was then examined by CT for inspection of overlying surface and its opening was confirmed by inserting thin steal wire under the fluoroscopic guidance.

Results : Seventeen herniation pits in 15 macerated femurs of 13 cadavers were noted. (14.8%, 13/88). Two of 13 individuals showed bilaterality. All lesions were found only in males. Six herniation pit in 6 femurs of 6 patients (8.6%, 6/70) were also noted. All lesions were on anterosuperior aspect of femur neck. Plain radiographs of macerated femurs revealed well marginated and thin sclerosis in 15 lesions. Of all 23 lesions, CT showed cortical breakdown in 3, and overlying cortical thickening in 8. In 15 macerated femurs, roughed area of cortex was found in anterosuperior aspect of femur in all cases, and tiny openings(diameter less than 1 mm) related to cystic lesions were confirmed in 9 lesions.

Conclusion : The incidence of herniation pits was 14.8% in 88 cadaver, and 8.6% in 70 patients. All were males.

Index Words : Femur, CT
Normal variant

The herniation pit has been known as a normal variation(1, 2), found incidentally in the femur neck on radiographs or CT(computed tomography). It is shows as a well defined radiolucency surrounded by sclerotic rim.

The herniation pit was proven to be produced by soft tissue herniation into subcortical bone, and it was found exclusively at reaction area on anterosuperior aspect of the femur neck(2). However, radiographically similar oval radiolucent lesions may often be observed on the posterior aspect of femur neck. Our question was, "how should herniation pit excluded in the differential diagnosis of the posterior lesion?" However, to our knowledge, not enough series had been reported

afort the hermiation pit which would in any way be an aid in answening one gnestion. Therefore, the authors investigated the location and incidence of herniation pit and its radiographic findings.

MATERIALS and METHODS

One hundred fifty-two macerated femurs of 88 cadavers(age 20—80 years, mean 51.5 years) were included in this study. One hundred twenty-eight femurs were conristed of pairs from same cadaver's. Male : female ratio was 64 : 24. We also reviewed CT images of randomly selected 115 femurs of 70 patients (age 5—71 years old, mean age 38.85 years) who visited our hospital for varions causes. Thirty patients were diagnosed as avascular necrosis of the femoral head on one side, 30 patients were with traumas, 10 patients were with degenerative diseases. Male : female ratio was 46 : 24. Twenty-four femurs were excluded in the analysis because exfersive destructive change made evaluation of the femoral neck lesions unfeasile.

¹Department of Radiology, Yonsei University, College of Medicine

²Department of Anatomy, Yonsei University, College of Medicine

이 연구는 연세대학교 정책 과제연구비의 지원으로 이루어졌음

Received September 30, 1994; Accepted November 17, 1994

Address reprint requests to : Department of Radiology, Yondong Severance Hospital, # 146-92 Dokok-dong, Kangnam-ku, Seoul Korea.

Tel. 82-2-3450-2698 Fax: 82-2-562-5472

Therefore total of 267 femurs in 158 individuals were included (age 5–80 years old, mean 45.7 years old, M : F=110 : 48).

Evaluation of the cadaveric femur were done as follows ; After screening the presence of the lesion in femoral neck by fluoroscopy and gross inspection, the femurs with a small radiolucent lesion were selected. Plain radiographs were obtained. CT evaluation were performed to investigate the details of the femoral neck lesions. CT images were obtained from the femoral head to intertrochanteric area, with 5 mm thickness without an interslice gap. CT machine was GE 9800 (GE, Milwaukee, Wisconsin). If a tiny opening was suspected around the reaction area in the selected femurs,

relationship of external opening with herniation pit was established by probing with a thin metallic wire under the fluoroscopic control.

In all subjects including cadaveric and living subjects, the presence of thin sclerotic margin and lobulation were evaluated using plain radiography. The overlying cortical thickening, small external opening, and marginal sclerosis of the herniation pit were determined by CT.

