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CT Patterns of Facet Fracture Dislocations in the Thoracolumbar Region

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Thoracolumbar facets are not as commonly dislocated as are those of the cervical spine. It is, however, crucial to make an early and accurate diagnosis of thoracolumbar facet dislocation since the injury may be unstable and require reduction and internal fixation. This paper presents three major CT patterns of thoracolumbar facet fracture dislocation. The first represents anterior subluxation of the vertebral body with anteriorly locked facets. The second is a lateral vertebral body subluxation with laterally locked facets. The third is an acute kyphosis with little vertebral body subluxation but superiorly dislocated facets.

Since the vertebral body subluxation may be missed on axial CT images, these facet-dislocation patterns should be recognized by identifying the paired superior and inferior facets and establishing their congruency. Identification of the facets is accomplished by their orientation with respect to the vertebral body (superior facets are directed posteromedially and inferior facets are directed anterolaterally) as well as by the shape of the articular surface (superior facet articular surface is concave, inferior facet articular surface is flat or convex).

Flexion injury of the thoracolumbar spine most commonly results in simple anterior compression of the vertebral body. The Chance fracture is seen less commonly. With the use of lap-type seat belts, a third pattern has been described [1] in which there is minimal vertebral body compression but extensive disruption of the ligamentous framework of the posterior elements, resulting in articular facet fracture dislocation. This pattern is also seen in vertical falls. Smith et al. [2] found by plain film and plain tomography that of 38 vertical-jump thoracolumbar injuries, four had one or more locked facets and nine had varying degrees of partially dislocated, perched, or completely dislocated facets.

Facet dislocations are usually unstable injuries that require internal reduction, fixation, and fusion. Early, detailed, and accurate diagnosis is essential to allow a well-planned surgical approach and the proper choice of an internal fixation device. CT is routinely used in the preoperative workup. A complete description of CT findings in the more common cervical facet fracture dislocations is found in the literature [3], but only occasionally can cases of thoracolumbar facet dislocations be found [1, 4]. We have collected a spectrum of such cases. Three major patterns of thoracolumbar facet dislocation have become apparent in this study. These patterns are (a) anterior subluxation of the vertebral body with anteriorly locked facets, (b) lateral subluxation of the vertebral body with laterally locked facets, and (c) an acute kyphosis with superiorly dislocated facets. CT is often obtained early in the diagnostic workup of these patients, but the CT appearance of these various facet dislocations may be confusing. The purpose of this paper is to present a simple and practical method of assessing the CT appearance of thoracolumbar facet dislocations.

