

# A technique for pelvic radiography in the standing horse

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**Keywords:** horse; pelvis; radiography; pelvic fracture; acetabulum

## Summary

**Reasons for performing study:** An alternative technique of radiographing the pelvis in the standing horse is required, to avoid the risks associated with general anaesthesia.

**Hypothesis:** That lateral oblique radiography in the standing horse would be a useful technique in the investigation of pelvic injury.

**Objectives:** To describe the technique of lateral oblique pelvic radiography in the standing horse and demonstrate the feasibility and usefulness of this technique.

**Methods:** A technique for lateral oblique radiography in the standing horse was devised and retrospective review made of radiographic findings in 18 clinical cases.

**Results:** The caudal iliac shaft, greater trochanter of the femur, femoral head, acetabulum and coxofemoral articulation on the side under investigation were visualised consistently using this technique. Of the 18 cases, 3 iliac shaft fractures, 1 acetabular fracture, 2 coxofemoral luxations and 4 horses with new bone formation around the coxofemoral joint and/or proximal femur were identified.

**Conclusions:** Lateral oblique radiography in the standing, conscious horse can be used to investigate conditions affecting the caudal iliac shaft, coxofemoral articulation and proximal femur in the horse.

**Potential relevance:** The technique is straightforward, noninvasive and useful in the investigation of horses with suspected pelvic injury. However, not all pelvic injuries would be identified, and normal radiographic findings do not rule out injury or fractures elsewhere in the pelvis.

## Introduction

Indications for equine pelvic radiography include investigation of hindlimb lameness in the absence of detectable abnormalities or response to local analgesia in the lower limb, asymmetry of the pelvic region and the presence of crepitus in the pelvic region. The most common indication is in the definitive diagnosis of suspected pelvic fractures, which often have a nonspecific clinical presentation. Although affected horses typically demonstrate significant hindlimb lameness, the presence of crepitus and/or abnormal findings on rectal examination have been found to be inconsistent (Jeffcott 1982; Hendrickson 1987; Little and Hilbert 1987).

Radiography is reported as a reliable diagnostic aid for equine pelvic fractures (Little and Hilbert 1987). Radiographic techniques include ventrodorsal radiographs obtained with the horse in dorsal recumbency under general anaesthesia (Lewis and Heinze 1971; Kangstrom 1972), and ventrodorsal (May *et al.* 1991) and lateral (Jeffcott 1979; Little and Hilbert 1987) radiographs in the standing horse.

Additional risks associated with general anaesthesia of horses with suspected pelvic fracture are the potential for fracture displacement and/or haemorrhage due to laceration of internal iliac arteries during recovery. May *et al.* (1991) described a technique of obtaining ventrodorsal radiographs of the standing horse with the x-ray machine positioned ventral to the abdomen and the cassette positioned dorsal to the sacrum. This technique avoids the risks associated with recovery from general anaesthesia, but there are some disadvantages. Centring and collimation of the x-ray beam and safe handling of the cassette can be difficult. The technique also poses some risk to the x-ray machine in fractious horses. Lateral radiographs of the pelvis of the standing horse are considered to be of little value (Little and Hilbert 1987) except in the identification of some sacral fractures (Hendrickson 1987).

Scintigraphy is highly sensitive but nonspecific for bone pathology. With its ability to image the whole skeleton in the standing sedated horse, it has had a major impact in the diagnosis of pelvic fractures (Driver 2003). However, there are several factors that may influence its sensitivity, including attenuation of the gamma-photons by the pelvic muscle mass and the position of the urinary bladder (Hendrickson 1987; Pilsworth *et al.* 1993; Hornof *et al.* 1996; Attenburrow 1997; Erichsen and Berger 2001). Bone scanning the horse too early following the originating incident also leads to false negatives, presumably because the 'up-regulation' of bone turnover has not yet occurred. It is commonly recommended to wait at least 7 days before performing a bone scan when investigating a suspected fracture. It is also possible to produce false negative images of the pelvis when a fracture is present without a definitive underlying cause, up to 14 days after injury (A.J. Driver, unpublished data). Scintigraphy is the technique of choice for the diagnosis of suspected stress fractures (Hornof *et al.* 1996).

