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Lumbar facet joint fat pads: their normal anatomy and their appearance when enlarged

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Summary. The polar recesses, superior and inferior to lumbar facet joints, are filled by fat pads from which fat-filled synovial folds project between the articular surfaces for a distance of two to four millimetres. The intracapsular superior recess lies between the ligamentum flavum and the lamina above. The extracapsular inferior recess lies on the back of the lamina below and communicates with the joint through a hole in the inferior capsule. The intracapsular folds move freely in and out of the joint during movements. These features are demonstrated in anatomic studies using transverse sections and radiologic studies using computed tomography. In about 4% of lumbar spines examined, the intraarticular fat pads are enlarged and extend from the joint recess(es) into the middle third of one or more facet joints. The fat pads can be identified in CT scans by their radiolucency and distinguished from vacuum phenomenon by measuring their attenuation values. The cause of the intra-articular enlargement of the fat pads is unknown, but it is suggested that their extension into the middle third of the joint may be secondary to degenerative change in the motion segment with capsular laxity in the affected joint.

Key words: Facet joints – Lumbar spine – Joint inclusions – Fat pads

The fat-filled synovial folds around the articular margin of synovial joints fill any irregularities or incongruities within the capsule and project between the articular surfaces to a variable extent as fat-filled joint inclusions. In some joints, larger fat pads occupy periarticular "spaces" both within and outside the fibrous capsule. They act as cushions attenuating the mechanical forces which accompany joint movements [1].

The lumbar facet (zygapophyseal) joints have the usual synovial fringes around the joint margin and there are also larger fat pads at the superior and inferior "poles" of the joints to accommodate the principal movements of flexion and extension. Various aspects of the normal cadaveric anatomy of the fat pads in the superior and inferior recesses of the facet joints have been described by ourselves and other authors [2–7]. At the superior recess, there is an extensive intracapsular fat pad above the tip of the superior articular process (SAP), between the ligamentum flavum and the lamina of the vertebra above. It may communicate through a small gap in the fibrous capsule with the fat in the intervertebral foramen [2]. A fat-filled synovial fold passes downwards from the superior recess, projecting to a variable extent between the articular surfaces. The much larger fat pad of the inferior recess lies outside the fibrous capsule, on the posterior surface of the lamina below, deep to multifidus. This fat pad consistently communicates with the intracapsular synovial fold through a gap in the inferior fibrous capsule. Studies of fresh unfixed cadaveric spines observe the synovial fringes changing shape and position to accommodate joint

Table 1. Number of lumbar facet joints sectioned

a) Transverse sections

Age group	L 3–4[b]			L 4–5[a]			L5–S1[a]		
(Years)	F	M	T	F	M	T	F	M	T
1–19	9	9	18	25	17	42	6	6	12
20–34	17	15	32	19	18	37	6	6	12
35–49	12	11	23	15	11	26	4	4	8
50–84	31	33	64	33	36	69	18	18	36
	69	68	137	92	82	174	34	34	68: (379)

F = female; M = male; T = total
[a] 2 mm undecalcified sections; [b] 100 micron LVN embedded sections

b) Sagittal sections

Age group	L 3–4[a]			L 4–5[a]			L5–S1[a]		
(Years)	F	M	T	F	M	T	F	M	T
1–19		1	1	4	6	10	–		
20–49	2		2	4	4	8		2	2
50–70				8	9	17	2		2
	2	1	3	16	19	35	2	2	4: (42)

