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Original Article

Supine vs Decubitus Lateral Patient Positioning in Vertebral Fracture Assessment

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Abstract

In vertebral fracture assessment (VFA), lateral scans are obtained with the patient positioned supine (C-arm densitometers) or lateral decubitus (fixed-arm densitometers). We aimed to determine the impact of positioning on image quality and fracture definition. We performed supine and decubitus lateral VFA in 50 postmenopausal women and used the algorithm-based qualitative method to identify vertebral fractures. We compared the 2 techniques for the identification of fractures (kappa analysis) and compared the numbers of unreadable vertebrae (indiscernible endplates) and vertebrae that were projected obliquely (Wilcoxon matched-pairs signed-rank test). The kappa score for agreement between the VFA techniques (to identify women with vertebral fractures) was 0.84 (95% confidence interval [CI]: 0.68–0.99), and for agreement with fracture assessments made from radiographs, kappa was 0.76 (95% CI: 0.57–0.94) for both supine and decubitus lateral VFA. There were more unreadable vertebrae with supine lateral (48 vertebrae in supine lateral compared with 14 in decubitus lateral; $p = 0.001$), but oblique projection was less common (93 vertebrae compared with 145 in decubitus lateral; $p = 0.002$). We conclude that there were significantly different projection effects with supine and decubitus lateral VFA, but these differences did not influence the identification of vertebral fractures in our study sample.

Key Words: Diagnostic imaging; dual-energy X-ray absorptiometry; osteoporosis; spinal fractures; vertebral fracture assessment.

Introduction

In 2006 and 2007, the International Society for Clinical Densitometry (ISCD) issued guidelines for densitometer-based vertebral fracture assessment (VFA) *(1,2)*, and the use of this technique in clinical practice has become increasingly widespread over recent years. Vertebral imaging applications are available for both rotating C-arm and fixed-arm densitometers. With a C-arm device, the rotating tube-detector assembly allows the acquisition of both posteroanterior and lateral projections with the patient in the supine position. With a fixed-arm device, the lateral image is obtained with the patient in the lateral decubitus position, that is, lying on their side with knees and hips flexed. A true lateral projection (with superimposition of the vertebral endplates) may be more difficult to attain using this approach. The spine must be parallel to the couch top to ensure that the central beam passes directly through the intervertebral spaces, but the curvature of the shoulders and hips can cause tilting of the vertebral bodies. This produces an oblique projection, in which the vertebral endplates may overlap and are projected with an elliptical appearance (''bean-can effect''). If the patient leans slightly forward or backward while in the lateral decubitus position, there will be mediolateral rotation of the vertebral bodies. Supine and decubitus lateral VFA have been compared using GE Lunar technology (GE Medical, Milwaukee, WI) *(3)*, but Hologic devices have not yet been evaluated in this way. The main aim of our study was to determine the impact of decubitus vs supine lateral

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positioning on image quality and fracture definition in Hologic VFA. Our specific objectives were to (1) compare the numbers of unreadable vertebrae and the numbers of oblique vertebrae identified on supine lateral and decubitus lateral VFA and (2) compare the 2 techniques for the identification of vertebral fractures in the same study population.

Materials and Methods

Recruitment and Study Design

We studied a subset of women from Sheffield, UK, who participated in the Fracture or Corticosteroid Use Study (FOCUS) or in the European Osteoporosis and Ultrasound Study (OPUS). These studies were run in parallel with baseline visits between 1999 and 2000 and follow-up visits 6 yr later. Both studies were approved by local research ethics committees, and the participants gave written informed consent. The investigations were carried out in accordance with the Declaration of Helsinki and good clinical practice guidelines established at the International Conference on Harmonization.