Ultrasonography is also useful in the assessment of pelvic damage, but is limited to the detection of discontinuity of bony surfaces and identification of soft tissue changes (Shepherd and Pilsworth 1994; Busoni 2001; Tomlinson *et al.* 2000, 2001; Almanza and Whitcombe 2003).

This article describes a technique for obtaining lateral oblique views of the pelvis in a standing, conscious horse.

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[Paper received for publication 25.08.05; Accepted 28.11.05]

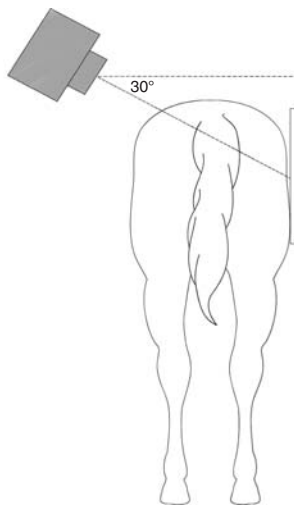


Fig 1: Positioning the x-ray tube and cassette for standing lateral oblique radiography of the equine pelvis.



Fig 2: Areas of the pelvis visualised during standing lateral oblique pelvic radiography.

## Materials and methods

The results of lateral oblique radiographic views obtained in 18 horses at the Equine Diagnostic Centre, University of Bristol, UK, between March 2000 and June 2005 were evaluated.

### Radiographic technique

Lateral oblique radiography (lateral 30° dorsal-lateroventral oblique) was carried out with the horse standing. In fractious animals, sedation was helpful. The rectum was evacuated where possible; an air-filled rectum provides good contrast for the visualisation of the bony structures and avoids the potential for artefacts created by overlying faecal material. The horse was, as far as possible, standing squarely on all 4 limbs. A vertically positioned x-ray cassette (X-Omatic)<sup>1</sup> was positioned against the side of the pelvis under examination and the x-ray tube angled approximately 30° ventrally from horizontal. It was centred between the level of the greater trochanter and the base of the tail on the tube side, approximately two-thirds along the craniocaudal distance between the palpable landmarks of the *tuber sacrale* and *tuber ischia* (Fig 1). The height and craniocaudal position of the cassette were adjusted to coincide with the path of the x-ray

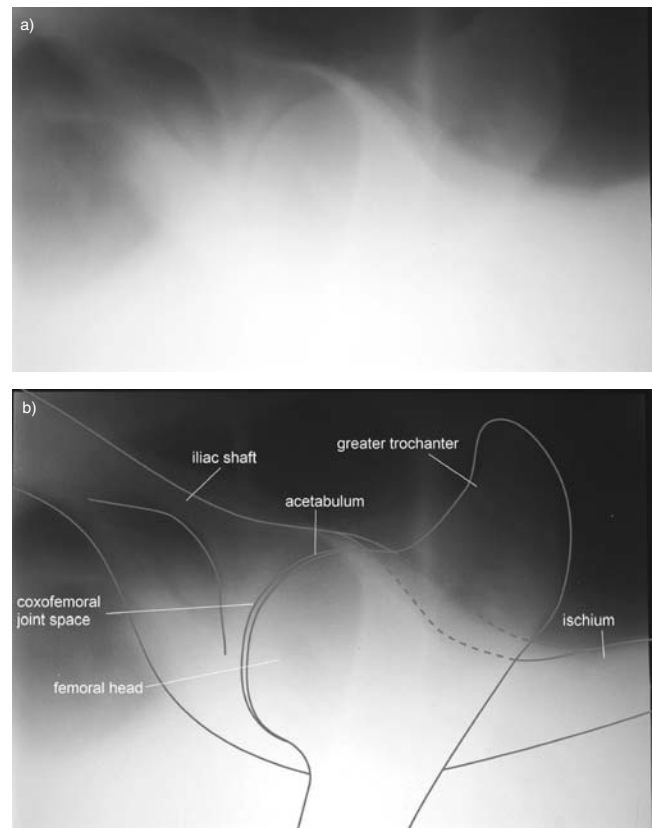


Fig 3: a) Normal standing lateral oblique view of the equine pelvis. b) The same image with diagram of visible structures overlaid.

beam. Rare earth screens (Lanex Regular)<sup>1</sup> and a stationary parallel grid (parallel 12:1 grid)<sup>2</sup> were used, with a film-focal distance of approximately 100 cm. For the x-ray machine (UD150B-10 generator, maximum exposure factors 150 kV and 1000 mA, with Comet tube, Argostat tube crane and Bucky system)<sup>2</sup> and film (MG SR Medical Film)<sup>3</sup>-screen-grid combination in our clinic, the settings used varied from 90 to 130 kV and 125 to 400 mAs, depending on the size of the horse and the pelvic muscle mass.