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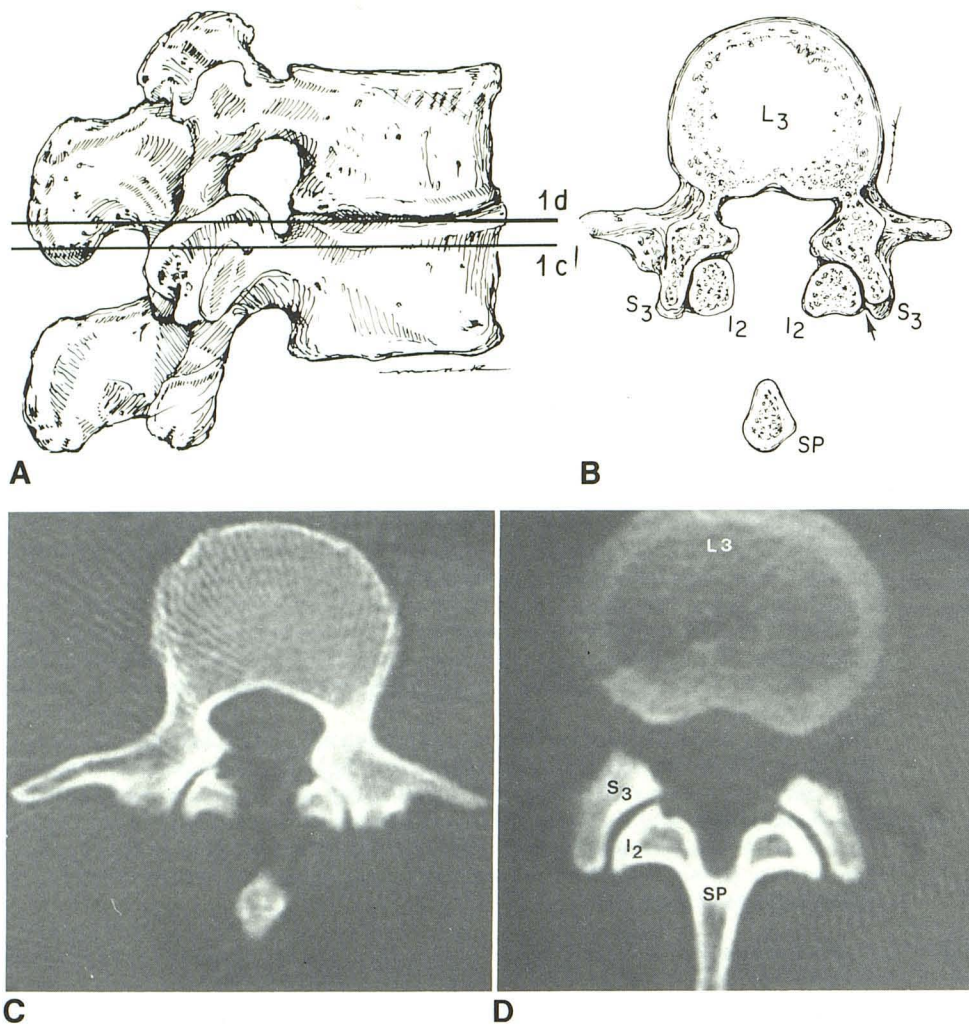


Fig. 1.—Normal lumbar facet joints. **A**, Line drawing of L2 and L3 in the lateral position, showing vertically and sagittally oriented articular facets. Lines 1c and 1d represent the levels of the axial cuts seen in parts **C** and **D**. **B**, Line drawing of axial cut at the level labeled 1c in part **A**. S = superior facet; I = inferior facet; SP = spinous process. Note that at this level, the pedicles extend into the superior facets. Just a tip of the spinous process of the adjacent body is seen. The articular facets fit concentrically together (arrow). The superior facet articular surface is concave and directed posteromedially. The inferior facet articular surface is flat or convex and is directed anterolaterally. **C**, CT at same level as line drawings in parts **A** and **B**. **D**, CT section slightly superior to that in part **C** (depicted in part **A** as level 1d), through superior endplate of L3. The pedicles are not seen attached to the superior facets of L3 at this level, while the inferior facets of L2 are seen to join the spinous process of L2. Despite those differences, the shapes and relationships of the articular facets remain constant (compare to part **C**).

Cases

Ten cases of facet dislocation, all the result of flexion injury, were examined. Examples are included with the discussion. Four cases demonstrated anterior subluxation of the vertebral bodies with anteriorly locked facets. Two of these were at the L4–L5 level, one at L5–S1, and one at T11–T12. Two cases demonstrated lateral subluxation of the bodies with laterally locked facets, one at the L3–L4 level and one at L4–L5. Finally, four cases demonstrated an acute kyphosis with superiorly locked facets. All were at the T12–L1 vertebral body levels.

