Sensitivity and specificity of lumbar spine radiography in the assessment of facet joint osteoarthritis were evaluated, with computed tomography (CT) as the standard. Two independent radiologists used a four-point scale to blindly grade facet joint osteoarthritis on oblique radiographs and transaxial CT scans obtained within an 8-month period in 50 consecutive patients with pain in the lower back. The L-3 to L-4, L-4 to L-5, and L-5 to S-1 facet joints were evaluated, and 68% appeared abnormal on CT scans, with 28% exhibiting moderate or severe disease. Interobserver agreement was high for conventional radiography (perfect agreement in 57% and agreement to within one grade in 39%) and still higher for CT (perfect in 63% and to within one grade in 35%). Receiver operating characteristic curve analysis indicated that oblique radiography was most accurate (55% sensitivity, 69% specificity) in distinguishing the presence from the absence of disease; in distinguishing absent or mild from moderate or severe disease, the specificity of oblique radiography was higher, at 94%, but its sensitivity was much lower, at 23%. Conventional radiography is a useful technique in screening for facet joint osteoarthritis but is insensitive compared with CT.

Index terms: Computed tomography (CT), comparative studies • Radiography, comparative studies • Spine, CT, 33.1211 • Spine, diseases, 33.77 • Spine, facet joints

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OSTEOARTHRITIS of the facet joints and a herniated nucleus pulposus are frequent causes of pain in the lower part of the back and sciatica. Clinical differentiation between disk herniation and the facet syndrome, which is characterized by chronic low back pain with unilateral radiation of the pain to the buttock and posterolateral thigh, is frequently difficult (1). Patients with initial symptoms referable to the lumbar spine are routinely first evaluated with conventional radiography. The typical series includes frontal, lateral, and bilateral oblique views, all of which demonstrate the lumbar apophyseal articulations, although the last views do so to the best advantage (2, 3).

In 1976, Mooney and Robertson (1) introduced a technique of injecting steroid preparations and local anesthetic into the facet joint. This created a renewed interest in the posterior articulations as a cause of low back pain. The technique of facet joint injection has been widely used to determine whether symptoms are referable to the apophyseal articulation (3–6). The relationship between radiographically demonstrated osteoarthritis and the presence of symptoms is unclear, and the prevalence of facet joint osteoarthritis in asymptomatic patients has not been assessed with oblique radiography. Carrera et al. (7) did demonstrate that, in a small series of patients evaluated with computed tomography (CT) before facet block, symptoms were relieved only in patients with osteoarthritis of the joint that was demonstrable on CT scans; those patients with normal CT scans did not respond to facet joint injection. Their data suggest that detection of facet joint osteoarthritis may help in selecting patients with appropriate symptoms for further evaluation.

The accuracy of plain radiographs in the detection of facet joint osteoarthritis has not been evaluated systematically. CT of the lumbar spine demonstrates the apophyseal articulations in the axial plane and allows evaluation of this joint, which is composed of complex curves. We used CT as the standard with which to investigate and compare the accuracy of conventional oblique radiography in depicting the facet joints of the lower lumbar spine. The sensitivity and specificity of radiography were also evaluated.

MATERIALS AND METHODS

The study population included 50 patients referred for lumbosacral CT examinations at the Veterans Administration (VA) Medical Center in San Diego between July and December 1985. Ten additional patients who underwent CT during this interval were excluded because correlative conventional radiographs were unavailable. Patients in whom limited examinations had been performed to investigate traumatic, neoplastic, or infectious processes were also eliminated. Each patient included in the study had chronic low back pain and had undergone lumbosacral spine radiography (including frontal, lateral, and both oblique views) within 8 months of the CT evaluation. Forty-nine of the 50 patients were men (reflecting the composition of the VA patient population), with a mean age of 52.8 years (range, 30–84 years). Seven patients had undergone prior spinal surgery: unilateral L-3–5 laminectomies in six and bilateral L-3–5 and L-4–5 laminectomies and lumbar fusion in one.

All CT examinations were performed by means of standard techniques on a scanner (Technicare 2060, Cleveland) with 5-mm, parallel, overlapping sections, a 512 X 512 matrix, and 0° gantry angulation. The L-3 to L-4, L-4 to L-5, and L-5 to S-1 spinal levels were evaluated in each patient and photographed at both soft-tissue and bone window settings. Only the images optimized for bone detail (level 354, window 2.025) were used in the remaining portions of the investigation.