The lead strips within the parallel grid were orientated vertically, so that the dorsoventral angulation of the x-ray beam did not result in the phenomenon of grid cut-off. Due to the relatively large exposure factors used, cassettes were not held by hand but by a gantry-mounted holder. However, a cassette mounted or suspended from a vertical stand would be equally suitable. To minimise the radiation hazard to personnel, only the person holding the horse's head was present at the time of exposure. Lead protective clothing is essential to protect personnel from the scattered radiation associated with the high exposures used.

## Results

Areas of the pelvis visualised during standing lateral oblique pelvic radiography included the iliac shaft, greater trochanter of the femur, femoral head, acetabulum and coxofemoral articulation on the side under examination (Fig 2). Depending on the craniocaudal centring of the x-ray beam, the ischium was also visualised. The structures on the side being imaged were projected dorsally, ideally superimposed on a gas-filled rectum (Fig 3). Areas of the pelvis that may not be

**TABLE 1: Age, breed, sex, history, radiographic findings and additional diagnostic information for the 18 clinical cases included in this study**

Case No.	Age, breed, sex	History	Radiographic findings from lateral oblique view of pelvis	Additional diagnostic investigations
1	7-year-old TBx gelding	Lame LH (grade 9/10) following a fall, rectal findings unremarkable	L iliac shaft fracture cranial to acetabulum	Confirmed on ventrodorsal radiographs, L ischial and pubic fractures also seen; scintigraphy nondiagnostic
2	6-year-old TB gelding	Acute onset lameness LH, grade 9/10	Left iliac shaft and coxofemoral joint appeared normal	Scintigraphy demonstrated mild IRU in area of L acetabulum
3	37-year-old TB mare	Traumatic injury to perineal region, pelvis appeared tilted on visual examination	No abnormalities detected	-
4	22-year-old Arab gelding	Cauda equina syndrome	No abnormalities detected	Lateral radiographs of sacrococcygeal spine and pelvic ultrasonography appeared normal
5	8-month-old IDx filly	Lame RH (grade 10/10) following a fall, pelvis appeared tilted on visual examination, no crepitus detected	R iliac shaft fracture	Ultrasonography confirmed R iliac shaft fracture and haematoma
6	7-year-old Shetland mare	Consistent upward fixation of L patella	Dorsal luxation of L coxofemoral joint	Confirmed on ventrodorsal radiograph
7	2-year-old TB mare	5-week history RH lameness (grade 10/10), pelvis appeared tilted on visual examination, muscle wastage	Fracture through right acetabulum	Confirmed, but less well visualised, on ventrodorsal radiograph
8	9-year-old TB gelding	3-week history of severe RH lameness and upward fixation of the R patella after a fall	No abnormalities detected	Scintigraphy demonstrated fractures of R tuber coxae and R iliac wing, confirmed with ultrasonography
9	9-year-old TB mare	Found in stable with haematoma over R coxofemoral joint	No abnormalities detected	-
10	5-year-old TB gelding	Acute onset RH lameness (grade 10/10) after jumping out of field	Apparent displacement of proximal femur	Post mortem demonstrated proximal femoral fracture
11	3-year-old TB gelding	Acute onset RH lameness	Over-riding fracture R iliac shaft	Ultrasonography confirmed R iliac shaft fracture and haematoma
12	17-year-old cob mare	3-week history of RH lameness following a fall	New bone evident on dorsal aspect of acetabulum; differential diagnoses include old nondisplaced fracture or coxofemoral osteoarthritis	Scintigraphy demonstrated corresponding but diffuse area of IRU
13	4-year-old Arab mare	4-week history of RH lameness after becoming cast	Irregular new bone on cranial aspect of greater trochanter RH	Scintigraphy demonstrated corresponding area of IRU
14	4-year-old Shire mare	Intermittent and severe hindlimb lameness	No abnormalities detected	Ventrodorsal radiographs appeared normal
15	12-year-old TB mare	RH lameness of 4 months' duration	Irregular new bone on cranial aspect of greater trochanter RH	Apparent mild diffuse IRU over R hemipelvis (because of reduced attenuation due to muscle wastage?); stifle ultrasonography demonstrated damage to lateral collateral ligament of stifle
16	10-year-old cob stallion	Trapped foot in gate 10 days previously, severe LH lameness	Dorsal luxation of L coxofemoral joint	Confirmed at surgery
17	12-year-old TB mare	Chronic LH lameness, severe muscle wastage L gluteal muscles	Osteoarthritis around L femoral neck, with joint incongruity	Corresponding area of IRU on scintigraphy
18	6-year-old TB gelding	6 months' RH lameness (diagnostic analgesia localised pain to the foot; right coxofemoral joint radiographed due to scintigraphic findings)	No abnormalities detected	Scintigraphy demonstrated IRU over R coxofemoral joint