Discussion

In the cervical region, the articular facets are small, flat, and angled approximately 45° from the horizontal plane. This orientation explains the great degree of motion allowed, as well as the relative ease with which cervical facets sublux, dislocate, and lock. Thoracolumbar facets, on the other hand, are large, curved, and much more vertically oriented [5]. The shape and orientation of the thoracolumbar facets act to limit flexion-extension and provide additional stability in a flexion

injury. An additional consideration is that the thoracic facets are coronally as well as vertically oriented. At L1, the orientation of the facet articular surface changes from a coronal plane to one closer to a sagittal plane [4]. This allows more flexion-extension than in the thoracic spine but is still very limited compared to the cervical spine. Thus, lumbar flexion-rotation injury rarely results in pure facet dislocation. Fracture of the facets occurs much more frequently; thus, a flexion-rotation injury of the lumbar spine not uncommonly yields a rotational fracture dislocation of the posterior elements.

Thoracolumbar fracture dislocations often are extremely unstable [5] and may be quite complex; therefore, early diagnosis is essential. If there are few fractured elements in this injury, spontaneous fusion may not occur. One cannot rely on restoration of stability by healing of posterior ligaments; such injuries often must be reduced and internally fixed.

In a trauma situation, the clinician is often first alerted to a potentially unstable lumbar spine fracture by widened interpediculate distance on the anteroposterior film, which may be indicative of a burst-type fracture. Lateral lumbar spine films