The studies have been described in detail elsewhere *(4,5)*. In brief, 382 postmenopausal women were recruited to FOCUS from outpatient clinics (metabolic bone or orthopedic fracture clinic) at the Northern General Hospital, Sheffield, UK. The women had been taking prednisolone therapy of 5 mg or more daily for more than 3 mo or had been diagnosed with fractures of the distal forearm (n = 78), proximal humerus (n = 75), proximal femur (n = 53), or vertebrae (n = 73). One hundred seventy-eight women returned for 6-yr follow-up. The population-based study, OPUS, is based in 5 participating centers, namely Sheffield (Academic Unit of Bone Metabolism, University of Sheffield, Northern General Hospital, Sheffield, UK), Aberdeen (Department of Medicine and Therapeutics, University of Aberdeen, Aberdeen, UK), Berlin (Diagnostische Radiologie, Klinikums, Benjamin Franklin der Freien Universität Berlin, Berlin, Germany), Kiel (Medizinische Physik, Klinik für Diagnostische Radiologie, Universitätsklinikum Schleswig-Holstein, Campus Kiel, Kiel, Germany), and Paris (Department of Rheumatology, Paris Descartes University, Cochin Hospital, Paris, France). The full baseline cohort comprised 463 women aged 20−39 yr and 2419 women aged 55−80 yr. In Sheffield, we recruited 600 women via general practice lists; 403 women attended 6-yr follow-up visits.

The analysis reported here is based on a subset of 50 postmenopausal women from FOCUS or OPUS who agreed to undergo both supine and decubitus lateral VFA at the 6-yr visit. The subset comprised 25 women with and 25 women without known vertebral fractures (identified from spinal radiographs at baseline) to allow us to assess the impact of positioning on fracture definition and image quality.

Measurement of Bone Mineral Density, Height, and Weight

The data collected as standard at the 6-yr visits included bone mineral density (BMD) measured by dual-energy X-ray absorptiometry (DXA), height, and weight. At our center, BMD was measured at the spine (vertebrae L1−L4) and hip using the QDR 4500 A densitometer, software version 11.2 (Hologic Inc., Bedford, MA).

Vertebral Imaging

Spinal radiography and supine lateral VFA of the thoracolumbar spine were performed as part of the standard FOCUS and OPUS 6-yr visits. At our center, VFA was performed using the Discovery A densitometer, software version 12.3 (Hologic Inc., Bedford, MA). This device has a rotating C-arm and the lateral projections are obtained supine with a horizontal beam. For the additional VFA examination, right lateral decubitus images were obtained using a fixed-arm densitometer, the Delphi C, software version 12.6 (Hologic Inc., Bedford, MA). For consistency, both supine and decubitus lateral images were acquired using the single-energy scan mode and the Hologic instant vertebral assessment option. Each individual participant underwent consecutive supine and decubitus lateral imaging on the day of their study visit.

Assessment of Spinal Radiographs and Scan Images

Vertebral fractures were assessed from the (digitized) spinal radiographs and vertebral scan images. The images were all assessed visually (without measurement of vertebral dimensions) using the algorithm-based qualitative (ABQ) approach *(6)*, with the readers blinded to the identity, characteristics, and baseline vertebral fracture status of the study participants (Fig. 1). The supine and lateral decubitus scans were reviewed by reader 1 (MAP), who is experienced in the evaluation of vertebral images using the ABQ approach. For the purpose of this analysis, reader 1 also used an additional VFA-specific algorithm to evaluate the projection of each vertebra (Fig. 2). The supine scans were read first, and the decubitus scans were read after a time lag of 4 wk and without reference to the supine scans or the results of the fracture assessments made from the supine scans. Radiographic images were reviewed by reader 2 (LF), who is experienced in VFA and in the application of the ABQ method. The 2 readers were blinded to the results of each others' fracture assessments. We used the radiographic readings as the standard for the evaluation of supine vs decubitus lateral VFA.

Identification of Vertebral Fractures

The ABQ method has been described in detail elsewhere *(6)*; we have validated the application of this method in VFA in previous studies *(7−9)*, and we use it clinically to evaluate patients referred to our Metabolic Bone Center. Using the ABQ approach, fracture is identified when there is evidence of depression of the central endplate, with or without fracture of the ring apophysis or the cortex of the vertebral body. A decision-making algorithm (Fig. 1) is used to rule out normal or developmental variation in vertebral shape or nonfracture deformity related to conditions such as Scheuermann's disease or degenerative changes.

For each study participant, we recorded vertebral fractures identified between the levels of T4 and L4. We also recorded