F = female; M = male; T = total
[a] 100 micron LVN embedded sections

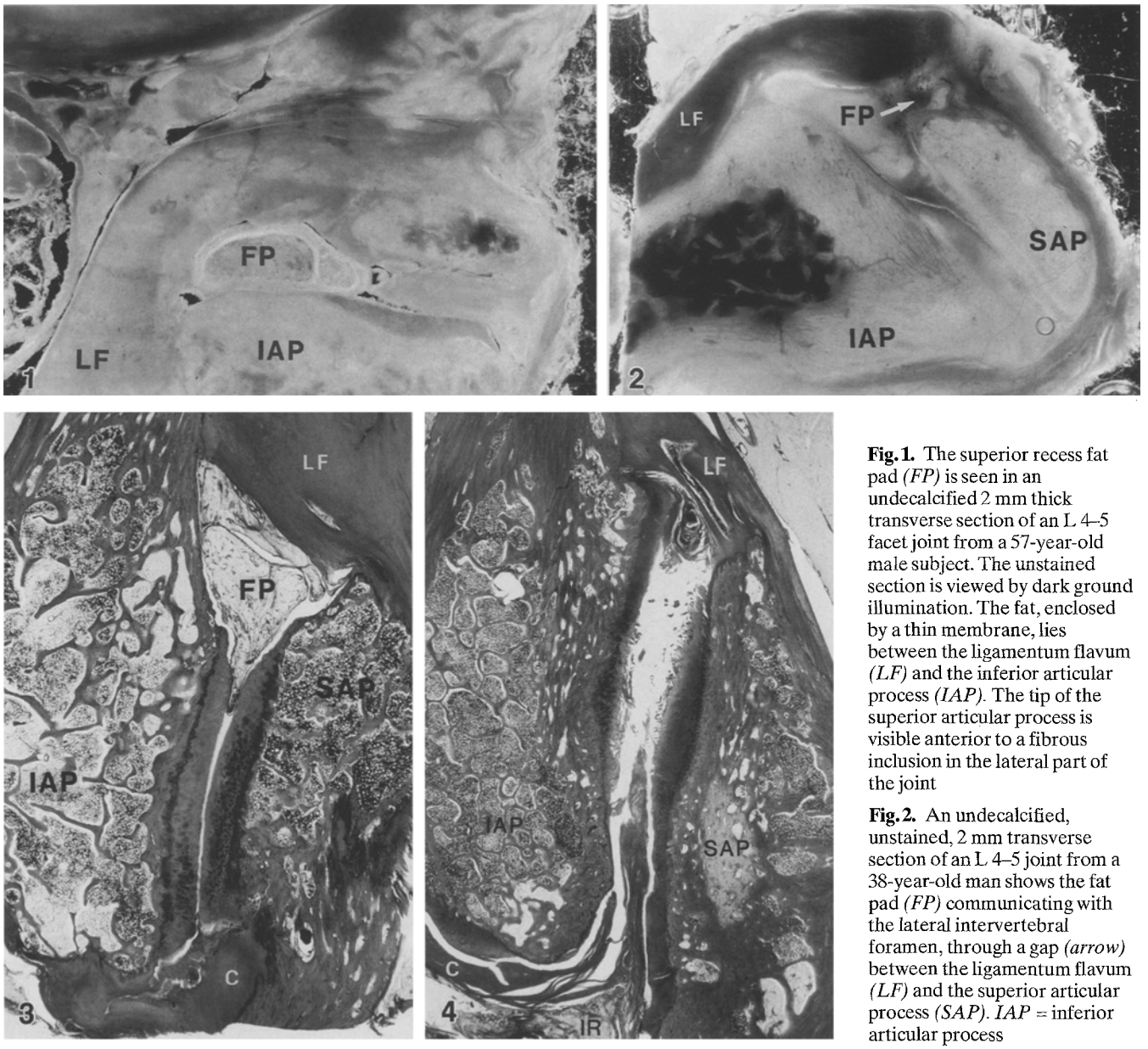

Fig. 1. The superior recess fat pad *(FP)* is seen in an undecalcified 2 mm thick transverse section of an L 4–5 facet joint from a 57-year-old male subject. The unstained section is viewed by dark ground illumination. The fat, enclosed by a thin membrane, lies between the ligamentum flavum *(LF)* and the inferior articular process *(IAP)*. The tip of the superior articular process is visible anterior to a fibrous inclusion in the lateral part of the joint

Fig. 2. An undecalcified, unstained, 2 mm transverse section of an L 4–5 joint from a 38-year-old man shows the fat pad *(FP)* communicating with the lateral intervertebral foramen, through a gap *(arrow)* between the ligamentum flavum *(LF)* and the superior articular process *(SAP)*. *IAP* = inferior articular process

Fig. 3. A 100 micron sagittal section of an L 4–5 joint from a 60-year-old woman, stained by haematoxylin and light green, shows an enlarged, triangular superior recess fat pad *(FP)* between the ligamentum flavum *(LF)*, the root of the inferior articular process *(IAP)* and the tip of the superior articular process *(SAP)*. This fat pad does not reach the middle third of the joint. The inferior fibrous capsule *(C)* is thickened, but the articular cartilage appears healthy

Fig. 4. A 100 micron sagittal section, stained by haematoxylin and light green, of an L 4–5 joint from a 61-year-old woman shows part of the extracapsular fat pad of the inferior recess *(IR)*. This communicates with the joint cavity through a gap in the inferior capsule *(C)* and projects between the articular processes (*IAP* and *SAP*). The articular cartilage is fibrillated and there is sclerosis of the subchondral bone plates

movements, as the extracapsular fat moves in and out of the joint through the gaps in the capsule [4, 8].

