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Bilateral Simultaneous Oblique MR Imaging of the Proximal Femur

Katsuhiro TODA[1], Seizou YONEDA[2], Tetsuya MORIOKA[2], Hidenori KAWANISHI[2] and Kazuyoshi AZUMA[3]

1) Department of Orthopedic Surgery, Miharashi Ishikai Hospital, 1–5–7 Miyaura, Mihara 723–0051, Japan
2) Department of Radiology, Miharashi Ishikai Hospital, 1–5–7 Miyaura, Mihara 723–0051, Japan
3) Department of Radiology, Hiroshima University Hospital, 1–2–3 Kasumi, Minami-ku, Hiroshima 734–8551, Japan

ABSTRACT

Oblique axial and oblique coronal MR images parallel to the femoral neck provide more valuable information concerning the proximal femur than orthogonal images. The main disadvantage of the unilateral oblique imaging is that the imaging time is significantly increased when both hips need to be imaged. If the bilateral oblique imaging is performed simultaneously, this increase in imaging time is eliminated because the scanning time for the bilateral oblique imaging and the orthogonal imaging is the same.

Key words: *MRI, Oblique method, Orthogonal method, Hip joint*

Magnetic resonance (MR) imaging has frequently been employed to examine the proximal femur, and imaging has usually been performed in the orthogonal planes. Several reports have referred to the advantages of oblique MR imaging parallel to the femoral neck[1–3]. However, the oblique MR imaging has only occasionally been performed because it is considered to require significantly increased imaging time when both hips need to be imaged.

MATERIALS AND METHODS

Both hips were imaged using the orthogonal method in five patients, the separate oblique method in three patients, and the bilateral simultaneous oblique method in four patients. The orthogonal method used the coronal plane and the axial plane (Fig.1-a). In the separate oblique method, the scanning lines were parallel to the femoral neck, and both hips were imaged respectively. In the bilateral simultaneous oblique method, the scanning lines were divided into two groups, and each group was moved to each hip joint and set parallel to each femoral neck (Fig.1-b, c). Both hips were imaged simultaneously. The scanning time was constant under the conditions using the same type of MR imager, the same scanning method, and the same slice width. It did not depend on each patient. The scanning time for T1- and T2-weighted imaging using the three methods was measured. MR imaging was performed using a 0.5-T superconducting system (Flexart®; Toshiba Medical Co., Tokyo) with a body coil. T1- and T2-weighted images were obtained. The basic standard protocol for T1-weighted spin-echo imaging was TR = 500 ms, TE = 15 ms, 3 excitations, 4-mm slice thickness, and 1-mm gap in all planes. The basic standard protocol for T2-weighted spin-echo imaging was TR = 4000 ms, TE = 120 ms, 4 excitations, 4-mm slice thickness, and 1-mm gap in all planes.

RESULTS

The scanning times were 19'12" (oblique coronal and oblique axial T1-weighted) and 18'16" (oblique coronal and oblique axial T2-weighted) for the separate oblique method. They were 9'36" (oblique coronal and oblique axial T1-weighted) and 9'08" (oblique coronal and oblique axial T2-weighted) for the bilateral simultaneous method. They were 9'36" (coronal and axial T1-weighted) and 9'08" (coronal and axial T2-weighted) for the orthogonal method. The scanning times were not average. These were constant in each scanning method.

DISCUSSION

The proximal femur is composed of the femoral head, the femoral neck, and the intertrochanteric region. The central axis of the femoral neck passes near the center of the femoral head and the

Address for reprints: Katsuhiro Toda, M.D., Department of Rehabilitation, Hiroshima University Hospital, 1–2–3 Kasumi, Minami-ku, Hiroshima, 734–8551, Japan
Tel: 81–82–257–5566, Fax: 81–82–257–5594

intertrochanteric region. The coronal plane and the axial plane are not parallel to the axis. Therefore, the orthogonal imaging does not readily depict complete proximal femur. It is especially difficult to obtain a complete image of the femoral neck with the axial imaging (Fig. 1-a). However, the oblique axial and oblique coronal imaging parallel to the femoral neck readily provide a complete image of the proximal femur (Fig. 1-b, c), and more than two slices depict the proximal femur in its entirety[3]. The difference between Fig. 1-a (axial imaging) and Fig. 1-b (oblique axial imaging) is remarkable. If the orthogonal imaging and the oblique imaging are compared using a series of slices the difference is increased.

