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Importance of sagittally reformatted images in CT evaluation of spondylolisthesis.

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single-dose contrast material), as well as lesions in patients for whom the CT is normal. Eighty-five percent of our patients with definite MS had plaques on MR. Fifty-nine patients had MR and CT examinations. The latter were obtained with plain and single-dose IV contrast (100 ml of Vascoray) from 2 weeks before to 1 week after the MR examination. Eighty-three percent of the patients had plaques on the MR exam and only 25% on the CT. Dr. Ambrosetto cites an article [4] in which CT showed a similar incidence of positive examinations in 34 patients with definite MS. However, in this report, a positive examination included cerebral atrophy, a criterion that was not considered in our or previous MR-CT comparisons. If only the sensitivity of plaque detection is considered, this study reports 47% incidence of hypodense plaques and 44% incidence of plaque enhancement, a sensitivity of detection well below that of MR but which is in the range reported by others [5-7].

Double-dose delayed-contrast CT appears to be more sensitive than single-dose CT in the detection of MS plaques [4, 8]; however, one report found no significant difference in sensitivity between the two methods [4]. Our article did not compare MR with this technique. This was studied by another group [9]. They reported an incidence of plaque detection on MR examination in 75% of patients with definite MS. The double-dose delayed-contrast CT study showed lesions in 60% of these patients. In acute lesions, they report equal sensitivity between MR and double-dose delayed-contrast CT.

Contrast CT evaluates the blood-brain barrier, and since the enhancing lesions are due to a breakdown of this barrier, they are considered a result of active disease [4, 8]. MR can detect active lesions during an acute exacerbation (93% in our series), but cannot characterize them as active on a single study. Serial examinations demonstrating increasing size and/or number of lesions would indicate active plaques.

Steroid therapy decreases the incidence of enhanced plaques on contrast CT (both single and double-dose) [10]. MR can still detect these lesions and is excellent for evaluating the effect of therapy.

Currently, MR is more sensitive than CT (single- or double-dose contrast) in detecting chronic MS plaques and is as sensitive as double-dose contrast CT in detecting acute lesions [9]. The latter examination probably has a slight advantage in determining that the lesion is acute. This would require a comparison of several MR studies for the same determination. MR has the advantage in that it does not use ionizing radiation, does not require contrast administration with its inherent risk, and its sensitivity is not reduced by steroid administration. Thus, it lends itself to repeated follow-up studies to evaluate the results of therapy.

We agree with Dr. Ambrosetto about the limited sensitivity of both imaging techniques in patients with possible or probable MS and also that the clinical criteria are the most useful in diagnosing definite MS.

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Importance of Sagittally Reformatted Images in CT Evaluation of Spondylolisthesis

We read with interest the recent paper by Teplick et al. [1] concerning axial CT findings in patients with spondylolisthesis and spondylolysis. This paper confirms a belief widely accepted by ourselves and other experienced radiologists that axial CT is superior to conventional radiography in evaluating these patients. However, we take issue with their conclusion that "in almost every case axial views alone can furnish the necessary information on spondylolysis and spondylolisthesis."

Teplick and his colleagues are not logically justified in making this conclusion, since by their own admission sagittal or coronal reformatting was performed only "in the exceptional case." By contrast, in the large series reported by Elster and Jensen [2] and Rothman and Glenn [3], sagittal or coronal reformatting was applied to every case. Had Teplick et al. reformatted more than an occasional case, they might be convinced, as we are, of the importance of sagittally reformatted images in evaluating these patients.

The "necessary information" needed to evaluate symptomatic patients with spondylolysis and spondylolisthesis must include more than merely identifying a pars defect or degenerative facet disease. At least two-thirds of these patients have a second significant structural abnormality, such as spinal stenosis, disk herniation, or foraminal narrowing, which may account for their pain [2]. Furthermore, these associated lesions are statistically clustered near the level of the spondylolisthesis.

While axial CT may at times adequately identify these associated lesions, we have encountered many situations where axial CT is misleading or insufficient. For example, the greatest degree of central spinal stenosis in spondylolisthesis does not occur in the axial plane parallel to an interspace, but rather at some angle to it. Sagittally reformatted images allow more accurate measurements and better three-dimensional appreciation of these spatial relationships. Similarly, diagnosis of a herniated disk at the same level as a spondylolisthesis can be treacherous by axial images alone [2, 3]. In 23 surgically confirmed cases, Elster and Jensen found irregular contour and protrusion beyond the posterior margin of the inferior vertebra on sagittal images to be more reliable than axial CT criteria for diagnosing disk herniation at the level of spondylolisthesis.

We feel strongly, therefore, that sagittal reformatting of axial CT images should be performed liberally in the evaluation of symptomatic patients with spondylolisthesis. This is particularly true when more than a minimal subluxation is present. Teplick et al. have surpassed

their own reported experience when they conclude that axial views alone are almost always sufficient.