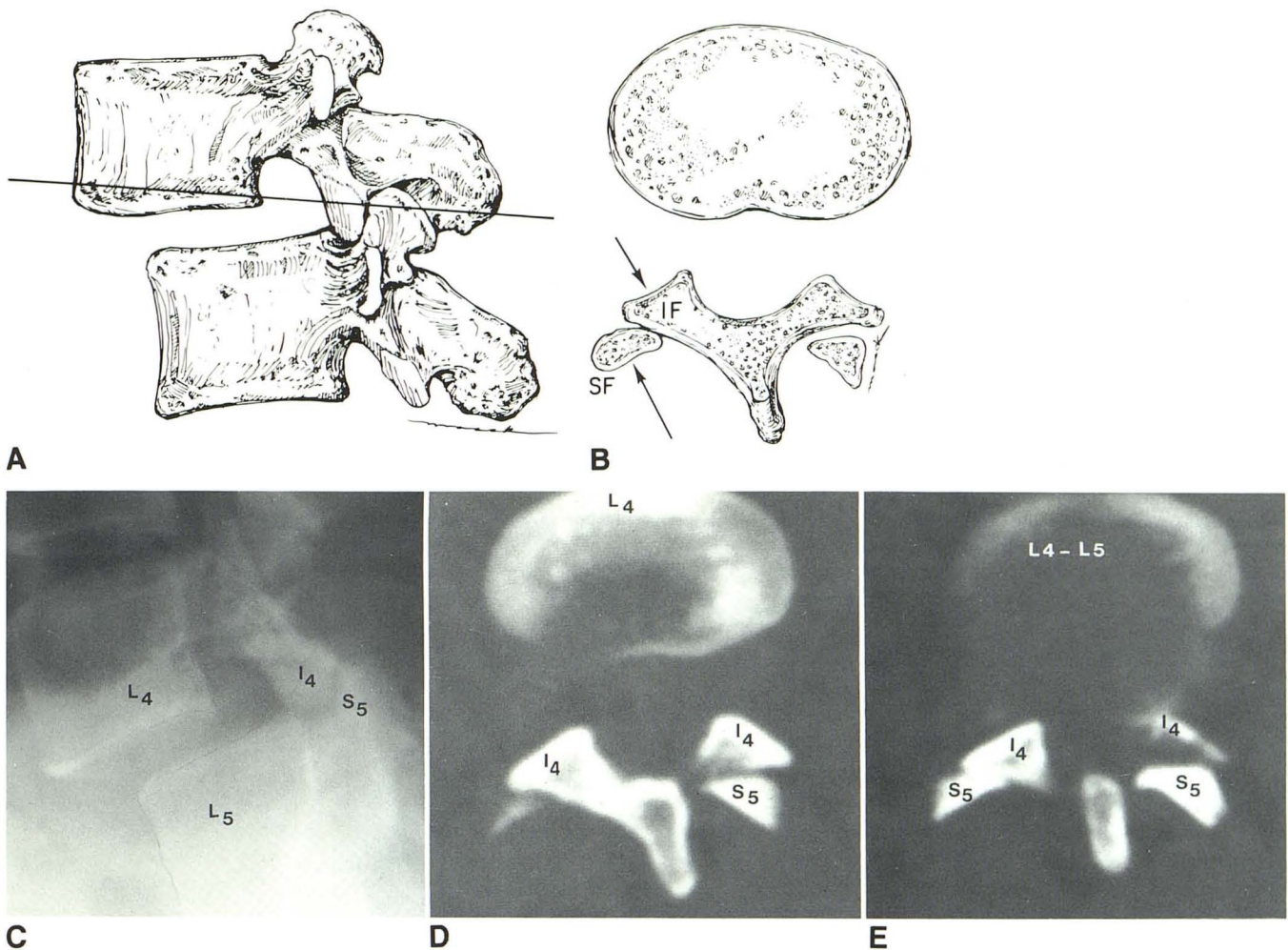


Fig. 2.—**A**, Line drawing of anterior vertebral body subluxation with anteriorly locked facets. The line corresponds to the line drawing depicted in part **B**. **B**, Line drawing of CT appearance typical of this facet dislocation pattern. SF = superior facet; IF = inferior facet. Arrows show their respective articular surfaces. **C**, **D**, and **E**, Anterior dislocation L4 on L5 with anteriorly locked facets. Lateral film, demonstrating lock (**C**); CT at inferior endplate of L4, demonstrating spinous process and inferior facets of L4 (labeled I4) with

superior facets of L5 (labeled S5) locked posteriorly (**D**). Notice that the shape and orientation of the facets make them easily identifiable. CT through L4-L5 disk space (4 mm caudal to part **D**) shows both superior L5 facets better (**E**). Notice that in this series of films, the superior subluxation and spondylolisthesis of the bodies is not easily recognized in the axial CT scans; it must be inferred from the locked facet position.

of good quality are difficult to obtain; cross-table lateral films are usually attempted, since rolling the patient into a decubitus position could cause neurologic damage. CT is now universally accepted as the next step in evaluation of a thoracolumbar fracture [1, 4, 6, 7]. The advantages of CT include superb visualization of the posterior elements and of the relation of bone fragments to the spinal canal; visualization of soft-tissue abnormalities, such as disk herniation or hematoma; improved speed of diagnosis; smaller radiation dose than with plain tomography; less patient manipulation (especially into decubitus positions); and the availability of multiplanar reconstruction.

There are, however, pitfalls in CT evaluation of spine fracture dislocations [8]. With axial sections, an increase in intervertebral distance can be missed. Furthermore, it may be difficult to correlate the alignment of adjacent vertebral bodies,

so either anteroposterior or lateral subluxation may be missed. Both sagittal and coronal reconstructions help eliminate these problems. It is also crucial to be aware of other subtle signs of subluxation/dislocation of the posterior elements demonstrated by CT.

One must be familiar with the normal appearance of facets on CT in order to recognize abnormal relationships. First, one must be able to reliably differentiate superior from inferior articular facets in the axial plane. The parameters used for this differentiation include the orientation of the facet in relation to the vertebral body, as well as the shape of the articular surface of the facet. A normal scan is illustrated in Figure 1. An axial scan at the level indicated in the line drawing shows the pedicles extending into the superior articular facets. Those superior facets are oriented medially and posteriorly with respect to the vertebral body. Note also that the articular