TB = Thoroughbred; ID = Irish Draught; RH = right hindlimb; LH = left hindlimb; IRU = increased radiopharmaceutical uptake.

seen using this technique include the iliac wings, *tubera coxae*, *tubera sacrale*, sacroiliac joints, sacrum, pubis and entire ischium.

Eighteen horses underwent standing lateral oblique pelvic radiography at the Equine Diagnostic Centre, University of Bristol between March 2000 and June 2005. A variety of breeds were examined, with bodyweight 125–550 kg (Table 1). Six horses (Cases 1, 5, 7, 10, 11 and 16) were unable fully to bear weight on the affected limb. Diagnostic quality radiographs were achieved in all horses.

Iliac shaft fractures (Fig 4) were diagnosed conclusively in 3 horses and an acetabular fracture in one horse. In 3 of these horses, the findings were confirmed with ultrasonography, scintigraphy and/or further radiographs. In one horse (Case 1), ventrodorsal

radiographs demonstrated additional fractures of the ischium and pubis. In 2 horses (Cases 6 and 16), dorsal luxation of the coxofemoral joint (Fig 5) was diagnosed and confirmed either at surgery or with ventrodorsal radiographs. In 4 horses (Cases 12, 13, 15 and 17), irregular new bone formation was identified. In one horse (Case 12) the new bone was located on the dorsal aspect of the acetabulum, and in another (Case 17) on the femoral neck, with associated joint incongruity. In both horses, this was considered consistent with osteoarthritic change. In 2 horses (Cases 13 and 15) the new bone was located on the cranial aspect of the greater trochanter of the femur. In all 4 horses, these locations corresponded to areas of increased radiopharmaceutical uptake identified using scintigraphy. In one horse (Case 10), the lateral oblique radiograph

**TABLE 2: Pelvic fracture locations in 100 horses (Rutkowski and Richardson 1989)**

Fracture location	Ilium	Ischium	Pubis	Ilium and ischium	Ilium and pubis	Ischium and pubis	Ilium, ischium and pubis	Central acetabulum	Tuber coxae	Total
Acetabulum involved	10	5	8	2	5	13	4	2	0	49
Acetabulum not involved	20	0	0	0	1	0	0	0	6	27
Unknown										24

demonstrated an abnormal relationship between the proximal aspect of the femur and acetabulum. *Post mortem* examination demonstrated a proximal femoral fracture, but this was not apparent on the radiographs. In 7 horses (*Cases 2, 3, 4, 8, 9, 14 and 18*) the lateral oblique pelvic radiographs were considered unremarkable. In 6 horses this conclusion was supported by ultrasonography (*Case 4*), additional radiographic views (*Cases 4 and 14*) and/or clinical outcome (*Cases 2, 3, 9 and 18*). In one horse (*Case 8*), scintigraphy demonstrated fractures of the ipsilateral *tubera coxae* and iliac wing, which were confirmed with ultrasonography.

### Discussion

The lateral oblique view of the pelvis in the standing horse consistently facilitates visualisation of the iliac shaft, greater trochanter of the femur, femoral head, acetabulum and coxofemoral articulation of the side under examination. This technique is straightforward, noninvasive to perform and provides an invaluable screening technique in horses with suspected pelvic injury, without the need for general anaesthesia.