RESULTS

In cadaveric specimens, 17 well defined radiolucent lesions were observed on the 15 femur of 13 individuals. Age ranged from 30 to 75 year, with mean 57.5 year. All individuals with radiolucent lesions were male, and two showed bilaterality (Table 1). On plain radiographs, well defined lesions with marginal sclerosis were found in 15 of 17 lesions. Lobulated appearance was seen only in one lesion. No intralesional calcification was seen. On initial gross inspection of the surface of the femoral neck, there were no recognizable abnormalities except minimal cortical irregularity, which had been described as the “reaction

Table 1. Incidence, Age, Sex of the Herniation Pits

	Cadavers*	Living Patients**	Total
Incidence	13/88(14.77%)	6/70(8.57%)	19/158(12.05%)
Bilaterality	2/64	0/45	2/109
Age (mean)	30–75yr(57.5)	24–57yr(44.16)	24–75yr(53.29)
male : female	13 : 0	6 : 0	19 : 0

* 17 lesions in 15 femurs in 13 individuals in cadaver study

** 6 lesions in 6 femurs in 6 individuals in living patients

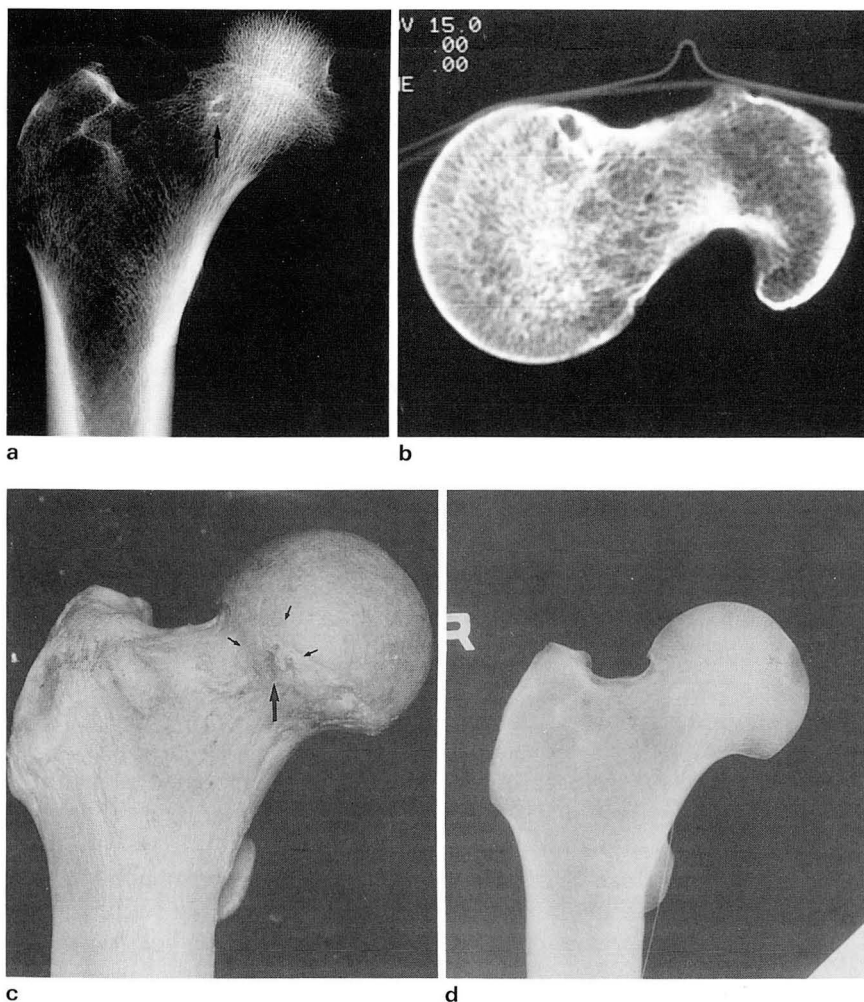


Fig. 1. a. Plain radiography of macerated femur of 60 year-old male cadaver. Small partially sclerotic rimmed radiolucent lesion (arrow) is noted on the femur neck. The lesion was anterior location on fluoroscopic examination.

b. CT scan revealed subcortical cystic lesion with thin sclerotic rim. Overlying cortex was thickened.

c. The surface of the anterosuperior aspect of femur neck show cortical irregularity area from head and neck junction to intertrochanteric line. (small arrows) Small pin point opening was noted. (large arrow)

d. Probing with thin metallic wire revealed the pin point opening communicating with cystic lesion.

area”, by Angel(5). The reaction areas were observed on anterosuperior aspect of the femur neck, just distal to the junction of articular surface and the femoral neck. They were round in shape, slightly elevated at their peripheries, and flat and irregular at the centers.

In every femur, several nutrient foramens were observed at the surface of the posterosuperior aspect of the femur neck, proximal to the greater trochanter.