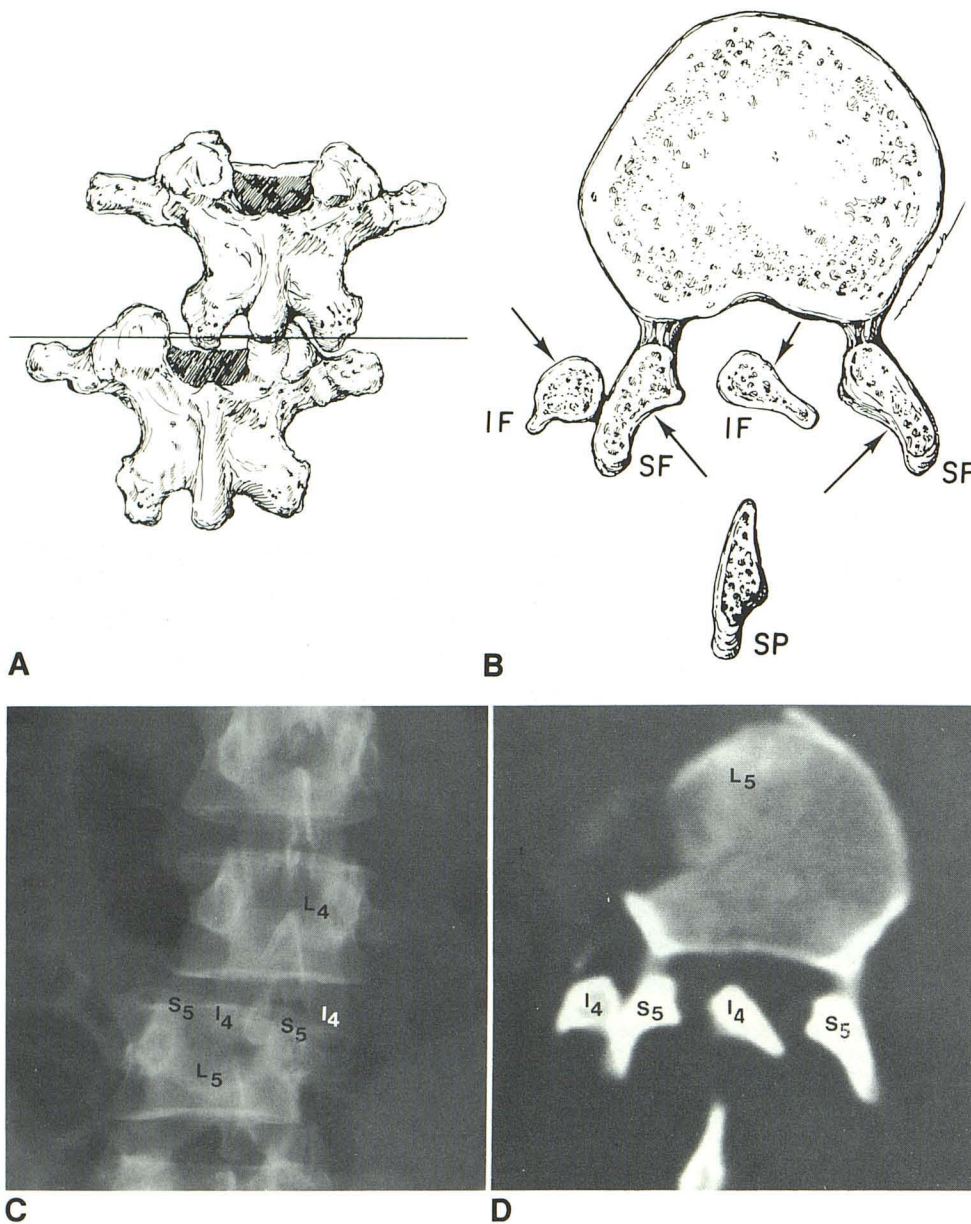


Fig. 3.—**A**, Line drawing of lateral vertebral body subluxation with laterally locked facets. The line corresponds to the axial CT cut shown in part **B**. **B**, Line drawing of the CT typical of this facet dislocation pattern. This corresponds to the CT scan shown in part **C**. SF = superior facet; IF = inferior facet. Arrows indicate the respective articular surfaces. **C**, Anteroposterior view demonstrates lateral subluxation of L4 on L5 in this patient with six non-rib-bearing vertebrae. The laterally locked facets are seen, as are multiple-fractured transverse processes. **D**, CT through superior endplate of L5 demonstrates laterally locked facets as well as compromised spinal canal diameter. Again, the facets are identified by the contour and position of the articular surfaces. S5 = superior facet L5; I4 = inferior facet L4.