Two experienced musculoskeletal radiologists independently reviewed both
oblique radiographs from each patient and blindly graded each facet joint at the L-3 to L-4, L-4 to L-5, and L-5 to S-1 spinal levels. The degree of abnormality was scored on a four-point scale in which 0 indicates normal; 1, mild degenerative disease; 2, moderate degenerative disease; and 3, severe degenerative disease (Fig. 1). Subsequently, the same radiologists independently and blindly evaluated the CT scans of the facet joints at the same levels from each patient and assigned severity scores using the same four-point scale (Fig. 2). Each of the two radiologists thus evaluated a total of 300 facet joints on both oblique conventional radiographs and CT scans. Interobserver agreement and kappa values were calculated independently for both imaging methods.

The sensitivity, specificity, and accuracy of oblique radiography were then calculated, with CT as the quality standard. The accuracy was determined for three different degrees of involvement (mild or greater, moderate or greater, or severe disease) as established with CT.

RESULTS

On the frontal projection alone, portions of the facet joints were seen at only 118 of 300 sites, or 39.3%. These articulations were difficult to evaluate on the lateral view because of the superimposition of other structures and an inability to lateralize findings. Oblique radiography demonstrated 296 (98.7%) of the facet joints sufficiently well to permit scoring, CT clearly depicted all but one of the facet articulations included in the study.

Regarding CT, there was perfect interobserver agreement in the scores of 187 of 299 facet joints (62.5%) and agreement within one grade in an additional 104 joints (34.8%). In only eight of 299 articulations (2.7%) was a difference of two or more grades observed. The kappa value for perfect interobserver agreement on CT scans was .46.

Regarding the oblique radiographs, perfect interobserver agreement was achieved in 168 of 299 facet joints (56.2%). Independent appraisals of 113 of 296 articulations (38.2%) agreed to within one grade. In 15 of 296 instances (5.1%), disparity of greater than one grade was noted. The calculated kappa value for perfect agreement on oblique radiographic grades was .26.

A total of 593 facet joints were evaluated on both CT scans and oblique radiographs by the two observers combined. On CT scans, 205 joints (34.6%) were considered normal, 234 (39.5%) grade 1, 97 (16.4%) grade 2, and 57 (9.6%) grade 3. The radiologists tended to underestimate disease on the oblique radiographs, with 334 (56.3%) considered normal, 195 (32.9%) grade 1, 52 (8.8%) grade 2, and only 12 (2.0%) grade 3.

Of the 57 facet joints considered severely diseased on the basis of CT findings, oblique radiography indicated some abnormality in 49 (sensitivity = 86.0%, specificity = 60.8%). Only 23 joints appeared moderately or severely diseased on the oblique radiographs (sensitivity = 40.3%, specificity = 92.4%).

CT indicated moderate or severe disease in 154 facet joints. Radiography demonstrated abnormalities in 106 of these joints (sensitivity = 68.8%, specificity = 65.2%) but indicated moderate or severe disease in only 41 (sensitivity = 26.6%, specificity = 94.7%).

Oblique radiography was insensitive to mild disease. Of the 234 joints graded as mildly diseased according to CT criteria, only 102 appeared abnormal on the oblique radiographs. Of all joints considered abnormal on the basis of the CT scans (338 of 593 [65.4%]), oblique radiography indicated abnormalities in just 208 (sensitivity = 53.6%, specificity = 75.0%).

In general, radiography was insensitive for mild disease but showed increased sensitivity for progressively more severe involvement. The radiographic grades were equal to the CT grades in 261 of 593 cases (44.0%), lower in 261 (44.0%), and higher in only 71 (12.0%).

Accuracy is dependent on the prevalence of disease in the population studied, whereas sensitivity and specificity are independent of prevalence. Receiver operating characteristic (ROC) curve analysis, which considers sensitivity-specificity pairs at different thresholds of detection, were constructed and are shown in Figure 3 (8).

DISCUSSION

The apophyseal articulations are paired synovial joints formed by the inferior articular process of the cephalic vertebra and the superior articular process of the caudal vertebra (9). The thin fibrous capsule of each joint is richly innervated by the dorsal rami of spinal nerve roots arising from the adjacent levels (3). This dual innervation makes it extremely difficult to identify a specific level as the origin of symptoms. The mechanism by which apophyseal osteoarthritic results in pain is complex and may include capsular distention, entrapment of synovial villi between the articular surfaces, and nerve root impingement by osteophytes (9, 10).