Fluoroscopically, only three radiolucent lesions were found on the posterior aspect of the femoral neck. These lesions were like a herniation pit, but they were proven to be nutrient foramens by probing with a metallic wire, on fluoroscopy. No subcortical cystic lesions were found on the posterior neck of femurs.

On CT scan, range of the size of lesions was 0.2–0.7 cm (mean 0.39 cm). Sclerotic margins were noted in 15 of 17 lesions. (Fig. 1) Overlying cortical thickening was noted in 8 of 17 lesions. (Fig. 2) Pin point breakdown of cortex was noted in 3 of 17 lesions. (Table 2, Fig. 3)

In 15 femurs with subcortical radiolucent lesion, nine tiny external openings were found proved by probing with a thin metallic wire(Fig. 1).

Most openings were small with the largest one being 2 mm in diameter. Six individuals showed subcortical lesions unilaterally in 70 patients. Patients' age ranged from 24 to 57 year with mean age of 44.16 year. All were male (Table 1). Size of the lesions ranged from 1 mm to 2 mm (mean 1.3 mm). Three of 6 lesions showed thin sclerotic rim, without overlying cortical irregularity, cortical breakdown or overlying cortical thickening. These 6 herniation pits were found in three patients with avascular necrosis, in one patient with degenerative disease, and two patients with trauma. There was no statistically significant disease predilection. (Chi-square test, $p > 0.05$)

DISCUSSION

The surface reaction area was first described by Allen, in 1882 (3). It is a localized intraarticular cortical surface change on the anterior superior quadrant of the femoral neck, but it is not at the attachment site of the joint capsule. It consists of collagenous tissue, neocartilage, and reactive new bone formation, and is known to be due to mechanical, abrasive effect of the adjacent overlying hip capsule (4, 5). The joint capsule over the reaction area is particularly thick due to crossing of the circular and vertical fibers, the zona orbicularis, and the lateral part of the iliofemoral ligament. During hip extension, the anterior capsule tightens and becomes closely apposed to the reaction area. The incidence and prominence of the reaction area are correlated with thickness and roughness of the overlying capsule(5). Its incidence was reported as 74% in females, and 83% in males(5, 6), but unfortunately the reaction area cannot be visualized on plain radiographs.

Focal attenuation or erosion of the cortical bone covering the reaction area, may result in exposure of underlying cancellous bone and marrow (3, 4, 5). The cortical defect may be single or multiple and may appear as a cribriform. According to Pitt *et al.* (2), the herniation pit is formed by penetration of soft tissue, probably derived from the covering synovium or adjacent retinacula, through the defect in the reaction area. A case was demonstrated, with dense fibrocartilagenous tissue herniating through cortical bone into subcortical cavity. Although authors agree with the suggestion of pathogenesis of herniation pit by Pitt *et al.*, the suspicion has remained. In our experience with macerated femurs, the external openings were too

