Lumbosacral Transitional Vertebrae: A diagnostic challenge by MRI. The value of MDCT and conventional radiograph in the definitive diagnosis.

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Learning objectives

To highlight the importance of identifying lumbosacral transitional vertebrae (LSTV) by MRI.

To demonstrate the usefulness of multidetector computer tomography (MDCT) in the definitive diagnosis of LSTV.

To explain Castellvi’s method as the standard classification system.
Background

Introduction:

Lumbosacral transitional vertebra (LSTV) is a common variant of the lumbosacral spine in general population with a reported prevalence of 4-30%.

It is defined either as a sacralization of the lowest lumbar segment (L5) or lumbarization of the most superior sacral segment (S1).

This condition occurs due to a defect in the segmentation of the lumbosacral spine during development.

When the L5 vertebra is completely fused to the sacrum (sacralization of L5), there are only four lumbar vertebrae, whereas when S1 is separated from the sacrum (lumbarization of S1), there are six lumbar vertebrae. There are many intermediate variations and they can be either complete or incomplete, unilateral or bilateral.

The incidence ratio of sacralization to lumbarization was reported as 2:1.

Correct identification is essential because there are important clinical and legal implications and an inaccurate identification may lead to performing surgeries and procedures at the wrong level.

Moreover, there is a relation between low back pain and LSTV, termed "Bertolotti Syndrome".

Imaging Techniques:

LSTV can be identified with all imaging modalities, easier or harder, but almost always incidentally. However, currently, CT with multiplanar and volume rendering reconstructions, is the best imaging technique for its characterization.

As always, radiation is the biggest disadvantage of the CT, and it is usually an incidental finding on a CT performed for another reason, so we have no special protocol. When we realize we have a LSTV we make thin (0,625mm) retrospective reconstructions in
standard soft tissue and bone windows and we perform multiplanar reconstructions in sagittal and coronal and volume rendering.

To analyze a radiograph properly we need two projections: Ferguson (30° angled anteroposterior lumbar spine radiograph) and lateral, which in most cases are enough to make an accurate description.

MR is the hardest although currently the most performed, even before conventional spinal radiographs, which makes the detection of LSTV even more difficult.

In our hospital, the MR protocol consists of fast spin echo (FSE) sagittal T1 and T2 weighted images and additional axial series in pathological segments.

**Numbering:**

We should have some criteria which allow us to number the vertebrae and establish whether an LSTV is a lumbarized S1 or a sacralized L5, above all in MR studies, where its identification is challenging. There are different methods such as identifying the iliolumbar ligament (ILL), that can be clearly seen on axial MR studies as a single or double low-signal-intensity band, on both T1- and T2-weighted images (Fig. 1 on page 14), extending from the transverse process of L5 to the posteromedial iliac crest, almost in the majority of the cases, so the vertebral body with the iliolumbar ligament can be label L5. This invariable localization indicates that the ILL is a reliable marker of the L5 vertebral level on axial MRI and is a good criterion for numbering LSTV. However, this ligament is not always identified on routine MRI axial images of the lumbar spine.

Moreover, we can use some anatomical markers, which are less reliable, but can be useful and include the aortic bifurcation located in L4 in most cases (Fig. 2 on page 14), the right renal artery usually located at the L1-L2 disk space (Fig. 2 on page 14), and the conus medullaris which is quite variable (D12-L2) and should not be used.
Fig. 2: Fig 2. A) Sagittal and B) axial T2-weighted fast spin echo (FSE) images where we can see the aorta bifurcation (arrow) located in L4. C) Sagittal FSE T2-weighted images. It shows the right renal artery (RRA) (arrow) located in L1-L2 disk space.

References: - Palma. Mallorca. Illes Balears/ES

Additionally, the perfect situation would be to have radiographs (Fig. 3 on page 15) and/or MR localizers to be able to number the vertebrae since C2, taking into account that there are 7 cervical vertebrae, 12 dorsal vertebrae and 5 lumbar vertebrae. In this way a correct enumeration could often be achieved, but there are still cases where it is difficult to differentiate hypoplastic ribs from transverse processes at the thoracolumbar junction.
On the contrary, the numbering cannot be made in the opposite direction because the last segment of the column (sacrum and coccyx) is the most variable, at the most the number of coccygeal vertebrae (5 sacral and 2-3 coccygeal) or remnants as in their articulation or fusion with the sacral segments.