These fat pads can also be identified on axial CT scans, as radiolucent areas, within the joint at its upper pole and outside the joint behind its lower pole, but they have not been adequately described in the radiologic literature. The purpose of this paper is to illustrate the normal anatomy of these fat pads in anatomic sections and CT scans, and particularly to describe enlarged fat pads which project beyond their normal positions into the middle third of the joint, i. e. fat pads between the articular surfaces, midway between the upper and lower poles of the joint, but in continuity with the superior or inferior recess fat pads.

Materials and methods

Anatomic studies

From a series of over 200 lumbar spines, 379 facet joints were sectioned transversely and 42 joints were sectioned in the sagittal plane. The segmental levels sectioned and the age distribution of subjects is shown in Table 1. The lumbar spines collected at autopsy were fixed in 10% for-

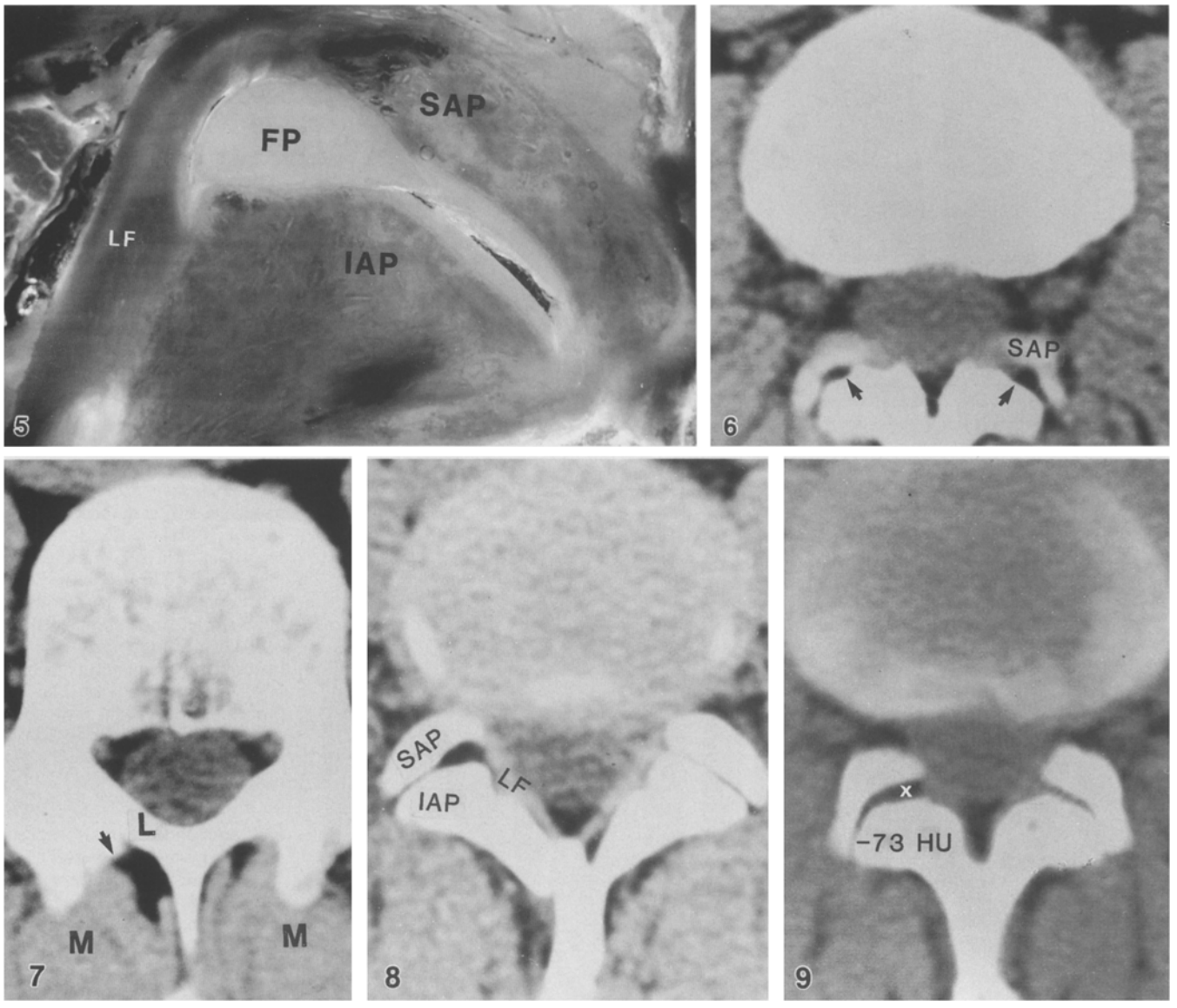

Fig. 5. A 2 mm unstained transverse section, through the middle third of an L 4–5 joint from a 43 year old man, shows a grossly enlarged fat pad *(FP)* which extends down from the superior recess under the ligamentum flavum *(LF)* and projects between the articular processes (*SAP* and *IAP*) with associated bony remodelling of both facets and absence of articular cartilage from the areas in contact with the fat