In comparison with the more established technique of ventrodorsal pelvic radiography, the most important advantage of this lateral oblique technique is the fact that it can be carried out in the conscious horse. This increases both patient safety and the convenience of the technique, facilitating both initial and follow-up radiographic examinations of the pelvis in horses in which general anaesthesia may not be appropriate. In the 4 horses which underwent both ventrodorsal and lateral oblique pelvic radiography, distortion of the anatomy due to the obliquity of the projection was minimal. The coxofemoral joint and associated pathology were easier to view on the oblique view, where they were superimposed on the air-filled rectum, than on the ventrodorsal view, where they were superimposed on the pelvic musculature.

Disadvantages of the lateral oblique radiographs include the lack of visualisation of the pubis, sacrum and iliac wings and the inability to assess right-left symmetry within the same image.

There are some situations in which further modification of the technique may help to improve the quality of the radiographs. Manual evacuation of the rectum did not always result in an air-filled rectum. In such cases, it may be possible to improve contrast by inflating the rectum with additional air. However, this technique was not evaluated in this study, as diagnostic radiographs were achieved even when the rectum was not air filled. In the 6 horses which were unable to take weight on the affected limb, the pelvis was tilted such that the affected side was positioned further ventrally. In order to compensate for this, it was necessary to increase the angle between the x-ray beam and the horizontal by 5–10°, and to centre several centimetres further ventrally than described for a horse standing squarely.

All radiographic techniques for imaging the pelvic region of the horse require the use of large x-ray exposure values due to the large muscle mass of this area. All techniques therefore pose a risk of scattered radiation reaching personnel involved in the x-ray procedure. It is essential that minimal personnel are present during the exposure and that no person is within 2 m of the collimated area of the primary x-ray beam. Those present should wear protective lead clothing. Close collimation of the x-ray beam to the area of interest helps minimise scattered radiation. The cassette should be mounted on a gantry or stand, and should never be hand-held. Careful patient preparation and positioning should minimise the need for repeated radiographs due to poor radiographic technique. The dosimeters of the personnel involved in the radiography of the 18 horses described in this report recorded no radiation exposure.

The need for high exposure factors also results in the use of relatively long exposure times, with a risk of movement blur. Use of the highest possible mA allows a reduction in the length of exposure for the same mAs value. Observation of the respiratory cycle allows the exposure to be made during the expiratory pause, thereby limiting the effects of respiratory movement. Judicious use of sedation and comfortable positioning of the horse also help reduce movement artefact. A high-speed film-screen combination maximises the sensitivity of the film to the penetrating x-rays,

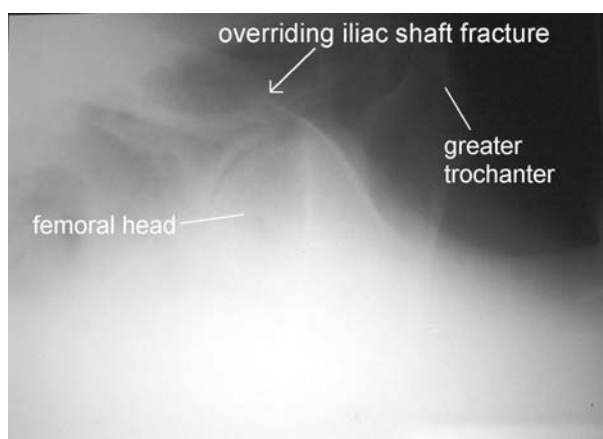


Fig 4: Iliac shaft fracture, as seen on standing lateral oblique radiography.

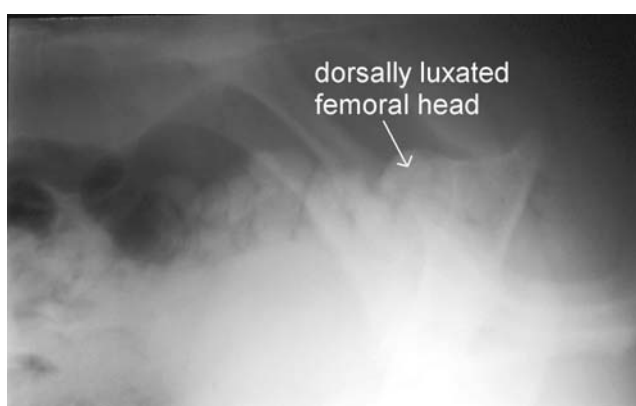


Fig 5: Coxofemoral luxation, as seen on standing lateral oblique radiography.

helping to keep exposure factors as low as possible. The use of a digital radiography system allows sophisticated post processing of the image, which should reduce the need for repeated radiography due to poor radiographic technique. It has been suggested that digital radiography may allow reduction of the exposure factors used, but this remains unresolved (Marshall *et al.* 1994; Dendy and Heaton 2003).