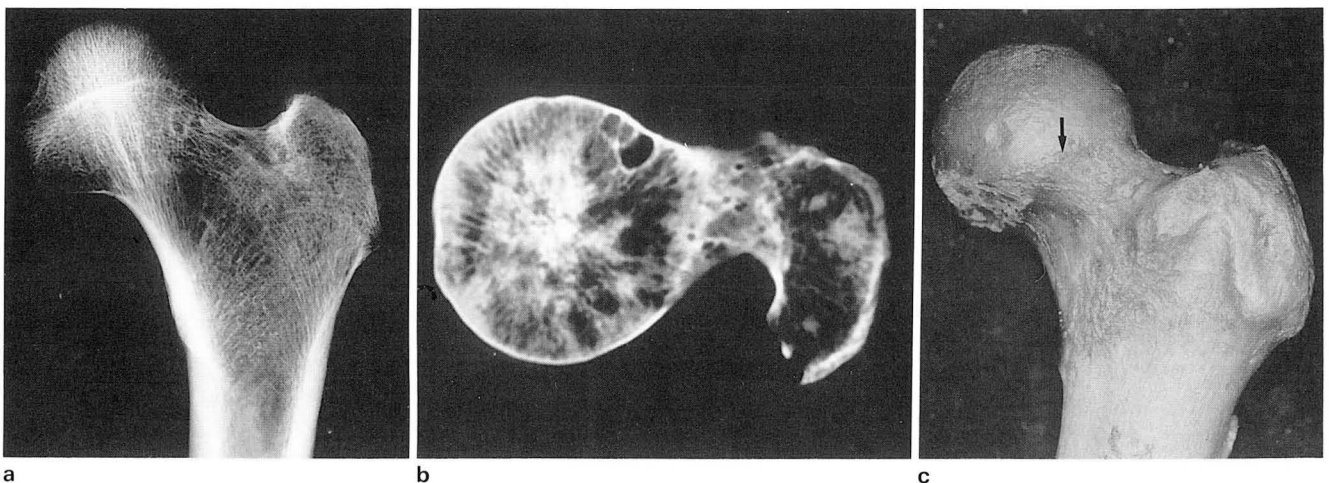


Fig. 2. a. Plain radiography of macerated femur of 45 year-old male cadaver. There showed also small thin sclerotic rimmed radiolucent lesion on the femur neck. The lesion was also on anterosuperior surface.
b. CT scan revealed subcortical cystic lesion with thin sclerotic rim. The lesion showed lobulation. Overlying cortex was also thickened.
c. The cortical surface of femur neck also showed reaction area. However, A opening couldn't be found, except a dark point(arrow).

small to be penetrated by thickened soft tissue through the subcortical cystic lesion. To confirm the suggestion by Pitt et al., more collective data must be gathered in cadaveric studies where soft tissue penetration may be present. This area have been thought to be a vulnerable area of various synovial proliferative disease, such as rheumatoid arthritis, pigmented villonodular synovitis (2).

Our demographic data differed from previous reports(7), in that the incidence was higher and in that male preponderance was noted.

Radiographically, herniation pits are small in size, and are well marginated, accompanied by a thin sclerotic rim. The majority of herniation pits are not greater than 1 cm in size. CT showed overlying cortical thickening and penings in addition to subcortical small well-defined cystic lesion. Bone scintigraphic findings varies, according to the degree of bone remodeling and repair(8). MRI is not indicated in most cases, but it may help in differentiating the herniation pits from other cystic lesions. On T1WI, the herniation pit appeared as uniformly low signal intensity lesion which was connected to the overlying anterior cortex. T2WI showed its peripheral margin with absent signal intensity(7).

The herniation pit itself is a benign lesion found incidentally. However, it may arise clinical concern when found in patients with vague hip pain, or metastatic carcinomas. Herniation pit may infrequently evoke

pain(2, 9), and may grow. The growing herniation pit may show increased uptake on bone scintigraphy(9). Herniation pit may be mimicked by metastatic bone lesions. MRI may be helpful in differentiating herniation pit with the sclerotic margin from metastatic lesions having the rarity of sclerotic margin.

Other cystic lesions on the femoral neck should be included in the differential diagnoses such as nutrient foramen, osteoid osteoma, intraosseous ganglion, Brodie abscess, avascular necrosis. Nutrient foramina were exclusively found in the posterior surface of the femoral neck. Osteoid osteoma may present as a nidus surrounded by reactive new bone formation and periosteal reaction on plain radiographs, and shows markedly increased uptake on bone scintigraphy. Intraosseous ganglion is located on the subchondral area, while herniation pit is on the subcapital area(10, 11). The histologic similarity between intraosseous ganglion and the herniation pit have been discussed. In the early developmental phase of the intraosseous ganglion, fibroblastic metaplasia of mesenchymal cell happen. However, intraosseous ganglions have been regarded as a different entity, due to the differences in anatomic locations and due to the differences in histologic findings in the mature stage(2). Brodie abscess may be difficult to be excluded. However, the typical location and negative bone scan, and the absence of symptoms in herniation pit may be helpful. Avascular necrosis may show similar cystic lesions with sclerotic rim. But most of the abnormalities are seen in subchondral areas of the femoral head.

In conclusion, the incidence of herniation pit was 14.77% in cadaver, and 8.57% in CT evaluation of randomly selected patients. Male predominance was noted. Radiographically, the herniation pit can be characterized by it's anterosuperior location, and one or more cystic lesions less than 1 cm in diameter, and being accompanied by a thin sclerotic margin.

Table 2. CT Findings of the Herniation Pits in Cadaver Study plus Randomly Selected Living Patients.