Fig. 6. The L 3–4 facet joints from a 65-year-old male patient: the superior recess fat pads *(arrowed)* are seen in this CT section through the mid – L 3–4 foramen. They appear as well defined areas of low density similar to that of the perirenal fat. The fat pads lie behind the tips of the superior articular processes *(SAP)*

Fig. 7. The inferior recesses of the L 3–4 facet joints from a 52-year-old man: this scan, through the tip of the right inferior articular process *(arrowed)* and just below the left inferior articular process, shows inferior recess fat pads which appear larger on the right than on the left and lie posterior to the laminae *(L)* and anterior to multifidus *(M)*

Fig. 8. The L 4–5 facet joints of a 52-year-old male patient: in the right medial part of the joint under the ligamentum flavum *(LF)* there is a triangular area of fat density. There is remodelling of the adjacent articular surfaces of the articular processes (*SAP* and *IAP*)

Fig. 9. The L 4–5 facet joints of a 47-year-old male patient: this CT scan is through the upper vertebral endplate of L5 and the mid-L 4–5 facet joints. In the right facet joint an elongated low density area *(x)* has a measured attenuation coefficient of *– 73 HU*

malin, post-fixed in Bouin's fluid and sectioned by one of two methods as previously described [6, 9].

a) Sections of deep frozen, gelatin embedded joints were cut as undecalcified 2 mm slices and mounted unstained on perspex trays.

b) Decalcified joints were embedded in low viscosity nitrocellulose and sectioned at 100 microns to be stained by haematoxylin and light green and mounted in Depex on glass slides.

Radiologic study

A series of 200 consecutively reported lumbar spine scans were examined for the presence of fat, within the facet joints, including their superior recesses and also at the inferior recesses. All scans extended from L3 to the sacrum, and therefore a total of 1200 joints were surveyed in this group. The age and sex distribution of the patients is shown in Table 2.

Where there was doubt about the nature of any tissue within the facet joints, its attenuation value in Hounsfield

Table 2. Computed tomograms examined for fat pads (L 3–4, L 4–5 and L5–S1 are included from all of 200 CT scans)

Age group	Numbers of patients scanned		
(Years)	Female	Male	Total
1–19	4	2	6
20–34	29	24	53
35–49	41	29	70
50–80	41	30	71
	115	85	200

Table 3. Computed tomograms: facet joints with mid-joint fat pads

Case no.	Age	Sex	Segmental level
1.	30	M	L5–S1 (left)
2.	40	F	L 3–4 (right)
3.	42	M	L 4–5 (right)
4.	44	M	L 3–4 (left)
5.	47	M	L 4–5 (right)
6.	52	M	L 3–4 (left) and L 4–5 (right)
7.	65	M	L 3–4 (right) and L 4–5 (left)

units (HU) was measured. Scans were carried out on an Elscint 2400 or Siemens DR2 whole body scanner, using 4 or 5 mm contiguous sections, with alteration of gantry angle where required. Images were displayed and photographed at the usual bone and soft tissue windows used in reporting.

Results

Anatomic studies

Histologic studies of large numbers of lumbar facet joints of all ages, confirm the consistent presence of intra-capsular fat pads in the superior joint recesses (Figs. 1–3). Figure 2 shows an opening from the superior recess fat pad passing anteriorly towards the intervertebral foramen. The large extracapsular fat pad of the inferior recess occupies a hollow on the lamina below the joint. The communication between the inferior extracapsular fat pad and the joint cavity, through a gap in the inferior fibrous capsule (Fig. 4), can be readily found at all lumbar segmental levels, infero-medial to each inferior articular process (IAP).

In the anatomic specimens, in a total of 421 joints sectioned, there are 6 examples of enlarged fat pads extending from the superior recess down into the middle third of the joint and projecting between the articular surfaces in mid-joint transverse sections (Fig. 5). These involve 5 different individuals from a total of 130 individuals.