In this series of 18 horses, 6 were finally diagnosed with pelvic fractures. All 3 iliac shaft fractures (*Cases 1, 5 and 11*) and the acetabular fracture (*Case 7*) were identified conclusively using lateral oblique pelvic radiography. However, in one horse (*Case 1*), the full extent of concurrent ischial and pubic involvement could not be appreciated. Fractures of the iliac wing and *tuber coxae* in one horse (*Case 8*) were not identified. In the final horse (*Case 10*), a proximal femoral fracture was not diagnosed until *post mortem*, although it was noted from the lateral oblique radiographs that the proximal femur was abnormally positioned.

Previous analyses of equine pelvic fractures demonstrated a relatively high incidence of iliac and acetabular involvement. In a study of 19 horses (Little and Hilbert 1987) 9 had iliac fractures, with 5 of these involving the acetabulum (determined from ventrodorsal radiographs). Six further fractures were described as involving the acetabulum together with the ischium and/or pubis. A case series of pelvic fractures in 100 horses (Rutkowski and Richardson 1989) recorded fracture location in 76 horses (Table 2) as determined by ventrodorsal radiographs (n = 57) or *post mortem* examination (n = 19). Fractures of the ilium were reported in 42 horses, involving the acetabulum in 21 of these. Overall, acetabular involvement was reported in 49 of the 76 horses. It was possible to visualise the acetabulum in all 18 horses in our case series; theoretically, therefore, acetabular fractures should be visualised consistently with this technique. However, as in *Case 1* reported here, it would not be possible to visualise fully the extent of ischial and pubic involvement. In addition, 6 fractures of the *tuber coxae* were reported in the case series of 100 horses (Rutkowski and Richardson 1989). These would not have been visualised with standing lateral oblique pelvic radiographs, as demonstrated in the present study (*Case 8*). Neither of the 2 previous case series distinguished between fractures of the iliac wing and iliac shaft. While most iliac shaft fractures should be identified with lateral oblique radiography, iliac wing fractures will not be seen, as demonstrated in our study (*Case 8*).

Coxofemoral luxation in the horse is rare (Jeffcott 1982); however, the technique described here may be used reliably to diagnose this condition (*Cases 6 and 16*). Lateral oblique radiography in the standing horse also has the potential to investigate such conditions as coxofemoral osteoarthritis (*Cases 12 and 17*), fracture of the greater trochanter, fracture of the femoral neck or slipped proximal femoral epiphysis. These conditions are important differential diagnoses for pelvic fractures and can be difficult to diagnose definitively. The clinical significance of the new bone seen on the cranial aspect of the greater trochanter of the femur in *Cases 13 and 15* is unclear, and would be interesting to investigate further.

This study demonstrates the potential use of lateral oblique pelvic radiography in the standing horse for investigation of pelvic lameness. However, it is important to appreciate that not all pelvic injuries can be identified and that normal radiographic findings do not rule out injury or fractures elsewhere in the pelvis. It should also be noted that the largest horse radiographed in this series weighed 550 kg. It may not be possible to obtain images of adequate diagnostic quality in very large or very fat horses. Lateral oblique pelvic radiographs should therefore be considered a useful

and noninvasive technique to be used alongside other diagnostic techniques in the investigation of suspected pelvic injury.

### Acknowledgements

The authors gratefully acknowledge the assistance of Mr John Conibear and Mr Nick Crabb, Department of Clinical Veterinary Science, University of Bristol, in the preparation of the photographs and line drawings. We would also like to thank the staff within the Department of Clinical Veterinary Science who contributed to the investigation and care of these horses, in particular those involved in the radiographic examinations, and our colleagues in the Department of Pathology for the results of the necropsy examination in *Case 10*.

### Manufacturers' addresses

<sup>1</sup>Eastman Kodak Company, New York, New York, USA,

<sup>2</sup>Shimadzu Medical Imaging Systems, London, UK.

<sup>3</sup>Konica Minolta Medical and Graphical Inc., Tokyo, Japan.

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