surface of the superior facet is concave. Unlike the concave superior facet, the inferior facet is either flat or slightly convex at the articular surface. The orientation is also different, the inferior facets being directed anterolateral with respect to the vertebral body.

After the superior and inferior facets have been properly identified, their relationship to one another is assessed. They are normally concentrically applied over several axial scans. The shapes and relationships of the facets to one another remain constant with axial scans either superior or inferior to the one demonstrated in Figure 1A and 1B. This is illustrated by a slightly superior scan (Fig. 1D) in which the pedicles are no longer seen attached to the superior articular facets but the laminae and spinous process of the higher vertebral body

are seen extending from its inferior articular facets. Notice that the facets have an identical appearance and relationship to one another, as in the lower axial scan (Fig. 1C).

With flexion injury, the facets may momentarily sublux and return to their normal position, resulting in a normal CT. With more significant flexion force, the inferior facets may dislocate superiorly. They may then either settle back into a normal position or become perched or locked. We have observed three patterns of locked facets. Figure 2 is a line drawing with clinical examples of the first, demonstrating severe anterior subluxation of the superior vertebral body on the inferior one, and dislocation with anterior locking of the inferior articular facets on the superior facets. Although the CT may appear confusing initially, when the facets are properly identified, the

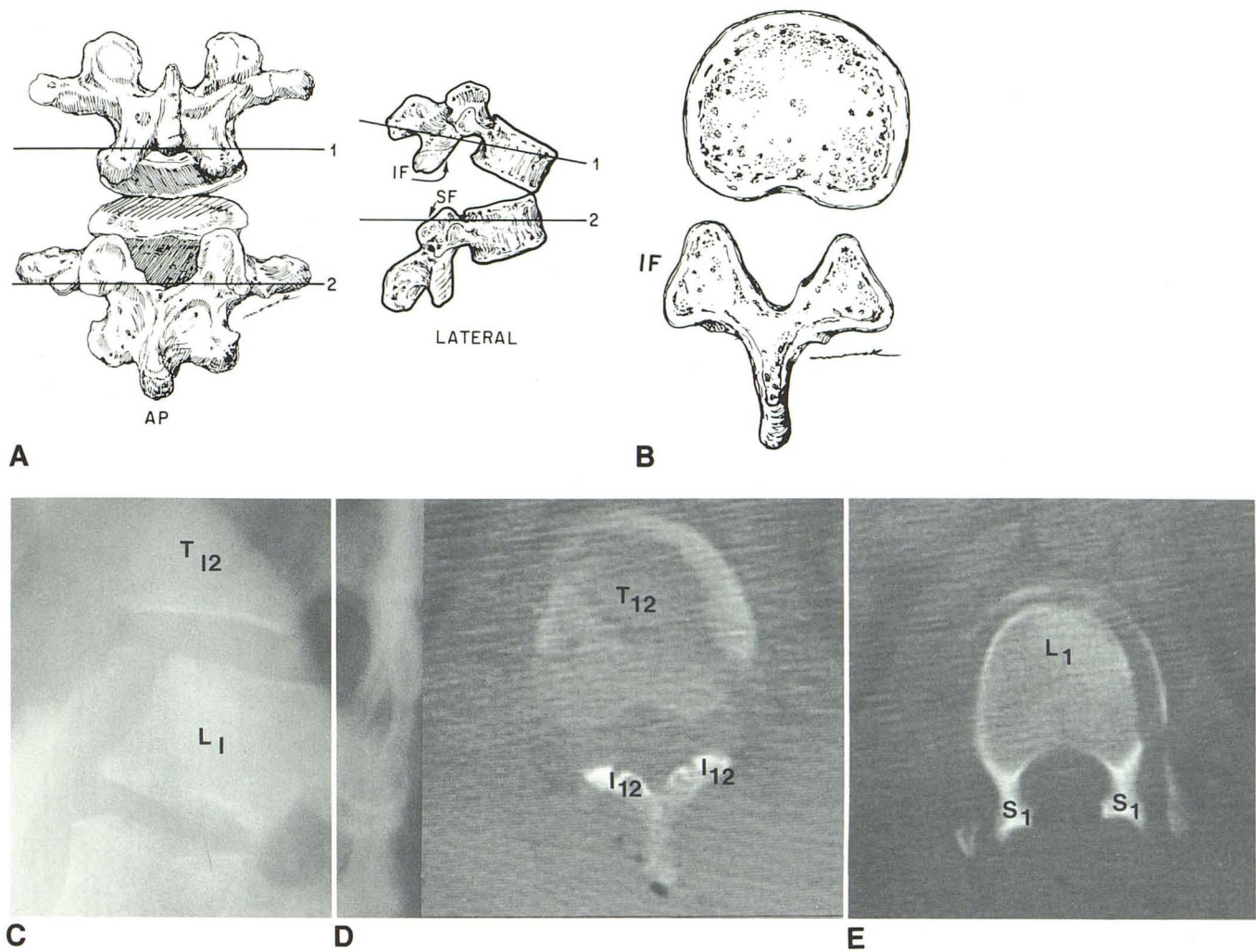


Fig. 4.—A, Line drawing of the third pattern of locked facets. Here, there is superior dislocation of the inferior facets from the superior facets. Line 1 corresponds to the CT drawing in part B and to the example in part D, which show "naked" inferior facets. Line 2 corresponds to the CT scan in part E and shows "naked" superior facets. B, Line drawing of a CT scan corresponding to line 1 in part A. Here, the inferior facets are "naked"; i.e., they are seen without the corresponding superior facets. SF = superior facets; IF = inferior facets.