One was at the L 3–4 level (right) in an 81-year-old female. Four were at the L 4–5 level (two right and two left) in a 37-year-old male, a 38-year-old male, a 43-year-old male and a 78-year-old female. One was found at the L5-S1 level (right) in a 43 year-old male.

The 6 joints with enlarged fat pads show capsular and articular cartilage age changes which are not excessive for their ages. In three examples from two individuals where the whole motion segment is sectioned for study (43M and 78F), the facet joint contralateral to the joint with the enlarged fat pad, and the corresponding intervertebral disc, show advanced degenerative changes. Each disc is fissured and each contralateral zygapophyseal joint shows advanced osteoarthrosis.

In the 6 examples described, the mid-joint fat pad is always in direct continuity with the superior recess fat pad and in two cases, also in continuity with the inferior recess fat pad. In all cases this continuity extends down under the ligamentum flavum in the antero-medial aspect of the joint. The superior recess fat pads of L 4–5 and L5–S1, in the 43-year-old male, are both grossly enlarged. The ligamentum flavum in these joints appears to bulge forwards, and the facets in the upper half of the joint show remodelling changes at the articular surfaces in contact with the fat pads (Fig. 5). These changes would give the appearance of a "filling defect" on axial scans (compare Figs. 5 and 8).

Radiologic studies

The normal radiologic anatomy of superior and inferior recess fat pads is illustrated in Figs. 6 and 7 respectively. The superior recess fat pad lies behind the ligamentum flavum and the tip of the SAP, and in front of the root of the IAP. The extracapsular inferior recess fat pad lies between the lamina and the multifidus muscle. It is best seen in sections between the basivertebral foramen and mid-pedicle levels.

In the prospectively examined group of 200 patients whose scans were examined for fat pads in the middle third of joints, 9 examples are found. These may have been easily overlooked, had not cursor measurement of intra-articular low density areas been carried out. Enlarged fat pads extending into the middle third of facet joints, are illustrated in Figs. 8 and 9. The nine enlarged fat pads were found in seven patients. The age and gender of each patient and the segmental levels affected are recorded in Table 3.

Discussion

In both anatomic sections and CT studies, fat pads are regularly identified in the superior and inferior recesses of normal joints. In a small percentage of joints, fat pads can also be demonstrated at mid-joint level. In serial anatomic sections and consecutive CT scan slices, these can be shown to be continuous with the superior recess fat pads. The "mid-joint fat pads" we have observed are therefore extensions of normal fat pads from a polar recess into the middle third of a joint. The capacity of the fat pads to move within the joints has already been noted [2, 4, 8].

In a previous publication, fatty or fibro-fatty inclusions were described in degenerate lumbar facet joints, filling areas between the facets where the articular cartilage was deficient [6]. It was suggested that these intra-articular inclusions had increased in size to replace the deficient cartilage. In a subsequent study [8], enlarged fat pads were associated with motion segment instability in three of five

unstable motion segments. The fatty inclusions identified at mid joint in this CT scan study closely resemble in position and configuration, those displayed in the current and previous cadaver studies.

In a previous CT scan series which studied zygapophyseal incongruity as a possible sign of motion segment instability [10] we utilised images photographed at bone windows. Low density intra-articular areas associated with "filling defects" in the articular facets were seen in incongruous joints. These had a similar configuration and position to joint inclusions identified in the current study, but they could not with certainly be identified as fat pads. In the prospective study presented here, it was possible to confirm the fatty nature of low density inclusions by cursor measurement of their attenuation value. The unique attenuation value of fat permits intra-articular fat pads to be readily identified if they are of sufficient size.

The prevalence of enlarged intra-articular fat pads extending into the middle third of the joint is low: in our two studies, 9 of 1200 axially scanned joints and 6 of 421 sectioned joints, contain identifiable fat pads at mid-joint levels. Taking the two series together, 12 individuals out of 330 examined (3.6%) are affected. Eleven are in the 37 to 81 year age range.

It is clearly not correct to state that magnetic resonance imaging (MRI) is the only imaging technique with the ability to demonstrate intra-articular fat pads or that fat pads are not seen on CT scans because of the lower contrast in soft tissues and the absence of direct digital scanning [11]. We suggest that it is probably also incorrect to identify intra-articular fat pads as "lipomas" [12, 13] as they are in continuity with the normal superior recess fat pads. They are more likely to represent an increase in the volume of intra-articular and peri-articular fat, perhaps in association with ligamentous laxity in the joint. While the vacuum effect has been recognised and frequently described in joints, it seems likely that some areas of low attenuation in zygapophyseal joints, due to enlarged fat pads, may have been mistakenly attributed to gas in these joints.

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