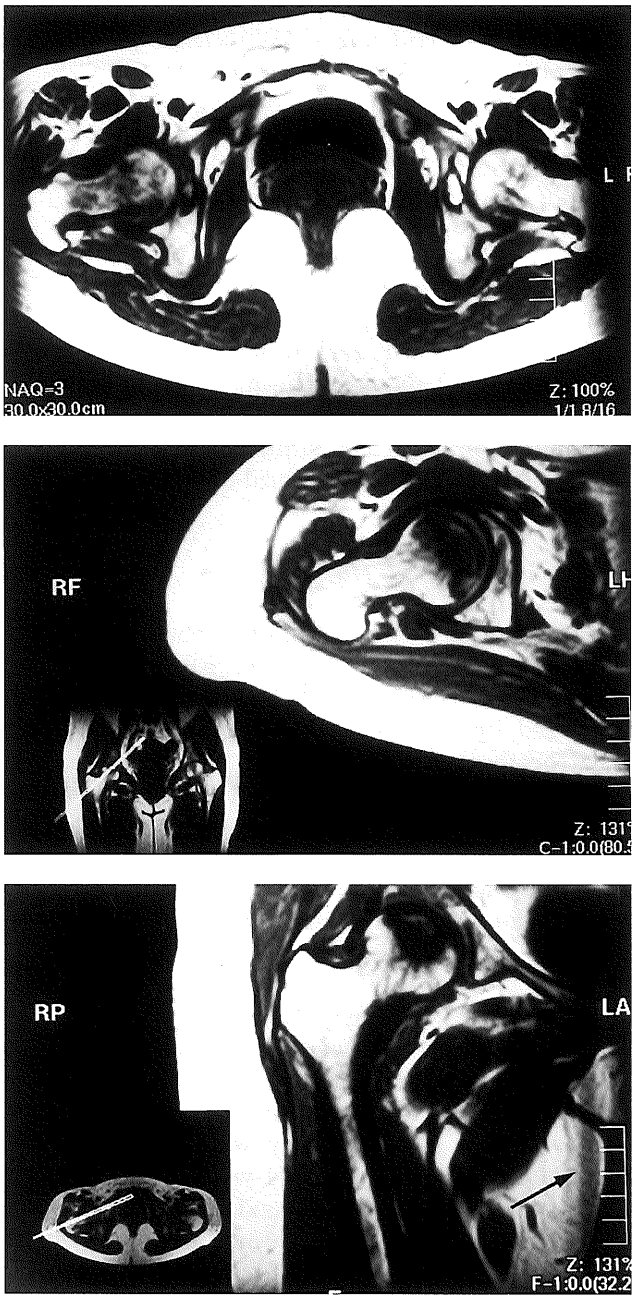

Fig. 1. T1-weighted MR image (500/15) of a 52-year-old woman with avascular necrosis of both femoral heads. (a) Axial image of both hip joints. No slice shows the femoral head, the femoral neck, and the intertrochanteric region completely. (b) Oblique axial image of the right hip joint. This slice shows the femoral head, the femoral neck, and the intertrochanteric region completely. There are two other excellent images in addition to this one. (c) Bilateral simultaneous oblique coronal image of the right hip joint. Image quality is degraded in medial regions where the two oblique planes intersect (arrow).

The hip joint is a weight-bearing joint. When diseases or injuries of the proximal femur are treated, the relationship between the lesion in the proximal femur and weight-bearing must always be considered. The direction of the oblique imaging and the direction of weight-bearing are the same. Such oblique images are excellent for assessing the relationship between the femoral neck and the femoral head and the relationship between the femoral neck and the intertrochanteric region (Fig. 1-b). These oblique images demonstrate the relationship between the lesion in the proximal femur and the weight-bearing area of the hip joint[1,3]. The coronal and axial images do not demonstrate this relationship. For these reasons, the oblique axial and oblique coronal MR images parallel to the femoral neck provide valuable information concerning the proximal femur.

The main disadvantage of the unilateral oblique imaging is that the imaging time is significantly increased when both hips need to be imaged[2,3]. This is perhaps the main reason why the oblique imaging has only occasionally been used to examine the proximal femur. Images of the healthy side are very important as control images. If no image abnormality is demonstrated on the healthy side, mild abnormal findings on the affected side are easily recognized as abnormal.

If the bilateral oblique imaging is performed simultaneously, the increase in imaging time is eliminated because the scanning time for the bilateral oblique imaging and the orthogonal imaging is the same. The scanning lines are divided into two groups, and each group is moved to each hip joint and set parallel to each femoral neck. These procedures require some additional preparation time, but only about 10 s for the oblique coronal imaging or the oblique axial imaging. The bilateral simultaneous oblique method can be applied in combination with other sequences, for example, fat suppression. This method can therefore be employed for the evaluation of most diseases and injuries of the hip for which MR imaging is performed. This method is routinely used for the examination of multiple intervertebral disc spaces. However, this technique is not widely employed for comparing paired structures. If the advantages of the bilateral simultaneous oblique method were more widely

known, the method would be performed more frequently for the proximal femur.

The main disadvantage of this simultaneous imaging technique is that local changes in repetition time result in loss of signal at the region of intersection of the oblique scans (Fig. 1-c). However, image quality at the proximal femur is maintained. Therefore, this disadvantage is usually of little clinical importance. The bilateral simultaneous oblique imaging of the proximal femur may be a routine procedure in a few institutions. However, the method is not always performed in many institutions. We hope that the method comes into wide use and is performed in more institutions.

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