Findings	Total 23 lesions	
	Yes	No
Sclerotic Margin	18	5
Cortical Thickening	8	15
Cortical Breakdown	3	20

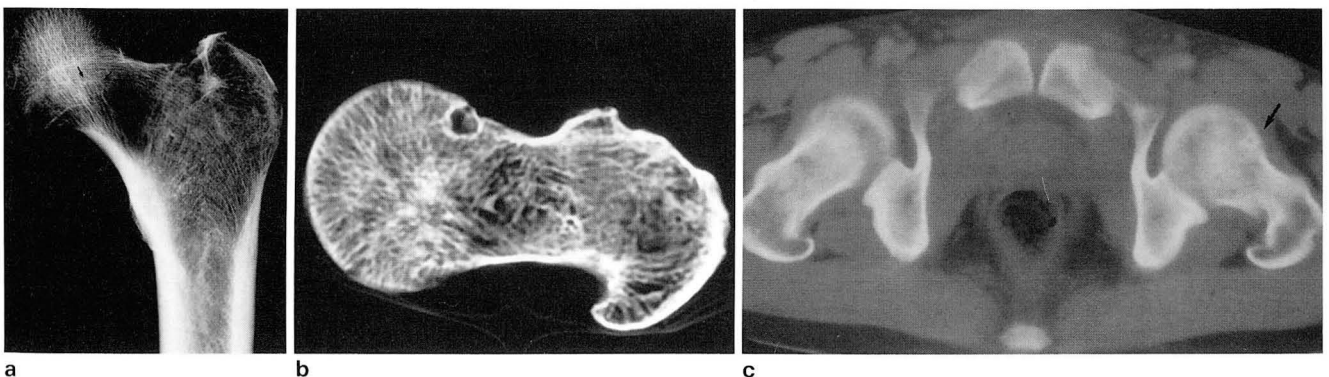


Fig. 3. a. Plain radiography of macerated femur of 57 year-old male cadaver. Suspected thin sclerotic rim was noted on anterosuperior aspect of the femoral neck(arrow), which was more evident on fluoroscopy.
 b. CT scan showed small thin sclerotic rimmed cystic lesion in the subcortical area. Overlying cortical breakdown was noted.
 c. CT scan of 34 year-old who had visited due to motor vehicle accident. Incidentally, about 2 mm sized small thin sclerotic rimmed cystic lesion was noted on left femoral neck(arrow).

REFERENCES

1. Keats TE. An atlas of normal roentgen variants that may simulate disease. 5th ed. Mosby year book. St. Louis. **1973**. p501-502
2. Pitt MJ, Graham AR, Shipman JH, et al. Herniation pit of the femoral neck. *AJR* **1982**; *138*: 1115-1121
3. Allen H. *A system of human anatomy including its medical and surgical relations*. Section II-bone and joints. Philadelphia, Lea. **1882**. 189-269
4. Walmsley T. Observations on certain structural details of the neck of the femur. *J Anat* **1915**; *49*: 238-267
5. Angel JL. The reaction area of the femoral neck. *Clin Orthop* **1964**; *32*: 130-142
6. Schofield G. Metric and morphological features of the femur of the New Zealand Maori. *J R Anthropol Inst Great Br Ireland* **1959**; *89*: 89-105
7. Nokes SR, Vogler JB, Spritzer CE, Martinez S, Herfkens RJ. Herniation pits of the femoral neck: Appearance at MR imaging. *Radiology* **1989**; *172*: 231-234
8. Thomason CB, Silverman ED, Walter RD, Olshaker R. Focal bone tracer uptake associated with a herniation pit of the femoral neck. *Clin Nucl Med* **1983**; *8*: 304-305
9. Crabbe JP, Martel W, Matthews LS. Rapid growth of femoral herniation pit. *AJR* **1992**; *159*: 1038-1040
10. Feldman F, Johnston A. Intraosseous ganglion. *AJR* **1973**; *118*: 328-343
11. Schajowicz F, Sainz MC, Slullitel JA. Juxta-articular bone cysts (intraosseous ganglia). A clinicopathological study of eighty-eight cases. *J Bone Joint Surg(Br)* **1979**; *61*: 107-116

대한방사선의학회지 1994; 31(6) : 1179~1183

대퇴골 경부의 Herniation Pit: 발생빈도 및 방사선학적 소견¹

¹연세대학교 의과대학 진단방사선과학교실

²연세대학교 의과대학 해부학교실

조 재 현 · 서 진 석 · 이 혜 연²

목 적: 대퇴골 경부의 herniation pit의 발현율 및 방사선학적 소견을 알아보기 위함이다.

대상 및 방법: 88 사체의 152 개의 대퇴골 및 임의로 선택된 70 명의 환자를 대상으로 투시 및 단순 X ray 촬영을 통해 herniation pit가 의심되는 병변을 선별하여, 전산화단층촬영으로 유무를 확인하고, 발현율과 위치, 방사선학적 특성을 분석하였다. 가는 금속성 wire를 이용하여 다시 투시를 이용하여 병변과 연결되는 개구(opening)의 유무를 확인하였다.