C, Superior dislocation of T12 inferior facets from superior L1 facets. Lateral film shows increased intervertebral space, anterior subluxation of the body of T12 on L1, and presumed dislocation of facets. D, CT through inferior endplate of T12. Inferior facets (labeled I12) are seen, without evidence of superior articulating facets. E, CT through superior endplate of L1, showing superior facets (labeled S1) without articulating inferior facets. This is a demonstration of "naked" facets. (Case is courtesy of Dr. David Giles, Boise, Idaho.)

bilateral facet dislocation and locking become obvious.

The second pattern is shown in Figure 3. Here there is severe lateral subluxation of the superior vertebral body on the inferior one as seen in the line drawing. The CT demonstrates associated lateral dislocation and locking of the facets. Again, the diagnosis becomes obvious once the facets are identified. The third pattern is shown in Figure 4. In this instance, only slight to no anterior subluxation of the superior vertebral body is present, but there is complete superior dislocation of the inferior facets from the superior facets. The resultant CT shows inferior facets without accompanying superior facets; a more inferior scan shows superior facets without accompanying inferior facets. The number of intervening scans between the two sets of facets depends on the

degree of distraction. This appearance has been described before and termed "naked facets" [1].

Conclusions

Three major patterns of thoracolumbar facet dislocations are described. These can be accompanied by various vertebral body and posterior element fractures. The diagnosis of facet dislocation by CT may be subtle and depends largely on identification of the superior and inferior facets by means of the articular surface shape and alignment, as well as congruency at the articular surface. Timely diagnosis is essential, as these are usually unstable fractures requiring internal fixation and fusion.

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