Classification:

LSTV have been classically identified by using Ferguson and lateral radiographs. In 1984 Castellvi et al. described a radiographic classification system identifying four types of LSTV (Fig. 4 on page 16).

I: dysplastic transverse processes, defined as measuring at least 19 mm in width - craniocaudal dimension-; it can be unilateral (Ia) (Fig. 5 on page 17) or bilateral (Ib) (Fig. 6 on page 18).
Fig. 5: Volumetric reconstruction (VR) of lumbosacral transitional vertebrae (LSTV) type Ia.

References: - Palma. Mallorca. Illes Balears/ES
Fig. 6: VR of LSTV type Ib.

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II: incomplete unilateral (IIa) (Fig. 7 on page 19) or bilateral (IIb) (Fig. 8 on page 20) lumbarization/sacralization with an enlarged transverse process that has a diarthrodial joint between itself and the sacrum.
Fig. 7: A) Anteroposterior (AP) radiograph of LSTV type IIb. B) VR of LSTV type IIa.

References: - Palma. Mallorca. Illes Balears/ES
Fig. 8: A) AP radiograph of LSTV type IIb. B) VR of LSTV type IIb. C) Coronal oblique reconstruction with maximum intensity projection (MIP) of LSTV type IIb. D) VR of LSTV type IIb.

References: - Palma. Mallorca. Illes Balears/ES

III: lumbarization/sacralization with complete osseous fusion of the transverse process(es) to the sacrum, unilateral (Illa) (Fig. 9 on page 21) or bilateral (Illb) (Fig. 10 on page 22).
Fig. 9: VR of LSTV type IIIa.

References: - Palma. Mallorca. Illes Balears/ES
**Fig. 10:** A) AP radiograph of LSTV type IIIb. B-C-D) VR of LSTV type IIIb.

*References:* - Palma. Mallorca. Illles Balears/ES

IV: involves a unilateral type II transition with a type III on the contralateral side (Fig. 11 on page 23).
**Fig. 11:** VR of LSTV type IV.

**References:** Palma. Mallorca. Illes Balears/ES
Images for this section:

**Fig. 1:** A) Iliolumbar ligaments (ILL) scheme. B) Axial fast spin echo (FSE) T2-weighted images where we can see the ILL (arrow) extending from the transverse process of L5 to the posteromedial iliac crest.

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Fig. 2: Fig 2. A) Sagittal and B) axial T2-weighted fast spin echo (FSE) images where we can see the aorta bifurcation (arrow) located in L4. C) Sagittal FSE T2-weighted images. It shows the right renal artery (RRA) (arrow) located in L1-L2 disk space.

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Fig. 3: Anteroposterior and lateral radiograph of the entire spine.

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Fig. 4: Schema of Castellvi classification.

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**Fig. 5:** Volumetric reconstruction (VR) of lumbosacral transitional vertebrae (LSTV) type Ia.

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Fig. 6: VR of LSTV type Ib.

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Fig. 7: A) Anteroposterior (AP) radiograph of LSTV type IIb. B) VR of LSTV type Ila.

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Fig. 8: A) AP radiograph of LSTV type IIb. B) VR of LSTV type IIb. C) Coronal oblique reconstruction with maximum intensity projection (MIP) of LSTV type IIb. D) VR of LSTV type IIb.

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**Fig. 9:** VR of LSTV type Illa.

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**Fig. 10:** A) AP radiograph of LSTV type IIIb. B-C-D) VR of LSTV type IIIb.

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Fig. 11: VR of LSTV type IV.

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Findings and procedure details

We made a retrospective review of 31 patients with a suspicion of LSTV by MRI.

One of the variants we found was the presence of hypoplastic ribs, difficult to differentiate from hypertrophic transverse process, so in these cases it was necessary to count since C2.

In most cases the patients had previous radiographs, and only in patients where the information was not clear enough to reach an accurate diagnosis by MR a complementary MDCT was performed.

Moreover, MDCT is definitely superior to the MR in establishing the type of LSTV by Castellvi classification, and also in helping orthopedic surgeons to define the morphology of the anomaly where surgery is indicated.
Conclusion

LSTV can be difficult to diagnose by MRI, so it is important to bear this anatomical variant in mind to avoid misdiagnosis and the possible resulting consequences.

Nevertheless, MDCT and conventional radiograph are helpful tools when there is any diagnostic doubt.
References