결 과: X ray 및 육안적 형태를 종합하여 herniation pit로 생각되었던 예는 모두 88 사체 중 13 사체, 15 대퇴골, 17 병변에서 보여 14.8%(13/88)의 발현율을 보였으며, 13명 모두 남자에서 보였으며, 통계적으로 의의가 있었다. 2 명에서는 양측성을 보였다. 임의로 선택된 70명중 6명, 6 대퇴골, 6 병변에서 herniation pit를 발견하여, 8.6%(6/70)의 발현율을 보였으며, 역시 모두 남자에서 관찰되었다. 모든 병변은 대퇴골 경부의 전상부에 위치했다. 대퇴골 단순 촬영에서 17 병변 중 15에서 경계가 잘 지워지며, 얇은 sclerosis의 띠를 가진 것으로 보였다. 사체 및 임의로 선택된 19명 23 병변의 전산화단층촬영에서 병변을 덮고 있는 골 피질의 비후가 8 예에서 보였으며, 골 피질의 단절부가 3 예에서 보였다. 병변이 있는 사체 13 구에서 모두 대퇴골 경부 전상부 골피질 표면에 불규칙한 부분을 관찰하였고, 가는 금속선을 이용하여 작은 구멍이 15 대퇴골 중 9 예에서 확인할 수 있었다.

결 론: Herniation pit의 발현율은 단순촬영 및 전산화단층촬영을 이용하여 사체에서 14.77%, 생체에서 8.57%을 보였으며, 모두 남자에서 관찰되었다.

국제 학술대회 일정표 [IV]

- 1995/11/08-08 Centenary Discovery of X-Rays by W.C. Roentgen**
venue: Wuerzburg, Germany.
contact: Deutsche Roentagens. e.V,
Postfach 1204, D-63232 Neu-Isenburg, Germany.
(tel: 49-6102-4032; fax: 49-6102-6668)
- 1995/11/26-01 81st Meeting Radiological Society of North America (RSNA)**
venue: McCormick Place Chicago, USA.
contact: Michel P. O'Connell, Director of Exhibits,
2021 Spring Road, s.600, Oak Brook, IL 60521, USA.
(tel: 1-708-5712670; fax: 1-708-5717837)
- 1996/03/02-07 21st Annual Meeting Soc. of Cardiovascular and interventional Radiology**
venue: Seattle Conv. Center Seattle, WA, USA.
contact: Soc. Cardio. Interv. Radiol., Technical Exh. Services,
2021 Spring Road, S. 600, Oak Brook, IL 60521, USA
(tel: 1-708-5717854; fax:)
- 1996/03/10-14 Int. London Courses in Computed Tomography and Magnetic Resonance Imaging**
venue: The Gleneagles Hotel Perthshire, Scotland, United Kingdom.
contact: Mrs. T. Seear, The London Clinic,
20 Devonshire Place, London WIN 2DH, Uniter Kingdom.
(tel: 44-71-2240164; fax: 44-71-9352430)
- 1996/03/17-20 Annual Meeting American Institute of Ultrasound in Medicine**
venue: New York, USA.
contact: Convention department, AIUM,
11200 Rockville Pike, MA 20852-3139 Rockville, USA.
(tel: 1-301-8812486; fax: 1-301-8817303)
- 1996/05/05-10 96th Meeting American Roentgen Ray Society**
venue: Marriott Hotel San Diego, CA, USA.
contact: American Roentgen Ray Soc,
1891 Preston White Drive, Reston, VA 22091, USA.
(tel: 1-703-6488992; fax: 1-703-2648863)
- 1996/05/15-18 77th Deutscher Roentgenkongress**
venue: Wiesbaden, Germany.
contact: Deutsche Roentgenges. e.V,
Postfach 1204, D-63232 Nue-Isenburg, Germany.
(tel: 49-6102-4032; fax: 49-6102-6668)
- 1996/05/25-30 Annual Meeting Society for Pediatric Radiology**
venue: Westin Hotel Boston, MA, USA.
contact: Univ. of Colorado, Dept. of Radiology,
4200 East Ninth Avenue, Denver, CO 80262, USA.
(tel: 1-303-2704512; fax:)

제공: 대한방사선의학회 국제협력위원회