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Reply

The numerous publications on spinal CT in journals and book chapters by Glenn and his associates have strongly advocated multiplanar reconstruction in all CT spine studies. Their contributions, although not accepted by many, have been very important, since the reformatted images have helped enormously to clarify perplexing or unusual findings on the axial section.

Armed with this clarification and abetted by experience, a careful and perceptive interpreter of axial images can correctly evaluate canal stenosis, foraminal compromises, herniations, and spondylolysis without use of the reformatted multiplanar images. This is the current practice in many centers. Certainly the reformatted images can supply a more facile appreciation of special relationships; but these are merely "stacked-up" axial slices and, as such, can reveal no pathology that is not present on the axial images, granted the reader is experienced. In CT of the brain or abdomen, reformatting is rarely performed, since spatial relationships are easily inferred from the axial slices.

We certainly do not argue against producing reformatted images in any CT study; apparently many feel lost without them. However, we do not find them necessary as a routine procedure. For the present, however, angled axial slices at each interspace give us the highest information return without resorting to the much more numerous continuous nonangled slices that good reformatting demands.

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Percutaneous Transluminal Angioplasty of the Carotid Artery

In the March 1986 issue of the *AJNR*, the article by Tsai et al. [1] would be more convincing with better quality illustrations. In the case of the stenosis at the origin of the left common carotid artery (Fig. 1), the post-PTA (percutaneous transluminal angioplasty) study was performed with the angioplasty catheter tip at least 2.5 cm distal to the stenosis. (Note: All figure references are to those in [1].) The authors relied on proximal reflux to demonstrate the origin of the left common carotid artery, thus the post-PTA image does not convincingly show any significant improvement. Arch aortography is the method of choice to document the results in such cases. In case 2 (Fig. 2, showing stenosis at the origin of the left common carotid

artery), the post-PTA arch injection is collimated in such a way that the arch does not appear to be the same one as in the preangioplasty study; that is, the shape of the innominate artery, the elongation of the aortic arch, and the appearance of the left subclavian artery appear different, even taking into consideration the slight variation in the degree of obliquity of the left anterior oblique projection. The position of the angioplasty catheter in Figure 2B does not seem to agree with the marked elongation of the aortic arch seen in Figure 2A. The stenotic segment of the left common carotid artery in Figure 2A is covered by two linear artifacts. In the caption for Figure 4B (stenosis of the proximal left subclavian artery), the authors state, "Postangioplasty angiogram. Full dilatation of stenotic subclavian artery." Actually in Figure 4B, the locations of both stenoses of the proximal left subclavian artery are not included in the illustration. In the same caption the authors suggest that the collaterals to the left vertebral artery through the cervical trunk are results of the angioplasty. From Figure 4A, there is virtually no doubt that the distal left vertebral artery was opacified through the collaterals, but again the illustration is collimated in such a way that the level of the distal left vertebral artery cannot be seen. The images of Figures 4A and 4B are significantly different in the exposure time after the initiation of the injection into the proximal left subclavian artery; it is well known that the retrograde flow through such narrowed left vertebral artery can be very slow. In the same case, in Figures 4C and 4D (stenosis of the left common carotid artery with complete occlusion of the left internal carotid artery), the authors state: "Full dilatation of distal common carotid artery" (Fig. 4D). This is not the case, because in Figure 4D there is still convincing stenosis at the level of the previous angioplasty. Figures 4C and 4D are in completely different projections, one in lateral and one in anteroposterior, and thus difficult to compare, since the apparent degree of stenosis can vary with different projections. The authors must use the same projection and filming for the postangioplasty study as for the preangioplasty study to make valid comparisons. Figure 5 (case of the weblike stenosis within the right common carotid bifurcation) has the same problem. The bifurcation on the preangioplasty lateral projection (Fig. 5B) is at the level of C4 and on the postangioplasty figure (Fig. 5C) it is much lower. The shape of the distal right common carotid artery as well as the projections of the branches of the external carotid artery are different on the pre- and postangioplasty studies. Figure 10 (case of stenosis at the origin of the external carotid artery) gives the impression of being more stenotic after than before angioplasty.

In case 9 (segmental stenosis of the distal left internal carotid artery with an aneurysm at the cavernous segment of the same internal carotid artery), the authors performed angioplasty on the distal internal carotid artery, but do not mention what type and size of balloon they used, a fact that would be important for the experience of others. In case 8, the authors state: "Anticoagulant with heparin, Persantine, and aspirin were initiated after angiography." The phrasing of the sentence is not correct and Persantine is a vasodilating drug and not used for anticoagulation purposes.

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Reply

The primary purpose of our paper was to present our opinion and recount our experience that a stenotic carotid artery may be treated by percutaneous transluminal angioplasty. I do not agree that the quality of images and illustrations degraded our goal. Case 2 (Fig. 2A) is shown with the patient's arm and chest elevated by pads for