Conventional radiography of the lumbar spine has significant limitations in the evaluation of the apophyseal joints. These articulations have a curved configuration, which permits visualization of only the small portion of each joint that is tangent.
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d.b.

Figure 2. Four grades of facet joint disease as seen on CT scans. (a) Grade 0 = normal. (b) Grade 1 = joint space narrowing. (c) Grade 2 = narrowing plus sclerosis or hypertrophy. (d) Grade 3 = severe osteoarthritis with narrowing, sclerosis, and osteophytes.

Figure 3. ROC curves for oblique radiographic findings, with different CT grades considered abnormal: grade 3 only (top line), grades 2 and 3 (center line), and grades 1-3 (bottom line). Sensitivity was maximal for severely diseased facet joints.

to the x-ray beam. In our investigation, the frontal projection demonstrated only 39.3% of all facet joints that were studied. The L-5 to S-1 facet joints are rarely seen on this view because of their predominantly transverse orientation. On the other hand, oblique radiographs demonstrate some portion of the ipsilateral facet joints in nearly all instances. The anterior portion of each articulation is seen on the conventional 45° oblique projection. Conventional tomography has been advocated as a means of depicting all portions of the apophyseal joints, but it is cumbersome, time consuming, and relatively high in radiation dose (11). Although CT clearly demonstrates the facet joints in the transaxial plane, scanner time demands and cost preclude its widespread application as a means of screening for facet joint disease.

Osteoarthritis of the facet joints is a frequent radiographic finding, particularly among the elderly. Fibrillation and erosion of cartilage lead to joint space loss, and, as the changes progress, eburnation and osteophytes develop (12). In 1980, using CT, Carrera et al. (13) observed abnormalities (ranging from joint space narrowing and bone hypertrophy and sclerosis to extensive osteophyte formation) in 65% of facet joints among patients with low back pain. Our finding of a 68% prevalence of disease is in close agreement with their findings. The clinical significance of radiographically evident osteoarthritis involving the facet joints has yet to be precisely established. Previous investigators have compared conventional radiographic findings in symptomatic versus asymptomatic patients, but these studies did not include oblique radiography of the asymptomatic ones (14–17). An increased frequency of disk space narrowing among symptomatic patients was reported by one author, without a difference in the prevalence of osteophytes (spondylolisthesis deformans) (16). Another investigator noted an increased incidence of "arthritis" but did not specify the portion of the spine evaluated; oblique views were also omitted (17).

In a small series of patients evaluated with both CT and facet block, it was found that only those with significant osteoarthritis responded to the injection technique (7). Patients with normal facet joints, as indicated on CT scans, did not exhibit any response to intraarticular injection. This study suggested that CT may be valuable in selecting suitable candidates for facet block. In contrast, other investigators have noted improvement following facet joint block among patients with normal-appearing articulations (1, 3). These authors did not comment on the appearance of the facet joints as shown with computed tomography, so the presence or absence of osteoarthritis among responders cannot be established. The preliminary results of Carrera et al. (7) suggest that detection and quantification of osteoarthritis involving the facet joints may aid in selecting patients for facet block therapy.

Our investigation indicates that experienced radiologists exhibit reasonable interobserver agreement in the evaluation of facet joint arthropathy. On 95% of oblique radiographs and 97% of CT scans, there was agreement to within one severity grade. Owing to the generally oblique orientation of the lumbar facet joints, only a limited number of these articulations were seen on frontal and lateral radiographs. In contrast, oblique radiographs demonstrated 99% of all facet joints at the three levels evaluated.

Our results indicate that conventional radiography is insensitive in the detection of mild facet joint disease and becomes slightly more sensitive for detecting severe disease. However, with this technique the degree of involvement tends to be underestimated; severe disease, as graded with CT criteria, was frequently graded as moderate or mild on the basis of conventional radiographs. Alternatively, the specificity of conventional radiography is apparently high, as radiographs of patients with absent or mild facet joint disease according to CT criteria were generally scored as normal. Radiography was most accurate in distinguishing between the presence and absence of disease. Grading the degree of involvement decreased the accuracy of conventional radiography, owing to its tendency for underestimation of the disease. However, 70% of patients with moderate to severe involvement of the apophyseal joints as indicated by CT criteria did exhibit positive findings on oblique radiographs.

In conclusion, although conventional radiography is moderately insensitive to degenerative alterations affecting the apophyseal articulations, it is valuable in screening for disease at these sites. Further investigation should attempt to develop selection criteria to be used in identify-
ing those symptomatic patients in whom facet block therapy is likely to succeed.

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References